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Vertical Handover Parameters in Wireless Heterogeneous Networks

RSS & QoS Analysis of Cellular and WLAN Networks

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Abstract—In recent decades the wireless access technologies have grown rapidly and continuously growing so leading to various different wireless technologies coexists in same geographical area. It leads to recent studies in providing the ability to mobile users to roam across these technologies in seamless manner thus providing seamless mobility. Vertical handover decision (VHD) algorithms are essential part of the architecture of Next Generation Heterogeneous Wireless networks which utilizes various parameters on which handover decision depends, like Available Bandwidth, RSS, QOS, Security, Monetary Cost etc. Our research would take RSS & QOS into consideration for making the handoff decision. These algorithms need to be designed to provide the required Received Signal Strength (RSS) & Quality of Service (QoS) to a Mobile Device for making better handoff decision [3]. In Future, different access networks like GSM/UMTS, WLAN, Wi-Fi, WiMAX, LTE Adv. will be bound together into a single network which will be glued by Internet Protocol (IP) which means service convergence in which services will be provided to users independently of their location, access technology and type of device. To fulfill this vision, we have to develop sophisticated policies for vertical handovers in which performance of mobile services will be determined by efficient and reliable vertical handoff algorithms.

Keywords—Algorithms, RSS, QOS, SINR, Vertical Hand off Decision.

I. INTRODUCTION

The technique of transferring the ongoing call or data sessions from the serving base station to adjacent base station without interruption is called handoff. The handover occurs when the mobile user moves from one cell to another cell during call and if we don't use any handoff strategy the call will disconnect. This process requires the various parameters such as handoff scheme, number of free channels, RSS, and QoS as standard.

Vertical handover may be referred as the process of transferring the call/data session between the different technologies such as the WLAN and Cellular networks, the wireless local area network are characterized by high bandwidth but low coverage area, while the cellular network are characterized by low bandwidth but large coverage area, hence whenever possible there is scope for transferring the call between the two technologies. In this thesis we will try to find out the reasons behind the quality degradation during the handoff process and try to suggest new techniques and processes to address the QOS and maintain the minimum standard of quality during the handoff.

II. EVOLVING TECHNOLOGIES

In cellular mobile technologies, there are main concerns regarding the technologies like bandwidth, mobility, coverage area, upon these we usually divide the technologies into the main broad areas.

- The technologies with low data rate and mobility.
- The technologies with high data rate but smaller coverage area.

As per above specifications in current age and technologies, WIMAX, WLAN, WIBRO, HSPDA and HSPA are offering both high data rate and coverage to circuit switched networks and packet switched networks.

III. WIRELESS LAN

The Wireless LAN is unlicensed band of 802.11 ISM frequency band. 802.11 standards are recent communication technologies of IEEE standard. It specifies the medium access control layer and physical layer and operates in different frequency bands. 802.11a operates in 5GHz band and provides 54Mbit/s of data rate, while 802.11b operates in 2.4 GHz band and provide slight lower 11 Mbit/s of data rate. 802.11g is recent development and operates in 2.4 GHz band provides 54 Mbit/s of data rate.

In Wireless LAN, two types of MAC protocols are used Distributed Coordination Function (DCF) and Point Coordination Function (PCF) are utilized. Nowadays, DCF is used as it is simple, robust and easy to implement in small devices, it employs the Carrier Sense Multiple Access (CSMA) with the addition of Collision Avoidance, and it resolves the problem of transmission of packets simultaneously at same time. The basic structure of WLAN is shown in Fig. 1.

The WLAN has shorter range but it supports higher bit rate and different standards employs different encryption algorithms (e.g. WEP).

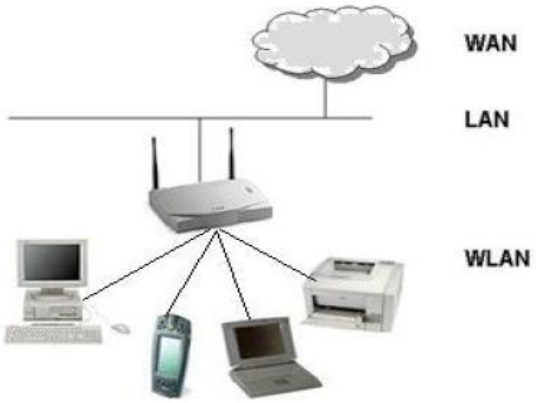

Fig. 1

IV. HETEROGENEOUS WIRELESS NETWORKS HANDOFF SCENARIO

In Heterogeneous networks, there are mainly two types of handovers.

- Horizontal handover
- Vertical Handover

A. Horizontal Handover

Handoff occurring within same network is known as horizontal, the main concern about this handoff to maintain the connectivity while the ongoing call. The majority of handoffs are horizontal handoffs.

B. Vertical Handover

The vertical handoff occurs in the heterogeneous networks. The access technology is also changed along with the IP address as the MS changes the networks, main concern about this handoff to maintain the ongoing call as well as the maintain the characteristics of network such as the QOS and RSS.

The Major difference between Horizontal and Vertical Handover is given below:

Technology	**Horizontal**	**Vertical**
Access Technology	Single technology	Heterogeneous technology
Network Interface	Single Interface	Multiple Interface
IP Address during the process	Remain unchanged	As per the network technology
QOS Parameter	Single value	Multiple values

Table. I

V. HANDOVER MANAGEMENT PROCESS

Handover process can be carried out in three phases:

- Handover Initiation Phase
- Handoff Decision
- Handoff Execution

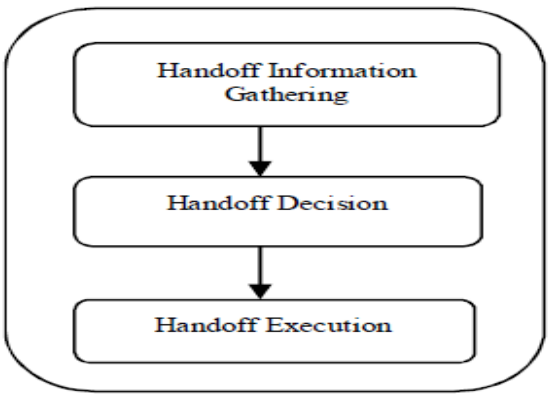

Fig. 2

Handover Initiation Phase is called handover information gathering or the system discovery which is used to collect the useful information required to initialize the handover process.

Handover decision Phase is the system or network phase in which determination on the basis of information gathered is done for handover process. The detailed plan to determine the suitable channel in target network and execution plan is designed.

Handover Execution Phase is used to select the network according to the handover decision phase.

VI. PARAMETERS USED FOR MAKING VERTICAL HANDOFF DECISIONS

The following decision criteria have been proposed for used in VHD algorithms.

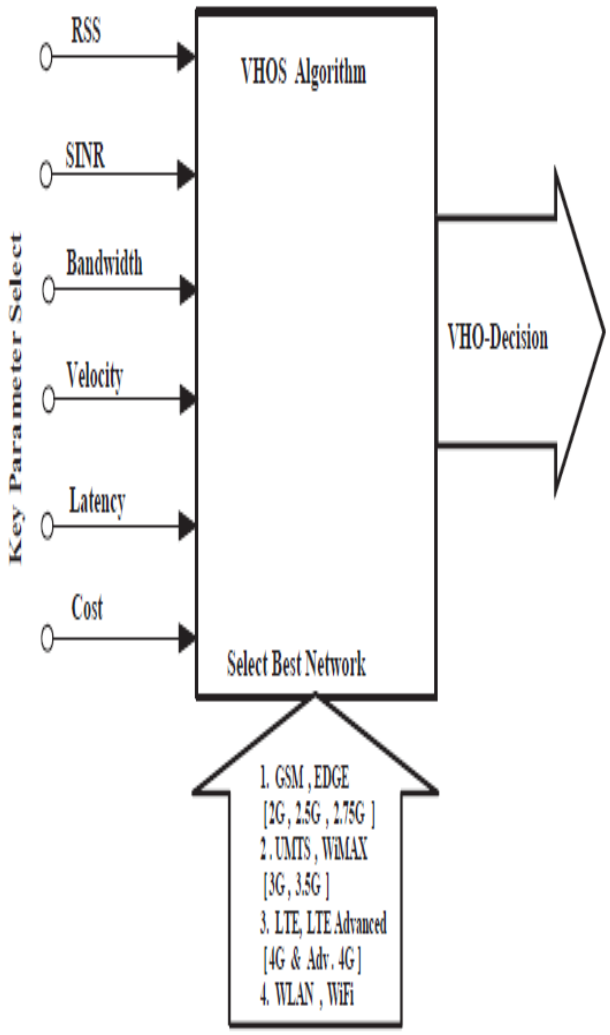

Fig. 3

- **Received Signal Strength**

This is traditional decision criteria in horizontal handover process while it is also important decision criteria as it is easy to measure and directly related to service quality. There is close relationship between the RSS and distance of mobile station from the base station.

- **Network Connection Time**

It is referred to as the duration to which the mobile terminal remains connected to point of attachment. This factor is very essential for picking the right time at which handover process can be start and to maintain the right level of service quality for network.

- **Available Bandwidth**

It is the calculation of available or consumed bandwidth resources during the whole activity expressed in bit/s and good indicator of traffic conditions and useful in delay sensitive networks.

- **Power Consumption**

If the MT's power is low then it is serious issue as it would be preferred to handover to PoA which would help in extending the battery life

- **Monetary Cost**

For some networks these may be different charging policies, in some simulations this factor may be taken consideration while performing the handover process.

- **Security**

For some systems, confidentiality and integrity of the network is must and this effect the decision process while performing the handoff process.

- **User Preferences**

A user preference for particular network may be taken consideration while performing the handoff process.

Difference between different wireless technologies specifications

Network Characteristics	*IEEE 802.11g WiFi*	*IEEE 802.16e WiMAX*	*Cellular systems (B3G/4G)*
Coverage	Small range (100-300m)	Medium range (2-5 Km)	Large range (3-10 Km)
Bandwidth	High (up to 54Mbps)	Medium (up to 30Mbps)	Low (up to 14.4Mbps)
Billing	Cheap	Medium	Expensive
Security	Weak (WEP-based)	Medium	High
Deployment Cost	Low	Medium	Very High
Cost of data service	Low	Medium	High

Fig. 4

VII. RECEIVED SIGNAL STRENGTH RELATED WORK

It is most used parameter which is directly related to service quality. There is close bond between the RSS value and distance of mobile terminal to its base station. It is equally important to Vertical handoff as well. The different types of RSS are explained as below:

- **Normal RSS**

If the candidate attachment point RSS is higher than the attachment point RSS($RSS_{new} > RSS_{cur}$).

- **RSS plus Threshold**

If the If candidate attachment point RSS is higher than the current attachment point RSS and the current attachment point RSS is less than a threshold T which is usually predefined ($RSS_{new} > RSS_{cur}\ and\ RSS_{cur} < T$).

- **RSS plus Hysteresis**

If the candidate attachment point RSS is higher than the current attachment point RSS with a pre-defined hysteresis margin H. ($RSS_{new} > RSS_{cur} + H$).

Network	Threshold RSS (dBm)	Downlink (Mbps)	Service Cost	Mobility
GSM/GPRS	-45 to -115	9.6 to 144 Kbps	High	High
UMTS	-45 to -115	3.14	High	High
Wi-Fi (802.11b)	-25 to -95	5	Low	Low
Wi-Fi (802.11g)	-25 to -95	20	Low	Low
Wi-Fi (802.11n)	-25 to -95	270	Low	Low
IEEE 802.20	Not known	80	High	Very High

Table. II

A. Network Related RSS Threshold Parameter

The Dwell timer is also added to above algorithms, whenever the handover parameters are satisfied the dwell timer is started and if conditions remain satisfied until the completion the handoff process is executed. The received signal strength depends upon transitive power, path loss and distance between the Mobile Station (MS) and Base Station (BS) and expressed in dBm.

$$RSS = G_t + L + 10n \log d + f(\mu, \sigma) \qquad (1)$$

where GT is the transmitted power, L is a constant power loss, n is the path loss exponent, d represents the distance between the MT and the WLAN AP, and f (μ, σ) represents shadow fading which is modeled as Gaussian with mean μ = 0 and standard deviation σ (6-12 dB) dependent on surroundings. We assume that whenever the RSS is below a certain sensitivity level, α, the MT is unable to communicate with the Base Station.

VIII. DERIVATIONS & SIMULATION

We have calculated our derivations in real world scenario by performing drive test in which we required laptop for viewing and storing the raw data and using the drive testing software's, Math Works Tool (MATLAB) for simulation work, GPS device for collecting data of latitude and longitude of each place/ measurement point, speed, time etc. Mobile Station (MS) for getting the mobile signal data and choosing the particular network provider for best signal. Radio Frequency (RF) Scanner device for scanning the spectrum.

We studied the RSS and QoS levels for two different technologies 3G/4G and WLAN or any cellular technology with WLAN network. We studied the vertical handover for various parameters such as RSS and QoS with different conditions such as distance, time and latency.

IX. SIMULATION PARAMETERS FOR RSS

For testing purpose we analyzed the two networks, Network A (3G/UMTS) network and Network B (WLAN) network.

- **RSS vs. Network A**

	D	Time	GT	L	N	μ	σ	RSS
	12	3	0.1	0.2	4.2	0	7	-81.43
	15	5	0.1	0.2	4.2	0	7	-87.91
Net. A	18	10	0.1	0.2	4.2	0	7	-94.17
	20	15	0.1	0.2	4.2	0	7	-98.34
	25	20	0.1	0.2	4.2	0	7	-106.73
	30	25	0.1	0.2	4.2	0	7	-115.03

Table. III

- **RSS vs. Network B**

	D	Time	GT	L	N	μ	σ	RSS
	12	3	0.1	0.1	3.3	0	8	-109.16
	15	5	0.1	0.1	3.3	0	8	-113.47
Net. B	18	10	0.1	0.1	3.3	0	8	-116.84
	20	15	0.1	0.1	3.3	0	8	-120.43
	25	20	0.1	0.1	3.3	0	8	-126.78
	30	25	0.1	0.1	3.3	0	8	-132.21

Table. IV

- **RSS vs. Networks Graph**

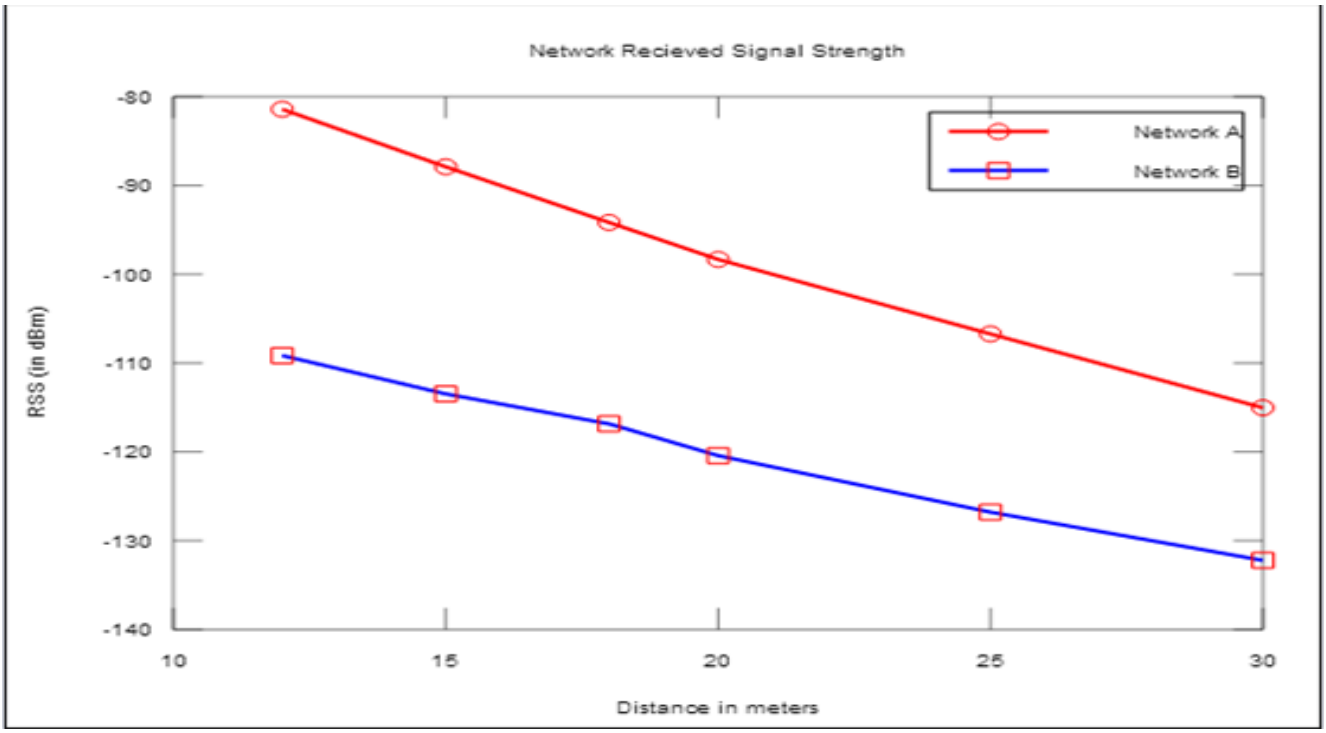

Fig. 5

- **QoS VS. NETWORKS**

It is defined as the number of calls that is served by network to number of calls attempted. Better the QoS ratio better the network and call drop is less.

$$QoS\ \% = (Calls_{Served}/Calls_{attemped}) * 100$$

- **QoS vs. Network A**

	$Calls_{atttempted}$	$Calls_{served}$	QoS %
	74	51	68.91
	72	47	65.27
Net. A	66	23	34.84
	73	34	46.57
	76	29	38.15
	70	41	58.57

Table. V

- **QoS vs. Network B**

	$Calls_{atttempted}$	$Calls_{served}$	QoS %
	76	53	69.73
	72	43	59.72
Net. B	68	21	30.88
	74	36	48.64
	75	14	18.67
	70	24	34.28

Table. VI

- **QOS vs. Networks Graph**

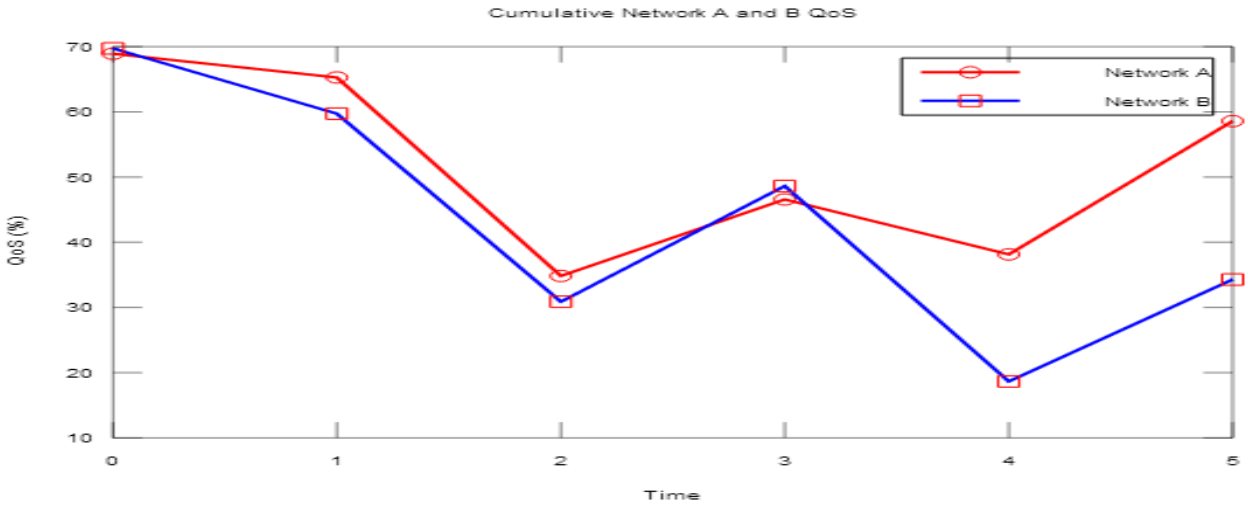

Fig. 6

X. CONCLUSION

In this work we have taken Received Signal Strength (RSS) & Quality of Service (QOS) to study the networks for handoff process. These network parameters are dependent upon many factors like distance, latency, jitter, transmitted power, power loss, environmental conditions. Transmitted power & distance between MT & UMTS/WI-FI server indices are used to calculate better performance. For continuous service, a smooth and reliable handoff is essential between different heterogeneous networks which in turn provide the user satisfaction.

The scope of this dissertation, we have to choose the best network from given heterogeneous network in the terms of Received Signal Strength(RSS) and Quality of Service (QoS) by analyzing the various parameters such as distance, latency, jitter, monetary cost, transmitted power, power less, bandwidth efficiency and environmental conditions.

Complex and reliable handoff algorithms are designed here for best network selection in the light of RSS and QoS. The future user will benefitted from this work and able to select the best network by taking consideration of other parameters which enable them to recalculate and refine our values to provide more precision.

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