A New Proposed Algorithm for the Priority of the Cellular Calls

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ABSTRACT

There are many criteria for managing the priority in calling queues. The purpose of our work is to make a balance between two conflicting requirements: maximize the resource utilization and minimize the forced handover call dropping rate. This balance can be satisfied by using the dynamically manages of the priority criterion which is changed according to the current status of the hand off queue(remaining time(Tr) and rate of change of RSS (ΔRSS)). The result is clear for reducing the blocking probability within range from 2% to 50%.

Keywords*:* Handover/Handoff, Wireless Network, handover management

اقتراح خوارزمية جديد للأولوية من المكالمات الخلوية

الخلاصة

الهدف من عملنا هذا هو جعل توازن بين اثنين من المتطلبات المتعارضة: هذا يعني تعظيم الاستفادة من المصادر المعاد استخدامها وتقليل معدل القطع القسري للمكالمات حال التسليم .
يمكن ان تحقق هذا التوازن من خلال استخدام ادارة ديناميكية من المعايير ذات الاولوية للتغيير وفقا للحالة الراهنة لانتظار عملية التحول. (الوقت المتبقي(Tr)، ومعدل التغير (RSS) ، (ΔRSS)).
كانت النتائج واضحة للحد من احتمالية القطع من 2% الى 50%.

INTRODUCTION

Mobile Networks have gained an impulsion in the past few years in rapacious dimensions. And since then mobility becomes a distinct feature of a wireless mobile cellular system **[1]**. With the mobile communication technology changing each passing day, cell distribution is denser, and the traffic handover between cells is more often **[2]**. While a call (mobile caller/user in service) is in progress the channel (frequency, time slot, spreading code, or combination of them) associated with this current connection is changed through Channel Allocation Control (CAC) proposals. The existing call may change its present Base Station (BS) also termed as Mobile Terminal (MT) to a new

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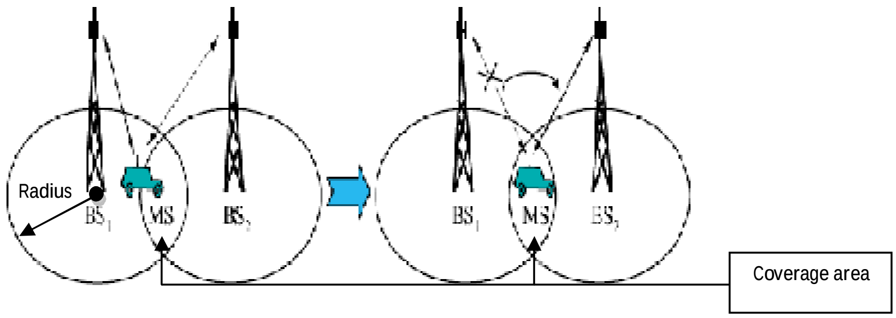
one. This phenomenon is whatever we call handover (handoff). It is shown in figure(1)**[3]**.



(a) Before Handoff (b) After Handoff

Figure (1) Handoff between the MS and BSs.

Therefore, by use, efficient call handling mechanisms can greatly improve cellular network performance. Accordingly, the system performance is improved **[4].**

RELATED WORK

In the existing technical literature, many related studies on handover Priorities decision have been reported.

B. Bhowmik:2011[5]; A new Prioritized Hard Handoff ordering scheme is proposed which can be used to provide rapid handovers with a smaller percentage of dropped calls than other methods.

B. Bhowmik:2011[1]; An improved Signal Strength Based Priority Queue Generation model is introduced for effective call scheduling. The model computes signal strength of a mobile caller (MC) to enqueue and introduces a tree with heap like structure for generated queue implementation in considerably reduced time.

Y. Watanabe:2011[6]; A baton handover strategy with channel reservation and preemptive priority mechanism is proposed.

A. Yang :2010[2]; Was developed a fast handover method based on channel quality messages associated with the priority messages in mobile multi-hop relay networks.

S. B. Rejeb:2010[3]; A scheme was gives higher priority to newly detected neighbor cells over existing cells and ensures fast and accurate updates after radio coverage changes are proposed.

S. Dhar:2010[7]; A CAC model with four priority levels supporting five classes of service in a wireless multi-services network are present.

Pushpa:2010[8]; A proposed method decides the priority of radio access network that is most suitable for user's application at a particular vehicular speed in the constraint resource environment was present.

H. Fehri:2009[9]; A scheme was based on analysis of the movement of users from one cell to another in different time stamp was proposed.

Y. Xiao:2009[10]; A new downlink handover priority scheduling algorithm for different scheduling services which is providing lossless handovers and QoS is present. Taking the power degradation rates into consideration, this algorithm assigns higher priority to the users who have higher speeds.

A. Zavabeti:2009[11]; He proposea new Channel Allocation (CA) policy by employing a hysteresis mechanism and guard channel schemes considered for use in Low Earth Orbit (LEO) satellite networks to avoid the forced call terminations due to handover failures.

L. Xu:2009[12]; In this paper, two queues are used for handover calls. First queue contains voice call handover requests and second queuecontains data/video handover call requests. Separate queues can also contain different network type handover requests. A higher priority is given to the first queue which is voice calls.

W. Wang:2008[13]; Present a novel combined Handover Guarantee and Interference Mitigation cell-level resource allocation scheme is proposed.

T. Wu:2008[14]; A dynamic priority queue handover scheme is proposed. With the scheme, a common queue manager is appended and the priority in the queue can be changed according to the variety of waiting delay.

W. Park:2007[15]; A multilevel queue processing method that can assign priorities to traffics and process binding updates based on the priorities was present.

[S. A. AlQahtani:2006[4]; He focuses on the performance evaluation of originating and handover calls prioritization using different queue size and discipline. Both calls will be queued until they reach a certain threshold, or a channel becomes available.

HANDOVER

Usually, this handover mechanism supports continuous services by transfer of an ongoing call from the current cell to the next adjacent cell as the Mobile Station (MS) moves through the coverage area (Handover area**[4]**) as in figure(1). Either crossing a cell boundary of current BS by (MS) or deterioration in quality of the signal in its channel is the primary responsible factor for initiating a handover**[1,5,16]**. However, handoff request is failed if no channel is available in the target cell. And it must be for the strategy reserves channels for handover calls, must sets according to different priorities for various handover calls according to their properties**[2]**.

PRIORITIES

Various access strategies are proposed to give handover calls higher priorities. These are**[2]**;

1. Divided voice handover calls into four different handover priorities. These are;(a)VIP high-speed, (b) VIP low-speed, (c) high-speed, (d) low-speed.
2. A strategy which reserves handover channels dynamically according to characteristics of users.
3. A hybrid channel allocation mechanism with handover call queuing and channel borrowing.
4. Provided a time-slot allocation strategy in TDMA system, they both give handover calls higher priorities, but did not take the different traffic classification and priorities into account.
5. Introduced a voice/data integrated services access strategy based on preemptive Priority and channel reservation, but the strategy does not consider that voice handover calls of different attributes have different contribution rate to the overall system performance.

The priority message is a parameter related to the Channel Quality Information (CQI). Then, it's information can be obtained by scanning, environmental monitoring and ranging, and can be divided into different levels, according to the CQI of the relay station and all terminals that attached to the relay station **[17]**.

Specifications of Priorities

There are many specifications must take into account, these are;

1. For each cell, the average number of calls that arrive is equal to that of leave during one unit time**[2]**.

2.As soon as a Mobile Unit (MU) enters an overlap region between two cells, it can communicate with both base stations simultaneously for some amount of time called 'transition region time. Handover requests can be queued in new cell if all channels are occupied by MUs. MUs in the queue will wait until there is a free channel available **[11]**.

3. The priority of queued handover calls is based on**[16]**;

   1. Received signal strength.
   2. Remaining time in the overlap region between two cells.
   3. Status of the current channel.

4**.**Velocity at which a MU is moving(different speed (Therefore, the handover requests need to be queued in such a way that the priority changes dynamicall yaccording to the dynamics of the user motion)).

5.**S**pecial care must be taken for priority subscribers (Police, National security, Special agents, government personnel or high speed moving terminals like trains) that might use the available resources (calls and handoff) and services (Quality of service (QoS)) without any disturbance**[18]**.

6.Remaining time, that RSS is reaching the lower threshold level. A priority can be given to a call in a handover queue that has a lower estimated remaining time[11].

Therefore, the dropping of an ongoing call is less desirable than a new call to be blocked. A higher priority is given to handover call queue and not to new calls. If any channel is released, a request which is pending in a handover call queue will be served first**[11,19].**Then, there are five types of hand over queuing priority's schemes these are**[20]** ;

1) First-In–First-Out (FIFO) queuing;

2) measurement-based priority queuing;

3) signal prediction priority queuing [or Dynamic Priority Queuing (DPQ)]**[19].**

4**)**The Guard Channel Scheme (GCS)

5) Hand off Queuing Scheme (HQS) are the popular and practical strategies to prioritize hand off calls in wireless cellular networks.

A key issue of giving hand off calls the higher priority is how to achieve a tradeoff among the hand off call blocking probability, new call blocking probability and handoff delay.

Analysis of the Handover Priorities

In order to study the handover queuing and present the impact of a queue on the system performance, it is necessary to analyze the prioritized handover procedure.

Thus, the generalized formula for the arrival rate of hand off calls**[5]**,

$$\lambda H=(8r+2)/(2r+1) \qquad ....(1)$$

where;

r-radial distance.

In megacitatyλ is very high in contrast to that value in a rural area. Therefore the distance between BSs must be least for batterservice (≈ 1 Km).

Thus in a particular region, number of subscribers (S), and number of Mobile Terminals (MTs)(X), λo can bedetermined as:

$$\lambda o = S/ \qquad ....(2)$$

where;

S-total No. of Subscriber in the region.

X-total No. of MTs.

departurerate, μ (number of MSs get serviced in unit time) at least equal to arrival rate λo such that waiting for getting service becomes zero. However, it depends basically on traffic intensity. From Poison distribution, the traffic intensity factor ρ (defined as λ/μ) lies between 0 and 1 i.e.

$$\rho = \lambda o/\mu \qquad 0 \text{to } 1 \qquad ....(3)$$

then

$$0 \leq \lambda o \leq \mu \qquad .....(4)$$

(1) The channel holding time*(TH)*,is the duration between the instant that a channel
isoccupied bya call to the instant it is released by either completion of the call or a cell boundary crossing by a portable, whichever is less. This time is a function of the cell radius *R* and of the maximum mobile velocity *(V*max(uniform distribution on the interval [0, V_{max}] and V_{max} is a vertical component of speed to the target cell)).

(2) The call duration(*TM)*is the time that assigneda channel would be held if no
Hand off is required and has an exponential distribution with mean value($1/\mu M$).

(3) The guard channel reservation for handover calls.

(4) Moreover, the cell dwell time, i.e., the time duration that a mobile user resides in the cell before crossing the cell boundary, follows an exponential distributions

Then,Let*N* be the total number of channels available in a cell and *k* be the buffer capacity. When the buffer is empty, as shown in figure(2a), the maximum number of channels, which can be used to transmit new calls, is $n(n \leq N)$. Consequently, all remainingchannels, $h\ (h = N - n)$, are reserved for handoffcalls. In the dynamic handoffscheme, the number of channels allocated to handoffcalls, h, changes according to the queue status. Specifically, when the buffer of handoffcalls is not empty, t more channels are allocated to handoffcalls in order to reduce the delay and loss probability of handoffcalls. In this case, the maximum numbers of channels which

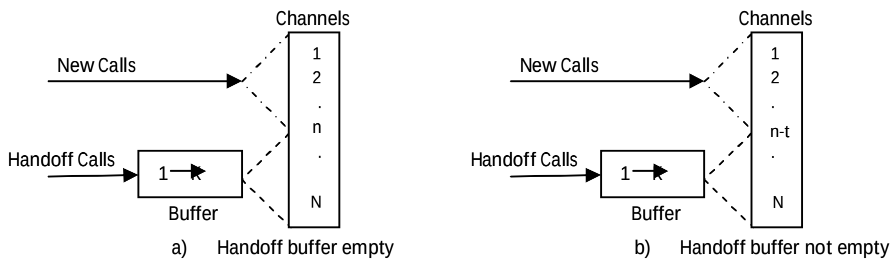


Figure (2) the dynamic handoffScheme

canbe used for new calls and hand off calls are changed to [19];

$$n' = (n - t) \text{ for new Calls} \quad \ldots..(5)$$

$$h' = (h + t) \text{ for hand over calls, as shown in figure(2b)} \quad \ldots..(6)$$

Therefore, the waiting in a queue does not necessary means having a higher probability of drop. MUs that is deleted from a handover queue is not dropped, but they will send requests for handover in a next time slots hence, they are able to return to the queue. A MU can enter the queue until there is free space in a handover queue or its estimated remaining time is less than estimated remaining time of aleast priority request in the queue**[11]**. While, In the heavy traffic networks, many MSs may send out HO requests to the same target at the same time leading to the performance degradation**[14]**.

PROPOSED WORK

4.1 Design Procedure:

There are many hypotheses must be taken and arranged as below;

1. $C = CA + CH + CT$

   $CH = CHD + CHT$

   Where;

C- total number of available channels in the cell.
CA– part of channelused to serve the new call.
CH- part of channelused to serve the HO calls (for deterioration CHD andtransformation CHT).
CT - part of channelused to serve at time t.
A new call is admitted if the total number of calls (including calls HO from other cells) is below the threshold CA. Handover call is served if the total number of callsin a cell is less than the total capacity C.

2. The call in progress is a higher priority than new calls.
3. *P (RT, H)> P (NRT, H)> P (RT, N)> P (NRT, N)*

$$\underbrace{P(RT,HD)>P(RT,HT)}_{P(RT,H)}>\underbrace{P(NRT,HD)>P(NRT,HT)}_{P(NRT,H)}$$

Where:

*P(RT, HD)*priority assigned to real-time HO calls (caused by deteriorationof channel).
*P(NRC, HT)*priority assigned to non-real time HO calls (caused by transferfrom a cell).
P(RT, H) priority assigned to real-time HO calls.
P(NRC, H) priority assigned to non-real time HO calls.
P(RT, N) priority assigned to the new real-time connections.
P(NRT, N) priority assigned to the new non-real time connections.
The priority changes dynamically to account for the dynamics of the user motion and power degradation rate.
Then, blocking and dropping probability of new and HO calls are[3];

$$P_{bn}=N_r/(N_a+N_r) \qquad \text{.... (7)}$$

$$P_{ch}=H_r/(H_a+H_r) \qquad \text{......(8)}$$

Where:

N_a– total no. of new call admitted.
N_r– total no. of new call rejected.
H_a– total no. of HO call admitted.
H_r– total no. of HO call rejected.

4. Priority of MUs in handover call queue is not only based on their Received Signal Strength (RSS) but the remaining time that RSS is reaching the lower threshold level. A priority can be given to a call in handover queue that has a lower estimated remaining time.
5. A handover request can be initiated when RSS is less than a threshold and a call will be dropped if RSS reaches below minimum acceptable RSS.
6. The priority of requests will change if another request enters the queue with a higher priority.

7. If remaining times of two requests are equal, a higher priority is given to a handover request with lower call duration[11].

Then, assume the RSS's rate of change at a time is then found asthe average of the five previously calculated RSS's rates of change. Therefore, one can estimate the remaining time in the queue for these users based on the RSS and the RSS's rate of change values at a time , as follows[2]:

$$T_i\Big|_t = \frac{RSS_i}{\Delta RSSi}\Big| \quad \dots (9)$$

where

T_i- estimated remaining times in the queue,

ΔRSS's- rate of change for user *i* ata time *t*,.

The MUsmovements between the cells are shown in figure(3)[3],the MU's velocity are calculated as below;

$$L_s = \sqrt{L_o^2 + L_1^2 - 2L_oL_1 cos\alpha} \dots \quad \dots..(10)$$

$$V = \frac{L_s}{t_1 - t_o} \quad \dots (11)$$

$$\beta = arctan\frac{L_o sin\alpha}{L_1 - L_o cos\alpha} \quad \dots (12)$$

$$v_1 = V cos\beta \quad \dots (13)$$

The parameters which will be used in our simulation are listed in table(1)[6,7].

Table(I). Simulation Parameters.

Parameters	Values
Number of cells	252 cells (84 eNBs, 3 sectors per eNB)
Cell radius	Average 350 m
Antenna height	40 ~ 60 m
Path loss from eNBto UE	Outdoor: 3D ray-tracing model Indoor: Statistical model
Log-normal shadowing by vegetationeffect	Standard deviation = 4 dB Correlation distance = 4 m (Note: Shadowing by buildings is includedin the ray-tracing simulation)
Carrier frequency / Bandwidth	2 GHz / 10 MHz
Total eNBTX power	46 dBm
eNBantenna gain / tilt	14 dBi/ 15 deg
UE antenna gain	0 dBi
UE noise figure	9 dB
UE required SINR	-6 dB
Time threshold for RLF	1 sec
UE ratio (Indoor / Outdoor)	80% / 20% (Vehicle: 4%)
UE speed	Pedestrian: 3 km/h, Vehicle: 40 km/h
Traffic intensity	Average 100 calls /hour/cell
Threshold of the number of measurementreports	Th_{Num}= 20, Th_{Num_Imm}= 3
Threshold of RSRP (Th_{RSRP})	-118 dBm
Forgetting factor (©)	0.68
Max. lengthof NCL (L_{Max})	32 cells
Max. numberof cells for immediateaddition (L_{Imm})	8 cells
Reuse Factor	4
Noise power each channel	-132 dBm
Channels per Cell	24

To provide lossless handovers, the proposed scheduling algorithm serves the service flow *i*with the highest priority $P_i$which is calculated with the following formula (Piavg). As we know, power-level fluctuations can occur due to mobility, fast fading and shadow fading or any combination thereof. Generally, the user with these power fluctuations needs to perform handover procedurein order to maintain its connection quality. But, in some cases power fluctuations are momentarily and there is no need to perform handover procedures for such users. In order to remove these users from high priority users, we replace *Pi* with *Piavg* which is calculated by the following formula[9]:

$$Piavg = \delta Pinew + (1-\delta)\, Piold \quad \ldots(14)$$

Where, δ is a constant between 0 and 1, which depends on the amount of signal variation. The priority *P iavg*can eliminate normal users withtransitional power-level fluctuations from high priority users.

Proposed Algorithms

1. The MU enter tothe HO region when RSSA = 0.1 RSSB.
2. The priority change according to the remaining time(Tr) and rate of change of RSS (ΔRSS) inside its properties Queue.
3. Divide the callproperties into four types [VIP real time (VRT) , VIP not Real time (VNRT), Normal high speed (NHS) Normal Low Speed (NLS) and Urgent (U)].
4. If New call repeat its request greater than 7 time enter to the urgent Queue.

Flowchart Description

The described queueing model is shown in Fig. (4).

1. There are three types of HO request [New call(New) , Transfer from another cell(HoT) and caused by deterioration of channel(HoD))
2. For HoT : IF RSS measured from new cell >> RSS measured from old cell THEN the request is live (enter tothe HO region).
3. When deterioration happens the request is in live(enter tothe HO region).
4. IF there is a free channelsTHEN get service.
5. IF NO free channels:
   a. For New call blocked if its request are repeated less than 7 times.
   b. For Ho(T& D) request and New graterthen7 times are arranged according to the priorities of call.
6. Separate HOT and HOD :
   a. Stop the deterioration channel until fixed it.
   b. Sort the HO request according the remaining time and ΔRSS.
7. Repeat for certain time (Wait Time):

a. IF a free channel available THEN get service
b. Else if Repeat the procedure for another time
c. Drop the call.

RESULTS

Simulation Scenarios for four MUs are described in figure (5). The priorities according to the proposed algorithms are shown in table (2).

Table (2) Priority Arrange Management

Times	HO Request	Slopes(ΔRSS)	Priority (P_{iavg})
t_1	MU1	X	MU1(1) OR X
t_2	MU2	F t_1 T t_2 S1 >	MU1(1)
t_3	MU3	F t_2 T t_3 S2>S1	MU2(1), MU1(2)
t_4	X	F t_3 T t_4 S1>S3>S2	MU2(1),MU1(2),MU3(3)
t_5	MU4	F t_4 T t_5 S2>S1>S3	MU2(1),MU1(2),MU3(3)
t_6	X	F t_5 T t_6 S3>S1>S2>S4	MU2(1),MU1(2),MU3(3), MU4(4)
t_7	X	F t_6 T t_7 S1>S3>S4>S2	MU1(1),MU2(2),MU3(3), MU4(4)
t_8	X	F t_7 T t_8 S4>S3>S2>S1	MU3(1),MU2(2),MU1(3), MU4(4)
t_9	X	F t_8 T t_9 S1>S3>S4>S2	MU1(1),MU3(2),MU2(3), MU4(4)
t_{10}	X	F t_9 T t_{10} S3>S4>S1>S2	MU3(1),MU1(2),MU2(3), MU4(4)

While, when use FIFO the priorities arrange as ; MU1(1), MU2(2),MU3(3), MU4(4) for all time.Therefore, when use the proposed criteria instead the criteria which based on RSS only, the dropping probability will be reduced as in table (3).

Table(3) Dropping Probability Reduction

Time duration	MU1	MU2	MU3	MU4
t_2-t_3	-	30%	-	-
t_3-t_4	-	-	-	-
t_4-t_5	2%	26%	-	-
t_5-t_6	-	-	-	-
t_6-t_7	50%	-	-	-
t_7-t_{10}	5%	5%	21%	44%

CONCLUSIONS

It is clearly that from tables (2) and (3), the proposed method which based on remaining time and ΔRSS gives better results than the method which based on RSS only or FIFO, because when based on RSS only may give error indication caused by direction, also for FIFO where the first user enter to the handover region may not require the HO firstly caused by the acceleration. Furthermore our proposed can be consider as dynamically priorities according to the states of the users (where it reduced the dropping probability in a range from 2% up to the 50% depend on the MU's variation)as in Tables(3) according to figure(5).

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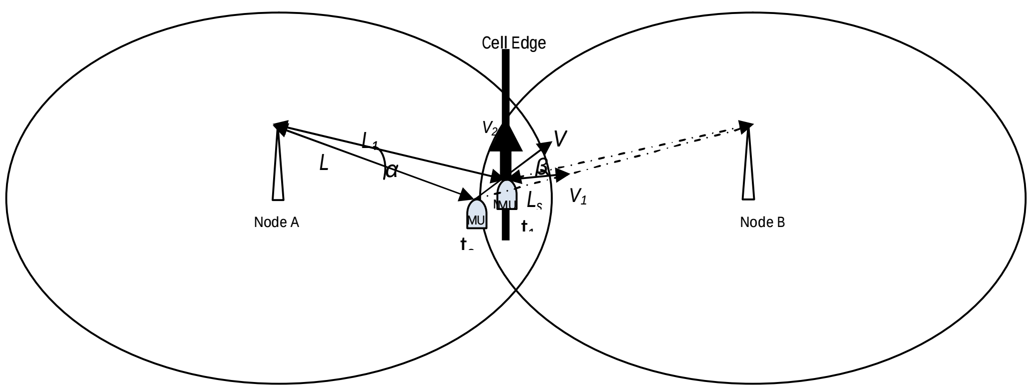
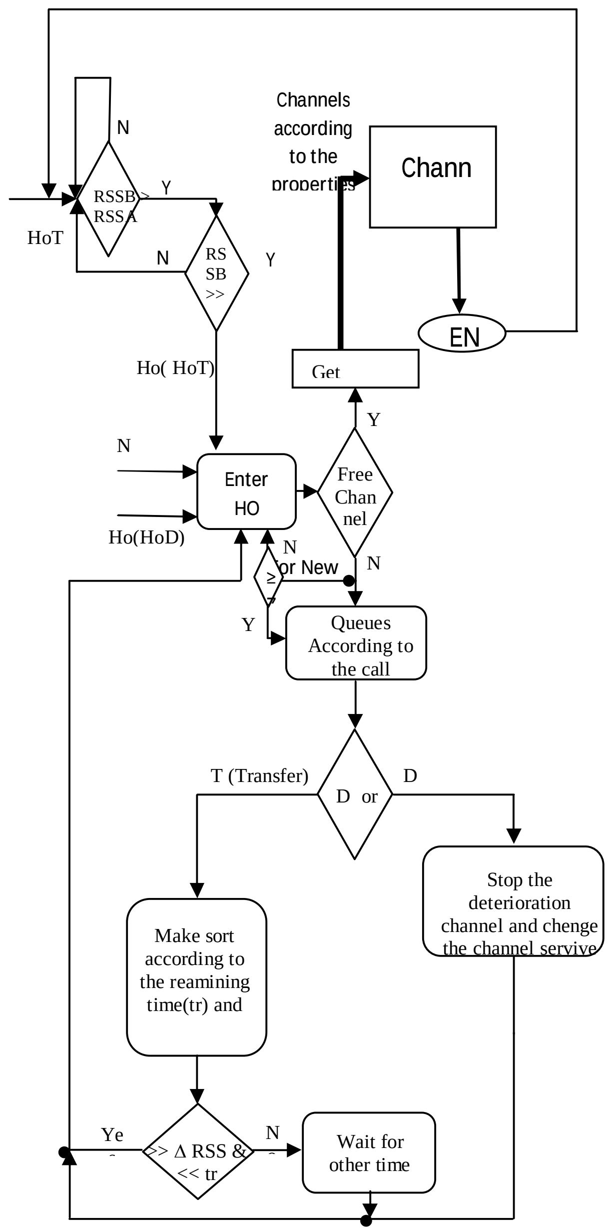
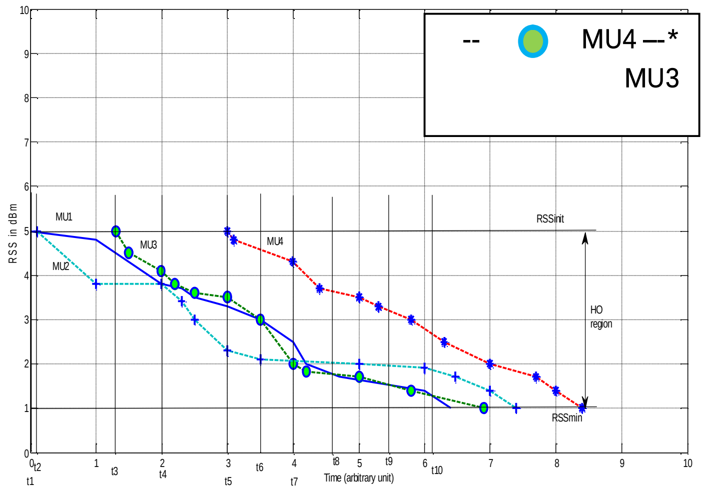


Figure (3) Schematic diagram of handover process



Figure(4) Flowchart of the Proposed Algorithm



Figure(5) Simulation Scenario of MUs RSS.