Client Based Proactive Handoff in Heterogeneous Network
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Abstract: In the present scenario various wired and wireless networks are contributing in information access for different users. But as we are moving towards next generation, the communication is targeting for integration of these wired and wireless networks. Once a client obtains a global address from Internet gateway it is able to communicate with nodes in Internet or it is able to access information across Internet. Overall the client needs frequent mobility while communication. However due to improper handoff there is a serious problem of call drop when client moves from one location to another. Earlier only one network used to provide services to the client. This article specifies how integration of heterogeneous network can give better quality of service to the client. Therefore in this paper we propose a proactive handoff mechanism for clients under heterogeneous network.

Keywords - Heterogeneous Network, MANET, Handoff.

I. INTRODUCTION

A heterogeneous network is an interconnection of multiple networks irrespective of topology, network architecture etc[1]. These networks may be multiple wired and wireless networks. Thus combination of WiMAX, IP networks, Cellular Networks, ad hoc networks, and satellite networks, vehicular network, radio network, WLAN etc constitute a heterogeneous network. Every network in a heterogeneous network is equipped with prescribed RSSI, bandwidth, link speeds and other parameters. Thus each network has its respective characteristics and performance metrics.

Handoff is the main issue in existing environment for better service in mobile network. In homogeneous networks handoff procedure is executed when MN moves away for the coverage area of the Access Point. Where as in 4G, handoff[19] procedure will be executed because of coverage area, better service availability, cost and so on. Because of the challenging features of the 4G [16] issues like, deciding the suitable handoff criterion, choosing the appropriate time to initiate the handover, selecting the most suitable access network for a specific service among those available and maintaining service continuity during the handoff are the challenging issues in heterogeneous networks.

Higher handoff latency, packet loss and triangular routing were the main issues in existing environment. Designing mobility management for heterogeneous network with all-IP while, considering issues such as context of networks, terminal, user and services is the main concern of industry and researchers in the current era. Handover in heterogeneous wireless network is referred to as vertical handoff which can be Mobile host controlled, network controlled, or mobile host assisted handover. Handoff decision algorithm is crucial part of the vertical handoff.

The paper is organized as Section – 1 Introduction. Section - 2 deals with Backgrounds that includes related work in reference to handoff problem. Moreover, the proposed architecture and mechanism for resolving handoff, discussed in Section – 3. Section 4 covers result and analysis. The conclusion of this research is mentioned in Section – 5.

II. BACKGROUND

Accessing information from Internet and online communication is a vital aspect in our everyday life. Quite often it is noticed that when a client changes its location while an ongoing session there is loss in connectivity or the client gets an interruption in the services. Thus service continuity or temporary loss in connectivity is a serious research issue [23]. Service continuity [3-4] in ad hoc network has been studied. Services can migrate from node to node. In order to maintain seamless interaction with the client application, a migratory service based reliability approach [4] has been proposed in order to address the shortcoming of continuity in services.

Any single type of existing wireless and mobile network such as Wi-Fi, Bluetooth, Universal Mobile Telecommunication System (UMTS) or IEEE 802.16 Worldwide Interoperability for Microwave Access (WiMAX), cannot provide all types of services, e.g., wide-area coverage and high data-rates. For future generation mobile communications systems, an integrated heterogeneous access network is introduced by combining different types of networks with different characteristics, e.g bandwidth, delay, communication range, speed support, power consumption, security, end-user cost and several other aspects [24]. This convergence of wireless networks provides the Mobile Station (MS) with a greater choice of Network Access Technologies (NATs), which offer different levels of Quality of Service(QoS) and radio characteristics [26].

[23]Heterogeneous Wireless Networks communication is a combination of various heterogeneous networks having different
capacity, technology and varying network parameters. [6] presents concept of testbed that integrates multiple network technologies (Ethernet LAN, WiFi and GPRS cellular data network) to provide seamless connectivity to mobile hosts.

When client moves from one network to another, vertical handoff takes place. [35] proposes a novel method for vertical handoff by using clustering of networks (WLAN, WiMAX and 3G) and packet delivery through tunneling in different clusters. In this scenario handoff time and its basis also play an important role. [36] evaluates the effect of various handoff decision attributes and their respective user preferences on vertical handoffs using various Multi Attribute Decision Method (MADM) based techniques.

It has been noticed [38] Denser deployments of heterogeneous networks (HetNets) lead to more frequent handovers, which results in a decline of user experience as well as heavy signaling overheads to the network. Most of the time when mobile nodes move in heterogeneous networks, there is degradation in strength of signal and quality service. Also in Vertical handoff there is no prediction about behavior of MN and access point. In [29] sub-game is formulated as a non-cooperative strategic game between a MN and an AP in which the Nash equilibrium is the solution of each strategic game. [29] optimizes the utility functions of the whole network by finding an equilibrium point.

A challenging problem for mobility of mobile nodes still existed for which various proposals of mobility management [13] are stated in different layers of Internet Protocol Suite. Media Independent Handover (MIH) [14] offers mobility information for the execution of a vertical handoff process and requires major modifications at both the network and user side. [18] inter-AP mobility, however, incurs handoff latency including discovery and re-authentication delay.

By extending the MIPv6 protocol, IETF has also proposed Network Mobility (NEMO) protocol [17] in order to manage the mobility of mobile networks. At the Transport Layer, Stream Control Transmission Protocol (SCTP) [9] is proposed, which is based on maintaining an end-to-end connectivity. Unlike MIPv6, SCTP does not require any intermediate network elements for maintaining status information. To support MU and enable vertical handover, SCTP is extended with a mobile SCTP (mSCTP) [10] solution, where a MU can manage different valid IP addresses by using the Dynamic Address Reconfiguration (DAR) feature [11]. The drawback however is that all the TCP based applications have to be modified in order to make use of SCTP solution.

Beside SCTP, the handover realization can be done via TCP by adding a cross-layered Radio Resource Control [15]. At the Application Layer, Session Initiation Protocol (SIP) [12] is proposed for managing the mobility of mobile units. However, like MIPv6 and middleware approaches [5], SIP requires major enhancements to existing network infrastructure and hence is an expensive proposition. [32] By utilizing these parameters, cognitive users make a handover decision to select an appropriate point of attachment (PoA) among multiple primary radio access technologies/networks without explicit negotiation with surrounding PoAs, and thus handover latency and signaling overhead are minimized. [7] Proposed a scheme to reduce the latency introduced during the process of mobile IP-based handoff between heterogeneous networks. [7] For low data rate applications, in which real-time voice services operate, it implements an adaptive packet size technique to reduce both the probability of packet loss and the handoff latency. [g] gives an optimal vertical handover approach based on multiple attributes decision making (MADM) algorithms and the utility function. [37] The MADM algorithms are used to calculate the performance for each network according to each traffic class. On the basis of which [37] utility function represent the user’s preferences on traffic classes to select the best access network. To lower the call drop [33] proposes /MC Markov model for the two layers of HCN with a FIFO queue. In order to handle various calls CAC scheme with optimized SINR in the femto cellular/ macro cellular network has been proposed.

[28] discusses novel Quality of Service (QoS) vertical handoff scheme with the support of the Software-Defined Network (SDN) technique for the heterogeneous wireless networks. In this selection of appropriate network, network congestion, timing of handoff has been introduced. To suit the conditions of continuous service execution abundant work on service migration [2-1] in mobile and pervasive computing environment has been performed, which involves the issues and challenges of migrating an ongoing service from one device to another. More recently a centralized model for context-aware service migration has been proposed [2]. [1] Considers a transport layer overlay to assist users to seamlessly migrate through heterogeneous networking environments.

Gateway acts as a bridge for transferring data between client and heterogeneous network. Two methods for Internet gateway discovery are described in draft “Handoffs in Integrating Ad Hoc Networks to Internet” [8]: Proactive gateway discovery and reactive gateway discovery. Proactive gateway discovery periodically disseminates advertisements to all nodes in the network [23]. Reactive gateway discovery utilizes solicitation and advertisement signaling between network and Internet gateway [23].

There is a flaw in reactive handoff mechanism. Clients continue transmitting the data without sensing the availability of current gateway. To minimize the reactive handoff latency [34] the total spectrum sensing duration required for cognitive radios in multiband environments is studied. Window-based strategy is introduced to estimate channel workload and sample-based strategy has been introduced to sense the probability of idle time.
Finally in [8] approaches to proactive handoff management for mobile devices for high quality requirements have been proposed. It gives efficient and streamlined continuity in case of handoff. [35] Compares proactive handoff mechanism with reactive handoff mechanism. It has also proved that in terms of least collision rate and higher capacity rate proactive handoff mechanism is the best. In view of the above work we have proposed a client based [24] and proactive [8] handoff [8] management mechanism for MANET in heterogeneous network. There is a flaw in reactive handoff mechanism as clients continue transmitting the data without sensing the availability of current gateway. The main aim of Qos is that the best available network in heterogeneous environment provides the services to the client. To overcome this problem a proactive handoff management mechanism has been proposed in the next section.

III. PROPOSED MODEL

III.A Proposed architecture and mechanism

III.A.a Architecture for proactive handoff:

Fig 1 client gets connected to the heterogeneous network through a gateway. When he moves from one place to a new location, he receives gateway advertisements from new gateways as well as old gateway. Client calculates hop count of each gateway. If the hop count of old gateway is less than hop count of new gateways then client utilizes the old gateway else he selects the gateway with min hop count. Client then sends notification to old gateway about updation of new gateway. Packets are then copied from old gateway to new gateway. Finally new gateway updates its server. If notification does not take place within lifetime to new gateway, then packet is removed from memory.

III.A.b Mechanism for Proactive handoff

Proactive Handoff()
1. If( MN==move)
2. Client ← adv
3. If(hop.NG >=THz)
   MN= CG
   exit()
4. else MN =NG. min hop
5. Notify CG
6. NG ← Copy.OG
7. Server update ← NG
8. If(notification != lifetime)
   Delete(packet, memory)

III.B Architecture for information retrieval

III.B.a COMPONENTS:

Information retrieval components:
1. Client-User who wants to access information across the internet.
2. URL-Allows a client to surf an application on the internet
3. Queue-Data structure that holds requests of different clients to be processed. Its processing is based on first in first out.
4. Data Manager-Checks the queue for input request. Fetches the Quality Database for available network and transfers information in form of thread.
5. Quality Database-It is a stack type of data structure and holds all the best available networks of heterogeneous network.
6. Monitor-Responsible for checking and informing the data manager if the available network of the ongoing thread is less than the threshold value.

QDM has four components:
1. Storage Manager- On the basis of feed forward neural network it keeps track of all the networks and the respective parametric values of heterogeneous network.
2. Quality Manager-It operates on values stored in storage manager to find the best available network.
3. Temporary database: Before updation into Quality Database the name of best available network are temporarily stored in this database.
4. Update Manager: Whenever QDM is called update manager sends an update to Quality Database.

III.B.b Communication: In Fig 2(a) for retrieving information the client enters a URL as a request for retrieving information from the internet. This request is forwarded in a FIFO queue. Data manager fetches one of request from the queue. Data manager fetches the available network from top of database for transferring the information. Then data manager activates a
thread to transfer information to the URL. Next the monitor is activated to decide the handoff. If handoff is initiated then Data Manager pauses the ongoing thread and receives its respective acknowledgement. In parallel it then calls the Quality Database Module(QDM) for best available network. From the response obtained from QDM Data manager fetches the available network from the top(database). It then resumes the ongoing thread and receives the acknowledgement.

**III.B.C Mechanism for information retrieval**

Information retrieval()

1. Input UR
2. URL ← UR
3. FIFO Queue ← URL
4. Alloc.availNT
5. Activates(thread)
6. for(monitor=on; monitor<10s; monitor++)

   if (availNT parameter > Thz)
   
   Top(QD)==availNT
   break();

   elseif (available.NP <= Thz)
   
   QD()
   Pause. thread
   ACK
   Top(QD)== available network
   Resume(data transfer)
   ACK

7. elseif (available.NP <= Thz)

   
   

**III.B.D Mechanism of Quality Database Module**

(a) Storage manager()
(b) Quality manager()
(c) Update()

(a) Storage manager()

{ 
Input()
Compute()
}

Input()

1. Initialize matrix Ij
2. Ij=Nj*Pj  //Nj is different networks and Pj are different network parameters
3. print("enter network and respective parameter values");
4. for (Nj=0; Nj<n; Nj++)

   
5. for(Pj=0; Pj<n, Pj++)

6. 

Fig: 2(a) Architecture for information retrieval

Fig. 2(b) Sequence diagram for information retrieval in heterogeneous network
input(Ij[Nj][Pj]);

Compute()
1. for(Nj=0;Nj<n;Nj++)
   1. Compute $U_k=(P_1(Nj)*w_1+P_2(Nj)*w_2+P_3(Nj)*w_3+P_4(Nj)*w_4+$
      $P_5(Nj)*w_5)/p$ is parameter and w is its associated weight
2. Compute $V_k=(U_k(Nj)+b_k)$ //bk is bais factor
3. Compute $Y_k=(1/e^{-(V_k)})$ // sigmoidal activation function
4. Store it in Oj

Fig 3. Feed forward neural network for calculating parameter values of networks

(b) Quality manager()

Input Ij                               //Ideal parameter values of respective networks
Input Oj                            //Input values obtained after processing of feed forward neural network
Calculate the difference $D_j =I_j-O_j$     // Compare with ideal
Now rank Nj according to max $D_j$       //bubble sort the difference values of diff networks
Temp Queue $\leftarrow$ Nj     //store the networks rank wise in Queue

(c) Update manager()
for(t=0;i<10;i++)
   Quality database $\leftarrow$ Temp Queue(Nj)

IV. RESULT ANALYSIS

IV.a Assessments of evaluation

Result has been prepared in MATLAB. Table 1 shows data efficiency with different data values. Comparison of data values has been made using different algorithms. Performance of the client based proactive handoff in heterogeneous network is evaluated by their transfer data rate and call drop rate over heterogeneous network on the following basis:

$$E=1-\frac{\text{minimum call drop (c_m)}-\text{total call darp(c_t)}}{\text{total call darp(c_t)}}.$$ 

Comparison between data rate and call drop rate is shown below in fig 1.0.Also Comparison between Data transfer efficiency and Call Drop is shown below in fig 2.0.

Fig: Comparison between data efficiency and call drop rate

Fig: Comparison between data rate and call drop rate
heterogeneous network. For this purpose we have proposed proactive handoff architecture and its algorithm. Proactive handoff explains how and on what basis client gets connected to a new network in heterogeneous environment. We have also explained an architecture and mechanism for information retrieval. We identified the challenges of information retrieval. Towards this goal, we employ quality database module which works on the concept of feed forward neural network. This neural network compares its processed values with ideal values and then updates the database. Evaluation results show that such client based proactive handoff approach can effectively address the limitations of existing handoff solutions and achieve the desired performance. Our ongoing work includes comparison between data rate and call drop rate. Also a comparison between Data transfer efficiency and Call Drop has been made. Comparing the accuracy of various networks, it resulted that FFNN is better than rest of the algorithms.

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**IV.b Comparison for various Networking methods**

As for getting the better result analysis all the tables of various networking techniques have been compared which has been published in the previous research work. The overall combined comparison of proposed Feed forward neural network(FFNN) with Hybrid Approach Algorithm (HA), Network selection Algorithm (NSA) , Fast reactive handoff Algorithm(FRH) [27]] with the various parameters such as data transfer efficiency, call drop rate, accuracy and information retrieval rate in respect of number of trials has been depicted in the above fig 1.0 and 2.0.

FFNN is performing better and giving improved handoff as compared to other networks. Thus performance graph fig 3.0 shows that accuracy percentage of FFNN is better than the rest of the algorithms.

**Table -1 Data efficiency calculation by comparing various networking methods**

**V. CONCLUSION**

In this paper, we investigate the problem of supporting seamless communication and internet access across heterogeneous network. For this purpose we have proposed proactive handoff architecture and its algorithm. Proactive handoff explains how and on what basis client gets connected to a new network in heterogeneous environment. We have also explained an architecture and mechanism for information retrieval. We identified the challenges of information retrieval. Towards this goal, we employ quality database module which works on the concept of feed forward neural network. This neural network compares its processed values with ideal values and then updates the database. Evaluation results show that such client based proactive handoff approach can effectively address the limitations of existing handoff solutions and achieve the desired performance. Our ongoing work includes comparison between data rate and call drop rate. Also a comparison between Data transfer efficiency and Call Drop has been made. Comparing the accuracy of various networks, it resulted that FFNN is better than rest of the algorithms.


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