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Priority/Distance based Call Admission Control for High Speed Downlink Packet Access

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ABSTRACT
HSDPA defines a new High Speed Shared Channel (HS-DSCH) that can achieve peak data rates of up to 14.4 Mbps. Fast link adaptation, fast scheduling and fast HARQ (Hybrid ARQ) are some new features introduced in HS-DSCH to enhance system performance. Radio Network Controller (RNC) is still responsible for admitting new users; however the scheduling function has been shifted to the base station (Node-B) for fast adaptability to the channel conditions. HSDPA cell throughput increase over previous UTRA-FDD releases has been evaluated to be in the order of 50-100% or even more, highly dependent on factors such QoS provisions and the radio environment. Mostly adopted call admission control algorithms uses cell power as limiting factor with static 'Guard Power Offset'. We propose CAC based on distance/priority to maximize the system throughput. We also introduce the concept of 'variable' guard power offset based on past experience. Since users near to the node-B consumer less power, giving higher priority to such users at the time of admission leads to increase in admitted user and number of satisfied users. But cell capacity gain is at the expense of increase in number of unsatisfied users. Our results show that increase in satisfied users is higher than increase in unsatisfied users.

Keywords— **Call Admission Control, High Speed Downlink Packet Access (HSDPA), QoS, UMTS.**

I. INTRODUCTION
Third generation mobile communication systems are being driven by enhanced data access. WCDMA Release 5 introduced HSDPA (High Speed Packet Data Access) with a newish downlink transport channel HS-DSCH (High Speed Downlink Shared Channel) into 3GPP specification to improve capacity. Fast link adaptation, fast scheduling and fast HARQ (Hybrid ARQ) are some new features supported by HS-DSCH to enhance system performance. System throughput is increased along with improvisation in power utilization and shortening of retransmission time due to HS-DSCH. Users are getting benefited with high data rates of up to 14.4 mbps and that too with low latency. From operators perspective, the HSDPA is hoped to play a key role for the much longed for break-through of high quality mobile data services like live TV and multi-user online games. From a technical perspective, the HSDPA brings a new paradigm to UMTS: HSDPA adapts link quality to the radio channel conditions rather than adapting transmit power to the radio channel conditions. This enables a more efficient use of scarce resources like transmit power, code resources and also hardware resources [3]. All HS-PDSCH channels use a spreading factor (SF) of 16. A user can be assigned several such spreading codes to increase the throughput of a user. But this assignment of SF codes is limited by UE capability as some UE supports 5, some 10 and some 15. In principle only 16 SF codes are available in a cell, thus if system assigns 15 codes to single UE then cell will become code-limited as only 1 SF code is available for other users and other purposes, such as control channels.

Data services are likely to have colossal growth rate over next few years and likely become the dominating source of traffic load in 3G mobile cellular networks. Decrease in TTI length to 2 ms, physical layer H-ARQ transmission scheme and Adaptive Modulation and Coding (AMC) scheme have lead to theoretical high data rates of up to 14.4 mbps.

SYSTEM	GSM	GPRS	EDGE	3G (R99)	HSDPA
Typical max. data rates (kbits/s)	9.6	50	130	384	2048 (or more)
Theoretical max. data rate (kbits/s)	14.4	170	384	2048	14400

Instantaneous variations of the user's channel quality are being detected by packer scheduler at Node B. The increase in spectral efficiency and user data rates of HSDPA makes it feasible to fulfill the all service requirements of users. However, as the capacity is always limited, a well designed radio resource management scheme is required; where the Call Admission Control (CAC) plays an important role for efficient use of scarce radio resources [7].

Call Admission Control decides whether to accept a new connection request or not. CAC is a powerful tool which guarantees QoS by limiting the load entering the network and by verifying if enough resources are available to satisfy the requested performance requirements of a new call without penalizing the connections already in progress.

If only best effort traffic with no strict QoS requirements are transmitted on HSDPA, then the admission control algorithm can be made fairly simple by only checking the availability of RNC and Node B hardware resources to serve a new HSDPA user. If more demanding services with stricter QoS requirements are considered for HSDPA, then a more advanced admission control algorithm is needed to ensure that the QoS requirements for existing HSDPA users in the cell as well as the requirements of the new user can be fulfilled after the potential admission. In this paper the algorithm proposed is Adaptive Guard Power based Call Admission Control (CAC) in HSDPA which will increase the number of admitted calls while maintaining the satisfactions ratio (i.e. number of admitted users that do not experience actual QoS degradation).

This paper is organized as follows: in Section II we introduce Radio Resource Management in HSDPA, in Section III we derive call admission control scenario using adaptive guard power based CAC; and performance analysis and results are discussed in Section IV. Finally, our conclusions are presented in Section V.

II. RADIO RESOURCE MANAGEMENT IN HSDPA

In wireless networks resource management algorithms define the way the system assigns the scarce radio resources. In HSDPA, this management is made through algorithms located on the RNC as well as on the Node-B. In R99, transport channels are terminated at RNC whereas in HSDPA additional intelligence in the form of a Medium Access Control (MAC) layer is installed at Node B. This leads to faster re-transmission and thus shorter delay.

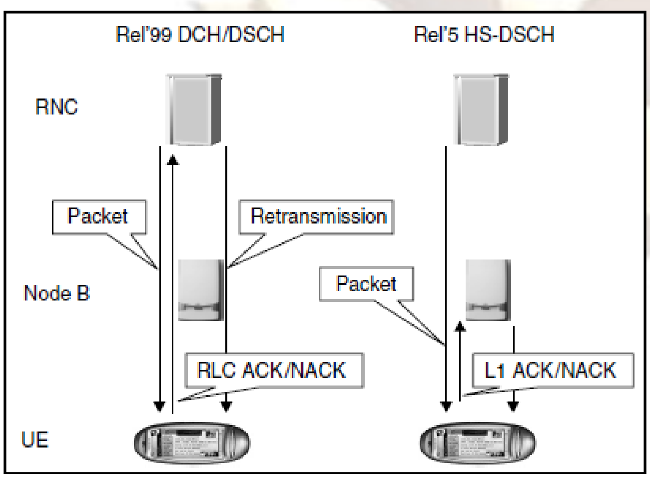

Fig.1 R99 and R5 HSDPA Retransmission Control

HSDPA admission control is different from the Release 99 dedicated channel (DCH) admission control algorithms, since HSDPA relies on a shared channel concept. Figure 2 shows a schematic overview of the most essential HSDPA RRM algorithms at the RNC and the Node B.

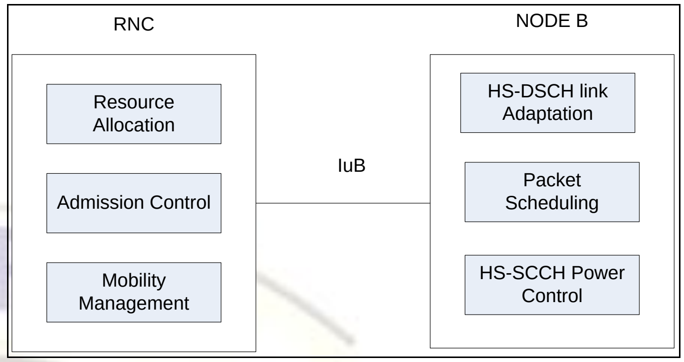

Fig.2 Most Relevant RRM algorithms

Power control algorithms decide the optimal amount of power that should be used to transmit signals between the Node B and UE. As the user moves from coverage area of one cell to coverage area of another cell, there is a need for user to be shifted from one Node B to another Node B which is taken care by Mobility Management. Admission control decided whether a new call or handoff call can be accepted or not based on amount of available power. High-speed shared control channel (HS-SCCH) power control is needed to minimize the power overhead while guaranteeing reliable reception. Finally, which user receives (or transmits) data at any given time interval is decided by packer scheduling algorithm (MAC-hs). TTI reduction from 10 ms in UMTS Rel'99 to 2 ms in Rel'5 (HSDPA) allows the packet scheduler to better exploit the varying channel conditions of different users. A well designed MAC-hs packet scheduler is able to maximize cell capacity while ensuring an attractive end user experience [5]. The 3rd generation partnership project only defines the interfaces and minimum UE performance requirements. Hence, network equipment manufacturers can individually design their Node B and RNC RRM algorithms according to market demands [5].

III. CALL ADMISSION CONTROL IN HSDPA

Call Admission Control (CAC) mechanism is essential to determine the level of adequate traffic load in a cell such that the minimum service requirements of users are guaranteed. In HSDPA, CAC also decides whether UEs will be served with HS-PDSCH or with the DCH. The admission control mechanism is situated at the RNC.

HSDPA adapts link quality to the radio channel conditions rather than adapting transmit power to the radio channel conditions. This enables a more efficient use of scarce resources like transmit power. Transmit power is key limiting factor in HSDPA and hence CAC is based on available power.

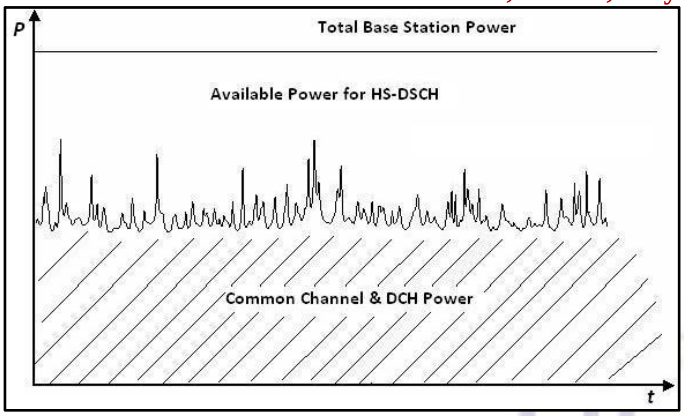

Fig.3 Base Station Power Distribution

Usually the base station (Node B) will contain a set of diverse transport channels, e.g. common channel (FACH and RACH) for voice services, dedicated channel (DCH) and HS-DSCH simultaneously. HS-DSCH can use the power which is leftover after satisfying common channels and DCH channels, as shown in figure 3. Thus, the available power of HS-DSCH is not a constant value and varies based on the channel conditions of other channels within base station.

RNC gets total average carrier transmit power and the non-HSDPA transmit power information from Node B. Using these two power measurements, RNC computes the amount of available HSDPA transmit power in the cell. HS-DSCH power required to serve all the existing HSDPA users in the cell with their guaranteed bit rates is also provided by Node B to RNC.

CAC process starts from new user requesting HSDPA access by sending Ec/N0 measurement report to the RNC on a common pilot channel (CPICH). Ec/N0 measurement is used by the RNC to estimate the HS-DSCH signal quality of the new user. Given these inputs– together with the user's QoS attributes – the RNC can calculate whether there is HSDPA capacity available to allow the new user access without violating the QoS requirements for the existing users in the cell. Finally, note that the non- HSDPA power measurement from the Node B can also be used for conventional power-based admission control of the Release 99 channels that coexist on the same carrier [5].

Here we are proposing a call admission control algorithm based on average CQI perceived by the user coupled with user's position. We are also modifying the way power offset value are calculated.

We use a priority/distance based HSDPA admission control algorithm, which is a modified version of [3]. In this approach a new user is admitted only if it can be served with its Guaranteed Bit Rate without degrading the QoS of all other users with the same or higher priority and with same or less distance. $P_{HSDPA,}$ total power available for HSDPA, is calculated at RNC using information provided by Node B. Average HS-DSCH power allocated to user *j* is estimated as

$$Pj = \frac{1}{N}\sum_{m=1}^{M_j} P'j(m) \quad (1)$$

where $P'_j(m)$ is the allocated transmission power in the m[th] TTI where the user was scheduled, and M_j is the number of TTIs user *j* was scheduled out of the N TTIs. When code multiplexing is used, we proportionally adjust $P'_j(m)$ according to the multi codes assigned to user *j* during that TTI. The average bit rate provided to user *j* over N TTIs is

$$Rj = \frac{1}{N*T_{tti}}\sum_{m=1}^{M_j} Bj(m) * Aj(m) \quad (2)$$

Here $B_j(m)$ is the transport block size (TBS) of the m[th] transmission to the user. Notice that it is not the actual PDU size that goes into the transport block. If the user does not have enough data to send then much of the transport block could be empty and the user will be experiencing a much less average bit rate than the provided bit rate. $A_j(m)$ = 1 if an ack was received from the user and zero otherwise. Given (1) and (2) the required power to provide all the users with their Guaranteed Bit Rate can be approximated as,

$$P(x) = Pj\,\frac{GBR_j}{R_j} \quad (3)$$

where GBR_j is the Guaranteed Bit Rate for user *j*. Now let the target bit rate and priority of the new user be denoted GBR_{new} and SPI_{new}. Let P_{new}, and P_{SCCH} be the estimated power required to serve the new user and the estimated power required for transmitting HS-SCCH respectively.

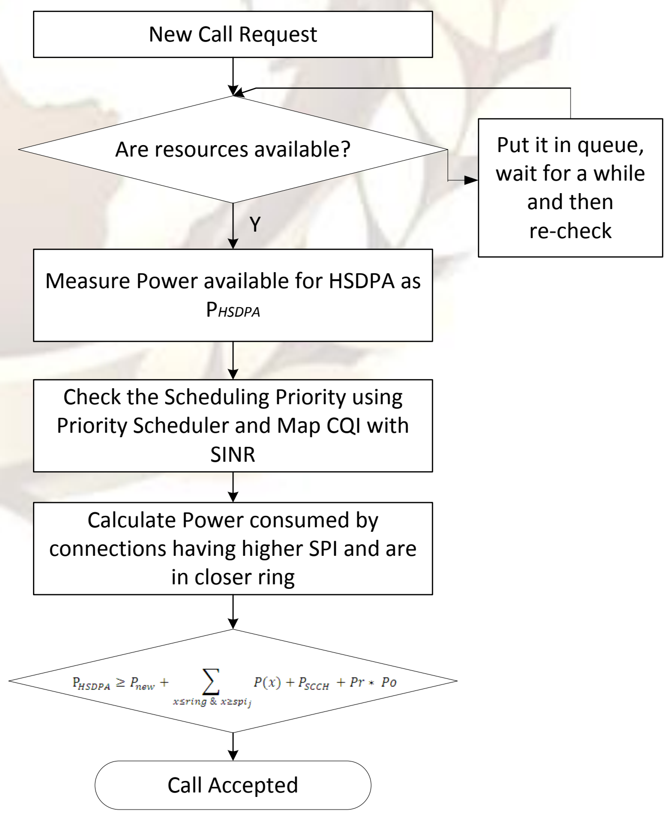

Fig.4 CAC Flow Chart

The new HSDPA user is admitted only if

$$P_{HSDPA} \geq P_{new} + \sum_{x \leq ring\ \&\ x \geq spi_j} P(x) + P_{SCCH} + Pr * Po \quad (4)$$

Here *Po* is safety power offset to compensate for potential estimation errors and to compensate for degradation in channel conditions. More power is required if channel conditions degrade to provide the same bit rate. First required power is calculated for each user with *n* CQI as degradation based on past performances and then it is summed up for all the connections to arrive at *Po*. *Pr* denotes the probability that all connections experience channel degradation at the same time.

IV. PERFORMANCE ANALYSIS AND RESULTS

A matlab program has been written to implement the above mentioned CAC. Although HSDPA power varies according to other loads, we have taken instantaneous HSDPA power as 10 Watts. System is having 13 users with three different priorities viz. 1, 2 and 3. We have divided the service area into three rings and have assigned priorities to each ring. UEs within 100m will have higher priority than UEs which are farther away. Similarly UEs between 101m and 200m will have higher priority than UEs which are farther away. UEs which are more than 200m away will have the least priority. Power consumer by control channel is estimated as 0.45 watt. Power offset is estimated at 32 dBm based on channel conditions.

Case I:
New user is 50m away from base station is requesting access to the HSDPA channel. Power requirement for the new user is estimated as 24dBm based on instantaneous channel conditions. New user is having priority as ‘2’.

New user is allowed to access the channel as power consumed by users with equal and higher priority and which are situated within the same ring as new user or in the nearer ring summed with power to be consumed by new user is 2.7885 watt, which is less than available 10W power. But this comes at the expense of lower bit rates for users which are farther away and having lower priority.

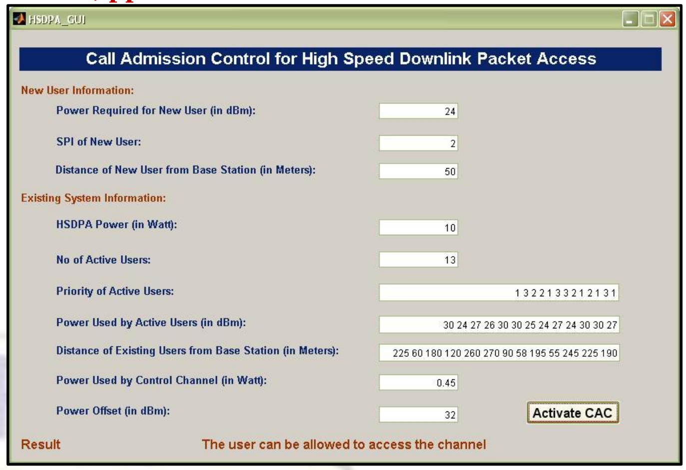

Fig.5 Practical Application of Priority/Distance based CAC

Case II:
New user is 250m away from base station is requesting access to the HSDPA channel. Power requirement for the new user is estimated as 30dBm based on instantaneous channel conditions. New user is having priority as ‘3’.

New user is not allowed to access the channel as power consumed by users with equal and higher priority and which are situated within the same ring as new user or in the nearer ring summed with power to be consumed by new user is 11.0064 watt, which is higher than available 10W power.

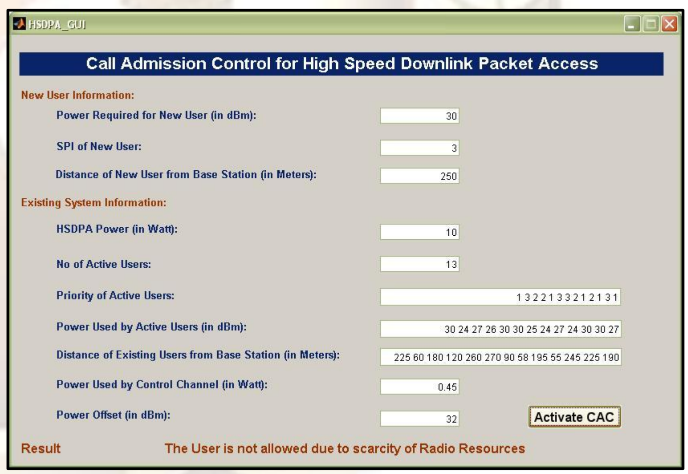

Fig.6 Practical Application of Priority/Distance based CAC

By considering user’s location for admission control we are able to increase the number of admitted users and number of satisfied users. This is due to the fact that UEs which are nearer to base station consumer less power than UEs which are farther away. But this comes at the expense of increase in number of unsatisfied users. But here we need to keep in mind that increase in satisfied users will be far higher than increase in unsatisfied users, especially when higher input parameters are considered.

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V. CONCLUSION

We have investigated the performance of our priority/distance based call admission control for HSDPA. Our results show that this CAC increases the number of admitted users and hence increases the throughput of the system. It also increases the number of satisfied users. System throughput is increased at the expense of increase in unsatisfied users which are farther away from the base station. To be fair to the users which are away from base station, we can divide the base station power equally into two parts. One part uses CAC based on user priority and other part uses CAC based on user's location.

REFERENCES

[1] Gustavo Florido, Fidel Liberal, "Network protocols and algorithms,"*ISSN 1943-3581,2009,Vol.1,No.1*.

[2] Joseph S. Gomes, Hyeong-Ah Choi, Jae-Hoon Kim, JungKyo Sohn, Hyeong In Choi, "Integrating Admission Control and Packet Scheduling for Quality Controlled Streaming Services in HSDPA Networks", *4th International Conference on Broadband Communications, Networks and Systems*, BROADNETS 2007 Raleigh, North Carolina,US.

[3] Dirk Staehle and Andreas Mader, "A model for time-efficient HSDPA simulation", *1-4244-0264-6/07 IEE*E, 2007,pp no-819-823.

[4] David Soldani, Man Li and Renaud Cuny, *QoS and QoE management in UMTS cellular systems*(John wiley and Sons,2006).

[5] Harri Holma and Antti Toskala, *HSDPA/HSUPA for UMTS: High Speed Radio Access for Mobile Communications* (John wiley and Sons,2006).

[6] Harri Holma and Antti Toskala, *WCDMA for UMTS:High Speed Radio Access 3rd Generation mobile communications 3rd edition*(John wiley and Sons,2004).

[7] Mario Marchese, "QoS aware Heterogeneus Networks ," pp no.46.

[8] K. Pedersen, "Quality based hsdpa access algorithms," *IEEE 62nd Vehicular Technology Conference,* 2005, pp. 2498– 2502