Realization Of Gateway Relocation Using AC And LB Algorithms In Mobile Wimax Networks

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Abstract:

The WiMAX Forum has defined a two-tiered mobility management to minimize handover delay and packet loss. However, it leads to another problem: When to perform ASN GW relocation? The standards only define the ASN GW relocation procedures without specifying when the ASN GW relocation should be performed. It is left for vendors and operators to develop their own proprietary solutions. In this paper, we propose an algorithm, which incorporates traditional Admission Control (AC) and Wiener Process (WP)-based prediction algorithms to determine when to carry out ASN GW relocation. We further develop an analytical model to analyze the proposed algorithm. Simulations are also conducted to evaluate the performance of the proposed algorithm. The results show that the proposed algorithm can improve the performance significantly in terms of blocking probability, dropping probability, average serving rate, and average signaling overhead. The performance is checked with hard handoff and compared with the existing system.

Keywords: Admission control Wi-MAX networks, Mobility management, resource management, statistics and stochastic process and wireless networks

1. Introduction:

The IEEE 802.16-series standards [1], [2] are expected to provide broadband wireless access for a variety of multimedia services. The working group standardizes physical (PHY) layer and Medium Access Control (MAC) layer only. To build a complete system, higher layers are still necessary. One of the major objectives of WiMAX Forum thus, is to develop and standardize the WiMAx Forum Network Architecture [4],[5],[6] ,[7] which is evolving into Internet Protocol (IP)-based Service Network (ASN) which provides wireless radio access for WiMAX subscribers. It consists of one ASN Gateway (ASN GW) and many base stations (BSs). Each ASN is connected to Connectivity Service Network (CSN), which provides IP connectivity services. To support IP mobility, Mobile IP (MIP) 1 is adopted. The Home Agent (HA) of a Mobile Station (MS) is located in the CSN of the MS's Home Network Service Provider (H-NSP). In the shown fig :1 there takes place two mobility's:
They are as follows

i) ASN Anchored mobility
ii) CSN Anchored mobility

ASN Anchored Mobility refers to MS's movement between BSs that belong to the same or different ASN GWs. In ASN Anchored Mobility, the context of the designated MS is transferred from the previous BS to the new BS. Without performing CSN Anchored Mobility, ASN Anchored Mobility can minimize handover delay and packet loss.An MS may perform intra-ASN handover (e.g., changing from Flow (1) to Flow (2) in Fig. 1) while still attaching to the same ASN GW. In addition, an MS may perform inter-ASN handover (e.g., changing from Flow (2) to Flow (3) in Fig. 1) where the ASN GW A is the traffic anchor point and responsible for ASN CSN tunneling. That is, traffic is still sent to ASN GW A, which then further tunnels traffic to ASN GW B. In Flow (1) and Flow (2), the MS is called Serving MS of ASN GW A. In Flow (3), the MS is called Anchored MS of ASN GW A and handover MS of ASN GW B. In such case, the ASN GW A and ASN GW B are called anchored ASN GW and Serving ASN GW, respectively. CSN Anchored Mobility refers to the process of changing the traffic anchor point and is independent of the MS's link layer handover [4]. It is also called ASN GW relocation. For example, if CSN Anchored Mobility is not performed, when the MS roams from ASN GW B to ASN GW C in Fig. 1, ASN GW A will tunnel traffic to ASN GW C. The MS is still served by two ASN GWs (ASN GW A and ASN GW C). As aforementioned discussion, the MS is called Anchored MS of ASN GW A.

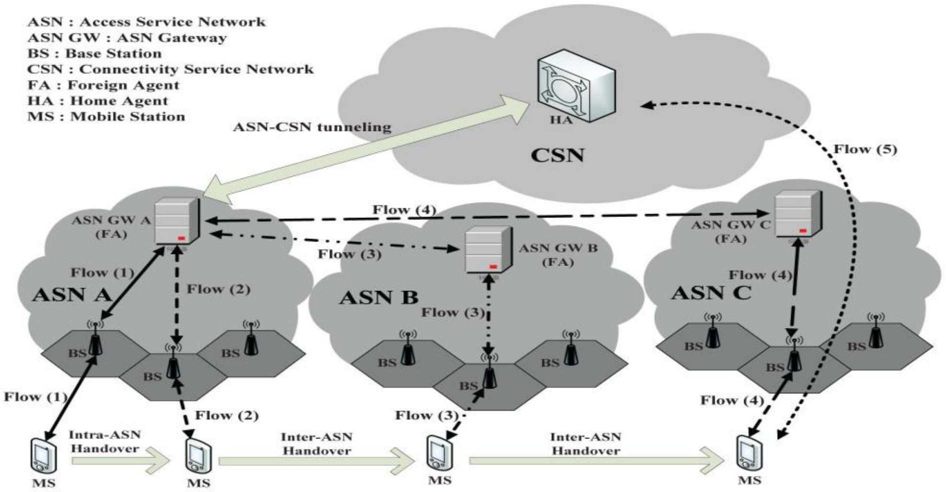


Fig: 1 ASN Anchored Mobility and CSN Anchored mobility in WiMAX Networks

The ASN GW A may request the MS to carry out CSN Anchored Mobility, i.e., ASN GW relocation. This may happen due to the heavy load of the ASN GW A, to reduce end-to-end latency, or for resource optimization purposes [4], [5]. After performing ASN GW relocation, the traffic anchor point is changed to ASN GW C. The MS then is not served by ASN GW A. This is shown in Fig. 1 after changing from Flow (4) to Flow (5).

2. Algorithms

2.1 Gateway Relocation Admission Control Algorithm (Grac)

The ASN GW relocation may be initiated at different times with different reasons. For example, as aforementioned discussion, an MS may perform ASN Anchored Mobility without performing CSN Anchored Mobility to reduce handover latency. After the handover is completed (i.e., the handover delay has been reduced), the MS may perform ASN GW relocation immediately so the number of Anchored MSs can be kept small. However, it may not be a good strategy always to relocate an Anchored MS so quick. For example, an MS may move fast and keep changing its Serving ASN GW. In this example, it might be better to keep the Anchored ASN GW unchanged. In some other examples, if the system load is light, there is no emergent need to perform ASN GW relocation. However, when more and more MSs are served by two ASN GWs, the system load will become heavy. New users may be blocked. Handover users may be dropped as well. The network performance may be reduced significantly. Therefore, performing ASN GW relocation is essential. In WiMAX standards [4], [5] it is specified that ASN GW can decide when to perform ASN GW relocation. In this paper, we consider that the system load is heavy so Anchored MSs are forced to perform ASN GW relocation. The proposed GRAC determines when to request Anchored MSs to perform ASN GW relocation and how many Anchored MSs should be relocated. After ASN GW relocation, resources are released and system performance is improved.

The proposed algorithm does not need to exchange information between neighboring ASN GWs. It also does not require centralized coordination and any assistance from extra servers. In addition, the proposed algorithm does not need to predict the movement of the mobile stations. It combines AC algorithm with a prediction technique to determine when is necessary to perform ASN GW relocation. Thus, it is called Gateway Relocation AC (GRAC).

2.2 New call bounding algorithm

The GRAC can work with any AC algorithm. In this section, we simply pick up the new call bounding algorithm. For simplicity, here we assume that the resource assigned to each MS in one ASN GW is equal. The main point is not on a specific AC algorithm. The focus is on how to modify an AC algorithm for the two-tier mobility management in WiMAX. The proposed GRAC with the new call bounding Algorithm will limit the number of Serving MSs and Anchored MSs in one ASN GW. The maximum number of MSs in the network and Tncb is the limit for the number of new MSs, which have been admitted into the network. when a new call enter the network it will either accepted or dropped based on the network resource availability.

2.3 WP-based prediction algorithm

In the above algorithm, we can set C0 as C because a new coming MS can be queued until the resource is available after ASN GW relocation is completed. However, this approach cannot be applied to handover MSs because handover MSs are sensitive to handover latency. The acceptable handover delay is much less than the queuing delays of a new MS. Assuming that a handover MS arrives and C is reached. If the handover MS needs to wait for the ASN GW relocation of one Anchored MS, the handover latency will be too high. Actually, if ASN GW relocation is performed just when a handover MS arrives, it is equivalent to performing both ASN Anchored Mobility and CSN Anchored Mobility. The handover latency cannot be reduced. On the other hand, one may perform ASN GW relocation much earlier than C is reached. However, this may force many Anchored MSs to perform ASN GW relocation, which may not be preferable as already discussed earlier. Thus, for handover MSs, it is critical to perform ASN GW relocation at an appropriate time. Therefore, we propose a prediction algorithm based on Wiener Process (WP) which provides a systematic way to determine when to request Anchored MSs to perform ASN GW relocation. In addition, the algorithm can also estimate how many Anchored MSs should be relocated. The proposed algorithm is simple and accurate.

Wiener Process has been proven effective in modeling Stochastic processes where the values of the random variables are affected by a large number of independent or weakly dependent factors, each with a relatively small impact [18]. The W (t) we want to model is impacted by a large number of factors. These factors are either independent or weakly dependent of each other. For example, W (t) is impacted by the arrival rate of new MSs, arrival rate of handover MSs, average connection holding time, average network residence time, and so on.

2.4 Load balancing algorithm(LB)

The load balancing algorithm will reduce the overload of packets and reduce the blocking and dropping of the packets. After the handover is completed (i.e., the handover delay has been reduced), the MS may perform ASN GW relocation immediately so the number of Anchored MSs can be kept small. Here the load balancing is done with the hard handoff. Here once the gateway is overloaded then the entire gateway is relocated immediately, therefore the mobile users can communicate with the new gateways. Because of the gateway relocation the dropping and blocking of packets will be reduced. Hence the average serving rate of the packets within the network will be increased. Hence the performance of the network will also be increased.

3. Performance analysis

We propose an analytical model to investigate the performance of the proposed algorithm. In the analysis, the connection holding time is defined as the time from an MS connects to the network until it is disconnected. The network residence time is the time an MS is served by an ASN GW. We assume each ASN GW has two arrival processes which are Poisson distributed with rate λn and λh for new MSs and handover MSs, respectively. If a new MS is admitted into the network, we assume the connection holding time and network residence time follow exponential distribution with mean $1/\mu c$ and $1/\mu n$, respectively. For a handover MS, only network residence time is required. It is also assumed to be exponentially distributed with mean $1/\mu n$ .To analyze the proposed GRAC, there are three major factors are —the number of Serving MSs, the number of handover MSs, and the number of Anchored MSs. Intuitively, a 3-D Markov chain may be used to investigate the performance. Unfortunately, the computational complexity of a 3-D Markov chain will be increased dramatically when the number of MSs in the system becomes large.

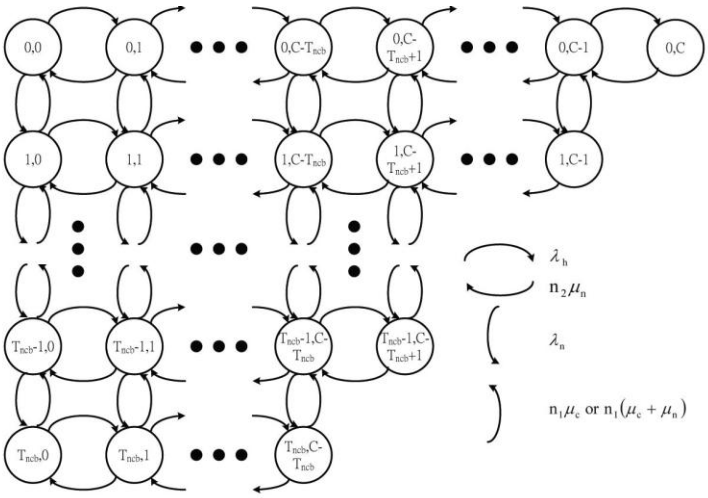


Fig: 2-State transition diagram

Upper bound: If we assume each MS never performs ASN GW relocation, it will always be served by two ASN GWs. For each ASN GW, the average service time of new MSs is 1/µc. That is, the MSs will stay in the ASN GW for the duration of whole connection holding time. It will result in the highest blocking probability for new MSs and dropping probability for handover MSs.

Lower bound**:** If each MS always performs ASN GW relocation immediately after each inter-ASN handover, the average service time of new MSs becomes 1/ (µc + µn) for each ASN GW

4.Numerical Results

The analysis is validated by extensive simulations by using Network Simulator-version 2 (ns-2). The analytical results of both upper-bound and lower-bound cases are close to the simulation results. In addition to the upper-bound analysis and lower-bound analysis, we also provide simulation results for the proposed GRAC with WP-based prediction. The parameters and values used in simulations are listed in Table:1.The following sections present the results with various performance metrics. The results are based on exponential distribution for connection holding time and network residence time. We have also conducted simulations by using gamma distribution to model connection holding time and network residence time with mean 1/µc and 1/µn

TABLE: 1 Parameters for simulation

Parameter	Value
C	50
T_{ncb}	25
$1/\mu_c$	1000 (s)
T_{wnr}	45
τ	5 (s)
k	25
α	$N(0,1)$

C: Maximum number of MSs in one ASN GW
Tncb: Threshold for blocking a new MS
1/µc: Average connection holding time for new MSs
Twnr: Threshold for carrying out WP-based prediction
T: Sampling time interval
K: Number of latest samples
α: Standard normal random variable

4.1 Blocking probability of New MSs

The blocking probability of new MSs when λn is varied from 0.01 (1/s) to 0.1 (1/s). We set λh= 0:04 (1/s) and 1/µn = 400 (s). As expected, for both upper-bound and lower-bound cases, the blocking probability increases significantly when λn increases. Nevertheless, Fig. 4 shows that the blocking probability of the proposed GRAC is close to that of the lower-bound case regardless of the value of Δt. This is because our algorithm can appropriately request Anchored MSs to perform ASN GW relocation when a new MS arrives. We also investigate the blocking probability with Different mean network residence time, 1=µn. In this case, we choose λn = 0.04 (1/s) and λh= 0.04 (1/s). When 1/µn increases, the MSs will be served by the ASN GW longer. Thus, they perform inter-ASN handover less. Therefore, the blocking probability in the lower-bound case and the proposed GRAC is increased even if λn and λh are fixed. On the other hand, because the new MSs never perform ASN GW relocation, the blocking probability of the upper-bound case is irrelevant to 1/µn. Therefore, it remains constant. Comparing the upper-bound case with the lower-bound case, when 1/µn is much lower than 1/µc, many new MSs become Anchored MSs. The incoming new MSs can be accepted easily by requesting the Anchored MSs to perform ASN GW relocation in the lower-bound case. Here HH referred to as Hardhandoff.

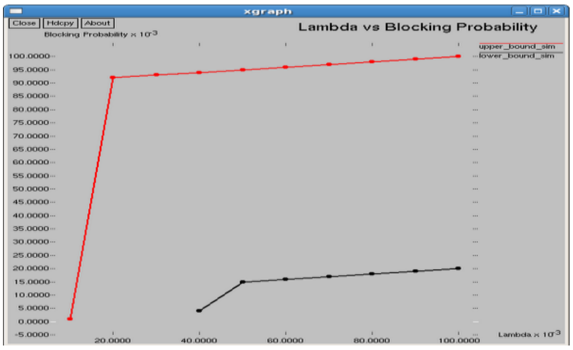


Fig: 3 Arrival rate vs. Blocking probability with AC with LB (HH)

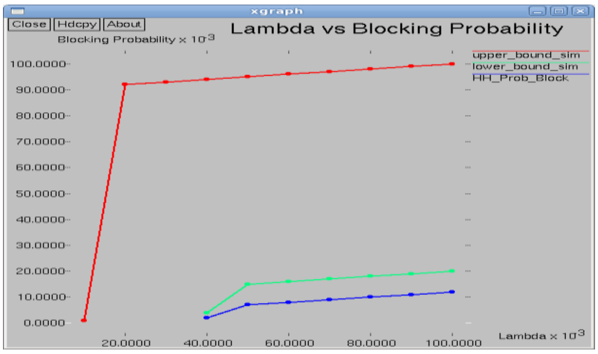


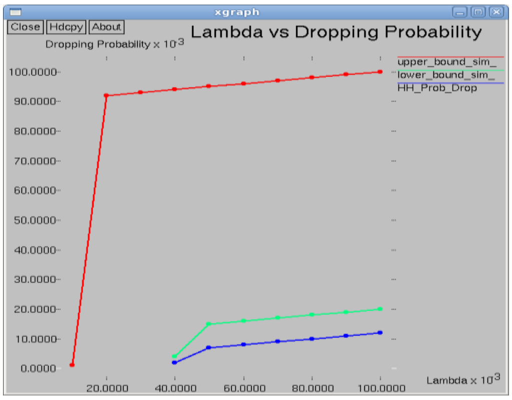
Fig :4 Arrival rate vs blocking probability

4.2 Dropping Probability of Handover MS

The dropping probability of handover MSs when λn is varied from 0.01 (1/s) to 0.1 (1/s) we set λh = 0.04 (1/s) and 1/µn= 400 (s). When λn increases, i.e., there are more MSs in the system, the dropping probability increases too. The handover MS is dropped when C in the AC algorithm is reached. In the proposed GRAC, however, the WP-based prediction is sensitive to the variation of the samples. The Anchored MSs are requested to perform ASN GW relocation when the system is expected to be overloaded. Thus, the dropping probability of handover MSs is reduced significantly. Thus, they perform inter-ASN handover less. Therefore, the dropping probability is increased even if λn and λh are fixed. The dropping probability of the upper-bound case is also increased. This is because the handover MSs are also served by one ASN GW longer. In addition, in the proposed GRAC, the dropping probability of Δt=10 (s) is lower than that of Δt = 5 (s).

4.3 Average Serving Rate

The average serving rate is defined as the average number of MSs served by an ASN GW per minute. It includes both new MSs and handover MSs. The average serving rate versus λn, where λn is varied from 0.01 (1/s) to 0.1 (1/s). We choose λh = 0.04 (1/s) and 1/µn = 400 (s). The upper-bound case and lowerbound case are almost equal when λn ≤ 0.02 (1/s). This is because the blocking and dropping probabilities are small in both cases. However, when λn increases, the average serving rate of lower-bound case increases faster than that of upper-bound case. This is because the blocking and dropping probabilities in the upper-bound case are higher than those in the lower-bound case. Thus, less MSs are served in the upper-bound case. Please also note that the average serving rate of the proposed GRAC is very close to that of the lower-bound case.



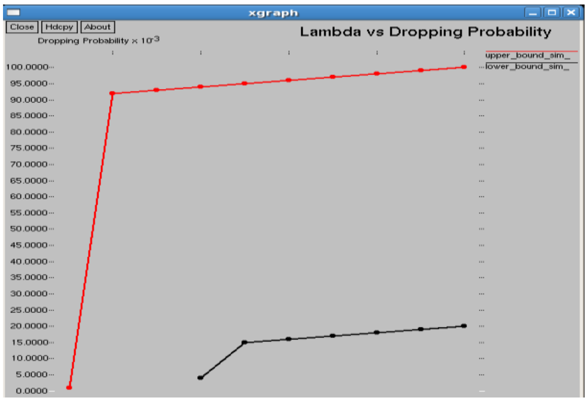


Fig: 5 Arrival rate vs dropping probability with AC. **Fig:6 Arrival rate vs dropping probability**
with LB(HH).

4.4 Average Signaling Overhead

The average signaling overhead per minute versus λn, where λn is varied from 0.01 (1/s) to 0.1 (1/s). We set λh = 0.04 (1/s) and 1/µn = 400 (s). The amount of signaling traffic generated by executing CSN Anchored Mobility can be measured by the number of ASN GW relocation performed in the system. As, the signaling overhead of the upper-bound case is 0, because new MSs never perform ASN GW relocation in the upper-bound case. In the lower-bound case, the signaling overhead is increased when λn increases. However, the signaling overhead of the proposed GRAC is always lower than that of the lower-bound case. This is because with WP based prediction, the proposed GRAC can request ASN GW relocation only when the system is expected to be overloaded. Furthermore, we also investigate the average signaling overhead with different mean network residence time, 1/µn. We still set λn = 0.04 (1/s) and λh = 0.04 (1/s). Again, the signaling overhead of the upper bound case is 0

5.conclusion

In WiMAX standards, an ASN GW can decide when to perform ASN GW relocation. In this paper, we consider that the system load is heavy hence more number of packets will be either blocked or dropped. In order to reduce that the we can increase the threshold value and the capacity of the network using load balancing algorithm.It is done with the Hard handoff. Hence here the capacity and threshold has been increased than in the existing system using hard handoff.The numerical results show that the proposed algorithm can effectively reduce the blocking probability, dropping probability, and average signaling overhead. It also increases the average serving rate. Hence we compare the proposed system with the existing system.

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