Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 158 (2019) 295–302

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd World Conference on Technology, Innovation and Entrepreneurship (WOCTINE)

Priority Management of the Handoff Requests in Mobile Cellular Networks

Messaoud Garah[1, 2,*], Houcine Oudira[1, 2]

[1]*University of Mohamed Boudiaf M'Sila, 28000, Algeria*
[2]*Laboratory of electrical engineering, M'Sila, 28000, Algeria*

Abstract

Due to the motion of mobile station with respect to the base station, the handover is required frequently in the communication process. In this paper, assuming that the user location and speed can be determined, we propose a suitable scheme for managing a queuing of handover requestes in wireless cellular network. The principle of the proposed method is the use of a separate queue for each transceiver in the cell (3TRX per cell) instead of using a single one and we consider that handover request to cell is queued with dynamic priority discipline; highest priority (head of the queue), least priority (joins the end of the queue). Fixed channel allocation is considered and call blocking probability (CBP), handover failure probability (HFP) are obtained as a results. In order to choose the best model which reduces significantly the handover failure probability, a comparison between the proposed model and the classical one is considered. Simulation results highlight that the newly proposed architecture can guarantee superior performance with respect to its competitor.

Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship

Keywords: Handover; Queue; FCA; residual time;

1. Introduction

In wireless terrestrial cellular network such as GSM, where microcells are used, the handover procedure has a significant impact on the system. More requests of handover are created when the users are in motion, a call of a fixed or mobile user can be transferred from a BTS to another since the call in progress cannot profit a suitable channel of communication in the current cell [1-2], handover establishes the transfer of communication connection of the current channel to another.

* Corresponding author. Messaoud Garah E-*mail address:* messaoud.garah@univ-msila.dz

Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship
10.1016/j.procs.2019.09.055

Studies have shown that one of the most important user concerns is that service not be cut off during an ongoing call. To this purpose, two types of handover events, the tranciver handover and the BTS handover, are studied. The first one refers to the transfer of an ongoing call from one tranciver to the next one in the same BTS , while the second one describes the transfer of an ongoing call from a BTS to another one.

Few studies have been carried out on the issue of handover, investigating channel allocation policies for new and handover requests using mainly fixed channel allocation (FCA) techniques.[3-6], In this paper, as the handover failure of the call is less desirable than the rejection of a new connection we are interested only in schemes that prioritize handover request in particular handoff queuing schemes.

For this aim several studies have been performed and various strategies of the handover requests priority on the new call have been proposed [7-9]. In the above references the proposed model for optimization of the handoff procedure uses a separate queue for each transceiver (TRX) of the same cell and the total number of channels is shared equal to the transceivers. Thus, the service discipline for queued handovers is assumed to FIFO discipline. In this paper, assuming that the user location and speed can be determined , we propose a suitable scheme for managing a queuing of handover requestes in wireless cellular network. The principle of the proposed method is the use of a separate queue for each transceiver in the cell(3TRX per cell) instead of using a single one, and we consider that handover request to cell is queued with dynamic priority discipline; highest priority (head of the queue), least priority (joins the end of the queue). Fixed channel allocation is considered and call blocking probability (CBP), handover failure probability (HFP) are obtained as a results.

In order to choose the best model which reduces significantly the handover failure probability, a comparison between the proposed model and the classical one is considered. This paper is organized as follows: Section 2 and 3 describes a discussion of FCA queuing analysis scheme. Section 4 presents a detailed description of the proposed scheme, Section 5 presents the simulation results and discussions. Finally, main conclusions are draws in the last Section.

2. Handoff schemes in single traffic systems

In the coming section, we introduce some traffic models which are widely used, then we describe the queuing handoff schemes for a single traffic system such as voice or data system. We assume that a system has many cells, and each has S channels. The channel holding time have an exponential distribution with mean rate μ. Both originating and handoff calls are generated in a cell, respectively with mean rates λ_O and λ_H. We assume the system with a homogeneous cell. We concentrate our interest on a single cell (called the marked cell).

2.1. Traffic model

Many traffic models have been established based on various assumptions about user mobility. In the coming subsection, we briefly introduce some of these traffic models.

2.1.1. Hong and Rappaport's Traffic Model (Two-Dimensional)

Hong and Rappaport [10] have proposed a traffic model. They assume that the mobile users (MU) are spread evenly over the service area; thus, the location of MU when a call is initiated is uniformly distributed in the cell.

They also assume that a MU initiating a call moves from the current location in any direction with equal probability and that this direction does not change while the MU remains in the cell. From these assumptions the arrival rate of handoff call is given by:

$$\lambda_H = \frac{P_h\left(1 - B_O\right)}{1 - P_{hh}\left(1 - P_{f'}\right)}\lambda_O \tag{1}$$

Where:

- P_h = the probability that a new call that is not blocked would require at least one handoff
- P_{hh} = the probability of a call that has already been handed off successfully would require another handoff
- B_O = the blocking probability of originating call

- $P_{f'}$ = the probability of handoff failure
- λ_O = the arrival rate of originating call in a cell

2.1.2. Zeng et al.'s Approximated Traffic Model (Any Dimensional):

Zeng et al.'s model [11] using simple formula, when the blocking probability of originating call and the forced termination probability of handoff call are small, the average numbers of occupied channels *E*[C] is approximated by:

$$E(C) \approx \frac{\lambda_O + \lambda_H}{\mu} \quad (2)$$

E[*C*] is the average number of contacts in a cell

If a channel has been allocated to a MU, it will be released at the end of the call is due to a handover to a neighboring cell. So the channel occupation time is the minimum duration of the contact.

We denote by:

- Pb: probability that a new user finds all channels busy in a cell.
- Ph: probability of failure of the handover. Is the probability that a handover contact finds all channels occupied on his arrival in the neighboring cell.

Pf: the probability of forced termination of the contact, is the probability that a contact has been accepted by the system is interrupted due to failure of handover

3. Priority strategy

3.1. Handoff Call Queuing Prioritizing Scheme (QPS)

In this scheme**,** If all channels in the destination cell are occupied, a handover request is put in the queue as it is shown in figure 1, if a channel is released when the queue of handover request is not empty, the channel is assigned following FIFO discipline, if the received signal strength from the current BS falls below the receiver threshold level before getting service in the target cell, the call is forced to termination.

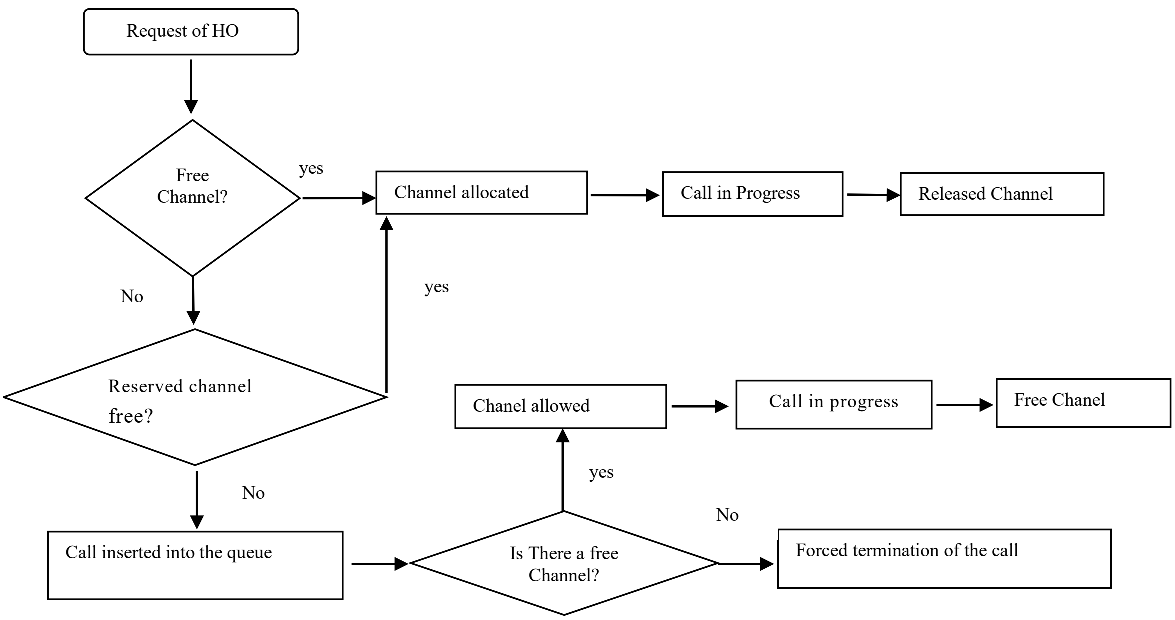

Fig. 1. System model with priority and queue for handoff contact

Analytical computation

$$P_n \begin{cases} \dfrac{(\lambda+\lambda h)^n}{n!\,\mu^n} P_0 & 1 \le n \le s-1 \\ \dfrac{(\lambda+\lambda h)^s \lambda h^{n-s}}{s!\,\mu^s \prod_{j=1}^{n-s}(s\mu + j\mu_w)} P_0 & n \ge s \end{cases} \tag{3}$$

New calls are blocked if all channels available in the cell are occupied. We get:

$$Pb = \sum_{n=s}^{\infty} P_n \tag{4}$$

In the state n, the failure probability of handover is given by :

$$P_{b2|n} = 1 - \prod_{j=0}^{n-s}\left[1 - \frac{\mu_w}{(s\mu + \mu_w)^{2j}}\right] \tag{5}$$

Therefore Ph is given by:

$$Ph = \sum_{n=s}^{\infty} P_{b2|n} P_n \tag{6}$$

3.2 Guard Channels with Queue for Handoff contact (QPS +RCS)

It is a combination of tow techniques: queuing requests and guard channels strategy reserved exclusively for guards Handover as shown in figure 2

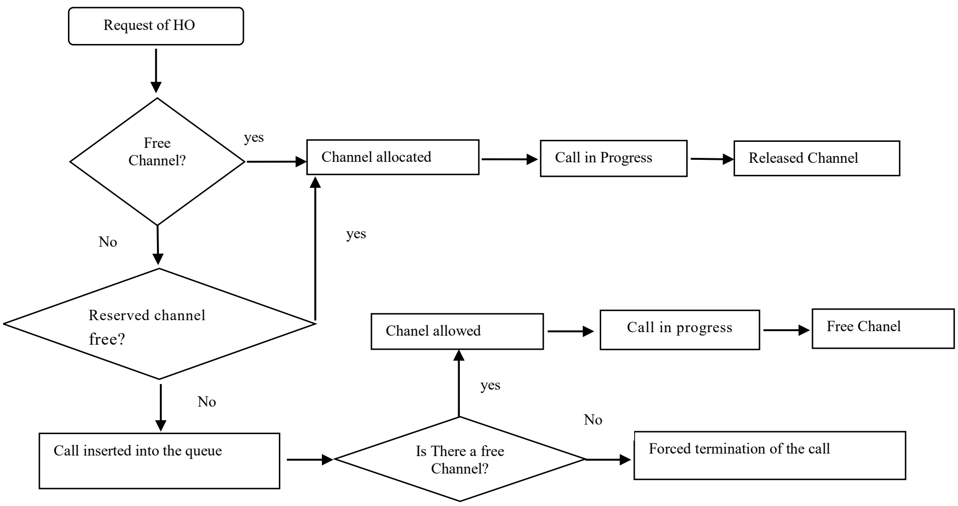

Fig. 2. System model with reservation channel and queue for handoff call

$$P(i)=\begin{cases}\dfrac{(\lambda+\lambda h)^{i}}{i!\,\mu^{i}}P(0) & 0\le i\le s_C\\ \dfrac{(\lambda+\lambda h)^{s_C}\,\lambda h^{i-s_C}}{i!\,\mu^{i}}P(0) & s_C< i\le s\\ \dfrac{(\lambda+\lambda h)^{s_C}\,\lambda_H^{i-s_C}}{s!\,\mu^{s}\prod_{j=1}^{i-s}[s\mu+j(\mu_w)]}P(0) & s< i<\infty\end{cases}$$

Where:

$$P(0)=\left\{\sum_{i=0}^{S_C}\frac{(\lambda+\lambda h)^{i}}{i!\,\mu^{i}}+\sum_{i=S_C+1}^{S}\frac{(\lambda+\lambda h)^{S_C}\,\lambda h^{i-S_C}}{i!\,\mu^{i}}+\sum_{i=S+1}^{\infty}\frac{(\lambda+\lambda h)^{S_C}}{S!\,\mu^{S}}\frac{\lambda h^{i-S_C}}{\prod_{j=1}^{i-S}[S\mu+j(\mu_w)]}\right\}^{-1} \tag{7}$$

So we obtain:

$$Pb=\sum_{i=S_C}^{S}P(i) \tag{8}$$

$$Ph=\sum_{k=0}^{\infty}P(S+k)P_{fh|k} \tag{9}$$

$$P_{fh|k}=1-\left(\frac{\mu_w}{\mu S+\mu_w}\right)\prod_{i=1}^{k}\left\{1-\left(\frac{\mu_w}{\mu S+\mu_w}\right)\frac{1}{(2)^{i}}\right\} \tag{10}$$

Where $P_{fh|k}$ *is* a probability that a handoff request fails after joining the queue in position k+1.

4. Proposing queuining scheme with assending priorpty

We assumed that there are three different transceivers (TRX) per cell covering the same geographical area. These three TRX have a number of channels assigned exclusively for handoff calls and also have a queue for handoff attempts, while there is not similar queue for new call attempts. The three queues have the same size and every TRX has the same number of guard channels. the principle of the service discipline of the requests queuing is : if all channels of a cell are occupied, calls originating within that cell are simply blocked and the handover request to that cell is queued with dynamic priority discipline. Highest priority (i.e., head of the queue) belongs to the MU whose residual time is short. On the other hand, the MU that has a longer residual time has the least priority (i.e., joins the end of the queue). The residual time is continuously measured, and the priority of a MU dynamically changes depending purely on time while waiting in the queue.

5. Simulation results

In this section, the performance of the proposed scheme is evaluated by simulation using Simulink matlab envirenement, and comparison with classical model is assessed. For the classical model (single queue), we assume a total of 21 channels per cell (C = 21) with three guard channels per cell, we also assume a single queue available with six positions (K = 6). For a case using three queues per cell; A queue by TRX, we assume that each TRX has a total of seven Channels (C = 7) with a single guard channel for handover requests ,and a queue with two positions (K = 2)

The following parameters are introduced to evaluate the performance of the system

- Call duration is exponentially distributed with a mean of 3 min.
- The traffic in the cells follows a Poisson distribution
- The average waiting time in the queue is exponentially distributed with a mean of 5 min.
- Blocked contacts are lost and cleared.
- The system has a total of 10 available channels per cell.
- The queue length is finite.
- The simulation results obtained are taken after 10 000s

Figure 3 gives the blocking probability for new call requests for two schemes versus offered traffic. By investigating the illustrated results, it is observed that 3 queue ascending priority scheme decrease blocking probability compared to the model scheme (one Queue AP). In another study based on the blocking probability for handover attempt (forced termination) versus offered traffic, as shown in fig 4. Our proposed scheme (3 queue ascending priority) provides a greater reduction especially when offered traffic load increases compared with the model which uses one queue AP.

Figure 5 gives the blocking probability for new call requests for three schemes *versus* offered traffic. It can be noticed that both AP queuing scheme with 3 Q and FIFO queuing scheme decrease blocking probability compared with the scheme which uses one queue

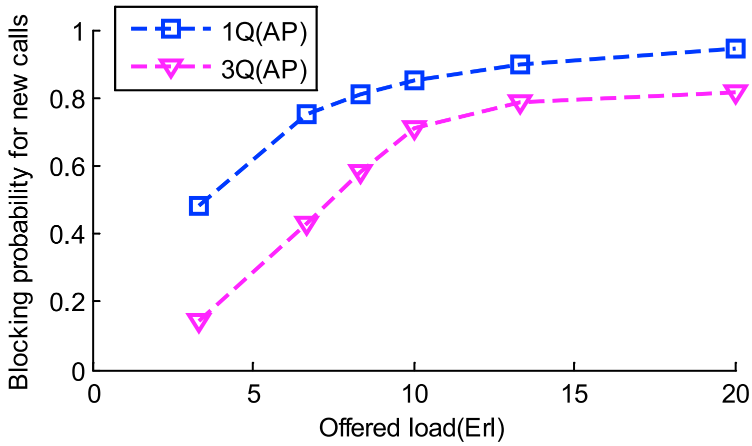

Fig 3 . blocking Probability of new calls for 2 cases

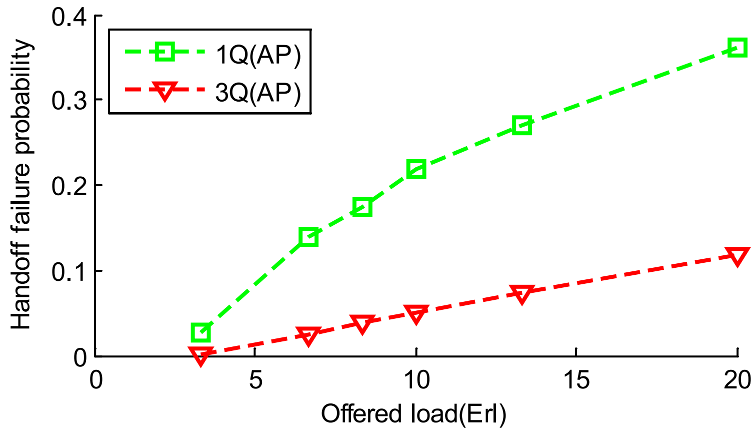

Fig 4 : Handover failure probability for 2 cases

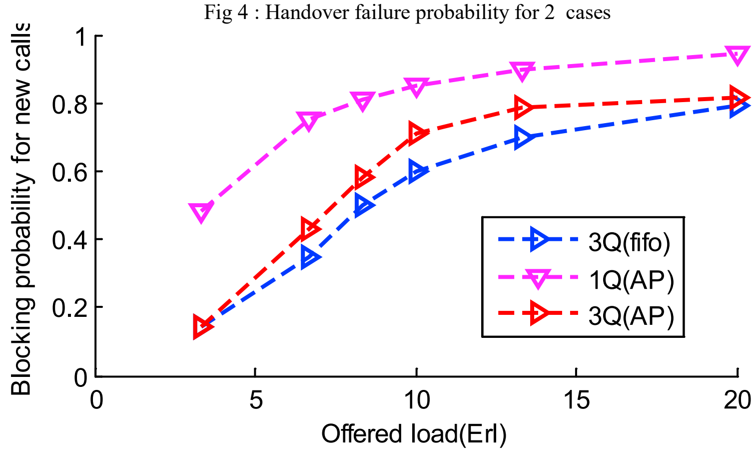

Fig 5 blocking Probability of new calls for the different queuing strategies

Figure 6 shows the blocking probability for handover attempt (forced termination) *versus* offered traffic. As the figure shows, both queuing scheme which consider 3 queues per cell provides better reduction in this probability compared to the other model with slight superiority to our proposed model 3Q (AP).

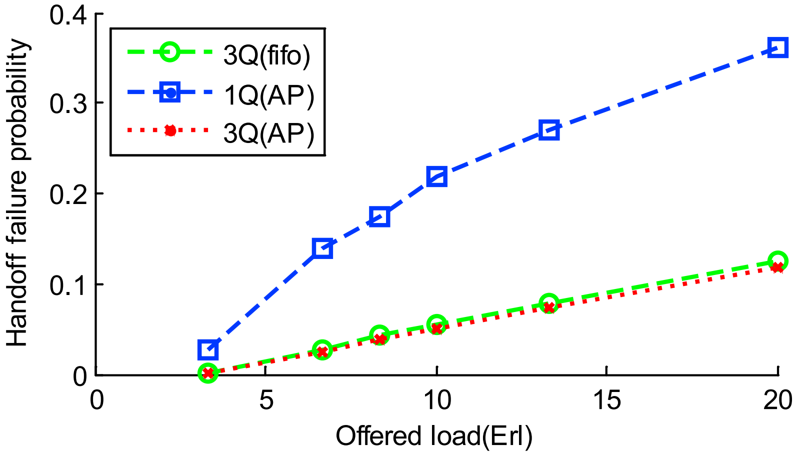

Fig 6: Handover failure probability for the different queuing strategies

6. Conclusion

The handover is one of the critical procedures of communication in mobile cellular networks, the management of this mechanism must be set appropriately in order to maintain communication between a mobile station and BTS, in order to ensure an acceptable level of quality of communication. A handoff schemes to reduce the probability of forced termination of ongoing call for visited cell is studied . Fixed channel allocation (FCA) strategy is adopted for simulation results. The proposed scheme which considers three queues for each cell and dynamic queuing of handover requests based on the measurement of the residual time of the user within the handover region was discussed, the obtained results clearly point out that the proposed scheme offers better reduction in both blocking probability (new call and handoff request) compared to classic model.

References

[1] B. Jabbari (1996) "Teletraffic aspects of evolving and next-generation wireless communication networks", *IEEE Pers. Commun* **3**: 4–9.

[2] N. D. Tripathi, J. H. Reed and H. F. Vanlandingham (1998) "Handoff in cellular systems" *IEEE Pers. Commun*: 26-37.

[3] Abdelali Achachi, Djamel Benatia, Messaoud Gareh (2014) "Satellite Handover Techniques for LEO Networks Serving Air Traffic Control Communication" *International Journal of Future Generation Communication and Networking* **7**: 49-62

[4] Nour El Houda Hedjazi, Malika Ouacifi, Rachida Bouchouareb, Meriem Ourghi, Messaoud Gareh, Djamel Benatia (2012) "The Handover in the Constellations of Satellites in Low *Orbit*"*International Journal of Advanced Science and Technology* **4**: 39-48.

[5] E. D. Re, R. Fantacci, and G. Giambene (1999) "Handover queuing strategies with dynamic and fixed channel allocation techniques in low earth orbit mobile satellite systems", *IEEE Trans. Commun* **47(1)**: 89–102.

[6] E. Papapetrou, S. Karapantazisny, G. Dimitriadis and F.N. Pavlidou (2004) "Satellite handover techniques for LEO networks", *Int. J. Satell. Commun.Network* **22**: 231–245.

[7] M. Gareh and D. Benatia(2009) "Handover prioritizing scheme for reducing call failure probability in cellular wireless network", *Wireless Communications and Mobile Computing* **9**:1660-1667.

[8] S. Louvros , J. Pylarinos, S. Kotsopoulos (2007) "Handoff multiple queue model in microcellular networks", *Computer Communications* **30**: 396-403.

[9] Geetanjali Sharma, G.N. Purohit and Rakhee (2012) ''Analysis of Multiple Queue Model in Cellular Networks with Sub Rating of Channels'' JKAU: Eng. Sci **23(1)**: 85-128.

[10] Hong D, Rappaport SS(1986) "Traffic model and performance analysis for cellular mobile radio telephone systems with prioritized and nonprioritized handoff procedures". IEEE Transactions on Vehicular Technology **35(3)**: 77–92.

[11]Q. Zeng and D. P. Agrawal (2002) "Handoff in Wireless Mobile Networks", *Department of Electrical Engineering and Computer Science, University of Cincinnati, Edited by Ivan Stojmenovic John Wiley & Sons*: 1-26.