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# A Survey on Vertical Handover Decision Making in Next Generation Heterogeneous Wireless Networks

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**Abstract:** *The next generation mobile devices will be enabled with the ability to support multiple types of networks i.e. the terminal supports multiple network interface. The key enablingfunction for achieving seamless mobility and seamless service continuity for such devices is seamlesshandoffs across heterogeneous wireless access networks. A challenging issue in themulti-service next generation wireless network (NGWN) is to select the appropriate Handover decision strategy for the handover initiation stage.An overview and categorization of various verticalhandoff decision schemes are shown that helps in selection of best scheme among them all accordingly to the requirements of different users.*

## 1. INTRODUCTION

NGWN mobile terminals (MT) are equipped with multiple interfaces and can access a wide range of applications provided by multiple wireless networks in an Always Best Connected(ABC) mode. To access the communication services anytime, anywhere with best Quality of Service (QoS) at minimum cost heterogeneous wireless communication system is a best solution. Numerous wireless networks such as Bluetooth, WI-FI, Wi-Max, GPRS and CDMA have been evolved. Each network has been developed for specific purpose with different features toensure that users equipped with multimode mobile terminals (MTs) in a next generationwireless network (NGWN) environment will experience seamless mobility and enjoyseamless communications and ubiquitous access to applications in an always bestconnected (ABC) mode that employs the most efficient combination of available accesssystems. Seamless communication involves the ability of the MT to successfully orsimultaneously attach to different points of attachment in the NGWN infrastructure.

Heterogeneous Wireless Networks has different access technologies, overlapping and coverage, and network architecture, protocols for transport, routing and mobility management. Also different operator offers different service demands from mobile users (voice, video, multimedia, text etc.) in the market. Because of these variations, when the mobile user moves there is a need to handover the communication channel from one network to another by considering its features and also the user requirements. Channel handover between two different networks is done by vertical handoff.In case of heterogeneous networks, the functionality of the handoff initiation phase and the handoff decisionphase are different, where as in homogeneous networks, handoff initiation phase and handoff decision phase arecombined into a single phase called handoff initiation phase. Since, in homogeneous networks, handoff is inbetween different cells of the same wireless technology, there is nothing called “choosing the best network”. Inhomogeneous networks, it is enough for the received signal strength value to decline below certain thresholdvalue to quick off horizontal handoff. Where as in case of heterogeneous networks, handoff decision phasecannot depend only on received signal strength, but different network characteristics such as user networksubscriptions, bandwidth, coverage of mobility, latency, power consumption and cost etc. should be taken intoconsiderateness. Counting on the user demands, mobile terminal features and network conditions, best networkwill be selected

for vertical handoff. During handover there is a need to decide and choose the best network so the Vertical Handoff Decision Making is an important research issue.

The vertical handoff process involves three main phases namely system discovery, vertical handoff decision, and vertical handoff execution. During the system discovery phase, the mobile terminal determines which networks can be used. These networks may also advertise the supported data rates and Quality of Service (QoS) parameters. Since the users are mobile, this phase may be invoked periodically. In the vertical handoff decision phase, the mobile terminal determines whether the connections should continue using the existing selected network or be switched to another network. The decision may depend on various parameters including the type of the application (e.g., conversational, streaming), minimum bandwidth and delay required by the application, access cost, transmit power, and the user's preferences. During the vertical handoff execution phase, the connections in the mobile terminal are re-routed from the existing network to the new network in a seamless manner. This phase also includes the authentication, authorization, and transfer of a user's context information.

## 2. MOBILITY MANAGEMENT PROCESS

Mobility management is a main challenge in the evolving multi-service heterogeneousNGWN. It consists of two components: location management and handoff management, Location management tracks and locates the mobile terminal (MT) for successful information delivery. Handoff management maintains the active connections for roaming MTs as they change their point of attachment to the network.

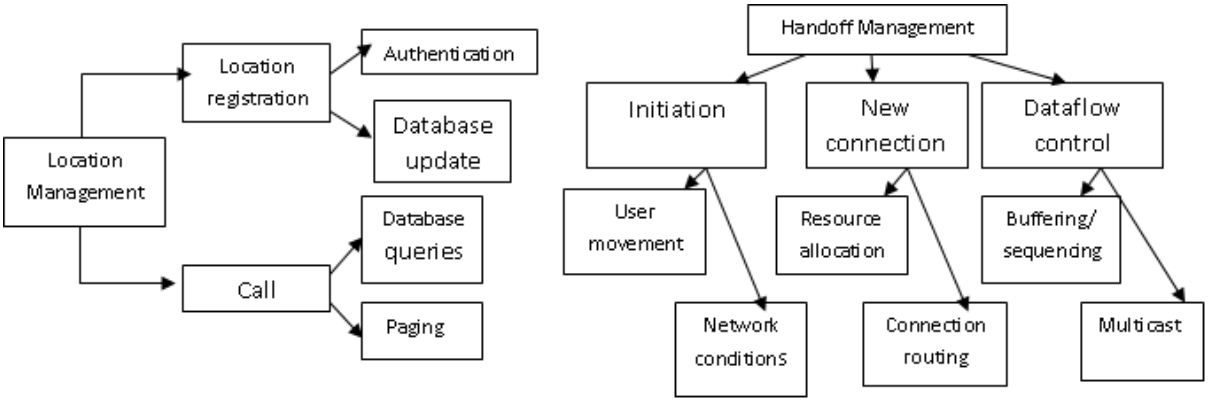


**Figure 1.** *Mobility management operations [10]*

### A. Location Management

Location management is pertained with the set of network protocols which are responsible for allowing the mobile users reachable anywhere in the network coverage area. Location management enables the networks to track the locations of mobile nodes. Location management has two major sub-tasks: (i) location registration, and (ii) call delivery or paging. In location registration procedure, the mobile node periodically sends specific signals to inform the network of its current location so that the location database is kept updated. The call delivery procedure is invoked after the completion of the location registration. Based on the information that has been registered in the network during the location registration, the call delivery procedure queries the network about the exact location of the mobile device so that a call may be delivered successfully.

### B. Handoff Management

Handoff management is the process by which a mobile node keeps its connection active when it moves from one access point to another. Handoff management issues include mobility scenarios, metrics, decision algorithms and procedures. Mobility scenarios can be classified into horizontal (between different cells of the same network) and vertical (between different types of networks).Handoff management is the key aspect in the development of solutions supporting mobility scenarios. It is the process by which MT maintains its connection active while moving from one point of attachment (base station or access router) to another. There are three stages in a handoff process. First, the initiation of handoff is triggered by either the mobile device, or a network agent, or the

changing network conditions. The second stage is for a new connection generation, where the network must find new resources for the handoff connection and perform any additional routing operations. Finally, data-flow control needs to maintain the delivery of the data from the old connection path to the new connection path according to the agreed upon QoS guarantees. Depending on the movement of the mobile device, it may undergo various types of handoff.

## 3. HANDOFF MANAGEMENT PROCESS

Both horizontal and vertical handoff processes may be divided into three sequential parts: 1. Handoff information gathering. 2. Handoff decision. 3. Handoff execution. Fig. Shows the handoff management process.

### 1. Handoff Information Gathering

The handoff information gathering phase collects not only network information, but also information about the rest of the components of the system such as network properties, mobile devices, access points, and user preferences. For that reason this phase receives different names: handoff information gathering, system discovery, system detection, handoff initiation or simply network discovery. In this phase, the information is collected to be used and processed for making decisions in the handoff decision phase. The information typically collected is the following: -Availability of neighbouring network links by offering information such as throughput, cost, packet loss ratio, handoff rate, Received Signal Strength (RSS), Noise Signal Ratio (NSR), Carrier to Interference Ratio (CIR), Signal to Interference Ratio (SIR), Bit Error Ratio (BER), distance, location, and QoS parameters. -The Mobile devices state by gathering information about battery status, resources, speed, and service class. User preferences information such as budget and services required.

### 2. Handoff Decision

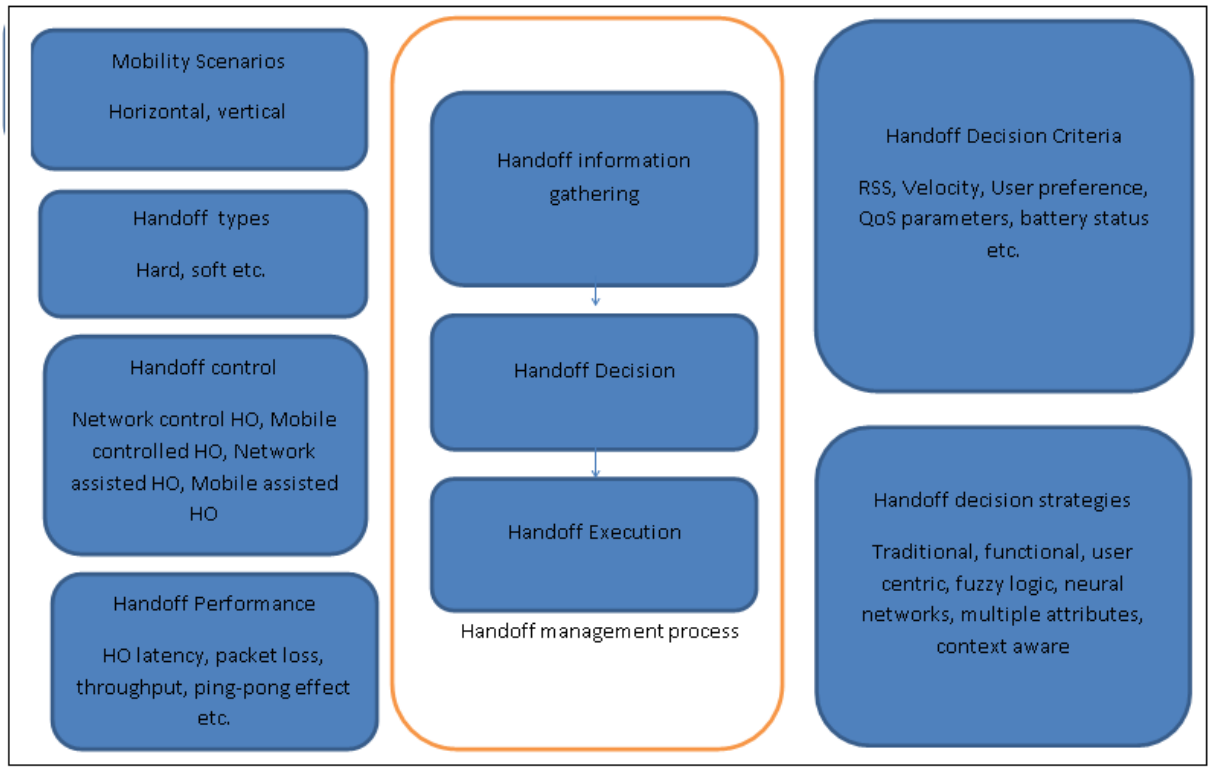


**Figure 2.** *Handoff management process[1].*

The handoff decision phase is one of the most critical processes during the handoff. This phase is also known as system selection, network selection or handoff preparation. Based on the gathered information, this phase is in charge of deciding when and where to trigger the handoff. The when decision refers to the precise instant in time to make an optimal handoff, while the Where refers to selecting the best network fulfilling our requirements for the switching. In a homogeneous network environment deciding When to handoff usually depends on RSS values, while the Where is not an issue since we use the same networking technology (horizontal handoff). In heterogeneous networks

the answer to these questions is quite complex. To make the best decisions the information gathered must be evaluated taking into account many parameters obtained from the different information sources, i.e. network, mobile devices, and user preferences. Vertical Handoff Decision Algorithms (VHDA) is used to weight up and evaluate the parameters involved under each specific criteria.

### 3. Handoff Execution

This phase performs the handoff itself; besides performing the handoff, the phase should also guarantee a smooth session transition process, i.e. Seamless connectivity or handoff. In order to perform the VHO different handoff strategies cooperate with control signaling, and the IP management protocols. This phase is usually known as Handoff execution, but it also receives the name of VHO assessment or Handoff implementation. The performance of each phase of handoff process must be focused on the distinctive characteristics and features of such type of networks. The information gathering phase must consider the dynamism of the available information at the devices and the net- work. Making decisions based on highly dynamic information with a given degree of the devices mobility requires a quick and reliable decision algorithm. Finally, the execution of the VHO must be carefully controlled to achieve accuracy by considering the geographical location, the selected network and the precise time.

## 4. TYPES OF HANDOFF

Handoffs are classified as two types with respect to the behavior of a mobile terminalfor allowing itself for a new connection. They are hard handoffs and smooth handoffs.A handoff in which a mobile terminal releases its existing connection with a base station before allowing itself connect to a new base station is considered as hard handoff.A mobile terminal connecting itself with a new base station before releasing its alreadyexisting connection is treated as soft handoff. Handoffs are classified as four types withrespect to who controls the handoff decision. Fig 1.2 depicts classification of varioustypes of handoffs.

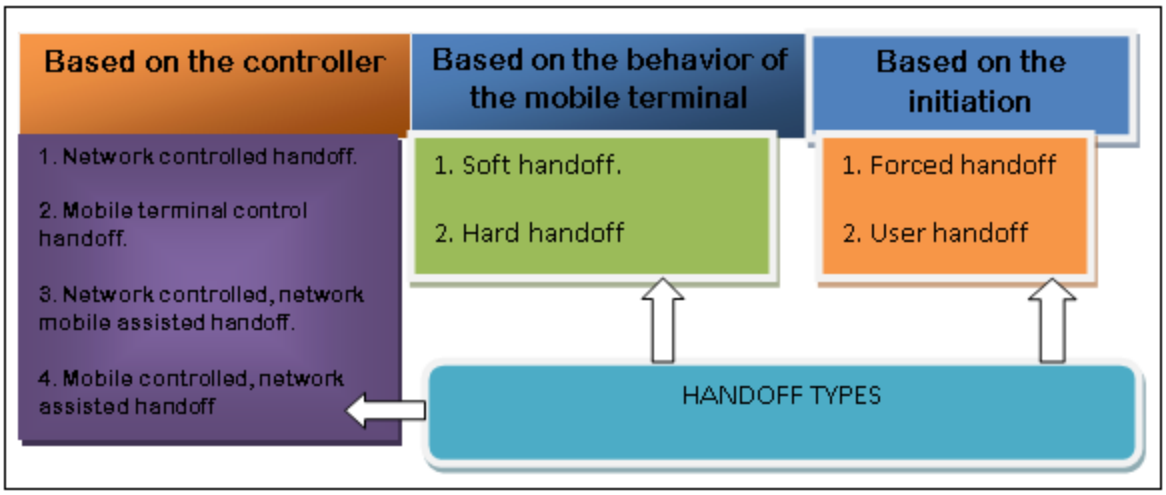


**Figure 3.** *Classification of handoffs [2]*

If the control agent for handoff decision resides on the network sidethen it is called as network controlled Handoff (NCHO), if it resides on the mobileterminal then it is called as mobile controlled handoff (MCHO). If the mobile terminalassists the control agent, who is on the network side, in giving the primary informationthen it is called as mobile assisted handoff (MAHO). In case, if the network assiststhe control agent who is on the mobile terminal side then it is called as network assisted handoff (NAHO).In addition to the classifications given above, based on the kindof initiation, handoffs can be classified as forced handoffs and user handoffs. Forced handoffs are mandatory handoffs which are initiated due to potentially inconvenient network conditions. User handoffs are initiated due to user preferences. Handoff decision algorithms are essential components of the next generation heterogeneous wireless networks that are needed to satisfy the requirement of seamless roaming across the networks. These algorithms helps us gain a good Quality of Service (QoS)at a wide range of networks and help improving the Efficiency by selecting the best network among different available networks by applying some parameters for selection.

## 5. VERTICAL HANDOFF DECISION MAKING PARAMETERS

The decision for vertical handoff may depend on various parameters like Bandwidth, Received Signal Strength (RSS), signal to inference ratio (SIR), cost, latency, security, velocity,battery power, user preferences, service capacities and Quality of service (QoS). In order to design a Vertical Handoff (VHO) mechanism for next generation wireless networks, it is essential to study the existing VHO mechanisms. The study of existing mechanisms will assist in the identification of important parameters for VHO mechanism.

### 5.1 Available Bandwidth

Bandwidth is a measure of the width of a range of frequencies. It refers to the data rate supported by a network connection or interface. It measures how much data can be sent over a specific connection in a given amount of time. In order to provide seamless handoff for QoS in wireless environment, there is a need to manage bandwidth requirement of mobile node during movement. Bandwidth is generally known as the link capacity in a network. Higher offered bandwidth ensures lower call dropping and call blocking probabilities; hence higher throughput. Bandwidth handling should be an integral part of any of the handoff technique.

### 5.2 Speed

It is the speed at which the Mobile Terminal (MT) is moving. In vertical handoff algorithms, the speed factor has a large and important decisions binding effect than traditional handoff decision algorithms horizontal handoff. When the users travel at high speed within a network coverage area is discouraged the idea to initiate vertical handoff process because after a short period of time the user will have to go back to the initial network because it will get out from under cover network host.

### 5.3 Received Signal Strength (RSS)

RSS is the most widely used criterion because it is easy to measure and is directly related to the service quality. Majority of existing horizontal handover algorithms use RSS as the main decision criterion, and RSS is an important criterion for VHD algorithms as well, but it is not enough for a complete decision. It is the strength of the signal received, as the RSS of the neighboring network rises above the threshold the Vertical Handoff is feasible i.e. the handoff takes place if and only if RSS of the BS or Access Point (AP) is above the threshold.

There is a close relationshipbetween the RSS readings and the distance from the mobile terminal to its point of attachment. Majority of existing horizontal handover algorithms use RSS as the main decision criterion, and RSS is an important criterion for VHD algorithms as well [4].

### 5.4 Power Consumption

The wireless devices running on battery need to limit the power consumption. If the battery level decreases, switching for a network to another network with low power consumption can provide a longer usage time. The power requirement becomes a critical issue especially if the hand held battery is low. In such situations, it is preferably transferred to an attachment point, and this will extend battery life. The attachment to the closest AP or BS is known to consume the least power for individual mobile devices at a given instant. So if battery level is low the MT must handoff to the closest AP or BS provided RSS is above threshold. The number of users also increases the congestion and in turn even the nearest AP or BS consumes more power.

### 5.5 Throughput

Network throughput refers to the average data rate of successful data or message delivery over a specific communications link. Network throughput is measured in bits per second (bps). Maximum network throughput equals the TCP window size divided by the round-trip time of communications data packets. As network throughput is considered in dynamic metrics for making decision of VHO, it is one the important requirement to be considered for the VHO.

### 5.6 Network Load

Network load is to be considered during effective handoff. It is important to balance the network load to avoid deterioration in quality of services. Variations in the traffic loads among cells will reduce the traffic-carrying capacity. To provide a high quality

communication service for mobile subscribers and to enhance a high traffic-carrying capacity when there are variations in traffic, network load must be paid attention.

### 5.7 User Preferences

When handover happens, the users have more options for heterogeneous networks according to their preferences and network performance parameters. The user preferences could be preferred networks, user application requirements (real time, non-real time), service types (Voice, data, video), QoS (It is a set of technologies for managing network traffic in a cost effective manner to enhance user experiences for wireless environments) etc. User Preferences can also be considered for VHO in next generation wireless networks.A user's personal preference towardsan access network could lead to the selection of one type of network over the other candidates [4].

### 5.8 Cost

A multi criteria algorithm for handoff should also consider the network cost factor. The cost is to be minimized during VHO in wireless networks.For different networks, there would bedifferent charging policies, therefore, in some situations the cost of a network service should be taken into consideration in making handover decision [4]. The new call arrival rates and handoff call arrival rates can be analyzed using cost function. Next Generation heterogeneous networks can combine their respective advantages on coverage and data rates, offering a high QoS to mobile users. In such environment, multi-interface terminals should seamlessly switch from one network to another in order to obtain improved performance or at least to maintain a continuous wireless connection.The cost functionis calculated for each available access network, and the network with the highest utility is chosen.Therefore, network selection cost is important in handoff decisions.This class of algorithmscombine metrics such as monetary cost, security, bandwidth and power consumption in a cost function, and the handover decision is made by comparing the result of this function for the candidate networks. Different weights are assigned to different input metrics depending on the network conditions and user preferences.

## 6. VERTICAL HANDOFF DECISION MAKING ALGORITHMS

The complexity of the handoff decision process has led to the proposal of a number of vertical handoff decision algorithms for wireless access networks. The overview and characterization of different VHDA is prescribed below.

### 6.1 Received Signal Strength (RSS) based VHDAs

The first approach is based on the traditional strategies of using the RSS that may be combined with other parameters. The RSS based vertical handoff decision algorithms compare the RSS of the current point of attachment with the RSS of the available point of attachment to make handoff decisions.

### 6.2 Cost function-based VHDAs

A vertical handoff decision cost function is a measurement of the benefit obtained by handing off to a particular network. It is evaluated for each network that covers the service area of a user. It is derived from a number of parameters and it is efficient, flexible and has a low implementation complexity.The main advantage brought by this approach is theincreased in percentage of user-satisfied requests and the reduction in blocking probability. However, no mention was made on the way in which QoS parameters were normalized, or how the weights were assigned [3].

### 6.3 Multiple Criteria VHDAs

Multiple criteria VHD algorithms make handoff decisions based on several handoff criteria such as signal strength, network coverage area, network security, and service cost. They combine the various criteria in order to select the most suitable access network for a new service request or handoff. They are efficient and flexible, and have a medium implementation complexity. The handoff decision problem is a typical multiple criteria decision making (MCDM) problem since the handoff decision problem involves selecting a suitable access network among a number of candidate access networks with respect to several criteria (attributes). The cost function based algorithm and the computational intelligence based algorithm are based on multiple criteria. These algorithms are the currently used approaches for combining many decision criteria for vertical handoff decision. The MCDM can be divided into multiple attribute decision making (MADM) that deals with the problem of choosing an

alternative from a set of alternatives which are characterized in terms of their attributes, and multiple objective decision making (MODM) that consists of a set of conflicting goals which cannot be achieved Simultaneously.Multiple attribute decision making (MADM) refers to makingpreference decision over the available alternatives that are characterized by multiple (usually conflicting) attributes. MADM is a branch of multiple criteria decision making (MCDM) which also includes multiple objective decision making (MODM). MODM problems involve designing the best alternative given a set of conflicting objectives, which creates a product in the design process [16]. For example, automobile manufacturers want to design a car that maximizes riding comfort and fuel economy and minimizes production cost. Apparently, network selection does not create any physical product but only makes a decision, so MADM is more suitable for this problem. The decision about access network selection in a heterogeneous wireless environment can be solved using specific multiple attribute decision making (MADM) algorithms such as [2]:

1. Simple Additive Weighting (SAW): The sum of the weights of all attributes values determines the score of a candidate network [2] [8].

2. Technique for order preference by similarity to ideal solution (TOPSIS): This method classifies the attributes into three types: Qualitative benefit criteria, quantitative benefit criteria and cost criteria. It defines two artificial alternatives: ideal alternative and negative ideal alternative. The network with score closest to the ideal solution and farthest from the negative ideal solution is determined as the right candidate for vertical handoff [2] [8].

3. Analytic Hierarchy Process (AHP): The available data is broke up into a hierarchy of choices and criteria. Data is then synthesized to find comparative ranking of the available choices [2] [8].

4. Gray relational Analysis (GRA): This method defines two extreme points: systems with no information and systems with perfect information. Every system in between these systems is defined as a grey system. Systems with no information can not contain any solutions; but systems with perfect information contain unique solution. This method ranks all the user subscribed networks and the network with the highest rank will be chosen for the handoff process [2] [8].

5.Multiplicative Exponent Weighting (MEW): The score of eachnetwork is determined by the weighted product of the considered decision metrics. The selected network is the one that maximizes the ratio of this score by the positive ideal network score. The ideal network is defined as the one that have the best values in each metric [8].

### 6.4 Computational Intelligence VHDAs

The fourth category of handoff decision algorithm uses computational intelligence techniques. Computational intelligence based handoff decision algorithms choose an access network for vertical handoff by applying a computational intelligence technique, such as Fuzzy Logic (FL)Fuzzy logic deals with uncertainness and is quite good to handledecision process issues. The advantage of such a representation is its capacity to analyze imprecise data such as the behavior of the RSS, the load or the BER. It is generally combined to other decision methods to determine the best choice [8], Fuzzy Multiple Attribute Decision Making (FMADM), Neural Networks (NNs), and Genetic Algorithm, to some vertical handoff decision criteria. Most computational intelligence-based VHD algorithms incorporate fuzzy logic. Formulating the vertical handoff decision as a FMADM problem allows the use of fuzzy logic to deal with imprecise information that the decision attributes could contain as well as to combine and evaluate multiple attributes. Computational intelligence based handoff decision algorithms have high efficiency, and improve users' satisfaction in usingheterogeneous wireless networks. However, they have high implementation complexity.

### 6.5 Context-aware approaches

The context-aware handoff decision concept is based on the idea that the behavior of the handoff algorithm should be governed by its surroundings.Context-aware handovers are based on the informationrelated to the mobile host, network and other contextual parameters for intelligent decision making. This information may include capacity, location, user preferences, network QoS, coverage, QoS requirements, and service type e.g. real-time, interactive or streaming traffic [3]. Context-awareness exploits device, network, and user information to improve connectivity, QoS and maintain a high level of user satisfaction. Context information, which is relevant to the handoff decision

algorithm, is related to the network (such as QoS, coverage), terminal (such as its location, capabilities), the service (such as QoS requirements, service type), and user preferences.

In [1], Kassar et al. propose an intelligent handover management system for future generation wireless networks using a context-aware vertical handover decision strategy. The paper uses a combination of fuzzy logic and the AHP for network selection. It attempts to address the issue of handling imprecise data during handovers.

**Table 1.** *Outline Table Of Vertical Handoff Decision Making Algorithms [1] [2]*

| Name | Method | Parameters Used | Advantages | Disadvantages |
|---|---|---|---|---|
| RSS Measurement | Traditional | RSS with Threshold, Dwell time, | Reduces the handoff blocking | Low through put and user preferences are not considered |
| Policy-enabled | Function | Cost function | Simplify handoff process, Speed up handoff decision | Increases the complexity, ambiguous handoff decision |
| Constraint MDP | User-centric | Connection duration, delay, bandwidth, cost, Velocity | Reduce call dropping, monetary budget for connection | When user's velocity increased call dropping also increased |
| Cross-layer | User Centric | User preferences | Works well for both QoS and non QoS applications, reduces handoff delay | Many input from different layers and user for handoff trigger |
| AHP | MADM | Bandwidth, delay, Jitter, Packet Loss, Cost, Security | Reduces handoff latency and Computational Overhead | RSS < threshold value is not considered |
| SAW | MADM | Bandwidth, delay, Jitter, Packet Loss | Reduce processing delay and trusted handover | Minimum number of parameters are considered |
| WPM/ MEW | MADM | Bandwidth, Jitter, delay, cost | Reduce processing delay and trusted handover | Minimum number of parameters are considered |
| TOPSIS | MADM | SINR, data rate, bandwidth, cost | Excellent performance against requirement of traffic and user | QoS parameters are Not considered |
| GRA | MADM | Bandwidth, Jitter, delay, cost | T-DVHD reduces procession delay. | Handoff dropping rate is high |
| Minimizing Handoff using Genetic Algorithm | Context aware | User, networks, and user device information | Fast handoff, less delay, minimum handoff, simple | Multimedia traffic is not considered |

## 7. ANALYSIS

Above table outlines the name of the algorithm, methods used for decision making, parameters used, advantages and its drawbacks. Out of these, the traditional and function based methods considers only the minimum number of parameters. So its performance on throughput and others may decrease while more constraints were added. User centric approach considers the user related parameters and preferences. But in some situation the network conditions and constraints should also be considered.

At that time the current method may become complicated and performance may degrade. Several VHO decision algorithms prefers Multi Attribute Decision Making (MADM) algorithm because more number of parameters can be used for decision making and the problem can be decomposed for simplicity in hierarchical model. Some uses Fuzzy based decision making which is an intelligent approach but more number of fuzzy rule set should be formed. Context aware decision algorithm considers the user information, network and user device context information which is an efficient method but more constraints are there.

## 8. ISSUES TO BE ADDRESSED

Future wireless systems will be based on heterogeneous wireless access technology. In order to provide seamless services many challenging issues to be solved.

QoS Issues– Mobile terminals carrying real time and non-real time traffic should be serviced with guaranteed QoS. To provide best network service several parameters to be considered.

TCP Performance Issues – When switching from low bandwidth, high data rate network to high bandwidth, low data rate network TCP performance should be considered for congestion.

Security Issues – Because of the wide coverage area when the sensitive data is transmitted it should be transferred in secured manner.

## 9. CONCLUSION

This paper presents an introduction to mobility management. An classification of different types of handoffs are also explained and a comprehensive survey on Vertical handoff decision making parameter's and decision making algorithms that helps in selection of most suitable vertical handoff decision making algorithm for selecting best network in NGHWN as per the requirement of the system.

## REFERENCES

[1] "An overview of vertical handover decision strategies in heterogeneous wireless networks", Meriem Kassar, Brigitte Kervella, Guy Pujolle, Computer Communications 31 (2008) 2607–2620, Elsevier, January 2008.

[2] "A Study of Vertical Handoff Decision Strategies in Heterogeneous Wireless Networks", DhanarajCheelu, M. RajasekharaBabu, P. Venkata Krishna, International Journal of Engineering and Technology (IJET) ISSN: 0975-4024 Vol 5 No 3 Jun-Jul 2013.

[3] Abubeker A. Yussuf, Wan H. Hassan, SinzobakwiraIssa" A Review of VHD Approaches in Next Generation Wireless Networks" IEEE 2012.

[4] Xiaohuan Yan a, Y. AhmetSekercioglu a, Sathya Narayanan b"A survey of vertical handover decision algorithms in Fourth Generation heterogeneous wireless networks" Computer Networks 54 science direct (2010) pp 1848–1863.

[5] NilaksheeRajule, Prof.BhavnaAmbudkar, Dr. A. P. Dhande" Survey of vertical Handover Decision Algorithms" International Journal of Innovations in Engineering and Technology (IJIET), 1 February 2013,pp 2319 – 1058.

[6] Mario Pink, Thomas Pietsch, Hartmut Koenig" Towards a Seamless Mobility Solution for the Real World: Handover Decision"IEEE 2012.

[7] DionysisXenakis, Nikos Passas, LazarosMerakos, and Christos Verikoukis" Mobility Management for Femtocells in LTE-Advanced: Key Aspects and Survey of Handover Decision Algorithms" IEEE COMMUNICATIONS SURVEYS & TUTORIALS, IEEE 2013.

[8] MariemZekri, BadiiJouaber,DjamalZeghlache" A review on mobility management and vertical handover solutions over heterogeneous wireless networks" science direct Computer Communications 35 (2012) pp 2055–2068.

[9] Sandra Brigit Johnson, SaranyaNath P and T.Velmurugan"An Optimized Algorithm for Vertical Handoff in Heterogeneous Wireless Networks"Conference on Information and Communication Technologies (ICT 2013), IEEE2013.

[10] Farhan Siddiqui, SheraliZeadally" Mobility management across hybrid wireless networks: Trends and challenges" science direct-Computer Communications 29 (2006) 1363–1385.

[11] Fei Shi, Keqiu Li, YanmingShen" Seamless handoff scheme in Wi-Fi and WiMAXheterogeneous networks" science direct-Future Generation Computer Systems 26 (2010) 1403_1408.

[12] Shusmita A. Sharna and ManzurMurshed" Impact on Vertical Handoff Decision Algorithm by the Network Call Admission Control Policy in Heterogeneous Wireless Networks" 23rd International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), IEEE2012.

[13] T.L. Saaty, "How to make a decision: The Analytic Hierarchy Process", European Journal of Operational Research, Vol. 48, 1990. pp 9 – 26.

[14] K. Abirami, S. SathyaPriya, K.Murugan" Improving TCP Performance in Wireless Network during Vertical Handoff from WiFi to WiMAX" IEEE – 31661, July 4 - 6, 2013.

[15] Safdar Rizvi, Asif Aziz, N.M. Saad" An Overview of Vertical Handoff Decision Policies for Next Generation Wireless Networks" IEEE 2010.