Congestion Based Vertical Handoff Decision Using TSCBVHO Algorithm

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***Abstract*—With the rapid development and increasing demand for data and real-time services, 4G Network technology are designed to improve the facilities over wireless communication with high network speed. Various network technologies exist currently that can satisfy different needs and requirements of the mobile user. Efficient handoff mechanism ensures the seamless connectivity and uninterrupted services. When the mobile node moves far away from the coverage of base station, the ongoing call is transferred to the next available channel with proper handoff technique. When all Vertical Handoff (VHO) decisions of a large number of users are made at the same time, the system performance may degrade and network congestion may occur. Congestion leads to poor quality of service (QoS) which increases number of handoff request for good quality service. It further leads to frequent handoff causes ping-pong effect. This paper focuses to find the congested channel before handoff in order to reduce number of unnecessary handoff and to provide successful QoS handoff by designing a new traffic sensitive congestion based vertical handoff decision (TSCBVHO) algorithm.**

***Index Terms*—Ant Colony Optimization, Congestion, QoS, Vertical Handoff.**

I. INTRODUCTION

Current 4G communication industry composed of different wireless networks that support each other [1]. The integration of such networks allows mobile stations to choose the appropriate access network among the available one such as, 802.11 Wireless LAN and 802.16 Worldwide Interoperability for Microwave Access (WiMAX), in addition to the cellular networks.

In 4G wireless networks, users of future mobile networks will be able to switch to different radio access technologies. Mobility nature of the mobile node leads those nodes to move far away from the range of base station (BS) which causes the ongoing call termination and poor QoS. One of the important issues in mobility is mobility management. This is concerned with location management and handoff management [2]. Location management enables the networks to track the locations of mobile nodes. Handoff management is the process by which a mobile node keeps its connection active when it moves from one access point to another.

Handoffs are important in heterogeneous network because of the cellular architecture to maximize the spectrum utilization. Handoff is the process of changing the channel (frequency, time slot, spreading code etc.) associated with the current connection while a call is in progress. Handoff management issues [3] include mobility scenarios, decision parameters, decision strategies and procedures. Mobility scenarios can be classified into horizontal (between different cells of the same networks) and vertical (between different types of network) .In homogeneous networks, horizontal handoffs are typically required when the serving access router becomes unavailable due to mobile terminal's movement. In heterogeneous networks, the need for vertical handoff can be initiated for convenience rather than connectivity reasons [4]. The integration of heterogeneous networks satisfies the user needs and requirements for best quality of services. These networks vary widely in service capabilities such as coverage area, bandwidth and error characteristics. As the mobile nodes initiates more applications, the network may have limited resources that would not allow it to provide the same quality of services. This is due to the occurrence of congestion in the network. In order to reduce the congestion on the network, an effective congestion control algorithms is required.

Handoff process is initiated when the mobile node moves out of coverage of the base station. Handoff can be classified as Horizontal Handoff which is handoff between homogeneous networks and Vertical Handoff where as handoff between heterogeneous networks. The vertical handoff process can be divided into three main steps [5], [6], namely handoff initiation, handoff decision and handoff execution. i) *Handoff Initiation Phase:* In order to trigger the handoff event, information to be collected about the network from different layers likes Link Layer, Transport Layer and Application Layer. These layers provide the information such as RSS, bandwidth, link speed, throughput, jitter, cost, power, user preferences and network subscription etc. A cross layer approach for handoff initiation and decision was proposed in [7]. Based on this information handoff will be initiated in an appropriate time. ii*) Handoff Decision Phase:* The mobile device decides whether the connection to be continued with current network or to be switched over to another one. The decision may depend on various parameters which have been collected during handoff initiation phase. iii) *Handoff Execution Phase:* Existing connections need to be re-routed to the new network in a seamless manner. This phase also includes the authentication and authorization, and the transfer of user's context information [8]. In this paper, section I introduces basics of mobile communication and handoff techniques and section II discuss about existing work to handoff congestion and vertical handoff. Section III depicts the problem of congestion over the communication network and causes of congestion and section IV provides an algorithm to solve the congestion. Section V analyses the performance of the algorithm and compares with existing one. Section VI concludes the work and Section VII lists some of the important references used for this work.

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II. RELATED WORKS

Several works have been proposed to perform congestion estimation, congestion reduction and resource allocation during congestion, congestion cost estimation, finding the congestion region etc. to reduce congestion and best resource utilization. Congestion aware proactive vertical handoff decision using coalition game is proposed to reduce the congestion and delay for handoff calls [9]. Congestion control algorithm presented in [10] achieves max-min fair sharing of the available bandwidth in heterogeneous. A guideline for the congestion control is provided in [11] for improving TCP performance during vertical handover. Cross layer approach to congestion control can allocate data rates without requiring precise prior knowledge of the capacity region. In cross layer approach, network jointly optimizes both the data rates of the users and the resource allocation at under lying layer. Cross layer congestion control presented in [12] uses imperfect scheduling information in which number of users in system kept fixed and dynamic. Distributed metric model [13] to predict routing congestion and applies it to technology mapping, which is guided by a probabilistic congestion map to identify the congested regions. Continuous integration method [14] used to estimate congestion cost. New scheme based on multi-information and fuzzy identification technique [15] to control congestion in wireless mobile Internet. Timing constrained global routing [16] achieved through a network flow formulation to reduce congestion. New congestion control policies [17] for CDMA networks by enhancement to CDMA call admission control and diversity control.

For vertical handoff decision also various algorithms are exists to solve handoff termination and best signal selection which meets QoS requirements of the traffic as well as users. Traffic sensitive vertical handoff algorithm [18] considers different types of traffic with QoS and selects the best channel among the various network technologies. QoS aware traffic sensitive handoff reduction algorithm [19] deals to reduce handoff decision time, number of handoffs and maintains the quality using Artificial Neural Networks (ANN). Statistical Analysis was proposed in [20] to find the quality of the various networks (WiFi, WiMAX, WCDMA) by applying multi-criteria decision making (MCDM) to select appropriate channel to handoff with best QoS. Ant Colony Optimization (ACO) based MCDM [21] was proposed by considering the pheromone concentration τ and the evaporation rate ρ for efficient signal selection. Enhanced handoff with hybrid parallelized ant colony search [22] deals with variants of ACO and proves that hybrid parallelized approach reduces the handoff decision time and selects best quality signal.

III. PROBLEM STATEMENT

Ant colony optimization works based on pheromone deposit rate and evaporation rate [21]. When more ants move towards the same energy source after some time period energy source may get decreased. As the mobile nodes initiate more applications, the network may have limited resources that would not allow it to provide the same quality of services. If signal strength of the next channel is strong enough, more numbers of ongoing calls switched over towards the same channel. Hence more resources are utilized and bandwidth starvation arise which leads to congestion. This is due to the occurrence of congestion in the network. There are solutions that range from, Data offload to Wifi networks, Data Capping via billing plans, Deploying New Capacity, Upgrading networks to new technology like and finally, optimizing the streams that go through the networks. But many of these solutions are expensive [23]. In order to reduce the congestion on the network, an effective congestion control algorithms is required. To reduce the congestion, fix the threshold value to reduce the numbers of handoff triggered to the same channel.

This paper focuses to minimize the number of handoff to the same channel to reduce the network congestion by fixing congestion threshold value. Handoff is triggered when there is a loss in Received Signal Strength (RSS) or QoS degradation because the Mobile Node (MN) moves out of coverage of Base Station (BS). Handoff may be Network Controlled (NCHO) or Mobile Controlled (MCHO) [24]. In case of network-initiated handoff, the network decides to perform handoff. In case of mobile-node -assisted handoff, mobile nodes provide the RSS to a network controller for making decisions. This work uses network-initiated handoff. In this case the network initiates the vertical handoff to reduce congestion in the networks.

IV. TSCBVHO WORK DESCRIPTION

The proposed algorithm assumes that when the MN starts roaming the RSS can be constantly monitored by the base station and calculated using the formula given below. Based on the speed and direction of MN it is possible to calculate the Time to Drop of an ongoing call. Using these values handoff initiation time can be estimated well advanced. If the RSS is weak the ongoing call is handed over to the TN using traffic sensitive vertical handoff algorithm [18]. If RSS is strong but QoS is not satisfied then use ant colony optimization [21] with Congestion Indicator Module (CIM).

The CIM receives the RSS of the and also collect the traffic information of the ongoing call to calculate required bandwidth for the traffic and available traffic of the target network. CIM again monitors the network congestion of the target network by considering the ongoing traffic congestion and the handoff initiation frequency and fixes the congestion threshold which is varying time to time. The traffic types considered over here are Control Data, Text Message, Voice, and Video. If (ReqBW<AvaBW) and (NetCon<NetConTh) then handoff is triggered. Otherwise ongoing call is remain in the same network which reduces unnecessary handoff. Because, if the handoff is executed without checking the congestion of the TN, then within short duration or immediately, again the handoff may be triggered that causes unnecessary handoff and poor QoS. This work mitigates these issues far better.

Assumptions:

i. Received Signal Strength (RSS) is given by [25]

$$10 \log 10\, r = 10 \log 10\, PTX + 10 \log 10\, C - 10 \log 10\, (d\ \tilde{}d\,)\beta + \eta \qquad (1)$$

where C, ˜d, β, and η, respectively, denote a constant value depending on the antenna characteristics and the average channel attention, a reference distance for the antenna far-field, the path loss exponent, and a variation depending on the channel fading[6]. By removing the logarithm of both sides in Equation (1), it is possible to obtain the RSS in milliwatt as follows.

r = nαd−β (2) where we define α and n as PTXC ˜d β and 10η/10, respectively.

For RSSI signal between -50db and -100db, quality ~= 2* (db + 100) RSSI ~= (percentage / 2) - 100

For example: High quality: 90% ~= -55db, Medium quality: 50% ~= -75db,

Low quality: 30% ~= -85db, Unusable quality: 8% ~= -96db

ii. Time to Drop (TD) can be determined by considering mobile node speed, direction using,

$$TD = Dx / Sx$$

$$Dx = \sqrt{(X2-X1)2 + (Y2-Y1)2}$$

Where Dx is the distance to be covered for the call to drop from the network currently being used and Sx is the speed in which the user is travelling. X1, Y1and X2, Y2 are the co-ordinates occupied by the mobile node and the antenna respectively.

iii. Network Congestion (NetCon) is calculated by the network

iv. Network Congestion Threshold (NetConTh) is calculated based on required bandwidth of current types of traffic (voice, streaming, interactive etc)

TSCBVHO Algorithm:

Step 1: Mobile Node (MN) starts moving

Step 2: Calculate the Received Signal Strength (RSS) using (1)

Step 3: Monitor the Speed and Direction of MN

Step 4: Estimate handoff initiation time based on Time to Drop using (2)

Step 5: If RSS<=RSST, use TSVHOA to find the next available channel

Transfer the ongoing call to the next channel

else

If handoff initiated for QoS requirement, use ACO with CIM

Congestion Indicator Module (CIM):

Step 6: Initiate Congestion Indicator Module

i. Receives the signal strength of the Target Network (TN) which is next available channel

ii. Receives the type of traffic of MN which is to be handoff

iii. Calculate the required bandwidth (ReqBW) for the traffic and the available bandwidth (AvaBW) of the target channel

iv. Calculate the network congestion(NetCon) based on current traffic and the handoff initiated frequency on the target network (TN), and fixes the network congestion threshold(NetConTh) value

v. If (ReqBW<AvaBW) and (NetCon <NetConTh) then handoff to the target network (TN)

else remain in the same channel (reduces unnecessary handoff)

vi. Repeat the same for the next available channel until less congested channel is identified

vii.Endif

TSCBVHO Flowchart:

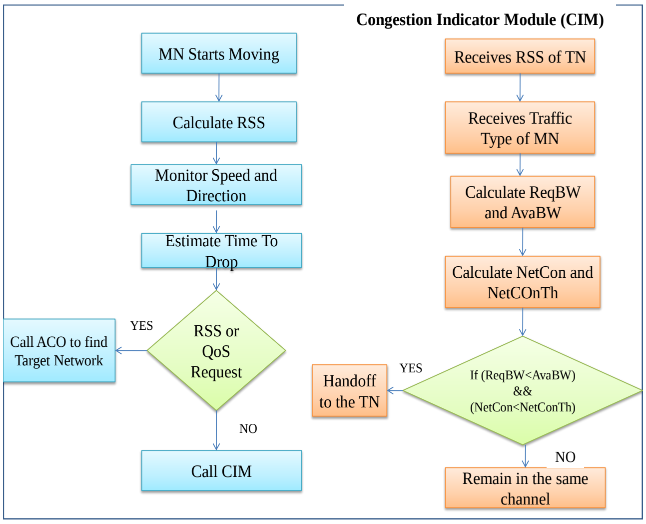

Fig.1 TSCBVHO Flowchart with Congestion Indicator Module

V. PERFORMANCE ANALYSIS

Fundamentally, there are too many people, using too many network-hungry applications in places where the wireless edge of the network does not have capacity or where there are bottlenecks in the base stations, the backhaul or core networks. Hence network congestion arises. Congestion leads to poor quality of service. Current work uses TSCBVHO algorithm and compares the results with TSVHOA [18]. In TSVHOA, handoff is executed immediately without considering congestion on the network in order to avoid call drop. TSCBVHO algorithm considers the congestion before handoff execution by monitoring target network. Network congestion is calculated based on existing traffic and congestion threshold value fixed. If throughput is more critical than latency, do not set the value too low. On the other hand, a very high might allow very high latency without any significant gain in overall throughput. If latency is more important, a very low value (lower than 20 ms) will result in lower device latency.

The Fig.2 shows that numbers RSS based and QoS handoff request triggered by considering the range of 20-100 mobile nodes. Fig.3 and Fig.4depicts that out of those requests how many RSS based and QoS based were successful by comparing both TSVHOA and TSCBVHO algorithms. Fig.5 compares the number of unnecessary handoff request reduced using TSVHOA and TSCBVHO algorithms.

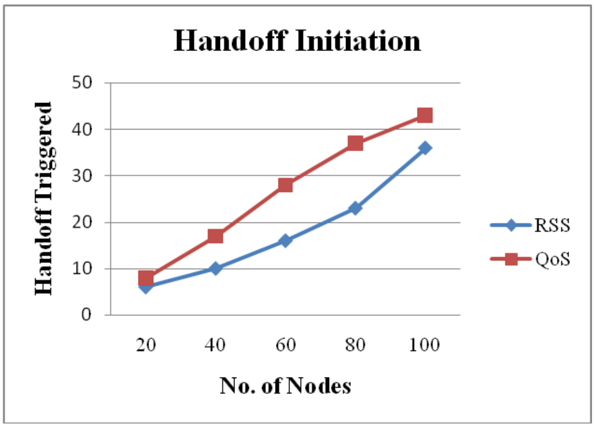

Fig:2 Number of RSS and QoS Handoff Initiated

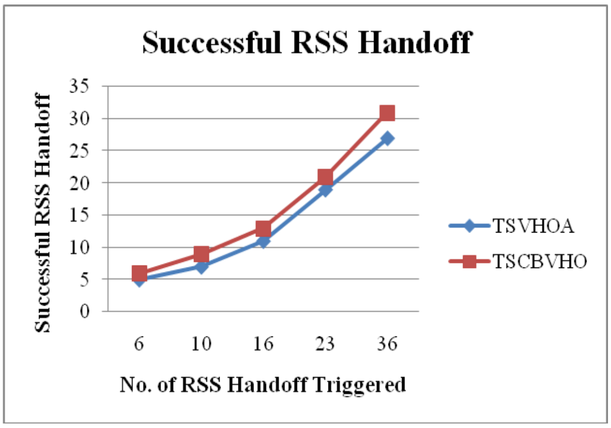

Fig:3 Successful RSS Handoff

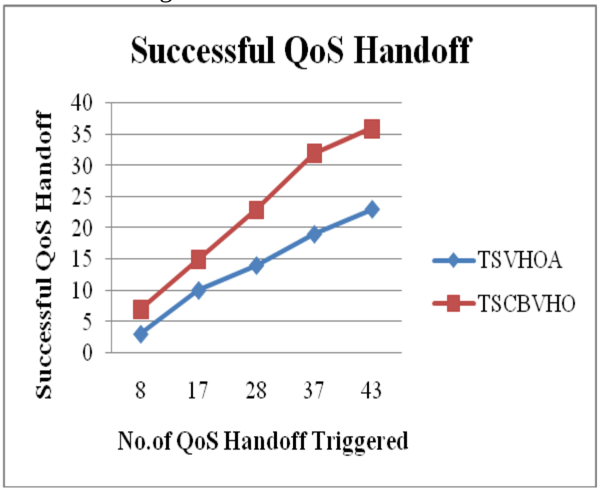

Fig:4 Successful QoS Handoff

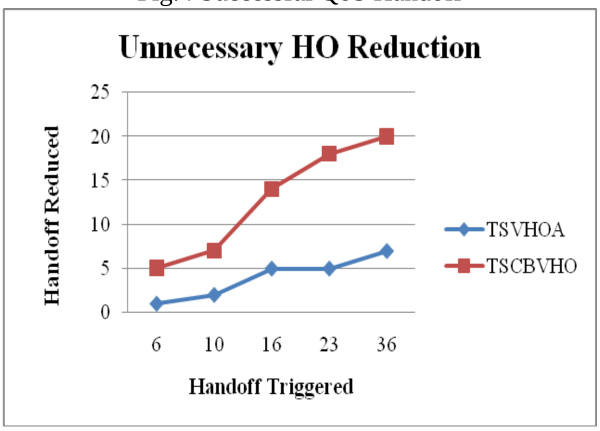

Fig.5 Unnecessary Handoff Reduced

VI. CONCLUSION

The proposed work considers congestion as key point to reduce unnecessary which causes ping effect and also to maintain good quality of service. When the handoff switched to the uncongested network then the existing resources can be utilized efficiently by the current mobile nodes. If the resources are strong enough the network can provide best network quality. TSCBVHO identifies the uncongested network before handoff, if so, handoff is executed. Hence the handoff calls safely transferred to the uncongested, highly resourced channel. So frequent handoff request for QoS requirement are reduced and QoS is maintained.

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