Location and Priority Based Vertical Handoff Approach for Seamless Mobility

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ABSTRACT
Recently, mobile communications need to benefit a good level of Quality of Services (QoS), to satisfy the current application's need. As the number of mobiles and mobile networks increases every year, we are facing new problems and challenges in incorporate various networks with various standards and technologies. In that the problem of handoff is a big parameter which affects the performance dramatically. In this paper we have proposed a method for minimizing the handoff latency which considers various factors like QoS, Energy Level, User Preferences, Network Status, Mobile Movement Direction and Location. The proposed method is suitable for reducing latency in both horizontal and vertical handoff.

Keywords
Handoff, Latency, QoS, User Preferences, Network Status, Mobile Direction, Location, Horizontal, Vertical, Energy Level.

1. INTRODUCTION
A node in the network is said to be a mobile if it has the ability to communicate with other nodes without any physical connection like cables. Generally mobile nodes works on battery power and it will have limited resources like memory, computing power and power backup. The reason why mobile usage increases every year is, it allows the user to roam freely anywhere and anytime within the service area, where in the fixed nodes this facility is not available. So, mobile becomes an essential part in our day today life. Mobile nodes get service from any one of the access point of a network. Each access point has a limited coverage area. When a mobile moves away from the access point, the signal strength of the current access point will get reduced.

If the mobile goes out of coverage area then the access point may not able to provide the services. In this situation, the mobile node has to search for a new access point and it has register with it for getting the services. The process of disconnecting the mobile from old access point and reconnecting the mobile to a new access point is called mobile handoff. The mobiles with high speed movement need frequent handoff. The number of handoff required for a mobile depends on the cell size, mobile's movement speed and pattern. During the handoff process the ongoing services will be interrupted for few milliseconds. This delay must be reduced to have uninterrupted services.

We can classify handoff into two major categories, that is hard handoff and soft handoff. If a mobile has the ability to receive signals from more than one access point at a time, then it can able to perform soft handoff. In soft handoff the mobile node can be connected to the new access point before disconnecting the old access point. Hence the service will be uninterrupted and the QoS will be maintained. The best example for the soft handoff enabled network is CDMA. If a mobile doesn't have the ability to receive signals from more than one access point at a time can only be able to perform hard handoff. During the hard handoff the mobile has to disconnect the old access point before connecting the new access point. Hence the service will be interrupted and the QoS will be reduced.

Another way to classify the handoff process is horizontal handoff and vertical handoff. If a mobile node has only one network interface card then it can only be able to perform horizontal handoff. Since, old access point and new access point are of same type. If a mobile node has multiple network interface card then it can able to perform vertical handoff. Since the old and new access points are need not to be of same type. Nowadays mobile device comes with variety of network interfaces like GPRS, 3G, HSDPA, GSM, 4G, WiFi, and Bluetooth ...etc. This makes vertical handoff possible at any time. Also, it is very common today to see the cells of different networks overlapped with each other as shown in figure 1 (especially in the city sides). This overlapped cell of different networks encourages the vertical handoff. Based on the QoS requirement of an application, the user can switch from one network to another network at any time.

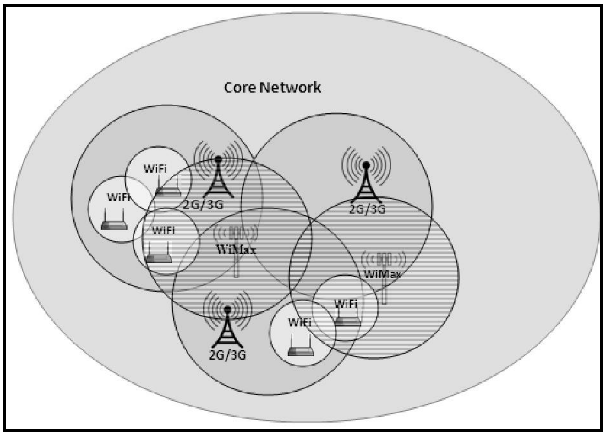

Fig 1: Network with overlapped cells

As the number of mobile user increases every day, the number of networks and operators got increased [1]. The operators are getting struggle in improving seamless handover of devices and services. This will continue in future. The network operators have to integrate multiple technologies in order to deliver unlimited content to the user. Hence, we need a method to provide seamless vertical handoff that considers user preferences, Energy Level and QoS.

This paper is organized as follows. In section 2, the Literature survey has been given. In section 3, we have shown the network architecture of the proposed algorithm. In section 4, we have discussed about the location and network status server. In section 5, we proposed a vertical handoff algorithm. Finally in section 6 we have given the conclusion.

2. LITERATURE SURVEY

In [1], we have presented a depth literature survey. In that we took few relevant works to discuss here. The handover generally trigged by signal quality. Based on the roaming characteristics and mobile configuration a particular handover strategy is required. The handover can be initiated not only by signal quality, some other reasons like received signal strength indicator, local interferences, number of packet transmissions, packet losses, effective cost, load balancing, user's decision to change in network for different quality of service levels and different cost benefit...etc will also trigger the handoff.

The device with multi interface to access multiple networks comes with a number of connectivity capabilities. Also the recent mobile software have the ability to manage multiple connections like Bluetooth, IEEE 802.11a/b/g, IEEE 802.16, GSM, HSDPA, WiMAX…etc. In future this type of multi homed devices will increase in the market. These devices will come with multi band antenna, which helps the device to communicate using variety of frequency. This makes the mobile users and the network operators satisfied, because the user can able to connect the best network always, based on service and situation [2]. While accessing different networks, the power consumption may vary from one network to another network, for example while accessing GSM netwok, 1 watt of power will be consumed [23], CDMA network consumes power between the range 4W to 1W based on the distance [23] and Bluetooth consumes 100 mille watts. Similarly, HSDPA, WiFi and WiMAX consume different watts of power. As we know the mobile device operates on battery power, the multi interface device software will select the best network based on the battery level. When the battery level is too low, it will not choose network that consumes more power.

A cross- layer handoff management protocol called CHMP have developed in [3], which is used to measure the mobile speed and predict the handoff signaling delay of possible handoffs. Also CHMP significantly reduces the false handoff initiation cost. In [4], two-layer downlink queuing model and scheduling algorithms have proposed for providing lossless handoff. That model is useful in reducing packet loss and complicated forwarding of data due to handover. An excellent work has been conducted on mobility in heterogeneous networks in [5]. It helps us to compare different solutions.

In [6], Nidal Nasser, Ahmed Hasswa and Hossam Hassanein conclude that the main challenge for seamless handoff is to find, reliable horizontal and vertical handoff schemes. They propose a vertical handoff decision function which helps in decision making when the user is in roaming across heterogeneous. Pahlavan et al [7], reviewed algorithms for horizontal handover. In [8], Lampropoulos et al presented a review of handover management solutions. Both of them describe architectural issues in WLAN-GPRS/UMTS integration.

In [9],Shantidev Mohanty and Ian F. Akyildiz, shows that the handoff speed depends on factors like type of application, link layer frame error probability, signaling delay and link layer access technologies. We concentrate on Quality of Service (QoS), Pricing and handover prediction. In fact all the architecture has to provide quality of service; the mobile must have the ability to submit the resource request, needed for the current application. For example the video data can be lost due to latency caused by vertical handoff, for this a solution is given by [10], for seamless video play out the streaming server predict the channel rate and the client buffering level, by analyzing RTCP RR and APP.

The problem related to the selection of available networks, the time consumed to initiate the handoff; schemes to minimize the data loss are forced to the development of vertical handoff procedures [11]. The main challenges in 4G networks, involves designing proper solutions to make the network selection which chooses the best wireless access network.[12], the complexity increases when it is necessary to perform vertical handoff during quality of service requirements. As the time taken for handoff increases, the packet loss and disconnection will happen and the QoS in 4G network will be degraded [13]. Also the varying bitrates, bandwidth allocation fault tolerance levels and handoff support among heterogeneous wireless networks makes the QoS more difficult [14].

As the mobiles keep changing the location from time to time, it is difficult to guess whether the mobile has connected to a particular server continuously from beginning of service to ending of the service, so the mobile should try to connect to different server according to the current situation. Mobile devices with multiple network interfaces today cannot perform handoff among devices without losing existing internet connection due to change of IP addresses [15]. Determining when to handoff to another interface is a complex decision. In the future architecture, pricing will be the main factor for decision making. But there is no relationship between quality of service request and price. The user will decide to handover the device to high speed network, when the services like video conferencing. However the video data can be lost due to vertical handoff latency.

Normally the user prefer low price network. In [16], Nyiato and Hussain propose a pricing model for resource sharing for IEEE 802.16/IEEE802.11 networks. They said that APs have dynamic demands depends on the user's QoS request. In [17], H.J. Wang, R. H. Katz, and J. Giese designed a cost function to decide the best movement and interface for vertical handoff. But the cost function proposed by them is very preliminary and not able to handle more complicated configurations and then logarithmic functions used in the cost function will also have difficulty in representing the cost value while the value of the constraint factor is zero. The prediction of handover in advance is a difficult task. The hints like user movement patterns, topological position of base station, signal quality…etc. will be helpful in prediction of handoff in advance.

Few researches have addressed position prediction in wireless networks, most of them by proposing solutions based on either the estimate of current position, speed or usual movement patterns. Prediction of future location, speed by exploiting a dynamic Gauss-Markov model applied to the current and historical movement data has did in [18]. In [19] Karimi, H.A., Liu, X, considers admissible path databases for predicting paths followed in the recent past. If the cell size is too small then the past user movement pattern may not useful to predict handoff, because the mobility behavior changes very frequently. In [20], Kapoor, Edwards and Sankar use retroactive adaptive filter predicting handoff. In [21], Sheu and Wu developed GM to decide when to initiate the communication handoff by comparing RSSI predictions with average and current RSSI values. However, both [20] and [21] apply RSSI prediction to improve communication-level handoff. In [22], DeLeon and Sreenan predicts network delay and avoids stream interruptions due to packet jitter variations by adapting buffer size to the expected packet arrival time. Many ideas and schemes for handoff mobiles with low latency have been proposed in the past. But, due to the out coming of new technologies and more number of networks every day, the existing ideas are no longer supported efficiently. So we need a different handoff schemes that consider the current situation.

3. NETWORK ARCHITECTURE

In this section, we have presented a network architecture which is suitable for seamless vertical handoff. Figure 2 shows the network model in which the mobile can able to receive signals from many access points belongs to different standards. The overlapping cells provide the facility to the mobile nodes for vertical handoff.

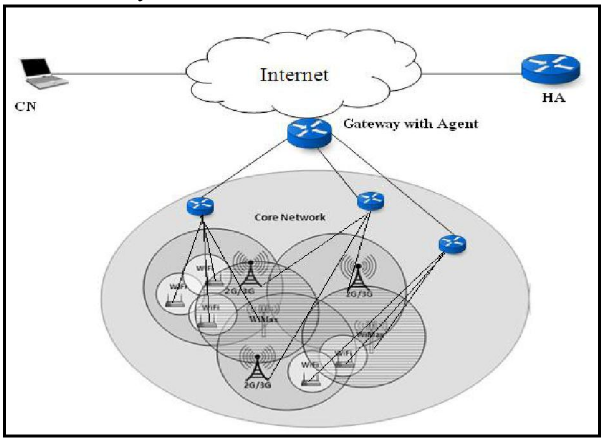

Fig 2: Network Architecture

A mobile terminal can be located in the above heterogeneous network for getting services from multiple access points of different standards, if and only if it has multi network interface. In each network, one or more node can act as a location and network status server. The main responsibility of this server is to monitor the network status and it has to maintain the topological information about the nearby access points. In the next section we have discussed in detail about the Location and Network Status Server.

4. LOCATION AND NETWORK STATUS SERVER

Generally, the mobile nodes may not know about the nearby access points. During the handoff process it has to scan for the available nearby access points. This scanning process will take too much of time. In order to reduce the handoff latency this scanning time has to be eliminated. To avoid unnecessary scanning, a separate server has to be maintained called Location and Network Status Server (LNSS). This server has to maintain the topological information about the access points along with the required information. Before scanning, the mobiles have to communicate with this server, for getting two useful information. The first information is about the nearby access points and the second information is about the current network status. The current location of the mobile node can be calculated by the techniques like GPS or Location sensor model…etc. This may reduce the handoff latency.

As said in [25], the movement of the mobile node can be predicted in advance. This will help in the selection of potential next access points. As we said in [24], the network status information may used to avoid unbeneficial handoff. Based on the network status information, the mobile node has to reduce the unwanted traffic. During the network busy time, the QoS may not be able to maintain by the network. In such situation, the mobile has to handover to the next network. That is the horizontal handoff should be avoided.

5. HANDOFF DECISION ALGORITHM

As shown in figure 2, an agent has to be installed in the gateway. This agent has to decide the handoff by considering many factors like user preferences, current network status, movement prediction, Battery backup and bandwidth required. The agent has to communicate with the LNSS and the information provided by the LNSS must be considered for handoff decision. During the handoff request, the agent in the gateway has to receive the SINR from the mobile node and it has to find the available bandwidth from the networks. If more than one network has the required bandwidth then the selected networks (SNs) has to be sorted based on user preferences, available bandwidth, energy level, network status, movement prediction and topological information.

During the network selection process many filtration works will be done.

a) At first, the SNs will be filtered by eliminating the networks with busy network status.
b) If the number of network is more than one, even after the first filter, then it will be filtered once again by checking the available bandwidth.
c) If the number of network is more than one, even after the second filter, then it will be filtered once again by checking the mobile movement prediction.
d) If the number of network is more than one, even after the third filter, then it will be sorted based on the user preferences. If no user preferred network is available in the selection, then best network will be selected base on the Energy Level of the mobile node. If the energy level is too good then the selection will be based on the movement prediction score. If the energy level is too bad then the network which consumes low power has to be selected. This will help the mobile to live long.

If the old and new access points are in same subnet then the LNSS will help the mobile for low latency handoff by providing information about the neighbor access points. If the old access point and new access point is in different subnet then the agent in the gateway will request a new Care of Address for the mobile network from the DHCP server.

5. CONCLUSION

In this paper we have proposed a vertical handoff approach for seamless mobility. The proposed handoff algorithm considers the factors like SINR, Network Status Information, Bandwidth Availability, Mobile Movement Prediction, User Preferences and Energy Level. This proposed algorithm will minimize the handoff latency, maintain the QoS, saves the energy level of the mobile node and reduces the handoff frequency.

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