Comparative Analysis Of Vertical Handoff In IEEE 802.11 WLAN And CDMA Network

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Abstract

Wireless communications is, by any measure, the fastest growing segment of the communications industry. As such,it has captured the attention of the media and the imagination of the public. Cellular systems have experienced exponential growth over the last decade and there are currently around two billion users worldwide.In this paper we use the vertical handoff algorithm and make a network based on WLAN and CDMA network and then analyse on the basis of this network by using the formula throughput and handoff delay in MATLAB.

Keywords: Hand-off,Vertical Hand-off(VHO),IEEE 802.11(WLAN),CDMA,Throughput,Handoff Delay

Introduction

Vertical handoff is one significant challenge for mobility management in heterogeneous wireless networks. Compared with horizontal handoff, vertical handoff involves different wireless network technologies varying widely in terms of bandwidth, delay, coverage area, power consumption,etc.

In cellular mobile networks, the coverage region is divided into smaller cells in order to achieve high system capacity.Each cell has a Base-Station (BS), which provides the service to the Mobile Terminals (MTs), i.e. users equipped with phones, within its region. Before a mobile user can communicate with other user(s) in the network, a group of the frequency bands or channels should usually be assigned. The MTs is free to move across cells. When the mobile user crossing a cell boundary or by deterioration in quality of the signal in the current channel, handoff process is initiated.[1]

1.1 Handoff Strategies

An event when a mobile station moves from one wireless cell to another is called Handoff. Handoff can be of two types: horizontal (intra-system) and vertical (inter-system) cases. Handoff within the same wireless access network technology is considered as Horizontal handoff, and handoff among heterogeneous wireless access network technologies is considered vertical handoff. The terminology of horizontal and vertical reflects the wireless access network technology instead of the administrative domain in comparison to macro- and micro mobility. There are different subclasses such as follows:

1) Vertical macro mobility refers to mobility among different administrative using different wireless technologies.
2) Horizontal macro mobility refers to mobility among different administrative domains using the same wireless technology.
3) Vertical micro mobility refers to mobility within the same administrative domain using different wireless technologies
4) Horizontal micro mobility refers to mobility within the same administrative domain using the same wireless technology.

1.2Handoff Methods

Handoffs have several methods and they are technology dependent. The two main handoff methods are:

1) Hard Handoff: It has a brief disruption of service as it has to break before a making a switching action. Hard Handoffs are used by Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA) systems.

2) Soft Handoff: It has no disruption of service action as it makes a switching action before the break. Multiple network resources are used by soft handoffs. Soft handoffs are used by CDMA system.

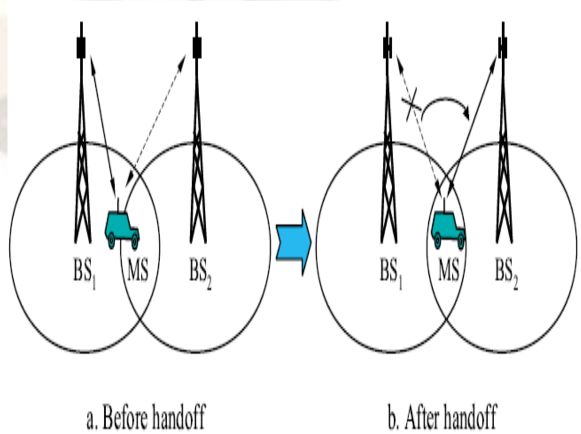

Figure.1: shows two different handoffs.

Related Work

Studies have been conducted that evaluate the performance of 802.11 handoff mechanisms. Mishra et al. performed an empirical analysis of handoffs using cards from several vendors and identified that the probe mechanism is the main cause of handoff latency[2].

In Large 802.11 Wireless Network it have been analyzed the performance Probe request, Association Request, Re-association Request[3].

The development of WLAN began with the implementation of first IEEE 802.11 WLAN standards. The 802.11 standard have the utmost throughput up to 1 to 2 Mbits per second and operate in 2.4GHz frequency. The 802.11 standard is based on radio technologies. WLAN intention was just to provide the wireless network infrastructure analogous to wired Ethernet network[4].

The problem discuss to prefer the handover in case of Mobile Out (MO) in the underlay network[5]. The design of VHO decision is one of the main challenges in heterogeneous wireless networks due to the huge diversity in the characteristics of networks and services. This heterogeneity propels the concept of a preferred network, which is usually the network that provides better service at a lower cost. Hence, VHO decision algorithms define a set of rules that enable determining the best network in the user vicinity.

In [6], the VHO decision is based on a periodic comparison of total network costs that are estimated as weighted sums of a normalized set of the VHO policy parameters. These weights vary according to user preferences and the MT status (e.g,power reserve).

In [7], they presented a seamless vertical handoff procedure and the effective handoff algorithm for the handoff transition region between the WLAN and CDMA cellular network. Mobility management using MA and SA was also adopted to minimize the handoff delay in the WLAN-CDMA Cellular interconnection architecture based on IP. In the handoff algorithm we use the number of continuous beacon signals whose signal strength from the WLAN falls below the predefined threshold value. We then classified traffic into real-time service and non real-time service. In real-time service, the handoff delay in the handoff transition region must be short, so the number of continuous beacon signals should be lower than that of the non real-time service in order to reduce handoff delay. Since the CDMA cellular network covers a wide area and the handoff time is not critical in MU, the value of λu should be higher than the other values.

In [8], the authors propose a policy-enabled handoff across a heterogeneous network environment using a cost function defined by different parameters such as available bandwidth, power consumption, and service cost. The cost function is estimated for the available access networks and then used in the handoff decision of the mobile terminal (MT). Using a similar approach as in [9], a cost function –based vertical handoff decision algorithm for multi-services handoff was presented in [10]. The available network with the lowest

Vertical Handoff Algorithm

Vertical handoff refers to a network node changing the type of connectivity it uses to access a supporting infrastructure, usually to support node mobility. For example, a suitably equipped laptop might be able to use both a high speed wireless LAN and a cellular technology for Internet access. Wireless LAN connections generally provide higher speeds, while

Cellular technologies generally provide more ubiquitous coverage. Thus the laptop user might want to use a wireless LAN connection whenever one is available, and to 'fall over' to a cellular connection when the wireless LAN is unavailable. Vertical handovers refer to the automatic fallover from one technology to another in order to maintain communication.[11]

For VHO, there are two additional and useful classifications to understand why VHO mechanisms are different from traditional horizontal handoff (HHO) mechanisms such as signal strength-based.The first classification is: upward and downward. An upward VHO occurs from a network with small coverage and high data rate to a network with wider coverage and lower data rate. On the other hand, a downward VHO occurs in the opposite direction. As an example for this classification let's consider the case of two of the most important current wireless technologies: 3G cellular networks and WLANs. The WLAN system can be considered as the small coverage network with high data rate while the 3G cellular system is the one with wider coverage and lower data rate. The trend in the literature has been to perform downward VHOs whenever possible.

The existing Vertical handoff algorithm between the WLAN and CDMA cellular networks[7] is shown in Figure 2.We use the following variables to determine the vertical handoff.[7]

χthresh : Predefined threshold value when the handoff transition region begins

λ : The number of continuous beacon signals that are received from the WLAN with below χthresh

λr : λ for real time service

λu : λ for mobile upward

λn : λ for non-real time service

The relationship among the variables is as follows.
λr << λn << λu ------------------------ (1)

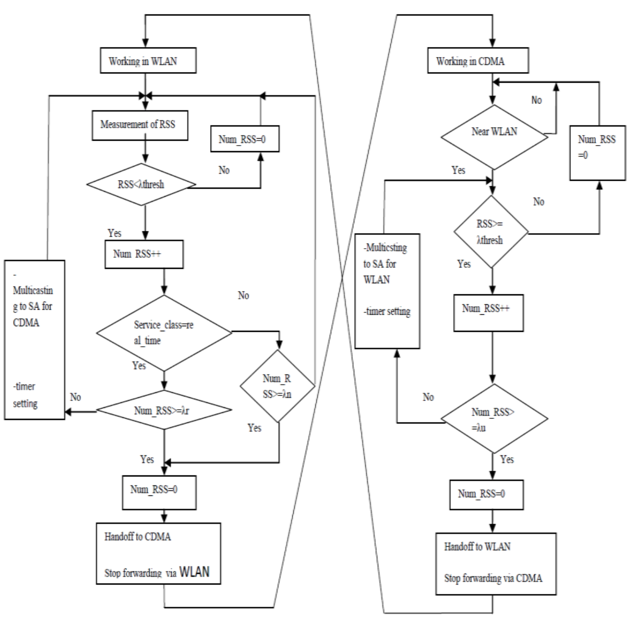

Figure2. Vertical Handoff Algorithm[7]

We use the following variables to deduce handoff delay and throughput as the MH moves around the handoff transition region. [7]

Tt: Region extending from the point at which the power P falls below χthresh for the first time to the point at which P falls below χthresh permanently.

T1: Each contiguous stretch of time where P > χthresh within Tt

T2: Each contiguous stretch of time where P <χthresh within Tt

TN: Normalized handoff delay in handoff transition region

S (i): Average throughput in each case

N: Number of times P crosses the value of χ

Δ : Handoff completion time

δ : Time between beacon signals

R1: Effective data rate available over the air in the WLAN

R2: Effective data rate available over the air in the CDMA Cellular Network

If a handoff is executed at each point where the strength of the beacon signal crosses χthresh in the transition region, then the average throughput is as follows:[7]

$$\overline{s(1)} = R_2(\overline{T_{2(tot)}} - \overline{T_N}/2) + R_1(\overline{T_{1(tot)}} - \overline{T_N}/2) \quad (2)$$

The three random variables in the above formula are as follows.[7]

$$T_{1(tot)} = \sum_{i=1}^{N/2} T_{1(i)} / T_t$$

$$T_{2(tot)} = \sum_{i=1}^{N/2} T_{2(i)} / T_t \quad (3)$$

$$T_N = N\Delta / T$$

We apply the proposed λr and λn to the real-time service and non real-time service handoffs respectively, and the formula of the handoff delay and average throughput in each case is as follows.

For the non real-time service, if it is not the case that the number of continuous beacon signals below the χthresh in the handoff transition region are same as λn, then the average throughput is:[7]

$$\overline{s(2)} = R_1(\overline{T_{2(tot)}} + \overline{T_{1(tot)}}) \quad (4)$$

$$\overline{s(1)} << \overline{s(2)}$$

We assumed the loads of the WLAN and CDMA Cellular are nominal and the data rate of the WLAN in the handoff transition region is higher than that of the CDMA cellular network. We can see that the average throughput of formula (4) is higher than that of formula (2) .

For non real-time service, if the number of continuous beacon signals below the χthresh in T2(2) of the handoff transition region is same as λn, then the average throughput is :[7]

$$\overline{s(3)} = R_1(\overline{T_{2(1)}} + \overline{T_{1(1)}} + \lambda_n \delta) + R_2(\overline{T_{2(2)}} - \Delta) \qquad (5)$$

$$\overline{s(1)} << \overline{s(3)}$$

We can see that the average throughput of formula (5) is higher than that formula (2) because R1 is higher than R2 in the handoff transition region.
Next, for the real-time service, if there is the case that the number of continuous beacon signals below the χthresh in the handoff transition region is the same as λr, then the normalized handoff delay is as follows,[7]

$$T_N = \Delta / T_t \qquad (6)$$

We can see that the value of formula (6) is N times lower than formula (3).

Simulation and Results

We have created a network in Figure 3,the hexagon region is CDMA region,the square inside the hexagon are WLAN,the blue * is the mobile host.The mobile host start from a WLAN and CDMA that is randomly chosen. There are 12 CDMA and 48 WLAN.For each WLAN and CDMA there is separate data rate and id while the mobile host moves the RSS value randomly changes.We give a threshold value for CDMA and WLAN that is 35dbm.If the RSS value reaches below the threshold value,this is consider as weak signal or beacon signal,while the mobile host moving the signal may be strong or weak,when the mobile host receives three continuous weak signal handoff takes place.We are assigning three as threshold for weak signal count,here the mobile host receives 3 weak signals so it take handoff to nearest CDMA.

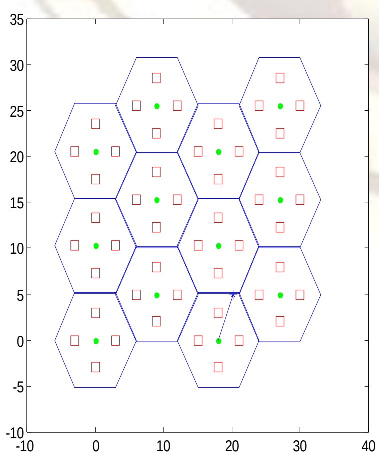

Figure3 Simulation network based on WLAN and CDMA network using the Vertical handoff

The average throughput will calculated based on the formula which is shown in the equation(2),(3),(4) and(5) We have to compare the S1 and S2 values,the condition is S1 should be too less than S2 and also S1 should be less than S3.

Normalized handoff Delay will calculated based on the formula which is shown in the equation(6).

4.1 CDMA Throughput versus Handoff Count in Real Time

The real time effect the WLAN and CDMA throughput as well as the handoff count When the handoff take place between WLAN and CDMA ,the RSS value generated based on the distance, then only throughput will generated. The simulation results using Figure 3 are displayed in Table 1 and Table 2.The graphs are plotted in Figure4.

Table1 CDMA Throughput vs Handoff Count in real time

CDMA Handoff Count	CDMA Throughput (bits/sec)
1	51.3600
2	79.8803
3	22.0261
4	20.8182
5	92.6857
6	100.1244
7	101.2185
8	0

Table 2 WLAN throughput vs Handoff Count in real time

WLAN Handoff Count	WLAN Throughput(bits/sec)
1	154.3308
2	121.7289
3	0
4	41.0341
5	26.4232
6	60.1401
7	0
8	229.6189
9	129.6204

In Figure4,for each CDMA and WLAN there is randomly generated RSS values which will differ according to the distance and switching will continue between the WLAN and CDMA network by using Figure3.So for each value throughput and total handoff count will generated. So for each run total CDMA handoff count =8 and WLAN Handoff count=9, also the corresponding values are displayed in Table 1 and Table 2 and then graph is plotted in Figure4.

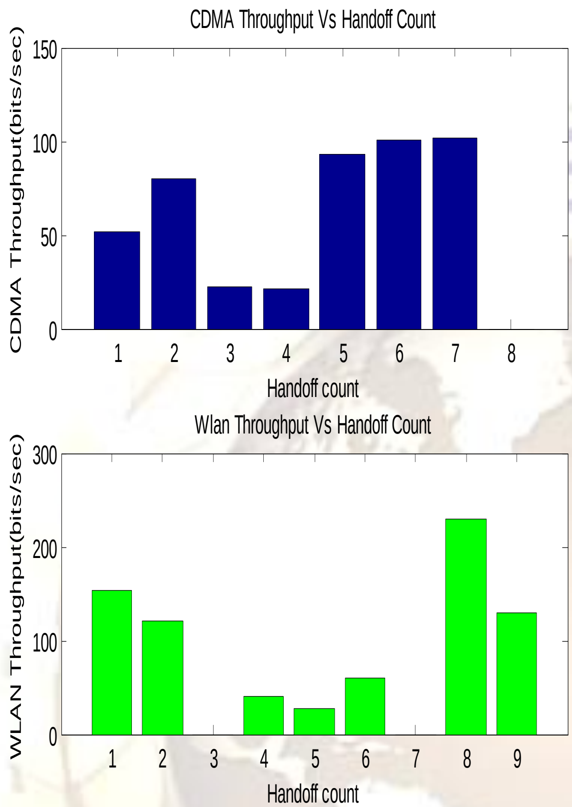

Figure 4 Plot of CDMA and WLAN Throughput vs Handoff Count in Real time

4.2 CDMA Throughput versus Handoff Delay in Real Time

Also in real time CDMA and WLAN Handoff Delay and Handoff count will generated. . The simulation results using Figure 3 are displayed in Table 3 and Table 4.The graphs are plotted in Figure5.

Table3 CDMA Handoff Delay vs Handoff Count in real time

CDMA Handoff Count	CDMA Handoff Delay (sec)
1	0.0040
2	0.0027
3	0.0019
4	0.0007
5	0.0009
6	0.0009
7	0.0010
8	0.0021

Table 4. WLAN Handoff Delay vs Handoff Count in real time

WLAN Handoff Count	WLAN Handoff Delay(sec)
1	0.0193
2	0.0010
3	0.0050
4	0.0009
5	0.0024
6	0.0003
7	0.0012
8	0.0014
9	0.0013

In Figure5,for each CDMA and WLAN there is randomly generated RSS values which will differ according to the distance and switching will continue between the WLAN and CDMA network by using Figure3.So for each value throughput and total handoff delay will generated. So for each run total CDMA handoff count =8 and WLAN Handoff count=9, also the corresponding values are displayed in Table 3 and Table 4 and then graph is plotted in Figure5.

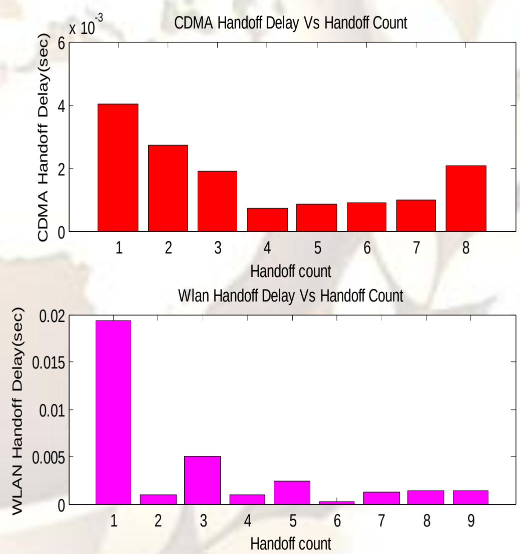

Figure 5. Plot of CDMA and WLAN Handoff Delay vs Handoff Count in Real Time

4.3 CDMA Throughput versus Handoff Delay in Non-Real Time

The non- real time effect the WLAN and CDMA throughput. When the handoff take place between WLAN and CDMA, the RSS value generated based on the distance, then only throughput will generated. The simulation results using Figure 3 are displayed in Table 5 and Table 6.The graphs are plotted in Figure6.

Table 5. CDMA Throughput vs Handoff Count in Non-Real Time

CDMA Handoff Count	CDMA Throughput(bits/sec)
1	2.6918
2	73.3776
3	19.7891
4	20.2511
5	91.1148
6	98.5383
7	99.5720
8	0

Table 6. WLAN Throughput vs Handoff Count in Non-Real Time

WLAN Handoff Count	WLAN Throughput(bits/sec)
1	156.7637
2	87.0112
3	0
4	40.6666
5	193.6961
6	49.3143
7	0
8	214.5706
9	224.4075

In Figure 6,for each CDMA and WLAN there is randomly generated RSS values which will differ according to the distance and switching will continue between the WLAN and CDMA network by using Figure3.So for each value throughput and total handoff count will generated. So for each run total CDMA handoff count =8 and WLAN Handoff count=9, also the corresponding values are displayed in Table 5 and Table 6 and then graph is plotted in Figure6.

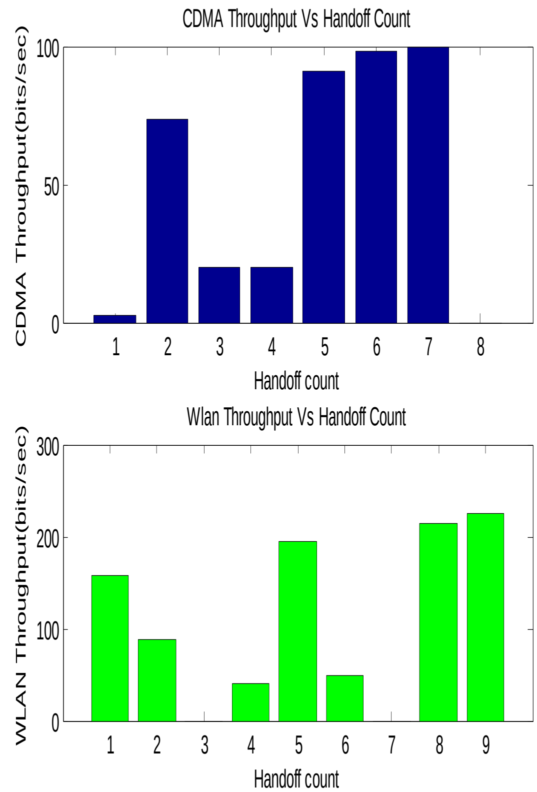

Figure 6.Plot of CDMA and WLAN Throughput vs Handoff Count in Non-Real Time

4.4 CDMA Throughput versus Handoff Delay in Non-Real Time

Also in real time CDMA and WLAN Handoff Delay will generated. . The simulation results using Figure 3 are displayed in Table 7 and Table 8.The graphs are plotted in Figure7.

Table 7 CDMA Handoff Delay vs Handoff Count in Non-Real Time

CDMA Handoff Count	CDMA Handoff Delay
1	0.0065
2	0.0010
3	0.0008
4	0.0008
5	0.0009
6	0.0009
7	0.0010
8	0.0017

Table 8. WLAN Handoff Delay vs Handoff Count

WLAN Handoff Count	WLAN Handoff Delay
1	0.0175
2	0.0007
3	0.0008
4	0.0009
5	0.0017
6	0.0003
7	0.0006
8	0.0013
9	0.0012

In Figure 6,for each CDMA and WLAN there is randomly generated RSS values which will differ according to the distance and switching will continue between the WLAN and CDMA network by using Figure3.So for each value throughput and total handoff delay will generated. So for each run total CDMA handoff delay =8 and WLAN Handoff delay=9, also the corresponding values are displayed in Table 5 and Table 6 and then graph is plotted in Figure6.

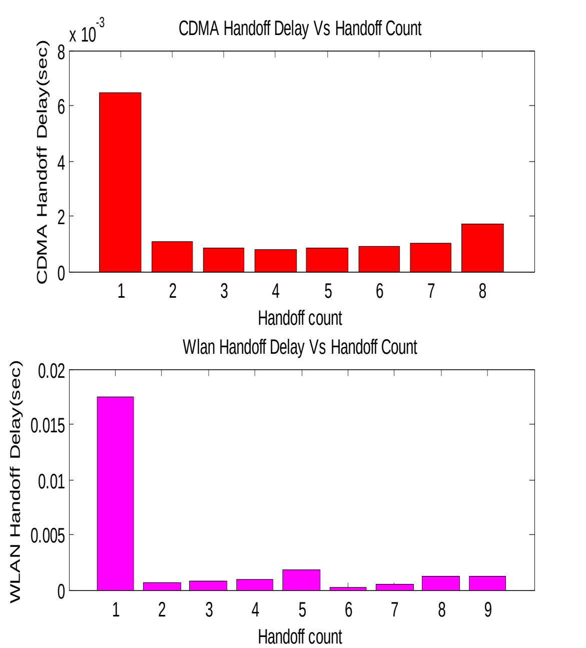

Figure 7. Plot of CDMA and Handoff Delay vs Handoff Count in Non-Real time

Conclusions and Future Work

In Vertical handoff algorithm which we have used and make a simulation network will generate the RSS value randomly using the threshold value 35 dbm.So at the time of handoff between WLAN and CDMA network the WLAN datarate,CDMA datarate,Handoff CDMA ID,WLAN CDMA ID,Throughput S1,Throughput S2, Throughput S3,Handoff Delay,Total Handoff,CDMA Handoff,RSS value with distance will generated.All the parameters are shown in the tables and also plotted the graph by using the formula average throughput and normalized handoff delay.

In Future we can also work on the real time application such as audio,video and can analyse the throughput and handoff delay.

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