

Qos Aware Vertical Handoff Solution For Heterogeneous Networks

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Abstract

The most famous strategy for making any decision is fuzzy logic theory. It is inevitable wherever uncertainty occurs. In wireless communications, most of the input parameters are fuzzy in nature. When MN switching from one network to other network in a heterogeneous network environment, it depend on different input criteria which is uncertainty. So this can be best addressed using fuzzy logic theory. Vertical handoff is the primary issue in wireless heterogeneous networks to achieve seamless connectivity. The vertical handoff process is split in to three stages such as vertical handoff initiation, vertical handoff decision and vertical handoff execution. Most of the existing research works shows that different decision making strategy with theoretical view and no reports on initiation phase as well as execution phase. This paper focused on VHO process and proposed VHO schemes for initiation, decision and execution in same network scenario. The proposed schemes are very useful to avoid unnecessary handoff and QoS improvement.

Key words: vertical handoff process, fuzzy logic theory, macro mobility management, VHD algorithms, unnecessary handoff, VHO criteria.

Introduction

The fourth generation (4G) is considered as a heterogeneous environment which integrate a huge number of radio access technologies (RAT"s) such as wireless technologies (802.11a, 802.11b, 802.15, 802.16, etc.) and cellular networks (GPRS, UMTS, HSDPA, LTE, etc.). The development of these technologies advocates the operators to design and to make the mobile terminals with several interfaces. With the variety of wireless interfaces, the users are able to benefit simultaneously from these RAT"s and they can also use various services offered by each type of access

network. The most important aim in heterogeneous networks is to ensure ubiquitous access for the end users, under the principle “Always Best Connected” (ABC) (Khan et al 2009). The design and development of heterogeneous wireless networks will provide seamless intersystem roaming across heterogeneous wireless access networks. However, a vertical handoff decision (Wang Katz 1999) is proposed to choose the most suitable network in terms of quality of service (QoS) for mobile users that should be used everywhere and at anytime. The vertical handover process can be divided into three parts namely: handover initiation, network selection and handover execution. The present work concentrates on three parts for providing better QoS under various mobility management techniques.

Related Works

This paper has put an effort to survey on macro mobility management in to two visions such as macro mobility architecture for seamless mobility and vertical handoff management for selecting optimum networks in the heterogeneous network environment.

In The View of Macro Mobility Architecture

Although macro mobility has made significant landmarks in the field of high-performance next generation networks, there are still a number of challenges that need to be addressed to provide seamless interworking heterogeneous environment. One of the main challenges is the heterogeneity that results from the vast range of technologies. Other major challenges are handling of location and handoff management across heterogeneous environment. Handoff management is the main concern of this research work. In the heterogeneous network environment, both intra-technology handoff and inter-technology handoff take place. Intra-technology handoff is the traditional Horizontal Handoff (HHO) process in which the mobile terminal hands-off between two Access Points (AP) or Base Stations (BS) using the same access technology. On the other hand, inter-technology handoff, or Vertical Handoff (VHO), occurs when the MT roams between different access technologies.

Mobile IP (MIP) is the most common solution for macro mobility and there are some disadvantages in basic MIP and improved by optimal schemes such as route optimization (Mohanty et al 2007) and seamless handoff through intelligent agents (Li-der Chou et al 2007). Traditionally, many researchers depend on MIP as the macro mobility solution for global internetwork. Many papers have been published under handoff solution but all are discussed and modified (Md. Mohiuddin Khan et al 2008) on top of MIP protocols and achieved good performance as far as handoff delay is concerned.

Several approaches have been published under how to combine different networks together (George Lampropoulos et al 2005) and also deal with hand off management between them. For example, several approaches show that how to integrate WLAN and UMTS networks (Ismat Maarouf et al 2006). Some of the integration approaches are, tightly coupled architecture, loosely coupled architecture and hybrid coupled architecture (Christian Makaya et al 2007). Though tight coupled architecture is well

suited for heterogeneous system, bottle neck situation arises when handoff from WLAN to UMTS during increased data traffic flow is routed via WLAN. Thus, to overcome all these issues, unified handoff architecture has been proposed in this paper by NIA-based seamless vertical handoff architecture (SVHA) which can be seen in later section.

In The View of Vertical Handoff Decision Algorithms

A key issue that aids in providing seamless vertical handoff in a heterogeneous environment is handoff decision, that is, the ability to correctly decide at any given time whether or not to carry out vertical handoff and determine the best handoff candidate access network. In order to take an intelligent and better decision as to when to reliably initiate a handoff (Vertical Handoff initiation process) and which wireless access network should be chosen (Vertical Handoff Decision process) in a heterogeneous wireless system and make it possible to deliver each service (Vertical Handoff Execution process) via the network that is the most suitable for it. Handoff decision criteria are the qualities that are measured to give an indication of whether or not a handover is needed. These set of criteria are classified as mentioned in (Kassar et al 2008) as network-related parameter, terminal-related parameter, user-related parameter and service-related related parameter. In traditional homogeneous network, handoff decision policy is based only on RSS. But in heterogeneous network environment, handoff decision with RSS alone is not sufficient and this leads to incorrect decision. Therefore it is obvious to mention that the combination of different criteria and the dynamicity of some of them will increase significantly the complexity of the vertical handover decision process.

As far as algorithmic view for handoff management is concerned, there has been several VHD algorithms proposed in (Yaw Nkansah-Gyekye et al 2007) to handoff between two networks. Several approaches have been considered in cellular networks using the Received Signal Strength (RSS) as an indicator for service availability from a certain point of attachment. Additionally, several handoff initiation strategies have been defined, based on the comparison between the current attachment point RSS and that of the candidate attachment points as shown in Pollini (1996). In VHO, the RSSs of PoA are unique due to VHO's unbalanced nature. However, they can be used to determine the availability as well as the condition of different networks.

There exist very few works dealing with VHO beyond simple extensions to the common techniques for HHO (Horizontal handoff). Based on criteria and decision policy, (M.kassar et al 2008) classified VHD algorithms in to five groups such as functions, User-centric, Fuzzy Logic and Neural Network-based, multi-criteria, and context-aware strategies. Various vertical handoff decision algorithms are found in (X.yan et al 2010) and has been classified in to four main directions such as RSS based , bandwidth based , cost function based and combination based algorithms.

Obviously single parameter information of a MT attached to the current network is not sufficient to initiate handoff and this may take incorrect decision and lead to a connection breakdown. So the combination of different parameters can provide better performance compared with single parameter. A number of studies have been conducted using fuzzy inference system and neural networks based algorithm (Xia et

al 2007) to represent combination based algorithm. In this heuristic algorithm, though normalization has been conducted after fuzzification, fixed weight has been assigned to the three inputs such as velocity, RSS and bandwidth. This may lead to a wrong predicted PEV (Performance Evaluation Value) factor and lead to an unnecessary handoff and handoff failure. Also handoff decision delay and throughput have not been addressed. Thus dynamic weight distribution has to be computed and also QoS related parameters have to be considered.

Several approaches have been found in the literature for VHD with multiple attribute decision making (MADM) methods such as SAW, TOPSIS, GRA, MEW and ALIVE-HO. Classical MADM methods are not composed of fuzzy based and provides almost similar performance and comparisons of SAW, TOPSIS, GRA and MEW algorithms has been found in (Stevens-Navarro et al 2006). An analytic network process based optimum network selection algorithm has been found in (Datta et al 2012). A novel context aware vertical handover algorithm based on multiple attribute decision making have been found in (Maaloul et al 2013). But all these approaches have used an imprecision attributes which cannot be used to handle analytic network process.

The recent development in VHD algorithms has been reviewed and the fuzzy based multiple attributes context aware algorithm has been proposed in (Anantha Narayanan et al 2014). By this algorithm, resource utilization and packet loss has been analyzed. But the probability of unnecessary handoff and handoff failure as well as throughput has not been taken in to considerations.

All the above-mentioned schemes have certain deficiencies and there is no one scheme that provides a complete solution to the vertical handoff problem. Some schemes lack in utilizing important parameters to perform handoff decisions. Some do not give any importance to the handoff necessity estimation. Some of them are based on bulky fuzzy rule-set. The others only provide numerical examples to evaluate the scheme without utilizing any simulation test-bed for heterogeneous wireless networks.

Motivation and Proposed Schemes

The introductory details and fundamentals are highlighted to ensure the strength and importance of the heterogeneous networks and need for mobility management techniques for today's communication wireless networks have been related. This suggests the scope for research on macro mobility management for heterogeneous networks. The existing scenarios for decision making did not consider pre-decision technique (initiation) with integrated input parameters to make accurate decision for further improvement of QoS. The existing macro mobility support protocols such as MIPv6, FMIPv6 and HMIPv6 have suffered from high handoff latency due to high binding update cost. The present work therefore focuses on this direction and proposed new NIA based seamless integration architecture which combine cellular, Wi-Fi and Wi-MaX carries out test by a new design of terminal controlled vertical handoff initiation and decision algorithm with fuzzy based approaches to achieve minimal delay and high throughput. Thus the overall contribution of this paper has been represented in figure 1.

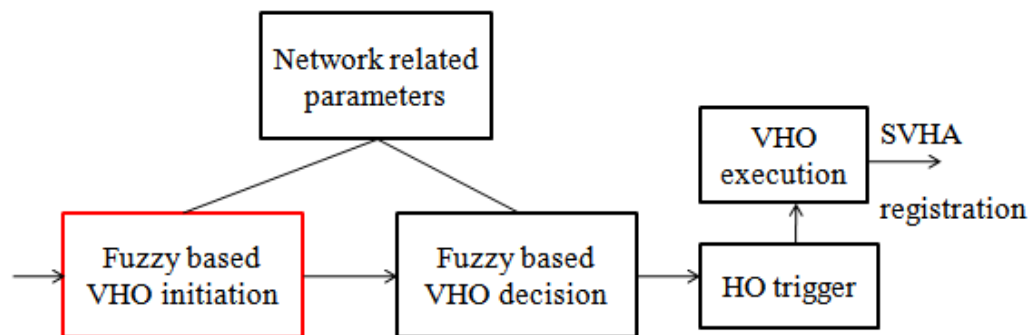


Figure 1: Proposed Architecture for VHO process.

An Adaptive Fuzzy Based Vertical Handoff Initiation Algorithm

Most of the existing scenario did not consider pre-decision technique and normalization of input parameters though they consider more parameters to make decision. Since the environment inputs and network related parameters are fuzzy in nature, vertical handoff problem can be best addressed by fuzzy logic theory.

Vertical handoff initiation is the network discovery procedure where the MT has to find a new PoA of various nearby available networks. To do so, the MT has to imbibe the network related parameters of different networks as shown in figure 2. These parameters are fed in to the fuzzy inference system to find out a handoff factor for each available network as shown in figure.3. Based on the HoF(handoff factor) of each networks, the MT announce the nearby available networks on a rank basis. The intermediate values of input parameters after fuzzification are normalized based on "larger the better division" (Joe.i et.al, 2008). The importance of normalization of the input parameters is to filter unsuitable candidate networks and produced accurate handoff on time. By doing these, unnecessary handoffs and handoff failure has been reduced.

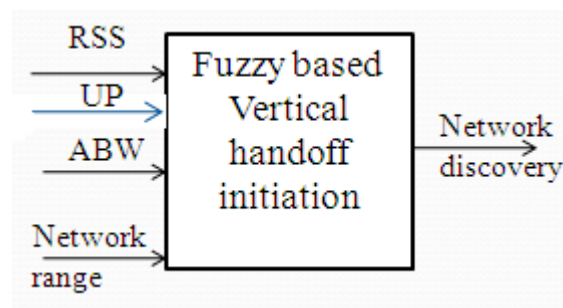


Figure 2: Input Criteria For VHO Initiation

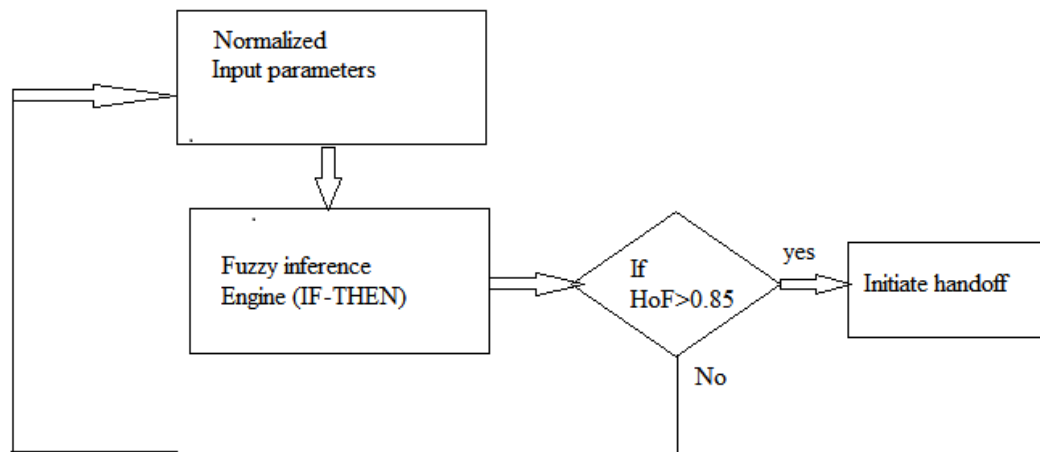


Figure 3: Adaptive fuzzy based vertical handoff initiation algorithm (FUN_HoI)

An Adaptive Terminal Controlled Fuzzy based Vertical Handoff Decision Algorithm in Heterogeneous Networks

After network discovery procedure with an adaptive fuzzy based initiation method, MT has to select optimum network to handover on-going calls seamlessly. For this, network selection process through an adaptive terminal controlled vertical handoff decision with fuzzy based approach for the interconnected networks such as cellular, Wi-MAX and Wi-Fi are implemented. Existing decision making algorithm did not provide complete solution to vertical handoff problem. Classical MADM approach such as simple additive or weighted summation method did not consider threshold condition on network selection factor (NSF) for the candidate network access points (NAP). Also this approach is not fuzzy based and therefore intermediate values of input parameters have not been considered.

The proposed terminal controlled vertical handoff decision algorithm exploits SAW (simple additive weight) method through fuzzy in an adaptive manner. In this algorithm a MT has to select the optimum network from the candidate network access points (NAP's) which has been discovered through an adaptive fuzzy based initiation method. The novelty of this algorithm is to use an integrated input metrics such as network related parameters, user related parameters and terminal related parameters for accurate handoff decision. For the computation of NSF (network selection factor) of candidate NAP, dynamic weight calculation has been made with these parameters. Weighed input metrics are multiplied with the normalized input metrics after fuzzification to produce NSF of each candidates NAP. This NSF of NAP has been compared with the threshold value. The NSF value of respective candidate network has been higher than the threshold value; it has been selected as the optimum network. The flow chart representation of this operation is shown in Figure4.

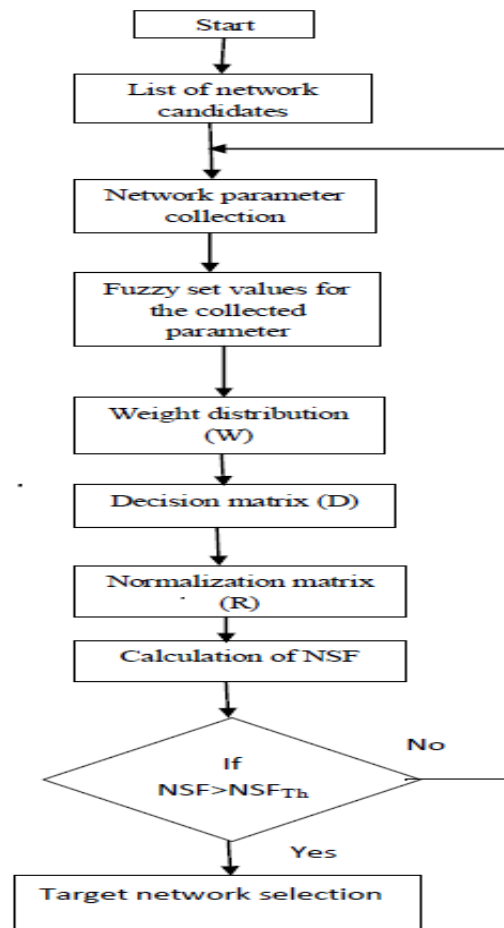


Figure 4: Flow Chart For AVHD Operation

A novel Vertical Handoff Architecture for Seamless Mobility (SVHA) in Heterogeneous Networks

Once a mobile terminal decides to perform a vertical handoff, it executes the vertical handoff procedure to be associated with the new wireless network. Handoff execution requires the actual transfer of data packets to a new wireless link in order to reroute a mobile user's connection path to the new point of attachment. After choosing an optimum network, MT has to deliver a packet to the selected network. Traditional macro mobility techniques had used MIP protocol to deliver packet, which experiences well known problem known as triangular routing which results in inferior QoS. In this work, we deployed NIA based architecture to improve QoS by localizing the binding updates. The novelty of the scheme is to retransmit the buffered packets during macro mobility handover between networks and introduce multiple Interworking gateway mobility agent protocol extensions to avoid potential bottlenecks that occur single inter working gateway mobility agent configuration. The NIA based seamless architecture to handle execution process is shown in figure 5 and 6. In this scheme, two different scenarios are proposed to handle macro mobility

between networks. The first scenario is handles the handover between cellular to Wi-Max. The second scenario handles the handover between Wi-Max to Wi-Fi networks.

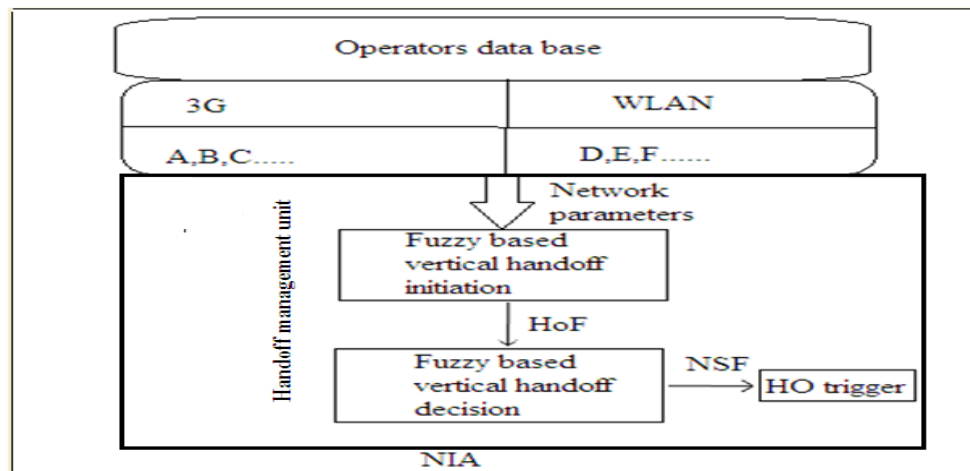


Figure 5: NIA Based Vertical Handoff Execution Phase

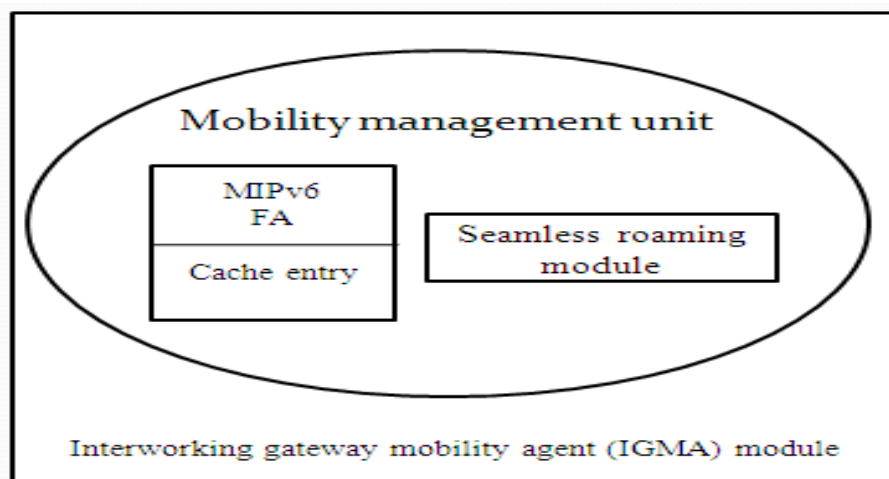


Figure 6: Interworking Gateway Module

Result Analysis

The network scenario for proposed schemes has been simulated using Ns-2 environment. The performance results have been discussed for each scheme. The proposed initiation technique with an adaptive fuzzy based initiation method (FUN_HoI) is implemented and the performance has been evaluated based on three input metrics. The results thus obtained were compared with the other vertical handoff algorithms such as RSS based, Bandwidth based, and simple fuzzy based algorithm as

shown in Figure7. It is evident that less number of unnecessary handoff for FUN_HoI method as compared to the other methods.

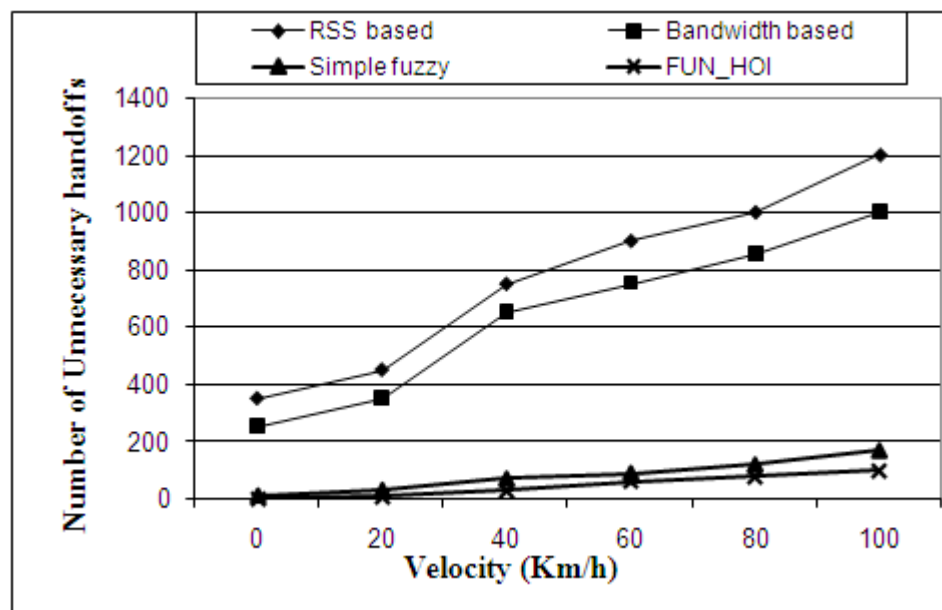


Figure 7: Number of unnecessary handoff

The result thus obtained for AVHD methods were compared with the existing VHD MADM algorithms such as TOPSIS, SAW, and FNQD method. A result for unnecessary handoff between cellular to wi-max and wi-max to wifi has been analyzed as shown in figure 8 and 9. It is also evident that the proposed scheme for VHO decision is outperform with other techniques.

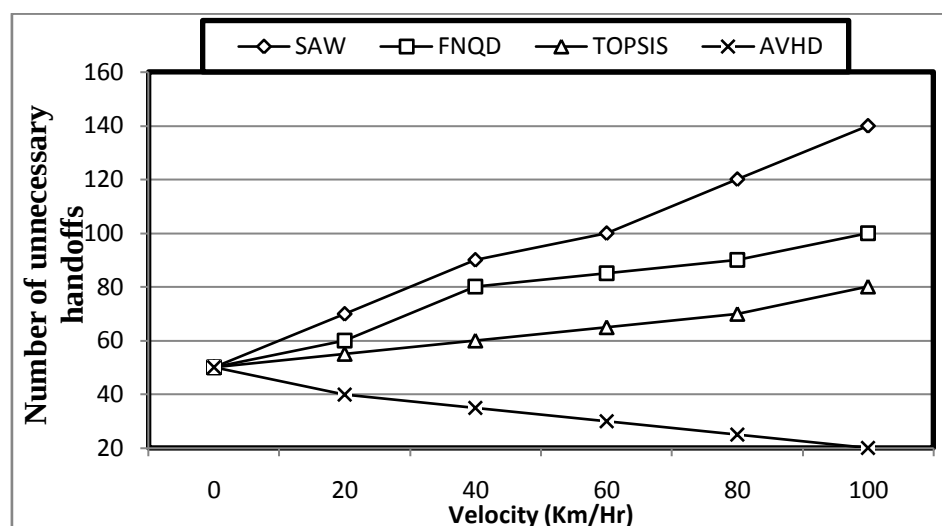


Figure 8: Number of unnecessary handoff between cellular to wi-max

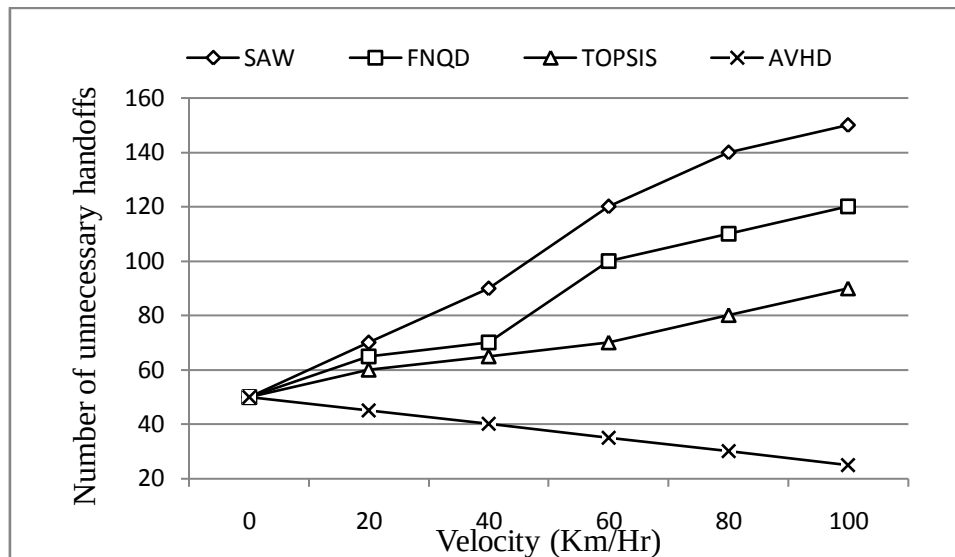


Figure 9: Unnecessary HO between wi-max-wi-fi

The results have been analyzed for vertical handoff execution by using NIA based seamless architectures in terms of QoS parameter such as throughput as shown in figure 10. Result reveal that the packet received for number of handoff occurs per minute. It is also evident that the proposed architecture for seamless mobility is outperforming with other schemes.

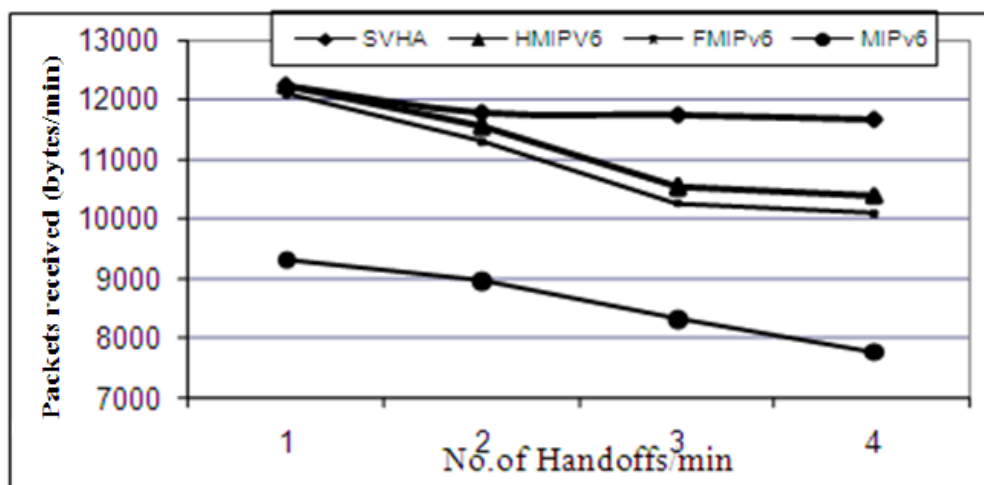


Figure 10: Throughput Vs number of handoff/min

Conclusion and Future Work

Vertical handoff is the primary issue in a heterogeneous network environment. Therefore three different phases of VHO process has been taken and proposed three

methods for each phase. The novel approach of each proposed schemes for each phase are also discussed. The results are evident that the proposed schemes outperforms with the existing schemes. Thus the proposed schemes are so effective and highly useful in QoS is concerned. Future work may deal with the security issues in vertical handoff algorithms.

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