

QoS Handover Scheme for UMTS-WLAN Handover using 802.21 Standards

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ABSTRACT: IEEE 802.21 is the Media Independent Handover (MIH) standard which supports vertical handover across heterogeneous networks. To predict handover requirements a cross layer scheduling scheme is proposed to find Link Going Down information from MIH. Further to improve the performance of Quality of Service (QoS) enabled transport services which have the limited radio spectrum available for handover in a heterogeneous network environment. Simulation results shows proposed scheme can effectively increase the effective range of QoS sensitive services at the cell border along executing the handover in heterogeneous environment.

KEYWORDS: IEEE 802.21, Media Independent Handover (MIH), QoS in heterogeneous handover, UMTS-WLAN handover

I. INTRODUCTION

Now a days we can see that users are having multi-mode wireless devices which allows them to connect to multiple access networks having different characteristics as per the radio access technology (RAT). RAN is the Radio Access Network. Mobile terminals transfers the communication sessions from one (RAN) to another. This process is known as handover. Therefore the process is required to make a handover decision among the available networks. This should take RAN's characteristics, application requirements as well as device capabilities into the consideration. Handover is a process where mobile nodes obtains facilities and preserves the traffic flows upon occurrence of a link switch event. Type of link switch event of handover can vary upon mechanisms and protocol layer. There are several access technologies are available to switch from cellular to wireless local area networks.

According to this survey from 2007 [23], the deployment of WiMAX technology is on an exponentially rising curve, with a predicted 5-fold increase in North America and Europe, and a 15-fold increase in the Asia Pacific and Africa/Middle East regions by 2012. City-wide WiFi coverage has also become a common phenomenon [24].

Motivation: Popularity of multi-mode mobile devices is increasing therefore simultaneous handover and switching of networks would frequently occur. This can be possible due to change of location by the user or when network becomes congested. In both conditions best possible network should be available. The algorithm which provides a better handover for network selection should also consider various uses at a time for a given particular area. For example a group of users having same requirements of connectivity passing through same region at a particular time and using the same kind of applications, like students at college area. The student's requirement likely to have similar uses of network as far as cheaper price and high bandwidth is considered. Another example the professionals seating inside conference hall who needs to check email and content of news without clips. The mobile device performing all these switching mechanism for connectivity, need not to be controlled by users.

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II. PROBLEM STATEMENT

Having considering the examples of need of connectivity. The mobile device should connect the best possible network for a particular given time and also consider the other operating mobile devices in that area.

Objectives:The objectives are to produce handover mechanism that

- Quality of Service (QoS) for a user
- Works better alternative services having multiple users.
- Has coordination in complexity of algorithm and simple computation.
- The practically viable and relevant process for handover.
- Making of access performance and handover scenes.
- Implementation of comparative result algorithm and conclusion

Simulation framework NS and NS2 add-ons have been used for this work to accomplish which is passing through continuous enhancement during development of this work.

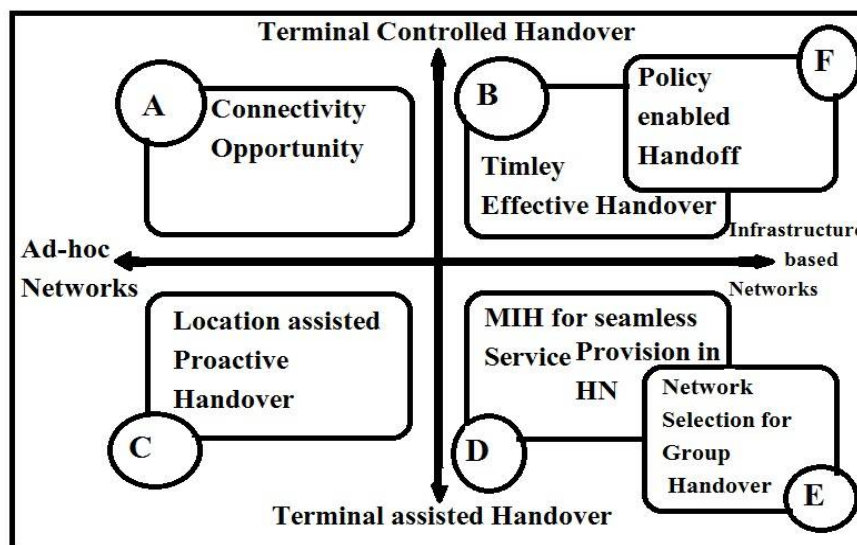


Figure 1- Directions in vertical handover event

Quality Provisioning: Efficient multi user handover algorithm performing best possible selection of the network which provides Quality of Service (QoS) to several users in the given area. This is Quantified Adaptive Delay Selection (QADS) handover. QADS consists of creative solution to enhance the Quality of Service where the users have similar Radio Access Network requirements and perform handover simultaneously. QADS focuses on selection decisions of terminal controlled network and gives weightage to handover of multiple users with respect to moving of them from one Radio Access Network to another.

Focus on Multiple Users: The network selection algorithm would be designed in manner that adopt the various conditions of network and also knows the decision of users influences these conditions.

The Quality of Service is the main aim of the algorithm for handover process which needs to go through simultaneous handover and random distributed nodes across multiple networks having no discrimination.

The need of Handover: heuser wants and choose network which provides best Quality of Service in a heterogeneous environment. It is essential that a one choice is not sufficient because terminals have mobility which enters and exits coverage of network area having speeding motion. Network Quality is majorly instable due to non-predictability environment which is not constant. It also faces situation where medium blocked by large obstacle suddenly prevents waves. Along the other devices which also passes through dynamic handover process.

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With various applications of the node changes time to time with changing environment and need of network. But in all these conditions the handover must be seamless by the terminal nodes and temporary to a given user.

Stages of Handover: Handover process passes through three steps:

1. Network Discovery: It identifies the networks in range of a device. It scans the medium to discover network availability.
2. Network Selection: Among the available networks, terminal network does the choice to connect. Terminal can be connected to subset in time.
3. Handover: This is the actual process where switching of data sessions from one network to other occurs.

III. LITURATURE SURVEY

The QADS implementation makes use of the Media Independent Handover, IEEE 802.21 standard [2]. The purpose of MIH is to enable the handover of IP sessions from one access technology to another, thus achieving mobility of end user devices. Recently this area of handover in heterogeneous wireless networks has seen increased interest.

A. D. Calvacanti et al. [4] propose selecting the best connection through a Connectivity opportunity Selection Algorithm (CSA), using network state information and a mobile profile, based on application requirements. As expected, the efficiency of the selection procedure depends on the availability and accuracy of the network state information. The concept of connectivity opportunity is defined by: Network Information (type, mode, authentication and cost), Routing Information (Gateway, Hops and Gateway Cost) and Network Condition (rate, throughput, delay and avg. packet loss rate).

B. S. Yoo et al. [6] make use of neighbour network information to generate proactive handover triggers in time to allow seamless handover. However, their algorithm does not take into account selection criteria such as cost, user preference, or application type.

They present a neighbour information-based predictive handover architecture that would place a handover decision engine between the MIH function and the layer three mobility protocol, with a handover trigger that can be configured to act on any quality metric.

C. In [5], A. Dutta et al. establish an algorithm that takes advantage of the mobile's location to perform proactive handover. While their algorithm does improve handover performance compared with a signal-noise-ratio (SNR) based selection, it involves considerable overhead by tracking all RANs and using transient tunnels to connect to several networks at once. The proposed architecture makes use of mobile assisted higher layer authentication, authorization and handover. An Application Information Service (AIS) offers information about the RANs available to the node. GPS positioning is used as a selection criteria and the terminal is aware of the coverage of the networks.

D. An 802.21-based architecture has been proposed in [23] which will satisfy all considered handover principles, using the information, commands and events provided by the

801.21 standard. All the RANs connect to the evolved packet core (EPC). The GPRS networks connect through an intermediary Service GPRS Support Node (SGSN), while WLANs are accessible through the evolved packet data gateway (ePDG). IP-based networks and 3GPP networks are placed under different gateways, which are in turn linked to a packet data network gateway (P-GW) that incorporates functionality such as packet filtering, interception and charging, IP address allocation and routing of traffic to the operator's network. Additionally, the EPC contains the following network servers:

- Authentication, Authorization and Accounting server
- Home Subscriber server
- Mobility Management Entity
- Policy Control Rating Function

E. A well-known utility function, introduced by Wang et al. in [15], employs weights and uses the logarithmic scale to serve as normalization. Out of the three parameters considered in thesis, namely bandwidth, cost and security, the last one is not within the responsibilities of the IEEE 802.21 standard, and therefore unavailable for use in the case of the proposed algorithm. An alternative quality function involving heterogeneous criteria such as different RAN parameters or a combination of network characteristics, user preferences and terminal characteristics were proposed in [4].

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F. Of the works that address the terminal-controlled network selection algorithm most do not consider the impact of multiple users employing the same algorithm. One exception is the work of Cai and Liu [14], in which the Group Handover problem is approached with Game Theory. The authors propose three RAN selection algorithms all of which involve some knowledge of all other user’s traffic load and the RANs capacity, or u ser’s broadcasting their handover choices and traffic load. In this thesis, it is considered that the terminals do not have this knowledge and work either on link parameter values detected at MAC level or on predicted values based on historic data.

In the present work, a weighted sum function was used, with both upper and lower bounds defined for all parameters, the parameter values are normalized with respect to their bounds, a different mechanism than the logarithm-aided normalization in [15]. As opposed to [4], where the formulas differ according to the type of application and the low/medium/high mobility involved, a generalized formula is presented which accounts for competing users simultaneously choosing the same target handover network.

IV. RELATED WORK

Qualified Adaptive Delay Selection (QADS): In infrastructure based networks in the current works there consists of drawbacks that algorithms related to actions of other users operating in same environment has no allowance been made by these terminal based algorithms. Besides this, given networks may be considered as the best RAN choice by number of user’s terminal when user terminal is in crowded area. In such a case users might end up handling over to same network in a given time span.

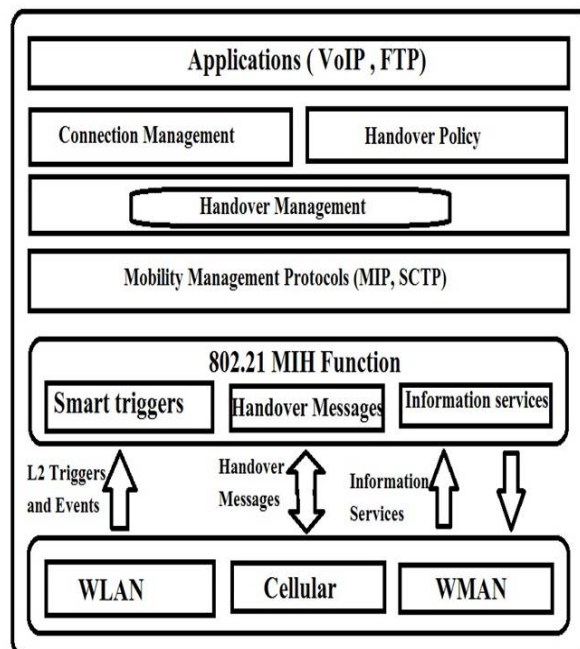


Figure 3- QADS Placement at Handover management level

In QADS when same RAN is chosen by number of users in same period of time, the connection to best candidate network is delayed in each mobile node. User gets benefit of delay which is inversely proportional to selected network. The environment where number nodes have the same preferences, computed delay could be the same. This makes possible those nodes which tend to connect same RAN in same time span, overloads new network. In QADS, this problem is solved by monitoring the QoS before, during and after handover.

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QADS uses weighted sum function for calculating candidate network score, minimum and maximum thresholds are used to eliminate candidate RAN's that fail minimum criteria. This helps in situation where very low network cost does not outweigh a poor unacceptable throughput rate.

Utility function: All information received from the application layer and from the MIIS ,is processed using a quality of service weighted sum function, which we have named the Application-Network Match(ANM)function. ANM represents the quality of service of a network as perceived by an application on the mobile terminal and is defined in (1).

$$ANM_{App}(N_i) = \begin{cases} 0, & p_{kR}(N_i) < 0 \\ \sum_{k=1}^m w_k * P_{kR}(N_i), & p_{kR}(N_i) \geq 0 \end{cases} \dots \dots (1)$$

For parameters that should be maximized

$$p_{kR}(N_i) = \frac{\min(p_k(N_i), p_{kUmax}) - p_{kUmin}}{(p_{kUmax} - p_{kUmin})}$$

$p_{kUmin} < p_k(N_i)$

For parameters that should be minimized

$$p_{kR}(N_i) = \frac{\max(p_k(N_i), p_{kUmax}) - p_{kUmin}}{(p_{kUmax} - p_{kUmin})}$$

$p_k(N_i) < p_{kUmin}$

$$\sum_{k=1}^m w_k = 1 \dots \dots \dots (2)$$

In (1), N_i represents the network i for which the ANM is computed; w_k is the weight attributed by the application/user to parameter k ; $p_{kR}(N_i)$ is the normalized value of $p_k(N_i)$ relative to the parameter bounds; $p_k(N_i)$ is the value the network provides for network parameter k ; p_{kUmin} and p_{kUmax} give the interval to which $p_k(N_i)$ must belong for it to be considered acceptable to the application: p_{kUmin} is the value of the parameter for which the utility provided to the user is minimum, while p_{kUmax} is the value for which the utility is considered maximum; m represents the number of parameters considered relevant for the application.

The upper and lower bound values for the interval are obtained from the application layer, and the values are specific to the application, user and device. Parameters that are better than p_{kUmax} may not add any benefit for the user or application. For example if an application requires only 0.8 Mbps average bandwidth, then a network offering a throughput of 2 Mbps brings no additional benefit over a RAN offering the required 0.8 Mbps. Equally, once a user can see no difference in the application quality on the device for additional parameter change, the upper bound has been reached.

p_{kUmin} represents the lowest acceptable bound on any parameter k , e.g. in the case of video applications, the lower bound on the transfer rate p_{kUmin} represents the minimum frame rate for which the stream can be reassembled. RANs which cannot meet this lower bound should not be selected. The physical limitations of the device are also used to define the bounds on certain parameters.

Other simple additive weighting formulas, for example the work in [], which do not consider bounds on the parameters, suffer from a very strong parameter value out-weighting an unacceptably low valued utility parameter [16]. This is avoided in our work by including the bounds in our network selection parameters.

Back off Delay: If the users employ the same network selection algorithm with no randomness involved, and one of the networks is particularly good, all the mobile devices may end up selecting that network. If all the mobile nodes within a local area handover to the same WLAN within a short interval and there is not enough link capacity

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available, the link quality will drop considerably. This drop could cause all the users to simultaneously switch networks again, possibly resulting in a ping-pong effect between local networks. To resolve this problem, a backoff delay (D) is introduced to avoid all nodes connecting at the same time.

D is computed in (3) based on the estimated benefit of handing over to the selected network (N_s) over staying on the current network (N_{cur}), the bigger the difference in quality between them, the less delay there is. If the gain in quality is above a predefined, heuristically determined threshold, GT (Gain Threshold), no delay is introduced, since the handover is considered of high priority. If the ANM value of the selected network is not significantly larger than the current network, the handover will be delayed for enough time for other nodes to handover to the network. MHT (maximum handover time) is an interval sufficient for the nodes to perform a vertical handover, for example the value determined in [6].

$$D = \begin{cases} (MHT) * (1 - (ANM_{App}(N_s) - ANM_{App}(N_{cur}))) & , ANM_{App} < GT \\ 0 & , ANM_{App} \geq GT \end{cases}$$

Random decision: If the nodes have similar user profiles, run similar applications and have the same choice of RANs then the likelihood is that their D would end up being the same. In order to account for this a check is performed after handover to the new link. The ANM value of the newly attached network is checked against the expected ANM and if it is considerably worse a random decision is made on whether to stay on the newly established link or not. The probability to stay on the new network can be fixed or based on the drop of the ANM value for the network.

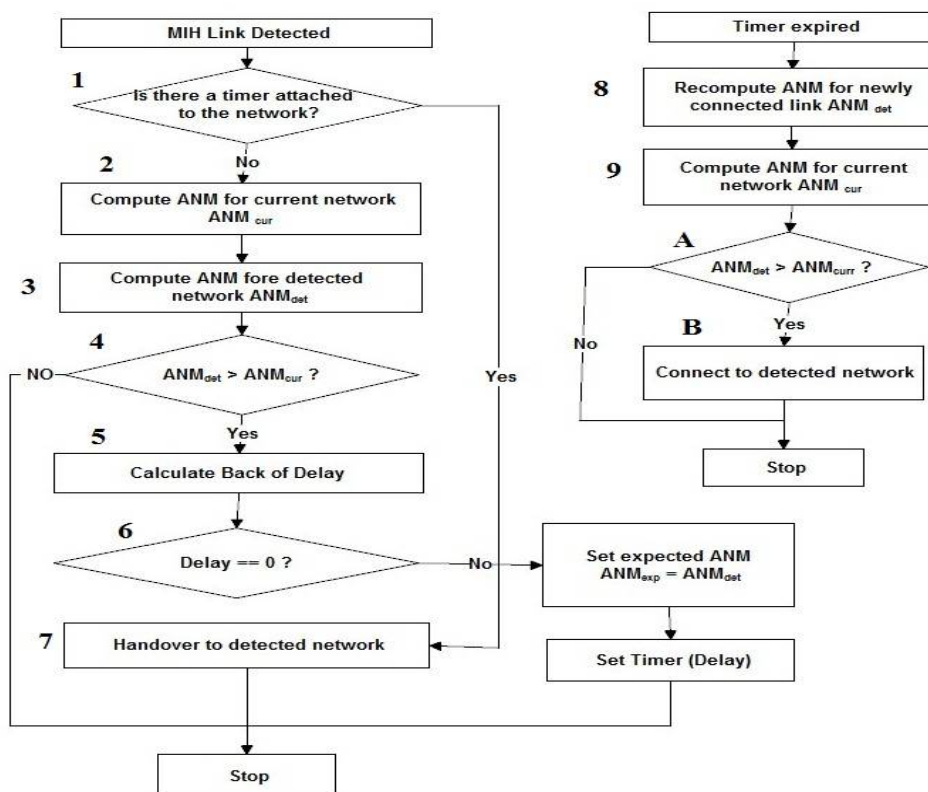


Figure 4- Flowchart of the QADS algorithm (1)

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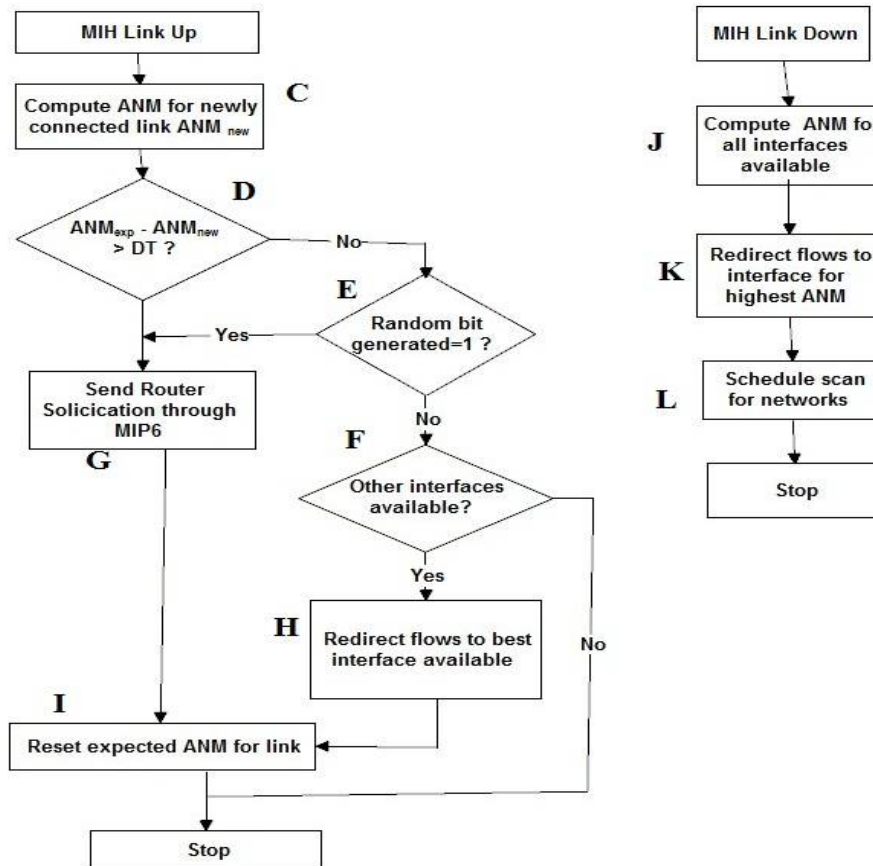


Figure 5-Flowchart of the QADS algorithm (2)

The proposed strategy, QADS, is designed to work with the IEEE 802.21 MIH function and a cross-layer architecture in the terminal to get the network parameters and the application characteristics, respectively. Figure 5.4 shows how the algorithm, implemented at the handover management layer, is integrated with the MIH Function. QADS uses IEEE 802.21 signaling together with Mobile IPv6 (MIP) as the mobility management protocol. Readings of the network parameters, such as throughput, are obtained from the MIIS. The algorithm reacts to specific MIES triggers, as described below, while the MICS offers support for network scan, link configuration and subscription to events. QADS uses minimum and maximum acceptable values for each of the network parameters. These are relevant to the application and/or to the user: such as delay for non-real time applications, jitter for real-time applications or cost for users. This work assumes that these values are determined in advance of the call setup. The user setup preferences may be gathered during the original application setup on the terminal or through a graphical user interface at run time [13].

The three features of the IEEE 802.21 standard are used by the algorithm. MIIS provides the network information, which is stored in a list, thus making the node aware of the networks that are available and their characteristics. MIES notifies the node of the changes in network characteristics, while MICS allows the node to react accordingly. The QADS algorithm is implemented by providing IEEE 802.21 handles to the MIH events. Figure 2 displays the flow of the algorithm for the considered IEEE 802.21 events. Once a new link is detected, its ANM value is compared with

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the current network. If the new link offers a higher ANM then a handover should be performed, based on the ANM difference a back off delay is computed, and a timer set accordingly. When the timer expires, the ANM value of the new network is checked again and if it is still higher, a connection is launched on the selected network. Once the link has been established, the link up event is triggered [2], the ANM is recomputed and compared to the expected ANM, and any loss in value is compared to the drop threshold (DT). If the link is far worse than expected, a random decision is made on whether to hand back to the original RAN or to stay on the new RAN.

V. IMPLEMENTATION

PNQS: In this work, we have implemented an algorithm – which we call PNQS for Polled Network Quality-based Selection - based on a variation of the function presented by Wang et al [1]. The idea behind it is simple, but effective: when new networks are detected, they are added to a list of candidates and a timer triggers the reassessment of the quality of the networks every second, the network with the best quality of service being selected. If this is not the same network that the user is connected to, handover is performed.

Utility function: As in the work referenced above, PNQS uses a weighted utility function to estimate the Quality of Service. Unlike the utility function proposed by Wang et al [1], this one does not take security into account, as this is not provided though the MIH and, since it depends on a lot of factors, it would be difficult to estimate. In the formula below, w_c and w_b are weights for cost and bandwidth respectively, B is the bandwidth required by the terminal and b_i is the actual bandwidth received by the terminal. Security was not considered in the simulations.

There are several differences to the implementation provided here: first of all, the utility function is different in that the objective for it is to be maximized rather than minimized as is the case of the cost function in their implementation, meaning that the parameters to which logarithm is applied are inverted. Second, the advertised bandwidth is not obtainable through MIIS, so the typical rate of the network, based on its technology, was used instead. Third, because a network might be free of charge, “infinity” was approximated with a very large number, so that below a very low cost (equal $1/\text{Very_Large_Number}$) the quality stays the same. However, it is unlikely that any network will ever charge $1e-15$ c/Gb for their network. Since the cost is not available either, it is read from a file for each network. Additionally, re-computation of the quality of service is made right after connecting to a network, to avoid disastrous choices.

Linkage to simulation framework: PNQS is connected to the handover framework similarly to QADS, through handlers to the MIH events. It uses the MIIS and the MICS to gather information about the networks and to issue commands to the MAC layer, respectively.

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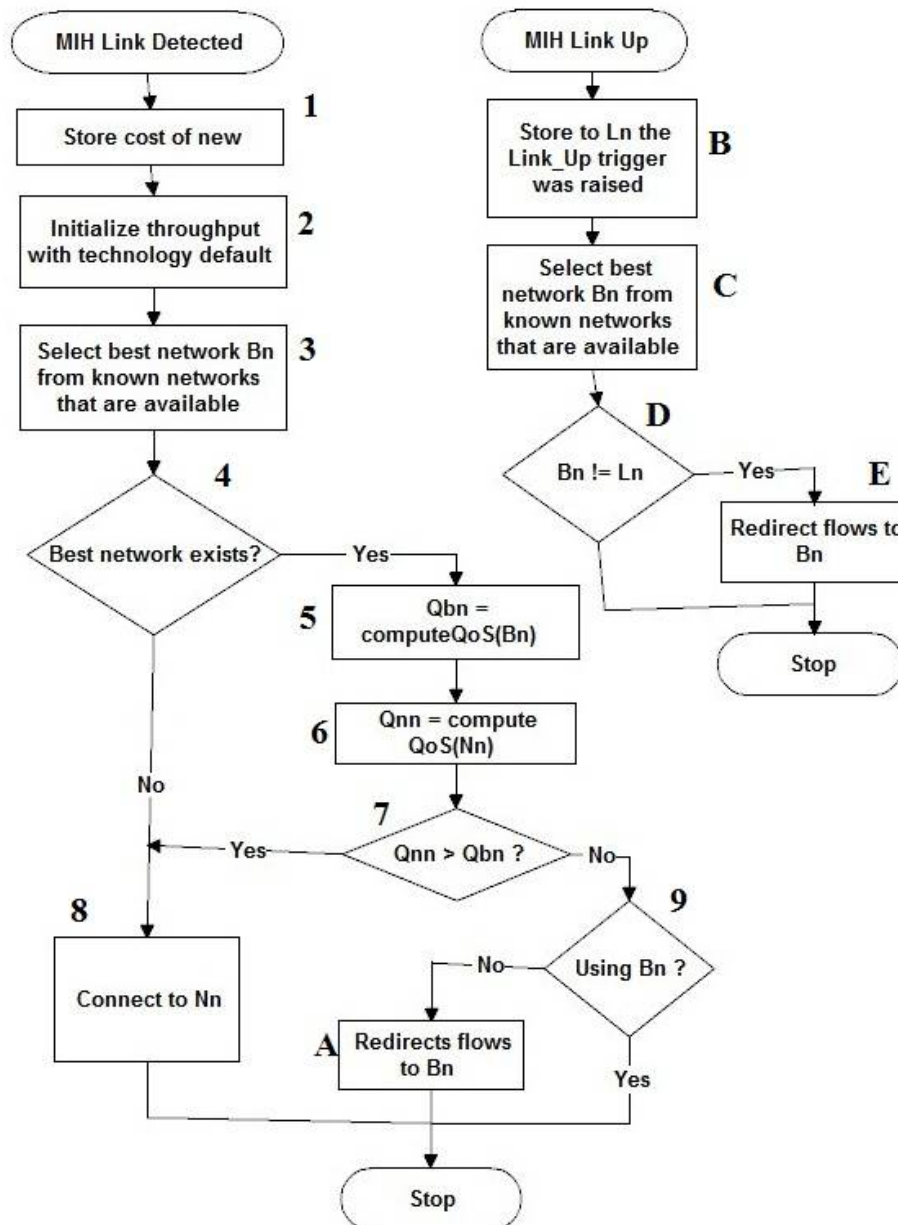


Figure 6-Flowchart of the PNQS algorithm (1)

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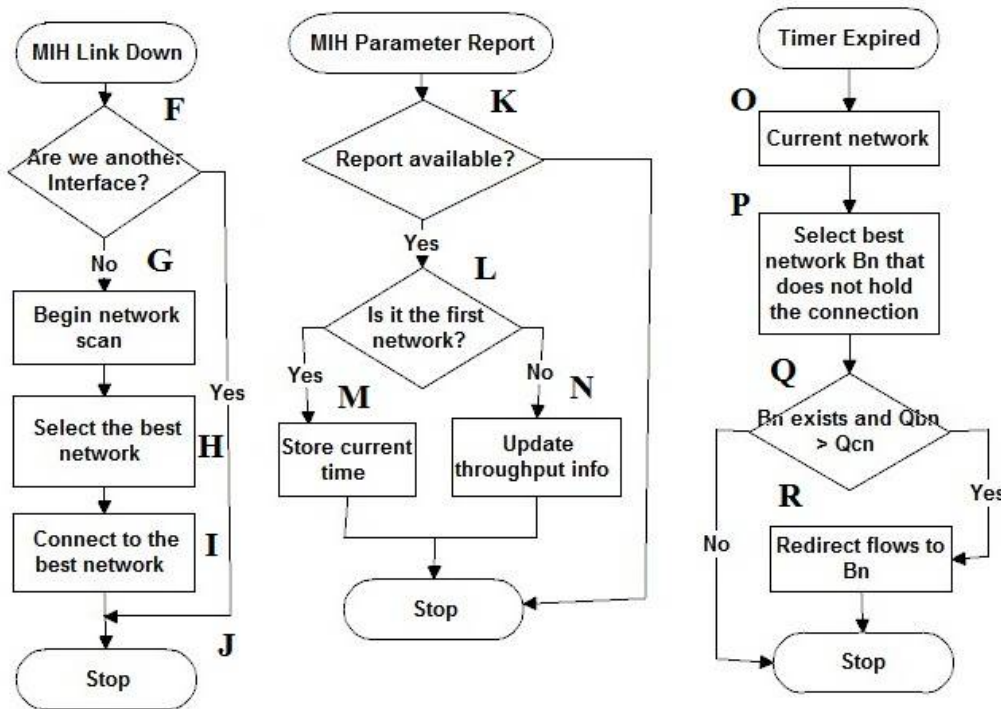


Figure 7-Flowchart of the PNQS algorithm (2)

When a new link is detected, its cost of the network is stored, and the throughput is initialized to the typical value for the technology. The best network available from the ones associated to the interfaces is selected, and its quality of service is compared to the new one detected. If the new one offers better quality, the user connects to it. Otherwise, if the best network available is not the one currently connected to the node, flows are redirected toward that interface. Once a connection has been established (the Link Up event), re-compute the quality of service and compare to the quality of service offered by the best interface that is not connected. If the best network is not the one the device is using, the flows are redirected to that interface. When the connection goes down, and no action has been taken to initiate a new one, the network scan is started on all interfaces. The network with the highest value of the utility function is selected. When a parameter report is received for the network, the throughput information corresponding to the network is updated.

An important part of the PNQS algorithm is the timer that dictates the re-computation of the quality of service of each network. Its purpose is to ensure the best quality all the time. A drawback can be a high number of handovers. Moreover, when multiple users switch networks simultaneously, the risk of ping-pong appears, because the quality of service for the network has the same value for all the users. After all devices handover to the network, it becomes so overloaded that all the nodes switch back. The simulations in 7 prove this point.

VI. EXPERIMENTAL RESULTS

Using the NS2 [17] simulation tool, we tested handover schemes based on the parameters in Table 3. In this scenario, we considered the received threshold power and the decrease in received power due to the local fading effect. Without QoS management, a wireless network is inherently incapable of guaranteeing QoS, though the means of determining the available bandwidth will certainly vary. Bandwidth estimation is a difficult problem here because a dropped packet

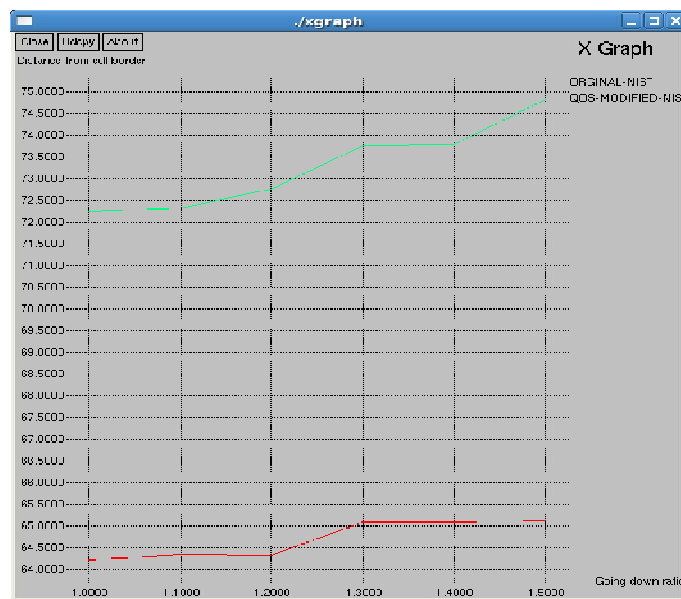
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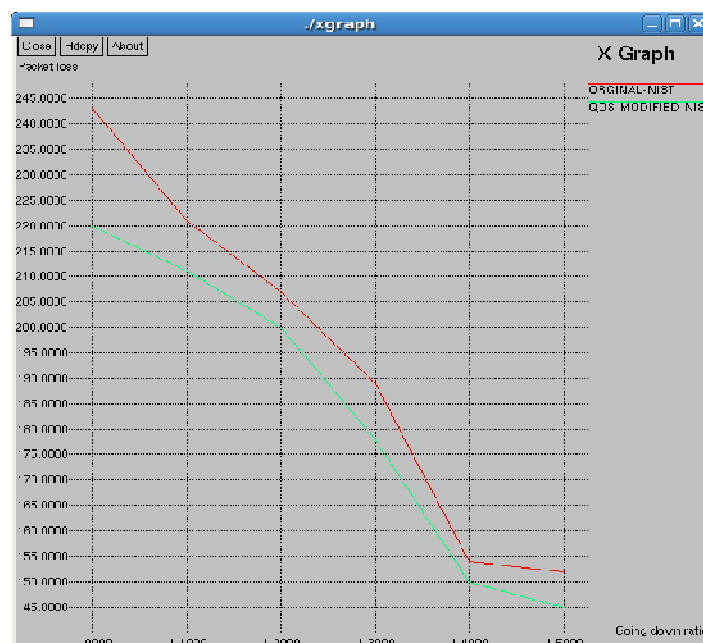
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does not necessarily indicate congestion, but could rather be due to errors on the air interface. However, the IEEE 802.21 scheme specifies certain types of handover triggers. Moreover, the available bandwidth on a wireless link tends to change as the user changes location by handover triggers. The primary interest here is in the effect that radio resource limitations during the handover effects the quality of different types of services. To this end, we conducted performance evaluations for different handover schemes in the 802.21 network environment.



Graph 1-Transmission distance from cell border in terms of different Link Going Down ratios



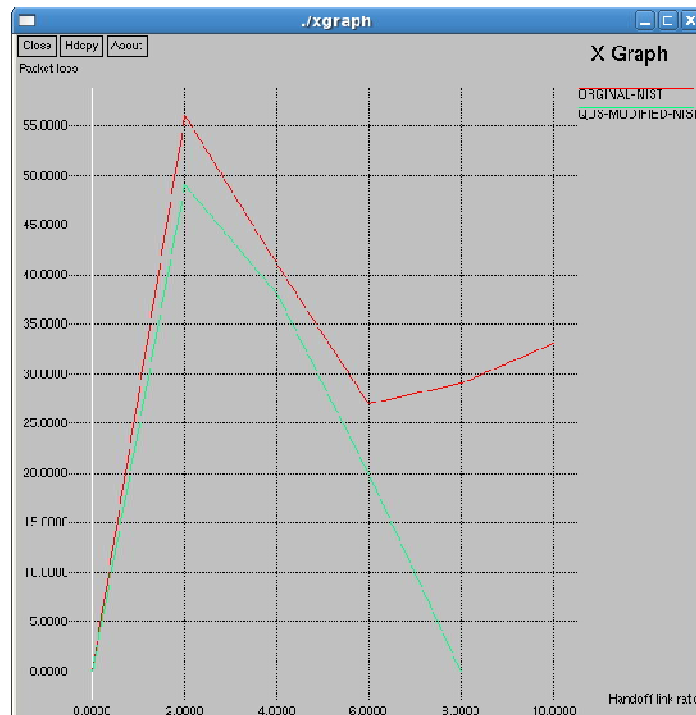
Graph2- Packet loss in terms of different Link Going Down ratios

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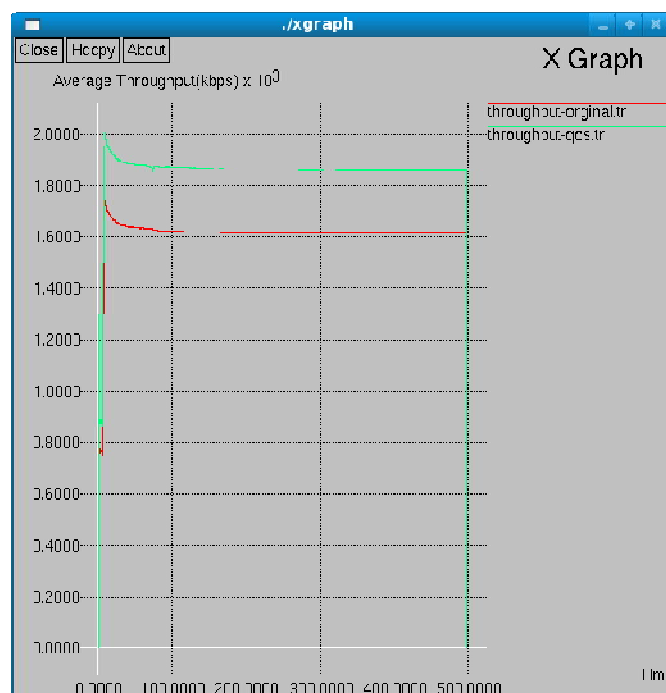
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Graph 3-Packet loss in terms of different Link Going Down time under UMTS Network



Graph 4-Throughput comparison with and without QoS control during UMTS Network handover

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V. CONCLUSION

Heterogeneous networks are springing up in the recent decade. Mobile users are expected to roam among different wireless network through multiple wireless interfaces on the mobile devices. Smooth handover among heterogeneous networks by well utilizing the radio resources is a challenging issue. In this paper we have investigated the management scheme for scarce radio resources during the handover period in heterogeneous networks. We also have proposed a scheme to effectively exploit Link Going Down information from MIH derived from the IEEE 802.21 standard as a determining factor for handover prediction. Evaluation results validate that the proposed mechanism can make QoS sensitive applications run more smoothly.

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