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Quality of service improvement, Handoff Prioritization and Channel utilization for Cellular Network

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ABSTRACT
In this paper Call admission control (CAC) is a significant component in wireless networks to promise quality of service requirements and also to improve the network flexibility. The reliability is measured in terms of quality of service (QoS) and grade of service (GoS). GoS is a call-level factor, which comprises of a new call blocking probability and handoff call blocking probability. So a robust Call Admission and Power Control Mechanism are desired. An admission control method considering the quality of service (QoS) requirements is accountable for deciding whether an incoming call/connection can be accepted or not. One major challenge in designing a CAC creates due to the fact that the cellular network has to service two major types of calls: new calls and handoff calls. The QoS performances related to these two types of calls are generally measured by new call blocking probability and handoff call dropping probability. Our work advance the dropping and handoff loss probabilities and present a coherent framework for comparative studies of presented approaches, but also helps future researches and developments of new call admission policies.
***Keywords* -** 3G, CAC, GoS, Quality of service.

I. INTRODUCTION

In cellular mobile networks, there are two major issues data rate and mobility, bandwidth and coverage, according to these two issues we can divide network technologies into two different technologies.

1. The technologies with low data rate and mobility.
2. Technologies with high data rate and bandwidth with small coverage.

The next generation wireless networks are expected to support multimedia traffic such as voice, data and video, which request different bandwidths and quality of service (QoS) requirements.

The main aim of this work is: Survey causes of unsuccessful Call Admission and Resource Allocation over WCDMA networks. Study the performance of current schemes and identify areas for enhancement. Introduce and develop enhancements to the existing schemes to further reduce loss rates and further prioritize services according to user requests.

- Cut dropped handoff calls.
- Advance the quality of service (QOS) by reducing Grade of service (GOS)
- Our work will reduce call dropping probability.
- Our work will reduce New call blocking probability
- Introduce and develop improvements to the existing schemes to further reduce loss rates and further prioritize services according to user requests.
- Call admission control (CAC) schemes admit users only if it can maintain a minimum signal quality to admitted users (including the new call and existing calls).

1. PRIORITIZATION SCHEMES

One way to reduce the handoff failure rate is to prioritize handoff. Handoff algorithms that try to minimize the number of handoff give poor performance in profound traffic situations. In such situations, a major handoff performance improvement can be obtained by prioritizing handoff. Two of the most important parameter for calculating the handoff processes are forced termination probability and call blocking probability. An ideal handoff is one in which forced probability reduces while maintaining blocking probability. In non prioritization scheme new call and handoff calls are treated in same way, leading to increases in the forced termination probability. Prioritization scheme reduce the forced termination probability by assigning more channel to handoff calls. The two known prioritization schemes are: Guard channels and Queuing of handoff calls.

1.1 GUARD CHANNELS

In this scheme some of the total available channels in a cell are reserved for handoff calls only. Hence, less no of channels are available for originating call. This process increases the call blocking probability. However, Guard channel scheme provide better spectrum utilization under dynamic channel assignment strategies.

1.2 QUEUING HANDOFF

Queuing schemes queues the handoff calls when all channels are engaged in a base station. When a channel is free it is assigned to one of the handoff calls in queue. Queuing is done due to time interval between handoff initiation and receiver threshold.

2. CALL ADMISSION CONTROL IN MOBILE WIRELESS NETWORKS

Call Admission Control (CAC) is defined as a system for managing arriving traffic, at the call, connection or session level based on some predefined criteria. A CAC scheme either admits, rejects or delays the incoming calls based on a criteria to achieve some QoS objectives for new and existing users.

The call admission control algorithms decide whether a call should be either accepted or rejected at the base station and assign the required channel(s) to the accepted call. This results in a distributed call admission control strategy which can be applied to each base station. At whatever time a new call arrives, the call admission policy accepts the call as input and based upon the current traffic conditions of network, decides whether or not to accept the user.

A good call admission control algorithm must have the following features in order of importance.

1. Maximize channel utilization in a fair manner to all calls.
2. Minimize the dropping probability of connected calls.
3. Minimize the reduction of the QoS for the connected calls.
4. Minimize the blocking probability of new calls.

II. QUALITY OF SERVICE

The term QoS refers to the capability of a network to provide better service for selected network traffic over various technologies. The primary goal of QoS is to provide priority, including dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics.

1.1 CHANNEL UTILIZATION

The channel utilization depends on the total traffic, λ_t and is given by

P = Traffic intensity / number of channel

1.2 CALL ARRIVAL RATE

Call arrival rate, λ_t, refers to the traffic offered expressed as the number of call attempts per unit time [1], which in this case is given as:

λ = number of call attempts per busy hour / 14400 second per busy hour

To relate call arrival rate to the performance of a network, the term grade of service (GOS) denoted by B is used. The GOS can be mean proportion of time for which congestion exists, or probability of congestion or blocking probability, or probability that a call will be dropped due to congestion. It is defined in as:

$$GoS = \text{Traffic lost} / \text{Traffic offered}$$

In general, $GOS = A - A_0 / A$

Where,

A= offered traffic

A_0 = carried traffic

$A-A_0$ = lost traffic

$$GoS = \alpha * P_{hb} + P_{nb} ;$$

Where,

α = 10, Which indicate Priority level from handoff call to new call

P_{hb} = Handoff blocking probability

P_{nb} = New call blocking probability

It is obvious that drop call-probability differs inversely with call arrival rate, that is, drop-call probability reduces as call arrival rate increases.

1.3 LOAD COMPUTATION

CAC algorithm computes the increase in the load as given by,

$$\Delta\eta i + \eta \leq \eta Thr.i$$

Where,

Load factor increment for new User = $\Delta\eta_i = \eta$Thr. *I:* uplink threshold load then arrived call can admit to enter the target cell, otherwise arrive call is queued or rejected based on queue available.

1.4 CALL DURATION

Call duration is another parameter that can affect the quality of service in a cellular network, hence it is considered when planning the network. Call duration or mean call holding time is defined as the time a mobile station takes to complete a call connection. Mathematically, call duration is given by:

$$H = A / \lambda$$

Where,

A = traffic intensity in Erlangs,

λ = call arrival rate

Thus call arrival rate varies with call duration the same way it varies with drop-call probability. Thus drop-call probability increases with a decrease in call duration.

1.5 DROP-CALL PROBABILITY

Drop-call probability is given by

$$P(Y = n) = \frac{(v_d t)^n}{n!} e^{-v_d t}, \quad n \geq 0$$

Where,

v_d is the drop-call rate,

t is the call duration,

Y is a random variable that counts the number of drops and

n is the confirmed calls dropped.

This is a Poisson Probability function with a discrete variable which counts the number of dropped calls
Drop call rate = Number of dropped call / number of call attempt
The probability of occurrence of the call dropping event (drop-call probability) is based on the above formula.

III. BASIC IDEAS OF QOS PROVISION

QoS has become an important issue both in fixed and in wireless networks, mostly due to the requirements of today's multimedia applications. In wireless networks, QoS requires even more attention than in fixed networks. This is because of the different nature of the physical medium – the wireless channel is significantly more error prone than a fixed one.
Introduction of wireless access to the network brings at least the following new technical challenges:
• Quality of the wireless channel is typically different for different users and changes randomly with time on both slow and fast time scales.
• Wireless bandwidth is usually a scarce resource that needs to be used efficiently. One cannot overprovision to the wireless link).
• An excessive amount of interference and higher used efficiently. One cannot overprovision the wireless link). Error rates are typical.
• Mobility complicates resource allocation.
The data transfer in a wireless access network should be reliable, which means that the error rate should be as low as possible.

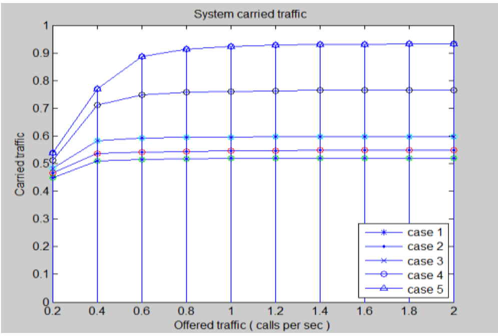

Figure 1: System Carried traffic

From these figures, it is clear that the performance improves as use the queue and the soft guard channel. Also, as the channel holding time decreases (for example mobility increases) the system performance increases. So as the service time decreases the waiting calls will have better chance to get the channel before they timed out. It is clear that our proposed algorithm has better system capacity and this improvements increase as channel holding time decreases.

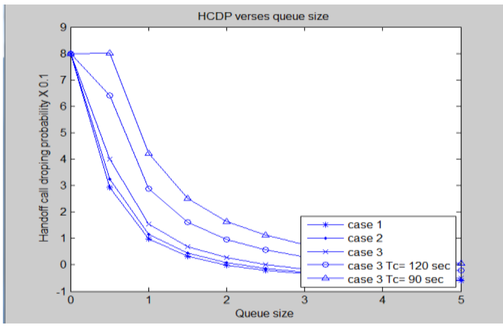

Figure 2: Handoff call droping probability with increase in queue size

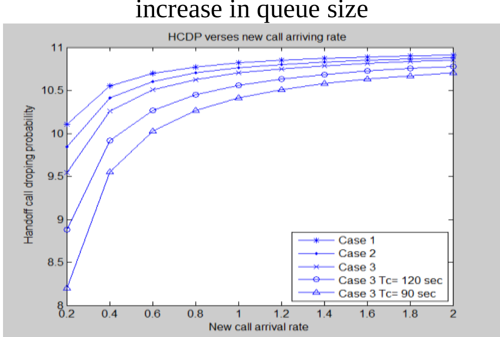

Figure 3: Handoff call droping probability verses new call arrival rate

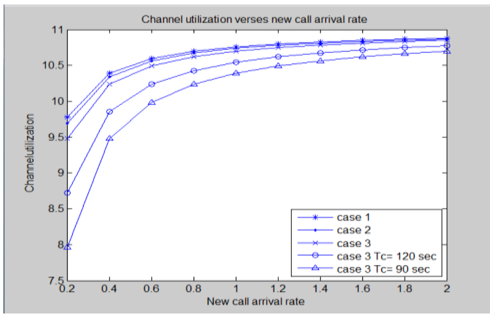

Figure 4: Channel utilization verses new call arrival rate

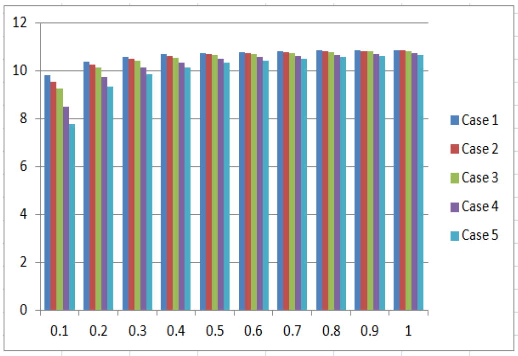

Figure 5: Graphical analysis of Data GoS vs. offered data calls/sec.

In simulation we consider the following five Cases:
* Case 1: All call services classes (new calls and soft handoff calls) are treated equally where they have the same load threshold and no queuing is used.
* Case 2: Same as 1, and in addition to that, the handoff calls are allowed to be queued till the resource is available or the time out is reached.

∗ Case 3 (proposed algorithm): Same as 2, and in addition to that, the handoff calls have higher load threshold than new calls.

∗ This Case is repeated using different channel holding times. Average service time for all services is 180 seconds.

∗ Arriving rates of all services are changed. Case 3 is repeated using different service times (120s and 90sec).

IV. Conclusion

Call admission control is a very important measure in CDMA system to guarantee the quality of the communicating links. In future wireless networks multimedia traffic will have different QoS requirements. In this paper, the uplink capacity and load estimation formulas is formulated. Then, a prioritized throughput based uplink call admission control algorithm for a WCDMA cellular system with perfect power control is presented. To give priority to soft handoff calls, we introduce queuing techniques and the idea of 'soft guard channels', which is represented by reserving a small fraction of the cell load for the higher priority calls.

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