AN EFFICIENT HANDBOFF SCHEME FOR UNINTERRUPTED ASSORTED WIRELESS NETWORKS IN OVERLAPPED AREAS

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Received: 21.12.2019 Revised: 24.01.2020 Accepted: 26.02.2020

Abstract

Evolution of communication standards has led to the deployment of heterogeneous environment in terms of various access technologies. In current scenario Long Term Evolution (LTE) and Long Term Evolution- Advanced (LTE- A) are widely deployed in the market and co-exist with previous standards such as 2G and 3G. The technology cycle upgrades digital standard in every two or three years. In this ever changing era of telecommunication, a user expects some sort of stability. Though the advancement in this field, in terms of data rate is breathtaking, it is undesirable to push a user to buy a new device whenever a new standard is introduced. A user would rather, prefer seamless connectivity in such a heterogeneous environment. The challenge in this situation is to select the best network, out of number of available networks, such that the ongoing communication session stays uninterrupted. To solve this problem, we used an algorithm to select the best candidate network, using certain parameters. The algorithm is parted in two categories. In first stage, we consider two candidate networks and identify the overlapped area to which the user is expected to move. Here distance parameter is used to estimate the overlapped region between the two networks. In second stage two important parameters, received signal strength and outage probability, further contributes to the decision of best network selection.

Keywords: Handover, Heterogeneous, Network Function, Outage Probability, Overlapped Area.

INTRODUCTION

We see a tremendous demand for high speed wireless data due to growth in telecommunication standards. The user demand is not only for high data rate but also for high quality of service (QoS) [1, 2]. The technology paradigm is continuously evolving to meet the user requirements. There is an important issue to consider while designing new technology standards. The upcoming standards must always harmonize with the previous standards. In simple terms, a backward compatibility is desirable so that a number of standards can coexist on devices with multiple interfaces [3]. Also, another important aspect to ponder over is the availability of large number of portable handheld devices. This Consideration helps us to depict the current picture of complexity in the world of communication; a large number of mobile users moving in a heterogeneous environment [10]. A wireless communication engineer is well aware of the challenges to make communication possible in such a scenario [11]. Thus the concept of handoff in heterogeneous networks emerged. Basically handover or handoff is defined as transfer of ongoing session without interruption from one network to another depending on various constraints [4]. The task is to assign the user with best network available among various candidate networks through handoff.

We consider two networks, Global System for Mobile (GSM) and Universal Mobile Telecommunication System (UMTS), where we have to deal with hard handoff (break before you make). Keeping a check on all these factors, we used an algorithm that provides a unified infrastructure for uninterrupted communication in a heterogeneous environment [12]. The best network is selected in terms of optimality, to allow the user to have a graceful experience while switching between various digital standards. In the conventional algorithm only received signal strength (RSS) was considered as basis for handoff. However this led to unpleasant back and forth switching of mobile station (MS) between different networks. The effect is called as Ping Pong effect. The disadvantages associated with this effect are low network throughput, high call dropping probability, long handoff delay [13].

The manuscript is organized in the following order. Detailed literature review is discussed in section II. The proposed system model and network selection algorithm are explained in section III and IV respectively. The simulation results are discussed in section V and the work is concluded in section VI.

LITERATURE SURVEY

In [6], optimization of network selection is done for heterogeneous wireless networks. Selection of the best among the candidate networks, is carried out using Markov Decision Process. Through simulation results it is proved that this scheme provides larger operator revenue and increased throughput. The priority value-based cell selection scheme proposed in [7] achieves the required QoS by maximizing the number of successful calls and minimizing the handoff rate in the network. This scheme is executed in three steps namely call selection of candidate network, priority value calculation and target cell determination. A utility function based
network selection scheme is highlighted in [14] which is more suited for urban road wireless network. In [9], network discovery and selection method called router discovery is proposed to execute handoff between wireless local area network (WLAN) and UMTS in improved manner. A handoff decision making with multiple attributes is explained in [15]. A network selection scheme using decision tree based supervised learning is proposed in [16]. The cross correlation function of the shadowing components, which affects the link present between the MS and the two candidate networks, is studied in [17]. The handoff performance between GSM and satellite integrated mobile communication system is analyzed in [18]. In order to execute handoff, the parameters like position and call dropping probability are considered.

**SYSTEM MODEL**

![Figure 1: System Model](image)

Fig.1 illustrates the basic system model under consideration. We have two base stations (BS), B1 and B2. Our first parameter under consideration is averaged RSS. MS gives preference to the network that gives the higher signal strength. The pilot signal strength received from BS1 is given by,

\[ P_r(k) = PL_i - 10 \gamma \log_{10}(ks) + x_i(k) \]  

(2)

Similarly, for B2,

\[ P_r(k) = PL_i - 10 \gamma \log_{10}(D-ks) + x_i(k) \]  

(3)

Where \( P(k) \) (i = 1, 2) is pilot signal strength, \( PL \) is path loss component, \( x \) represents shadowing parameter and \( y \) is path loss exponent [19].

In this system, we observe an effect called shadowing that occur between transmitter and receiver due to the obstructions of mountains, trees, buildings etc. [20]. Shadow fading results in fluctuation of received signal and thus its components appear in (2) and (3).

The auto-correlation function of shadow fading is,

\[ E((x(k)x(k+1))^2) = \sigma^2|\beta|n \]  

(4)

where \( \beta = \exp((-ut)/d_i) \).

(5)

\( \sigma \) is standard deviation of shadow fading, \( n \) is an integer. Sampling distance is given by \( t_s \) and \( u \) is velocity of MS. Therefore, \( s = ut_s \). Here \( d_i \) is correlation distance.

Now, we use second selection parameter, distance, to search the overlap area. The following equation describes the distance of MS from B1 and B2 respectively.

\[ d_1(k) = ks + \Gamma_1 \]  

(6)

\[ d_2(k) = D-ks + \Gamma_2 \]  

(7)

\( \Gamma_1 \) and \( \Gamma_2 \) are distance measurement errors, which are wide sense stationary (WSS) with zero mean and variance \( \sigma^2 \) and can be represented as \( \Gamma_1, \Gamma_2 \sim N(0, \sigma^2) \). This decision needs to be taken when MS is in overlapping region. As mentioned earlier this area is measured using distance estimation technique [21] representing the networks GSM (2G) and UMTS (3G) respectively. The two cellular networks are assumed to be separated by a distance \( D \).

Assume MS is initially connected to GSM network. Both the networks are assumed to have their base stations at the centre of the respective cells. MS continuously measure RSS with respect to each of the cells in order to know, which network is closer. The measurements are done at regular intervals \( d \).

\[ d = ks \]  

(1)

where \( k \) is an integer, \( k \in [0, D/s] \) and \( s \) is sampling distance. \( k \) is used to represent various parameters at different intervals. When MS moves, it needs to decide whether it has to maintain its current connection or whether it should switch to otherAls, we define the relative distance of MS with respect to both the BS as

\[ Z(k) = d_1(k) - d_2(k) \]  

(8)

The third parameter, the outage probability, when described for a specific system has a predefined threshold, i.e., it is confined within some limit [22] [23]. This threshold is crucial for enhancing the efficiency of network selection algorithm and is measured by finding a probability that the averaged RSS is below this threshold. Mathematically, we express it as,

\[ P_O = P(\rho < \rho_t) \]  

(9)

\( p \) represents RSS from BS and \( pt \) is threshold RSS.

**NETWORK SELECTION ALGORITHM**

The algorithm aims at selecting the best candidate among various available networks [16]. The algorithm also maintains agood QoS. We use network function (NF) to represent all the necessary conditions of optimal network selection.

NF of the \( j \)th wireless network is best expressed mathematically as,

\[ NF(j) = F(P_{o(j)}(k) - P_{a(j)}(k))F(P_{o(j)}(k) - P_{a(k)}(k))F(P_{o(j)}(k) - P_{a(j)}(k)) \]  

(10)

where \( F \) is a step function. \( P_{o(j)} \) is averaged RSS from different access networks and \( P_{a(j)} \) represents threshold RSS [19]. \( j \) represents the current network and \( j+1 \) is used to represent the next network to be connected. \( k=1,2, ..., D \) is an integer that is used to represent sampling at regular intervals. \( P_{o(j)} \) reflects threshold outage for multimedia services. \( d_{th} \) depicts overlapping threshold between different networks [20].

The flow chart of network selection algorithm is displayed in fig.2. MS can have multiple interfaces suitable for heterogeneous networks [21] [22]. In this paper, we consider MS having two interfaces. We assume that initially MS is operating in cell 1, i.e., it is connected to network 1 (GSM). MS continuously scan its surroundings to check the availability of nearby networks. Link quality parameters are important aspects along with QoS.

![Figure 2: Network Selection Algorithm Flow Chart](image)
The algorithm is categorized in two parts.

- Firstly, network discovery is done based on RSS received by MS. We estimate distance in order to identify the overlapped region between the two networks [23].
- In the next step, we used another important metric, the outage probability. This parameter in conjunction with averaged RSS help in making better decision of network selection.
- We check, out of the two networks which one has a higher value of network selection function.
- Based on this the, MS switches to the next network or stay connected to its own.

RESULTS AND DISCUSSION

We perform simulation using MATLAB 2015a software. Initial assumption include that MS is moving with a constant velocity from one network to the other. For computational purpose, simulation parameters are enlisted in Table 1.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM Radius</td>
<td>1000m</td>
</tr>
<tr>
<td>UMTS Radius</td>
<td>50m</td>
</tr>
<tr>
<td>Outage RSS threshold of GSM</td>
<td>-88dBm</td>
</tr>
<tr>
<td>Outage RSS threshold of UMTS</td>
<td>-94dBm</td>
</tr>
<tr>
<td>GSM Path Loss Exponent</td>
<td>3</td>
</tr>
<tr>
<td>UMTS Path Loss Exponent</td>
<td>3.4</td>
</tr>
<tr>
<td>Sampling distance</td>
<td>1m</td>
</tr>
<tr>
<td>Shadow fading standard deviation</td>
<td>8dB</td>
</tr>
</tbody>
</table>

In our simulation, we consider two networks, GSM (2G) and UMTS (3G). As per the specifications, GSM radius, UMTS radius and the overlapped area are defined to be of switches from network 1 to network 2 in 3(a). In 3(b) MS selects UMTS as it moves away from GSM towards UMTS.

![Figure 3(a): Network Function to Switch from 2G to 3G](image)

![Figure 3(b): Network Function to Switch from 3G to 2G](image)

An average RSS experienced by a MS versus distance is displayed in fig 4. It is clear that as the MS moves from network 1 to network 2, the average RSS from network 1 decreases and that received from network 2 increases. We can see, when MS is moving towards UMTS, the signal strength falls largely especially after d > 900m. Similarly, when MS moves from UMTS to GSM, RSS fro mGSM increases after d > 600m.

Next, we consider another selection parameter, outage probability, to understand it's role in this algorithm. To finalize the decision of network selection, outage probability is used. From the plot we notice that, whenever MS moves towards network 2, outage probability associated with network 1 reduces and that of network 2 increases. Thus, the network selection favors for the network with a lower outage probability and this condition is represented in fig 5.

CONCLUSION

This paper focuses on selection of best available network in a heterogeneous environment. The link parameters such as outage probability and RSS are used to present an improved framework over the conventional one, where only RSS was considered for simulation. Efficiency of the system increases due to the reduction of overheads on MS, since our system model considers the overlapped region for network selection decisions. The paper aims at fast network selection with out any compromise on QoS. The network model for future work can be implemented for handoff in LTE and 5G small networks.

REFERENCES