# Dynamic Mobility Management and Resource Management in Heterogeneous Wireless Networks Environment

Sulata Mitra,
Department of Computer Science and Technology
Bengal Engineering and Science University, India

## ABSTRACT
In the next generation wireless network each mobile node will be equipped with multiple network interfaces to utilize multiple wireless access technologies simultaneously. Such mobile nodes are multihomed mobile nodes. The seamless mobility management to provide uninterrupted connectivity to the multihomed mobile node and the dynamic resource management to reduce packet loss corresponding to the ongoing sessions of the multihomed mobile node are the challenging issues for such a heterogeneous wireless networks environment. In the present work each multihomed mobile node has multiple care of addresses corresponding to multiple network interfaces associated with it. A network analysis module is associated with each access network to determine its performance. The mobility management module provides the uninterrupted connectivity to the multihomed mobile node. The session admission control module controls the admission of sessions at various networks depending up on their performance after receiving the network selection request message from multihomed mobile node. The performance of the proposed scheme is evaluated in terms of the percentage of network usage, percentage of resource utilization per network, blocking probability and throughput of the system, bandwidth management.

## General Terms
Mobile computing

## Keywords
Mobility management, Resource management, GPRS WiMAX, IEEE 802.11 integration

## 1. INTRODUCTION
The mobile nodes will be equipped with multiple wireless access technologies in the future wireless networks. One of the challenging problems in such an environment is to provide seamless mobility support so that the mobile nodes can switch from one wireless access technology to another. Such a mobile node is multihomed and can get internet connectivity through any wireless access technology. The other challenge in such an environment is to reserve the available resources of the wireless access networks for the various sessions of multihomed mobile nodes (MMNs) dynamically to balance the effective load of the heterogeneous wireless networks environment.
Several resource management schemes in heterogeneous wireless networks environment have been reported so far. The call admission control (CAC) is one of the techniques to manage radio resources dynamically. The local CAC schemes [1,2,3] use information of local cell alone to take the admission decision. The collaborative schemes [3] use information of more than one cell to take the admission decision. Shen and Zhen proposed two resource allocation schemes [4] to support multiple traffic in integrated networks environment. The priority of different types of traffic is different and the traffic having lower priority can be preempted by the traffic having higher priority. In the first scheme, the last accepted call with lower priority is first preempted. In the second scheme, the lower priority call that reaches higher bandwidth network earlier is preempted first.
The present work considers the integration of three wireless access networks, GPRS (Net_1), IEEE 802.11x (Net_2), WiMAX (Net_3) (NO_OF_Net=3). Each MMN in the heterogeneous wireless networks environment has three network interfaces such as GPRS, IEEE 802.11x and WiMAX having care of addresses (CoAs) N1, N2 and N3 respectively. The maximum data rate is 70-75 Mbps for WiMAX, 54 Mbps for IEEE 802.11x and 172.2 Kbps for GPRS. Thus WiMAX, IEEE 802.11x and GPRS offer high, medium and low data rate respectively.

**Table 1. Three traffic classes**

| Class (p) | Require Capacity, $RC_p$ kbps | Average packet size, $P_p$ kb | End to End delay, $D_p$ sec | Average Service Time, $S_p$ |
|---|---|---|---|---|
| 1 | 160 | 35 | 0.89 | 0.21875 |
| 2 | 80 | 16.6 | 1.02 | 0.2075 |
| 3 | 25 | 12.5 | 2.34 | 0.5 |

The present work considers three different traffic classes (NO_OF_TC=3) [5] as shown in Table 1, where class 1 has the highest priority and class 3 has the lowest priority. Accordingly w1, w2 and w3 are assumed as the weight factor for class 1, class 2 and class 3 type of traffic respectively depending up on their priority.
The average service time per traffic class is the ratio of average packet size and its' require capacity. Each MMN has three network interfaces such as GPRS (I), IEEE 802.11x (II) and WiMAX (III) having CoAs i1, i2 and i3 respectively (NO_OF_CoA=3). The maximum data rate is 70-75 Mbps for WiMAX, 54 Mbps for IEEE 802.11x and 172.2 Kbps for GPRS. Thus WiMAX, IEEE 802.11x and GPRS offer high, medium and low data rate respectively.

**Table 2. Possible ongoing sessions per traffic class**

| Traffic class | WiMAX | IEEE 802.11 | GPRS |
|---|---|---|---|
| 1 | 437-468 | 337 | 1 |
| 2 | 875-937 | 675 | 2 |
| 3 | 2800-3000 | 2160 | 6 |

The maximum number of possible ongoing sessions per traffic class in each network interface depends up on the required capacity per traffic class (Table 1) and the data rate of the network interface. It is shown in Table 2.

The maximum number of ongoing session is possible for class 3 type of traffic using WiMAX network interface and it is 3000 as observed from Table 2. So the maximum number of bits require for representing the possible number of ongoing sessions per traffic class is assumed as 12 (size_OF_OS).

The present work maintains a mobility management module (MMM) to store the active CoA(s) of all the MMNs and a session admission control module (SACM) to control the session admission at the 3 access networks. A network analysis module (NAM) is associated with each access network. NAM is able to detect the IP addresses of all the MMNs which are residing within the coverage area of its associated access network. It maintains an address list which contains the IP addresses of all such MMNs. It reserves resources per traffic class dynamically depending up on the priority of traffic and arrival probability of traffic in its associated access network. It also determines the performance of its associated access network in terms of resource utilization per traffic class and average delay per traffic class.

MMM reads the address list from all the 3 NAMs and determines the set of active CoA(s) of all the MMNs which are residing in the proposed heterogeneous wireless networks environment.

When a MMN wants to initiate a session, it sends network selection request message to SACM. The network selection request message for a session has three components as Node_id which is the identification of the requested MMN, desired traffic class of the requested MMN and number of packets associated with this session.

SACM reads the set of active CoA(s) of the requested MMN from MMM and reads the average delay of the desired traffic class from NAMs which are associated with the set of active CoA(s) of the requested MMN after receiving network selection request message. SACM selects a suitable CoA (sel_CoA) whose associated network has minimum average delay for the desired traffic class from the set of active CoA(s) of the requested MMN and sends the same network selection request message to NAM associated with sel_CoA ($NAM_{sel\_CoA}$).

If the unused resource which is available for the desired traffic class at the access network associated with sel_CoA is at least equal to the desired resource to establish the session, $NAM_{sel\_CoA}$ sends a positive acknowledgement to SACM and assigns resources to the requested MMN for establishing the session. Otherwise it sends a negative acknowledgement to SACM. SACM sends a network decision message to the requested MMN if it receives positive acknowledgement and increases the number of blocking sessions of the requested MMN by 1 if it receives negative acknowledgement. The network decision message has two components as Node_id of the requested MMN and sel_CoA.

The dynamic computation of the reserved resource at each network depends up on the arrival probability per traffic class which helps to reduce the blocking probability per network and packet loss per session. The MMN initiates a session using suitable CoA which is selected by SACM for the desired traffic class. It helps to balance the load among various wireless access networks which in turn helps to forward the packets of various traffic classes via suitable network interface. The forwarding of packets via appropriate network interface saves network resources, gives user satisfaction, and reduces wastage of resources.

## 2. PRESENT WORK

The function of NAM, MMM and SACM are considered for discussion in this section.

## 2.1 Function of NAM

The functions of the $Ni^{th}$ NAM (where $1 \leq i \leq 3$) associated with the $Ni^{th}$ network are considered for discussion in this section.

### *2.1.1 Maintenance of address list*

The IP address of each MMN has network identification (Net_id) component and MMN identification (Node_id) component. The Net_id component of an IP address changes when the corresponding MMN moves from one access network to another access network and Node_id component of an IP address remains stationary as proposed in [6]. The Net_id component of all the MMNs within the coverage area of the same network is identical and so each NAM maintains an address list which contains only the Node_id components of all the MMNs which are residing within the coverage area of its associated network. For example, the address list which is maintained by $Ni^{th}$ NAM is shown below.

| j1, j3, j6 |
|---|

Here Ni is the Net_id component and j1, j3, j6 are the Node_id components of the MMNs in the coverage area of the $Ni^{th}$ network. The IP addresses of these MMNs are Ni.j1, Ni.j3 and Ni.j6. It updates the address list in case of any handoff of MMN within its coverage area. Let the total number of MMN in the heterogeneous wireless networks environment be NO_MMN and the number of bits in Node_id component is $\log_2$(NO_MMN). So the required average storage space at each NAM for maintaining the address list is 1/3*(NO_MMN*$\log_2$(NO_MMN)) bits.

### *2.1.2 Resource reservation per traffic class*

The $Ni^{th}$ NAM maintains 3 counters as $Count_{1Ni}$, $Count_{2Ni}$, $Count_{3Ni}$ to count the number of network selection request message for class 1, class 2 and class 3 type of traffic respectively. So they also indicate the number of class 1, class 2 and class 3 type of sessions at $Ni^{th}$ network. It increases the value of $Count_{1Ni}$, $Count_{2Ni}$, $Count_{3Ni}$ by 1 with computation complexity O(NO_OF_TC) after sending a positive acknowledgement in response to the network selection request message of SACM for a class 1, a class 2 and a class 3 type of traffic respectively. So the arrival probability of class 1 ($AP_{1Ni}$), class 2 ($AP_{2Ni}$) and class 3 ($AP_{3Ni}$) type of traffic are $Count_{1Ni}/(Count_{1Ni}+Count_{2Ni}+Count_{3Ni})$, $Count_{2Ni}/(Count_{1Ni}+Count_{2Ni}+Count_{3Ni})$ and $Count_{3Ni}/(Count_{1Ni}+Count_{2Ni}+Count_{3Ni})$ respectively at $Ni^{th}$ network.

The available resource at $Ni^{th}$ network is ($C_{Ni}$) kbps. The $Ni^{th}$ NAM reserves a fraction of $C_{Ni}$ for class 1, class 2 and class 3 type of traffic dynamically depending up on their priority and their arrival probability at $Ni^{th}$ network with computation complexity O(NO_OF_TC). The reserved resource at $Ni^{th}$ network for class 1 ($R_{1Ni}$), class 2 ($R_{2Ni}$) and class 3 ($R_{3Ni}$) type of traffic are $AP_{1Ni}*w_1*C_{Ni}$, $AP_{2Ni}*w_2*(C_{Ni}-R_{1Ni})$ and $C_{Ni}-R_{1Ni}-R_{2Ni}$ respectively, where $w_1$ and $w_2$ are assumed as 3 and 2 during simulation.

### *2.1.3 Computation of network performance parameters*

The computation of the performance parameters of $Ni^{th}$ network by $Ni^{th}$ NAM is considered for discussion in this section.

$Ni^{th}$ NAM determines the performance of its associated network in terms of resource utilization ($RU_{Ni}$) and average delay ($Delay_{Ni}$). $RU_{Ni}$ is the ratio of used resource at Ni ($U_{Ni}$)

and $C_{Ni}$. $U_{Ni}$ is computed as $\sum_{p=1}^{3}(RC_p*Count_{pNi}*N\_pac_p)$ kbps where $RC_p$ is the resource capacity for $p^{th}$ traffic class, $Count_{pNi}$ is the counter value which is maintained for $p^{th}$ traffic class at $Ni^{th}$ network, and $N\_pac_p$ is the total number of packets corresponding to $p^{th}$ traffic class at $Ni^{th}$ network. $N\_pac_p=\sum_{t=1}^{CountpNi}(N\_pac_{tp}$, where $N\_pac_{tp}$ is the number of packets in the $t^{th}$ session of $p^{th}$ traffic class. $Ni^{th}$ NAM computes $RU_{Ni}$ and $U_{Ni}$ after establishing a session and also after terminating a session with computation complexity $O(NO\_OF\_TC*Count_{pNi})$.

**Table 3. List of active CoAs of all MMNs**

| Node_id | Set of active CoAs |
|---|---|
| j1 | (N1,N3) |
| j2 | (N2,N3) |
| j3 | (N1,N2,N3) |
| j4 | (N3) |
| j5 | (N2) |
| j6 | (N1) |

The $Ni^{th}$ NAM computes the service time for each ongoing session as the product of number of packets which are associated with that session and the average service time corresponding to the traffic class of that session as given in Table 1. It computes the delay per session as the difference of its termination time and service time.

The average delay at $Ni^{th}$ network for $p^{th}$ class of traffic ($D_{pNi}$) is $\sum_{k=1}^{CountpNi}(D_{pNik})/(Count_{pNi})$ where $D_{pNik}$ is the delay for $k^{th}$ session of $p^{th}$ traffic class with computation complexity $O(Count_{pNi})$.

It computes the delay per traffic class after terminating each session of the corresponding traffic class. The average delay of $Ni^{th}$ network is computed as $\sum_{k=1}^{CountpNi}(D_{pNik})/\sum_{p=1}^{3}(Count_{pNi})$ with computation complexity $O(Count_{pNi}*(NO\_OF\_TC^2))$.

## 2.2 Function of MMM

Let the address list at $Ni^{th}$ NAM contains j1, j3, j6 as Node_ids, at $N2^{th}$ NAM contains j2,j3,j5 as Node_ids and at $N3^{th}$ NAM contains j1, j2, j3, j4 as Node_ids. The MMM reads the address lists continuously and prepares the list of active CoAs of all the MMNs which are residing within the coverage area of all the three access networks in tabular form as shown in Table 3. The $q^{th}$ row in Table 3 is for $q^{th}$ node. The size of Table 3 is maximum if each node has 3 active CoAs. So the size of $q^{th}$ row ($Row\_q_3$) is $log_2(NO\_MMN)+NO\_OF\_NET*log_2(NO\_OF\_NET)$ bits. The size of Table 3 is $\sum_{q=1}^{NO\_MMN}Row\_q_3$.

As soon as MMM detects a change in any of the address list at NAMs due to handoff of MMNs it updates Table 3 and sends handoff message to SACM. The handoff message has two components as Node_id and Handoff_flag. The Handoff_flag component is set to 1 to indicate the occurrence of vertical handoff of the MMN which is identified by the Node_id component of handoff message.

## 2.3 Function of SACM

The functions of SACM are considered for discussion in this section.

### *2.3.1 Selection of suitable CoA*

Let the $j1^{th}$ MMN sends a network selection request message in the form (j1, 2, X) to SACM. SACM reads (N1, N3) as the set of active CoAs of $j1^{th}$ MMN ($Active\_CoA_{j1}$) from Table 3. It also reads $D_{2N1}$ and $D_{2N3}$ from $N1^{th}$ and $N3^{th}$ NAM respectively. If $D_{2N1}$ is greater than $D_{2N3}$, SACM selects $N3^{th}$ CoA as sel_CoA for class 2 type of traffic of $j1^{th}$ MMN; otherwise it selects $N1^{th}$ CoA as sel_CoA. If $D_{2N1}$ and $D_{2N3}$ are equal, SACM selects one of the CoAs randomly as sel_CoA with computation complexity $O(Active\_CoA_{j1})$. It sends the same network selection request message to $NAM_{sel\_CoA}$. $NAM_{sel\_CoA}$ computes the desired resource for the requested session of $j1^{th}$ MMN as $RC_2*X$ kbps where $RC_2$ is the required capacity for class 2 type of traffic as given in Table 1 and X is the total number of packets in the requested session as specified in network selection request message of $j1^{th}$ MMN. If the unused resource at the selected network associated with sel_CoA for class 2 type of traffic is at least equal to the desired resource, $NAM_{sel\_CoA}$ establishes the session and sends a positive acknowledgement to SACM; otherwise it sends a negative acknowledgement to SACM. SACM sends network decision message in the form (j1, sel_CoA) to $j1^{th}$ MMN if it receives a positive acknowledgement. It increases the number of blocking sessions of $j1^{th}$ MMN ($B_{j1}$) by 1 if it receives a negative acknowledgement.

### *2.3.2 Details of ongoing sessions*

SACM maintains the details of ongoing sessions in tabular form as shown in Table 4. The details of ongoing sessions for $j1^{th}$ MMN and for $j2^{th}$ MMN are shown in Table 4. The number of column in Table 4 is 5 ($NO\_OF\_COL_4$). Each row in Table 4 has a few records and it is for a particular MMN which is identified by Node_id attribute of the records. The number of row in Table 4 is NO_MMN. The number of records in each row depends up on the number of different types of traffic classes which are associated with the ongoing sessions of the corresponding Node_id ($NO\_OF\_TC_{Node\_id}$). For example $j1^{th}$ MMN has ongoing sessions for all the three traffic classes and so the corresponding row in Table 4 has 3 records ($NO\_OF\_TC_{j1}=3$). But $j2^{th}$ MMN has ongoing sessions for class 1 and class 3 type of traffic. So the corresponding row in Table 4 has 2 records ($NO\_OF\_TC_{j2}=2$). The size of the user satisfaction attribute in each record is assumed as 32 bits (size_OF_US). The $q^{th}$ row in Table 4 is for the $q^{th}$ Node_id and the size of the $q^{th}$ row ($Row\_q_4$) is $log_2(NO\_MMN)+size\_OF\_US+NO\_OF\_TC_q*[log_2(NO\_OF\_TC)+size\_OF\_OS+log_2(NO\_OF\_NET)]$ bits. So the size of Table 4 is $\sum_{p=1}^{NO\_MMN}(Row\_q_4)$ bits. After receiving a positive acknowledgement from $NAM_{sel\_CoA}$ in response to the network selection request message, SACM searches Table 4 using Node_id which is specified in the network selection request message as the search key with computation complexity $O(log_2NO\_MNN)$. If not found it inserts a new row in Table 4 with computation complexity $O(NO\_OF\_COL_4)$. Otherwise it searches the traffic class attribute of the records in the existing row for the traffic class as identified in the network selection request message with computation complexity $O(NO\_OF\_TC_{Node\_id})$. If not found SACM inserts a record in the existing row with computation complexity $O(NO\_OF\_COL_4)$. Otherwise it increases the number of sessions per traffic class attribute in the record corresponding to the traffic class of the network selection request message by 1 with computation complexity O(1). For example, let the $j1^{th}$ MMN sends a network selection request message for class 3 type of traffic and $j2^{th}$ MMN sends a network selection request message for class 2 type of traffic. SACM searches Table 4 for $j1^{th}$ MMN and for $j2^{th}$ MMN. It increases $O_{3j1}$ by 1 in the row which is associated with the $j1^{th}$ MMN whereas it inserts a new record in the row which is associated with the $j2^{th}$ MMN in Table 4. SACM deletes a particular row from Table 4 if the ongoing session of the traffic class corresponding to that record is over.

**Table 4. Ongoing sessions**

| Node_ids | Traffic class | Number of Sessions per Traffic class | Selected optimal CoA | User Satis-faction |
|---|---|---|---|---|
| j1 | 1<br>2<br>3 | $O_{1j1}$<br>$O_{2j1}$<br>$O_{3j1}$ | N1<br>N3<br>N1 | $US_{j1}$ |
| j2 | 1<br>3 | $O_{1j2}$<br>$O_{3j2}$ | N2<br>N3 | $US_{j2}$ |

The size of a particular session is computed by SACM as the product of the number of packets of that session and size of packet depending up on its traffic class type as given in Table 1. SACM computes the throughput per session as the ratio of the size of this session and its termination time. The average throughput of the system is the ratio of the sum of throughput of all the sessions and the number of sessions. Let $B_{j1}$ be the total number of blocking sessions for $j1^{th}$ MMN. It computes the blocking probability of $j1^{th}$ MMN ($BP_{j1}$) as $B_{j1}/(O_{1j1}+O_{2j1}+O_{3j1})$ and user satisfaction of $j1^{th}$ MMN ($US_{j1}$) as 1 - ($BP_{j1}$). The complexity to compute the blocking probability and user satisfaction is O(NO_MMN). It computes the user satisfaction of all Node_ids in Table 4 and arranges the rows in Table 4 in the ascending order of user satisfaction with computation complexity O(NO_MMN$^2$). So $US_{j1}<US_{j2}$. If SACM receives multiple network selection request message from multiple MMN simultaneously it processes the network selection request message of the MMN having minimum user satisfaction. For example, let SACM receives the network selection request message from $j1^{th}$, $j2^{th}$ and $j7^{th}$ Node_ids. It searches Table 4. It observes from Table 4 that $US_{j1}<US_{j2}$. The $j7^{th}$ Node_id is a new MMN and so it has maximum user satisfaction. The SACM processes the network selection request message of $j1^{th}$ Node_id.
Let a vertical handoff occurs for $j1^{th}$ MMN from the coverage area of network N1 to the coverage area of network N2. The $N1^{th}$ NAM deletes the Node_id j1 from its address list and $N2^{th}$ NAM inserts the Node_id j1 in its address list. The MMM detects such vertical handoff of $j1^{th}$ MMN from the address lists which are maintained by $N1^{th}$ NAM and $N2^{th}$ NAM. MMM searches Table 3 for $j1^{th}$ Node_id with computation complexity $\log_2$(NO_MMN) and updates the record of $j1^{th}$ Node_id in Table 3 by replacing the old set of active CoAs (N1,N3) by the new set of active CoAs (N2,N3) with computation complexity O(1). It sends a handoff message in the form (j1,1) to SACM. SACM searches Table 3 for the new set of active CoA(s) of $j1^{th}$ MMN which is (N2,N3) with computation complexity O(log2(NO_MMN). It also determines from Table 4 that the $N1^{th}$ CoA is the selected optimal CoA in 2 records (NO_OF_REC), one for $O_{1j1}$ number of sessions of class 1 type of traffic and the other for $O_{3j1}$ number of sessions of class 3 type of traffic of $j1^{th}$ MMN. SACM selects an alternative CoA (alt_CoA) (as discussed in section 2.3.1) from the new set of active CoAs (N2,N3) of $j1^{th}$ MMN with computation complexity O(Active_CoA$_{j1}$) for the continuation of its $O_{1j1}$ and $O_{3j1}$ number of ongoing sessions. Accordingly it updates the selected CoA attribute of the $1^{st}$ and $3^{rd}$ record in the row which is associated with $j1^{th}$ MMN in Table 4 by replacing N1 by alt_CoA with computation complexity O(NO_OF_REC).

# 3. SIMULATION RESULTS

The performance of the proposed scheme is studied on the basis of percentage of network usage, percentage of resource utilization, blocking probability of the system, throughput of the system and bandwidth management. Fig.1 shows the plot of the percentage of network usage vs. traffic load, Fig.2 shows the plot of the percentage of resource utilization vs. traffic load, Fig.3 shows the plot of blocking probability of the system vs. traffic load, Fig.4 shows the plot of average throughput vs. simulation time and Fig.5 shows the plot of bandwidth management vs. resource utilization. The traffic load is computed as the ratio of session request arrival rate and session request departure rate. At low traffic load most of the resources of all the three networks are free. So both the percentage of network usage and the percentage of resource utilization increase slowly with traffic load for all the three networks.
The amount of the reserved resource per network per traffic class is proportional to its arrival probability and so most of the reserved resources of the three networks are utilized to process the sessions of the three different traffic classes. At high traffic load all the three networks are saturated. So the percentage of network usage starts to reduce and the percentage of resource utilization becomes maximum. The high data rate of WiMAX network satisfies maximum MMNs up to a heavy traffic load. So it has maximum percentage of network usage and resource utilization. The blocking probability of the system is minimum up to a traffic load 1000. After this it increases rapidly with traffic load. The system throughput is maximum due to minimum blocking probability at low simulation time. At high simulation time it decreases slowly due to high blocking probability. The rate of decrease of the system throughput at high simulation time is lesser due to the high data rate of WiMAX network. The available bandwidth of all the three networks is reserved dynamically for all the three classes of traffic which helps to utilize the available resource efficiently.

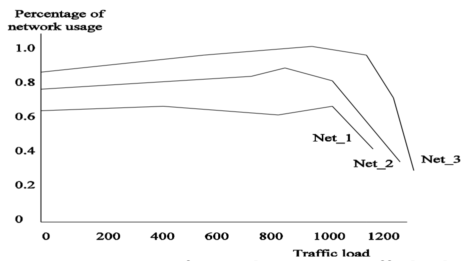

Fig.1 Percentage of network usage vs. traffic load

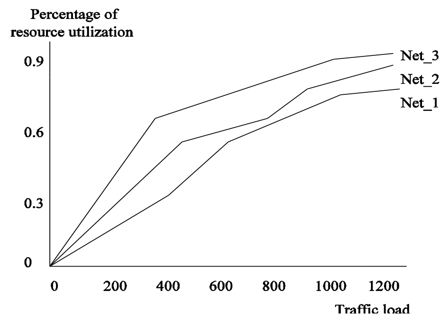

Fig.2 Percentage of resource utilization vs. traffic load

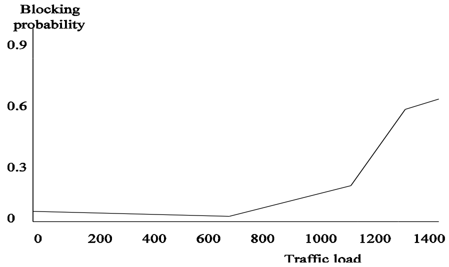


**Fig.3 Blocking probability of the system vs. traffic load**

The performance of the proposed scheme is compared with the schemes [7,8] on the basis of blocking probability and is presented in tabular form as shown in Table 5(i). It can be observed from Table 5(i) that the present scheme has less blocking probability even though it is simulated up to a high traffic load in compared to the schemes [7,8]. It is also compared with the scheme [9] on the basis of maximum throughput and is presented in tabular form as shown in Table 5(ii).

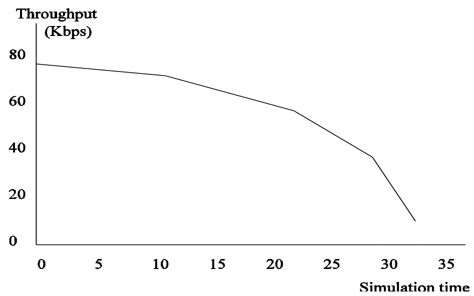


**Fig.4 Average throughput of the system vs. simulation time**

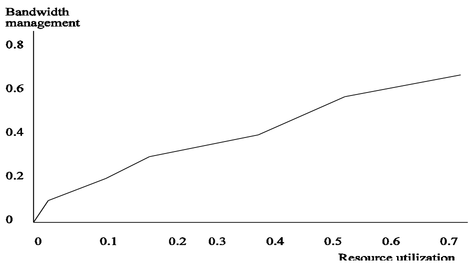


**Fig.5 Bandwidth management vs. resource utilization**

**Table 5(i). Comparison**

| Reference | Traffic load | Blocking probability |
|---|---|---|
| 7 | $10^{-1}$-$10^{1}$ | 0-1 |
| 8 | $10^{-1}$-$10^{3}$ | 0.8 |
| Present | 0-1400 | 0.6 |

**Table 5(ii). Comparison**

| Reference | Maximum Throughput (kbps) |
|---|---|
| 9 | 4 |
| Present | 80 |

## 4. CONCLUSION

The present work is the combination of dynamic mobility management and resource management for a MMN in heterogeneous wireless networks environment. It uses NDM to forward the packets of various sessions to the appropriate network interface. The MMM detects the occurrence of vertical handoff of each MMN. The NAM maintains an address list to help MMM for the detection of vertical handoff of MMN and determines the performance parameters of its associated network to help NDM for the selection of the optimal CoA for the session initiation of MMN.

The present work may be extended by determining the blocking probability for new session request and dropping probability for handoff session request separately. It helps to determine to what extent the proposed scheme is able to support vertical handoff in the heterogeneous wireless networks environment.

## 5. REFERENCES

[1] C.-T.Chou and K.G.Shin, “Analysis of combined adaptive bandwidth allocation and admission control in wireless networks”, IEEE Conference on Computer Communications (INFOCOM), pp.676-684, 2002.

[2] C.W.Ahn and R.S.Ramakrishna, “QoS provisioning dynamic connection admission control for multimedia wireless networks using a Hopfield neural network”, IEEE Transactions on Vehicular Technology, no.53, vol.1, pp.106-117, 2004.

[3] T.Zhang, E.v.d.Berg, J.Chennikara, P.Agrawal, J.-C.Chen and T.Kodama, “Local predictive resource reservation for handoff in multimedia wireless IP networks”, IEEE Journal on Selected Areas in Communications, no.19, vol.10, pp.1931-1941, 2001.

[4] W.Shen and Q-A. Zeng, “Resource allocation schemes in integrated heterogeneous wireless and mibile networks”, Journal of Networks, no.5, vol.2, pp.78-86, 2007.

[5] C-H. Wang, “Bandwidth Allocation and QoS Routing for Heterogeneous Networks”, Applied Mathematical Sciences, vol.1, no. 43, pp.2139-2151, 2007.

[6] P. Vidales, L.Patanapongpibul, G.Mapp and A.Hopper, “Experiences with heterogeneous wireless networks, unveiling the challenges”, Second International working conference on performance modelling and evaluation of heterogeneous networks, HET-NETs04.

[7] F.Zhu and J.McNair, “Multiservice Vertical handoff Decision Algorithms”, EURASIP Journal on Wireless Communications and Networking, pp.1-13, vol.2006.

[8] S.Mitra, “Policy Based Admission Control and Handoff Decision Algorithm for Next Generation All-IP Wireless Network”, vol.2, pp.594-599, IEEE ICECE 2008.

[9] S.Sharma, I.Baek, Y.Dodia and T-C. Chiueh, “Omnicon: A mobile IP-based vertical handoff system for wireless LAN and GPRS links”, Software-Practice and Experience, no.1, vol.37, pp.779-798, 2007