ANALYSING OF OPTIMIZING CALL ADMISSION IN CELLULAR NETWORKS USING EVOLUTIONARY ALGORITHM

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Abstract- *The wireless cellular network had undergone a phenomenal growth in terms of number of mobile users in the last decade. In modern telecommunication era, the scarce resources and the constraints in using them drives the technocrats to optimize the use of available resources to the maximum extent possible. Incredibly, the demand for bandwidth is ever increasing to the far end. By exercising priority based services, the burst arrival of calls is limited and hence the congestion in the network is controlled. This enhances offering trusted QoS to the users without compromising the resource allocation to the existing users. The proposed algorithm provides guaranteed QoS to both new calls and handoff calls. When the requested resource is not available, instead of denying the handoff call request the call is buffered. Proposed Evolutionary Handoff Algorithm (EHA) permits the new calls and handoff calls to share the cell capacity while maintaining certain access priority to handoff calls.*

Keywords *– Handoff, Cellular network, Call blocking probability, Call dropping probability*

1. Introduction

In the current scenario, the demand for wireless resources has increased enormously due to the drastic increase in the number of Mobile Users (MU). In wireless cellular network, the availability of network resources is limited which lags to meet the requirements of a MU. The MU has the freedom to move anywhere, anytime randomly; the user may move to different cells after establishing the link to the called party. An efficient bandwidth allocation algorithm is required at this point of time, in order to maximize the system utilization.

The Call Admission Control (CAC) decides to accept or deny the incoming call to a cell, while the Bandwidth Management algorithm assigns available resources for different types of calls in a network. Fulfillment of QoS requirement of a MU is a critical and very important practical issue. It is equally important to limit the call failures to the minimum, and there is a compromise between QoS satisfaction and network utilization now that the network resources are not developing in proportion with the number of MUs.

2. Related Works

A comprehensive survey is conducted to study the related works and researches.A mathematic al model to characterize different mobility-related traffic parameters in cellular systems was developed. The distribution of the cell residence time[2] of both new and handover calls, channel holding time, and the average number of handovers. (Pubudu et al 2004) provided mobility estimation and prediction for a variant of the Global System for Mobile Communication (GSM) network that resembles an ad hoc wireless mobile network in which base stations and users are both mobile.

A study of channel occupancy times and handoff rates for mobile computing is presented [4]. The channels occupancy times are found to be exponentially distributed and call traffic is Poisson if and only if the cell residence times are exponentially distributed. Jamie and David Everitt (1999) developed product form traffic models for single- and multiple-cell Code-Division Multiple-Access (CDMA) networks with multiple classes of mobile subscribers.

Anum et al (2010) derived a set of algebraic equations that examines the relationships between cell dwell time and residual cell dwell time as well as between cell dwell time and channel holding time. Nandhakumar et al (2011) analyzed the handoff mechanism based on the received signal strength from two base stations. Based on load status of the cells, handover algorithm is presented. Jian Ni et al (2007) investigated two CAC policies reservation and threshold policies. A fast and efficient search algorithm to determine the parameters of the structured policies is developed here. Samya Bhattachariya (2008) proposed an analytical model for channelized cellular mobile circuit switched systems. A 2D Markovian chain applicable for dynamic channel allocation scheme is developed to compute congestion for all kinds of traffic schemes. Jiogkuan Hou and Yuguang Fang (2011) presented a mobility based call admission schemes and new call bounding schemes for wireless mobile networks providing services to pedestrians and vehicular travelers.

Thuy Van and Dinh Que Tran (2012) proposed the Data mining technique to investigate the spatial and temporal attributes of data and apply a spatiotemporal to discover frequent mobility patterns for predicting the next location of the mobile node. Haitham Abu Ghazaleh (2010) proposed the Markov Renewal Process (MRP) which is used for the both mobility modeling and predicting the likelihoods of the next cell transition, along with anticipating the duration between the transitions, for an arbitrary user in a wireless network. A new Call admission control algorithm[1] to reduce New Call Dropping Probability (NCDP) and Handoff Call Dropping Probability (HCDP) using back propagation algorithm.

3. Evolutionary Handoff Algorithm

In the conventional Blocked Calls Cleared (BCC) system, the total available channels are shared by both the Hand Off (HO) calls and New Calls as shown in Figure 1. As the Received Signal Strength(RSS) of the connected BS fall below the threshold level, the MU scans for the target BS.

If the RSS of the target BS is above the threshold, the MU gets connected with the target BS before the time gets lapsed.

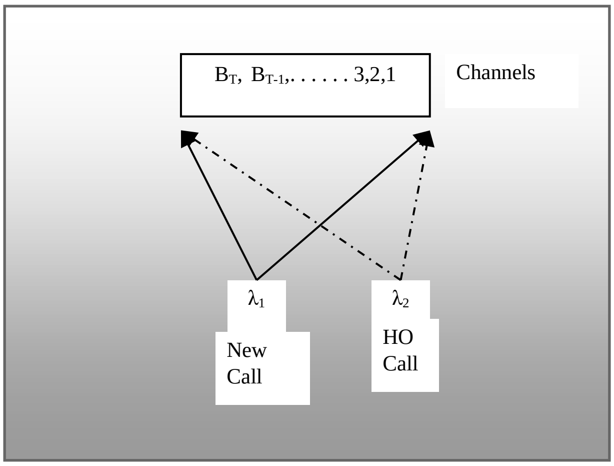

Fig 1 Non Prioritized CAC

Now, CAC allocates channel to the handoff mobile user. In conventional CAC scheme, priority is not assigned to the handoff MUs. The available channels are shared between both HO calls and new calls. So, the call failures are not kept in control.

The state transition diagram for the system shown in Figure 1is given in Figure 2.

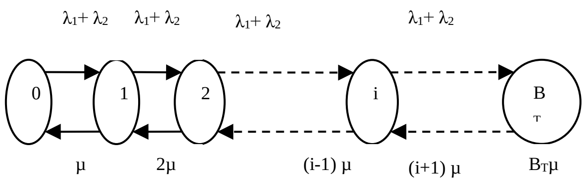

Fig 2 State transition diagram of non-priority scheme

The HO call should be treated in a unique manner, so that the handoff failures are reduced to a minimum possible level. A homogenous cellular system is assumed in this work. The number of channels allotted to each cell which is served by a BS is fixed. They are allocated to new calls and handoff calls distributed. The following are the assumptions made in the system

i) The call arrival in a cell is Poisson process. The new call arrival rate is λ_1 and handoff call arrival is λ_2.

ii) The service time for the new calls and handoff calls is μ_n and μ_h respectively.

iii) The priority is given to HO calls than new calls.

iv) The HO buffer (C_{HC}) capacity is varies according to the traffic.

v) The total available Bandwidth (BW) is N.

vi) Channels reserved for Handoff calls are B_H.

vii) The remaining channels available for new calls is

$$B_N = N - B_H$$

viii) The maximum channels required for a MU is B_{max} and minimum channels required is B_{min}.

ix) The network is said to be saturated only if all N is occupied.

x) Priority to HO is based on dwell time τ_d.

xi) The HO call in queue Q_H is dropped if the channel is not available before the lapsed time τ_e.

xii) The dwell time of MU in handoff area is $\mu_{\tau d}$

Here, out of N channels, B_H channels are exclusively reserved for HO calls. The HO calls are blocked if and only if,

$$B_{H,req} > N \qquad (1)$$

The new calls are blocked if

$$B_{n,req} > N - B_H \qquad (2)$$

The HO calls are queued if the requested channels for HO are not available in reserved channels. The algorithm starts executed in the overlapping cell area

If any of the channels is released before the HO in queue gets lapsed, the channel is allocated to HO call. If not the call is dropped. The call will be forced terminated if the new BS signal strength is very low, so this CAC is triggered in the overlapping area of a cell to overcome the drawback.

Figure 3 shown the channel allocation for the proposed model. The number of channels in the network is i=0,1,2,. . . .∞. The equilibrium probability is P(i), where

$$\sum_{i=0}^{B_T} P(i) = 1 \qquad (3)$$

The balance equation of the system shown in Figure 4 is

$$P(1) = \frac{\lambda_1+\lambda_2}{\mu} P(0)$$
$$P(2) = \frac{\lambda_1+\lambda_2}{2\mu} P(1) \qquad (4)$$

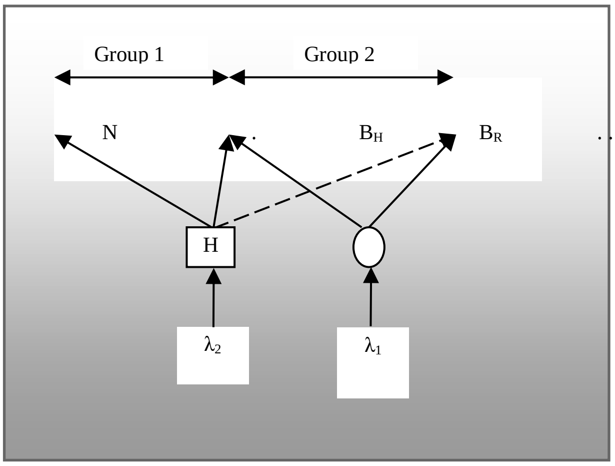

Fig 3. Channel allocation in buffering scheme

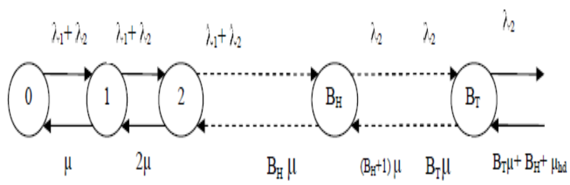

Fig 4 State transition diagram of queuing scheme

The equilibrium probability is

$$P(i) = \frac{\lambda_1+\lambda_2}{i!\mu} P(i-1) \quad 0 \le i \le B_H \qquad (5)$$

$$P(i) = \frac{\lambda_2}{i\mu} P(i-1) \qquad B_H < i \le N \qquad (6)$$

$$P(i) = \frac{\lambda_2}{[N\mu+(i-N)(\mu_n+\mu_{\tau d})]} P(i-1) \qquad N < i \le \infty \qquad (7)$$

The blocking of new call happens if all ($1 \le i \le B_H$) channels are occupied.

When handoff calls are queued and when no free channels are available, the probability of blocking of the handoff call is determined as

$$B_{hq} = \left(\frac{b_2}{N}\right)^{M_2} Q_q(0) \qquad (8)$$

M_2 is the handoff call queue size

$$b_2 = \lambda_2/\mu \qquad (9)$$

and

$$Qq(0)=1/N!\sum_{i=0}^{N-1}\frac{a^{i-N}}{i!}+\frac{1-\left(\frac{b1}{N}\right)^{M2+1}}{1-\left(\frac{b1}{N}\right)} \quad (10)$$

The capacity $M_2=C_{HC}$ of Q_{HC} is large enough so that blocking probability of the handoff call is negligible. If there are N numbers of sessions in a cell, and a user wants a connection, if channels are not available the user's request for the connection will be blocked or denied by the system. As a result, a request for connection may be dropped i.e., a user has to initiate a new request for a connection next time, or may be queued i.e., the system is keeping the request in hold and waiting for a channel to be free.

The handoff calls are queued instead of rejecting them if the new cell is busy. The queuing of the moving calls is not needed if the arrival of handoff calls is uniform.

The blocking probability for new call when queuing is done only for handoff call:

$$B_o = \left[\frac{1-(\frac{b_2}{N})^{M_2+1}}{1-(\frac{b_2}{N})}\right] Q_q(0) \quad (13)$$

The handoff calls are blocked if all the channels are occupied, irrespective of the reserved channels. When the handoff call arrives, it scans for availability of channels. If the channel is available the call is accepted. If not, the call is placed in the queue with priority set.

4. Genetic Algorithm for channel allocation

Genetic Algorithm(GA) is also referred as search algorithm. Here GA is used to find the appropriate call for along a channel under demanding situation. The handoff calls are queued based on the priority of the calls. The call which needs a channel is selected based on the fitness function. GA based channel allocation finds number of possible channels to the user. The GA is structured as below:

1. Collect the MUs information such as location ID, time, User ID from HLR of the serving BS
2. Train the prediction algorithm with the information in step 1
3. BS starts identifying the calls need of channel
4. Generate Population
5. Evaluate fitness function
6. Find Fitness Function with maximum value
7. Select Chromosomes with high fitness value
8. Perform Crossover for the selected chromosomes
9. Form new generations
10. Repeat step 5,6, 7,8,9
11. Select chromosome with high fitness value
12. Decode the selected chromosome to find the exact position of the MU

The proposed algorithm is given in Figure 5. The algorithm sets low priority to the calls holding the channel for a long duration. So, when a new call arrives to the network, the priority of buffering is made based on the channel occupancy time.

When Call arrives

1. Check call arrival is a new call or a handoff call,
2. If it is a new cal, check for channel availability
3. If channel is available, the call is accepted
4. If channel is not available, then the call is rejected
5. If the arrival is a handoff call, if channel is available, the call is accepted, else
6. The call is put in a queue
7. Fix priority based on the channel holding time
8. If channel holding tome is long, low priority is fixed.
9. Else high priority is fixed
10. Set waiting time for the call in buffer
11. Apply GA to select the call to assign channel
12. Check channel availability
13. Repeat steps 4 to 11

Figure 5 Channel allocation for buffered calls

The algorithm proposed here tries to find the channels before the buffer waiting time gets lapsed. If the channels are not available before this time, the handoff call anyway, will be rejected. But, the rejection of handoff calls is reduced in this algorithm when compared to the existing non priority algorithm.

5. Results and Discussion

The performance evaluation for the proposed system is done in terms of reduced call failure and better channel utilization. The simulation parameters considered here are the call arrival rate and the number of channels available for new calls and handoff calls, HCDP, NCBP. The simulation parameters used here are number of users, velocity of users, accuracy and training set. The number of users is 100, training set is 250. Different classes of users validated here are slow velocity, average velocity, and high velocity travelling users. The Table 5.6. exemplify the simulation environment considered

Table 5.6 Simulation parameters

Description	**Value**
Dimension of cell	1000 * 1000
Bandwidth	2 MHZ
No. of Users	100
Training set	250
Classes of users	Average variable velocity, constant velocity, very high velocity
Optimum prediction accuracy of conventional method	
Uniform User	70%
Random User	30%

The algorithm proposed in this paper studies the performance of network under two scenarios. Normally, when a call arrives, it checks for the channel availability. Conventional algorithm suffers sever call failures. The algorithm designed in this research, overcomes this drawback.

Figure 6 compares the blocking of new call request of the proposed algorithm with the conventional method. The blocking of new calls is reduced when compared to conventional method of call acceptance. The network is capable of accepting the new call arrival rate of 60 calls. In the conventional method, the blocking of call starts at the arrival rate of 50 calls itself. The network is incapable of accepting the estimated traffic.

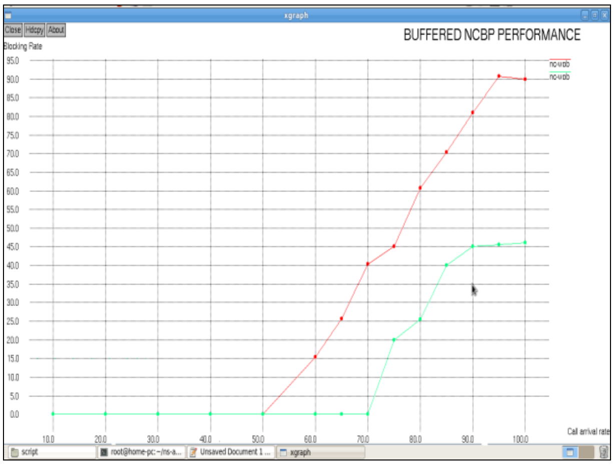

Fig 6 NCBP Performance

Figure 7 shows the probability of denying a handoff call request. The algorithm is triggered, when the MU crosses the cell boundary and it is in the overlapping area. So, the channel would be available before the call gets expired. Form the result, it is understood that more number of active ongoing users get uninterrupted service. So, the customer satisfaction achieved is better in this scheme. This algorithm thus provides “make before break” service for the handoff users.

The channel utilization is also better in the proposed scheme. Since the call failures is kept controlled, the available resources is utilized efficiently and effectively. This is evident form Figure 8.

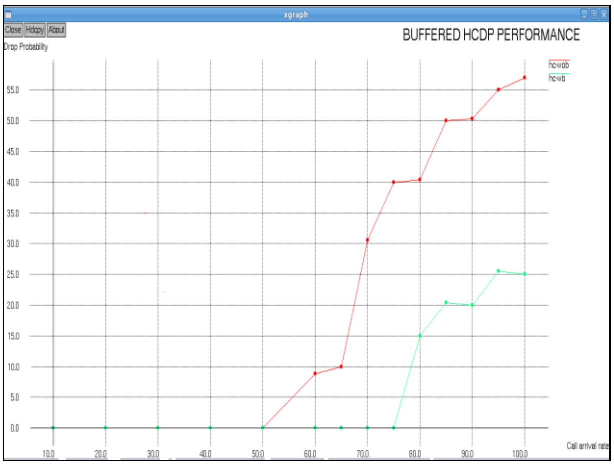

Figure 7 HCDP performance

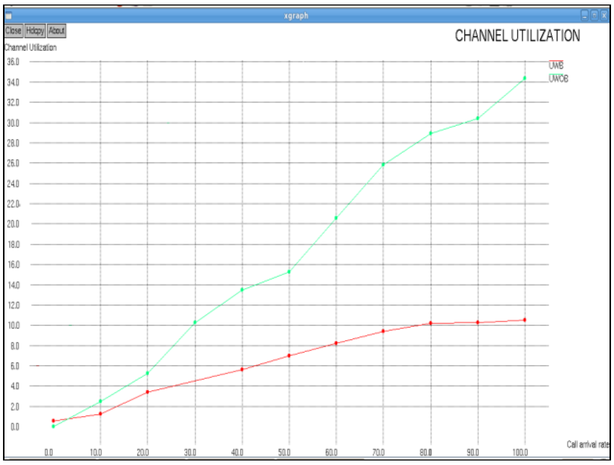

Figure 8 Channel utilization in buffering scheme

Through analysis and simulation it is shown that, the proposed algorithm helps in reserving the channels for the guest users.

6. Conclusion

In this paper, a solution for reducing the call failures is proposed and analyzed. A comparison with the existing CAC algorithm is made and found that the proposed algorithm works better in terms of system utilization. This scheme enables a prioritized CAC by extending the static guard channel policy.

Table 1 Performance comparison

Parameter	Conventional Scheme	EHA
New call arrival rate	80	80
HO arrival rate	80	80
Blocked call rate	62	25
Dropped call rate	41	15
Channel utilization Improvement	10 %	29 %

Table 1 compares the performance of the conventional algorithm and the proposed algorithm. In the proposed scheme, large number of calls could be accepted since the calls are buffered and the channel is allocated by selecting the buffered call using GA when no channels are available instead of denying the request.

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