EFFICIENT VERTICAL HANDOFF IN HETEROGENEOUS NETWORK BY CEAM PROTOCOL

FARAH PATHAN[1], DR. JAYMIN BHALANI[2]
[1]Research Scholar, V.T Patel Dept. of Electronics and Communication, CHARUSAT, Changa, India
[2]Associate professor, Dept. of Electronics and Communication, BIT, Vadodara, India
E-mail: [1]farahmafat@gmail.com, [2]jaymin188@gmail.com

ABSTRACT

Heterogeneous wireless networks comprise of variety of wireless technologies integrated to satisfy user's demand. In these heterogeneous networks, the vertical handover problem exists and causes issues in satisfying user demand which are tackled by handover algorithm. Even though, the Vertical handover algorithm tackles the handover problem internally they are in the need to select optimum network among the available networks with energy preserving for their efficient process. In order to satisfy the above stated need in this framework, an Energy Effective Context Based handover algorithm, CEAM (Context and Energy Aware MADM) Protocol is formulated. Multiple attribute decision making (MADM) based on CANVI handover algorithm are capable in selecting optimum network having requisite set of context parameters. Context information related to quality of service parameters offered by networks varies with movement of mobile terminal, which is more efficient, and optimal way of content finding by ANFIS and similarly the ideal solution is found out by vector normalized preferred performance based VIKOR method. The performance has been analyzed for conversational traffic and compared with other available normalization methods based on CANVI (Context Aware ANFIS-VIKOR) Algorithm and energy efficient resource allocation by Mutt FG-CRA algorithm. Simulation results show that the proposed algorithm performs better in terms of network selection and number of handovers as compared with other methods used in this work.

Keywords*: ANFIS, CANVI, CEAM, FG-CRA, VIKOR*

1. INTRODUCTION

The explosive growth of wireless communication through the deployment of cellular networks and the internet has made the always-connected phenomenon a reality [1]. To support always-best connected (ABC) at an affordable bandwidth cost, cellular networks are integrated with other non-cellular wireless networks [2]. This integration creates heterogeneous wireless networks (HWNs) that can be more efficient and has flexible network capacities for the operators; while providing the consumers with diverse data transmission rates and cost [3]. A heterogeneous wireless network is a wireless network that differs in operating parameters and characteristics, such as: bandwidth, latency, security level, reliability, or cost can coexist [4]. It allows mobile nodes (MNs) to connect to different supporting network services with diverse Quality of Service (QoS) requirements [5]. In HWNs, Radio Access Technology (RAT) selection can be network-centric or user-centric. Attribute-selection decisions are based on the network criteria, the application requirements and users' preferences, which lead to multi-criteria, influenced decision processes [6].

Vertical Handover (VHO) decision algorithm for heterogeneous network architectures integrates both cellular networks and Wireless Local Area Networks (WLANs). The cellular-WLAN and WLAN-WLAN VHO decisions are taken based on parameters which characterize both the coverage and the traffic load of the WLANs [7]. Both HHO and VHO processes consist of three steps: handover requirement estimation, target network selection and handover execution [8]. Networks such as LTE, WLAN and WiMAX provide multiple choices for network access. Moreover, roaming terminals are equipped with multiple radio interfaces for heterogeneous wireless network access [9]. Taking the smartphone for example, it can integrate GSM, 3G, WiFi and Bluetooth in a nutshell, and is able to access any one of them [10].

The best solution to handle the issue concerning selection of access networks is to define set of parameters of interest and devise a cost function using multiple attribute decision making (MADM) algorithms [11]. MADM methods are widely used for solving multi-criteria decision problems including the network selection problem[12]. Handoff Decision is a very crucial process because it will be helpful in determining when and where to perform handoff and to select the best network in the Heterogeneous environment without any degradation in the performance [13].To improve the performance, introduced a vertical handoff algorithm based on both analytic hierarchy process (AHP) and SINR. In this algorithm, more than one network parameters are taken into account such as required bandwidth, handoff cost and available bandwidth of the participating access networks [14]. The major problem with classical MADM method is their dependency on the attribute normalization and weight calculation methods. Hence these dependencies not only provoke unreliable selection of the network for handover, but also give rise to a rank reversal (abnormality) problem in the case of the removal and insertion of the network in the network selection list during network ranking [15].

The VHO decision process in HWNs involves complex and often-conflicting multi-criteria, which can be modeled as multi-criteria decision-making (MCDM) problems. MCDM is an advanced tool of the optimization-research technique for resolving multiple and conflicting criteria decision problems [16]. MCDM methods offer HWN designers a decision-making tool that considers all the criteria of the decision problem, using a more robust, explicit, rational and efficient decision-making process for wireless access network selection [17].

A lot of MCDM schemes, such as Simple Additive Weighting (SAW) , Multiplicative Exponent Weighting (MEW), Grey Relational Analysis (GRA) , Analytic Hierarchy Process (AHP), Elimination Et Choix Traduisant la Realitie (ELECTRE), Technique for Order Preference by Similarity to Ideal Solutions (TOPSIS), Distance to Ideal Alternatives (DIA) , MULTIplicative forms with Multi-Objective Optimization Ratio Analysis (MULTIMOORA), and Preference-Ranking Organization Methods for Enrichment Evaluation (PROMETHEE) , have been utilized in HWNs [18]. There are other types of algorithms that have been employed to resolve the problems of VHO and network selection in HWNs that can be found in the literature, such as utility functions, game theory, and genetic algorithms [19]. However, there are some major drawbacks in the application of these algorithms, with respect to the application of MCDM algorithms in VHO and access-network selection in HWNs [20]

Wireless network accessing technologies are in vast growth. Owing to this organization of different networks technologies such as 3G (UMTS, IEEE 802.11), 4G (LTE, IEEE 802.16) and 5G, the users get a great opportunity to connect to these technologies, anytime and anywhere. The mobile terminal is equipped with multiple accessing modes. Owing to this, the access to technologies is required to be very fast. These multi accessing modes have enabled users also to handle simultaneously various applications by using different access networks. Although heterogeneous wireless networks can access most technologies, there exists the issue owing to enabling the users to choose continuously the most appropriate access network during their communication. Vertical Handoff occurs while one user tries to access a base station belonging to a network and communicates with other user belonging to another base station of other network, which causes a delay while accessing the networks.

Above discussed problems are tackled by utilizing our proposed methodology. Initially, when a user access from one network to another network, a handover problem occurs. For that, we are using CEAM, Content and Energy aware MCDM (Multi Criteria Decision making) Protocol technique to weigh and rank the users and networks based on certain criteria and at the end by matching the respective user to network based on weighed and ranked criteria value.

2. RELATED RESEARCHES

Meriem Zekri et.al [21] proposed Fuzzy logic and Analytic hierarchy process based intelligent context-aware algorithm which considered both users and service's requirements. Information regarding static (user's preference, cost) and dynamic context parameters (mobile terminal velocity, RSS etc.) was gathered and applied to Fuzzy inference system in handover initiation phase of vertical handover to check whether handover is required or not. Network selection is then performed by AHP. Due to multi-criteria nature of vertical handover, MADM algorithms are able to incorporate number of context attributes and provide compromising solution among conflicting criterion involved in complex vertical handover decision.

Ji-rui Li et.al[22] described a cross layer collaboration handoff mechanism based on improved multi-attribute decision (CCHMD) to make reasonable, effective and efficient handoff decisions by considering the frequent movement of intelligent terminals and the heterogeneity of wireless networks. Cross-layer collaboration refers

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to the cooperation between communication handoff and computation handoff. The former mainly depends on received signal strength of mobile terminals, the minimum equality parameter and the minimum improvement parameter of all network attributes. CCHMD can improve the application performance of tasks and reduce the computation and communication overhead of mobile terminals. Because of the limitation of time and energy, many problems still need to be studied further in mobile computation offloading and handoff, which mainly include the following two aspects. (1) The complex motion model for terminals was not considered. (2) CCHMD has not been applied to a specific environment, and we will consider realizing it in an actual MCC.

Petander et al. in [23] considers the handover operation between WLAN and UMTS networks on an Android mobile phone and examines energy consumption values. The results indicate that the energy consumption of UMTS is approximately equal to WLAN as a function of transfer time. However, for bulk transfers, the results indicate that transferring a byte of data using UMTS may require much more energy (over a hundred times) than using the WLAN. In this context, the proposed approach makes use of traffic load estimations according to Signal to Noise Ratio (SNR) and network load provided by the Home Agent (HA). The proposed scheme uses the aforementioned information to compute a threshold for the UMTS to WLAN handover operation. Moreover, handover from WLAN to UMTS is automatically initiated once the station leaves the coverage area of a WLAN.

Charmodrakaset.al [24] explained the network selection which is performed using Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) decision model on different parameters such as delay, jitter, bit error rate, packet loss ratio, communication cost, response time, and network load. The PoA of a network calculates its rank using TOPSIS and sends it to the user. The user then selects the network with the highest rank. The proposed vertical handover decision scheme is compared with grey relational analysis and analytical hierarchy process in the context of handover rate, failed handovers, packet loss ratio, and throughput. This methodology reduces the computational time.

Mustafa Ali Hassouneet.al [25] presented an analytical model and a Vertical Handover decision method for Highways called VHH. It is based on position, velocity, jitter, and density as mandatory inputs, which aim to both minimize Vertical handover frequency and avoid unnecessary handoffs and ping pong effect between different networks, in the goal of enhancing multimedia streaming services in highways. The solution VHH algorithm a Vertical handover decision method based on position, velocity, jitter, and density as crucial inputs which aims to both minimize Vertical handover frequency and avoid unnecessary handoffs and ping pong effect between different networks in the goal of enhancing multimedia streaming services in highways.

Baghla and Bansal [26] stated that the optimal network selection is a key issue in the vertical handoff (VHO) decision phase which depends on multiple criteria such as bandwidth, cost, delay, jitter, security, velocity etc. During handoff, all of these criteria should be kept in view for network selection. To deal with large number of attributes for network selection MADM methods offer promising solution. The effectiveness of any MADM method depends on weighting method used to prioritize the attributes. Further, a suitable weighting method will be able to deal with limitations of MADM algorithms such as number of handovers and ranking abnormality. This paper compared the performance of VIKOR MADM method for various weighting methods.

3. EFFICIENT VERTICAL HANDOFF IN HETEROGENEOUS NETWORK BY CEAM PROTOCOL

Vertical Handoff occurs when a user accesses from one network to another network. Existence of handoff while a mobile node from one network accessing other mobile node in another network where arise a mismatch in accessing network. Thus the wireless networks will be based on heterogeneous access technologies and must be able to support features such as inter-carrier handoff, personal mobility, and location management for a heterogeneous network which is previously tackled by Multi Criteria based decision making process which considers the larger number of attributes larger will be the handover delay and energy consumption consequently which may be due to less awareness of content based decision making process. Application aware-based scheme that improves Multimedia QoS services by reducing channel scanning time and the number of channels involved in each scanning. For packet loss and delay sensitive applications such as Voice over IP (VoIP), they increase the channel frequency and pre-scanning duration, but this change has negative effects on Energy consumption. At the same time, if some intelligent reconfiguration mechanisms like self-channel management, self-configuration, or self-

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adaption are deployed in network entities, then an optimal solution with end-to-end efficiency. Thus we have aid enhanced multi streaming schemes for the application of the video streaming, conversation for handling handoff with energy consumption and reduction of delay with content-aware Handoff tackling strategies with all improved attribute functions aids in reduction of handover occurrences since the Handoff problem and inaccuracy of QoS are most undesirable event in a wireless network framework.

In this research we are focusing an accurate VHO process ought to take into account and care about the service continuity, network discovery, network selection, and QoS issues. In order to reduce the handoff occurrences with energy efficiency and content based reduction this framework formulates CEAM Content and Energy aware MCDM (Multi Criteria Decision making) Protocol technique to weigh and rank the users and networks based on certain criteria as like the previous work along with the aware of content and energy efficient process at the end by matching the respective user to network based on weighed and ranked criteria value through beneficiary resource allocation strategy. The Overall Schematic diagram is shown in Figure 1.

3.1 CEAM Protocol Architecture

CEAM Protocol is content based energy efficient protocol in which the handoff is tackled efficiently by combined effect of CANVI (Content Aware ANFIS-VIKOR) Algorithm and Mutt FG-CRA (Fairness Game - Cooperative Resource Allocation). CEAM Protocol utilizes CANVI for deep sensing of the attributes which are parameters from the networks involved in handoff and chooses a very ideal decision for the selection of attributes by weighing and ranking and states out the defined handoff causing criteria.

In wireless communication there are a number of parameters on the basis of which we can determine and decide the QoS. Some of them are bit error rate (BER), jitter, latency, error vector measurement (EVM), throughput, delay etc. The paper considers these parameters for analysis. Throughput or network throughput is the average rate of successful message transmission over a correspondence channel. Throughput is typically estimated in bits consistently (piece/s or bps), and some of the time in data parcels each second or data bundles per time opening. The End-to-end delay demonstrates the time span taken for a packet to travel from the CBR (Consistent Bit Rate) source to the goal. It addresses the average data postpone an application or a client encounters when transmitting data. The delay is generally estimated in seconds. Jitter is a difference in packet transit delay produced by coating, disputation and series effects on the path through the network. In general, more elevated amounts of jitter are more likely to occur on either slow or deeply congested connections. The typical causes integrate connection timeouts, connection time lags, data traffic congestion, and intrusion. Basically, this jitter is an undesirable yield of basis faults and interruptions. Bit error happens once one or more bits of data peripatetic across a system fail to reach them destination. Restricted number of bits on the whole forms a packet. In addition to this, Bit Error probability is also affected by Signal-To-Noise Ratio (SNR)and distance between the transmitter and beneficiary. The SNR ratio is considered as the control ratio between a signal and the background noise (unwanted signal). Because many signals have a very wide dynamic range, SNRs are often expressed using the logarithmic decibel scale.

The proposed methodology uses these parameters for different alternative networks in order to reach the decision of best available network. Once this decision is made, the connection between the networks are re-established by means of energy efficient resource allocation by means of Mutt FG-CRA. The diagrammatic representation of the CEAM Protocol is shown in Figure 2.

3.1.1 CANVI algorithm

The CANVI Handoff Algorithm (Context-aware ANFIS-VIKOR) consists of two modules: (1) Handover decision and (2) target BS selection or ranking. For the handover decision, we use Adaptive Neuro-Fuzzy Inference System to check for the handover condition considering multiple user context parameters such as Received signal strength, Delay, jitter, throughput, security, cost and packet loss. Since, ANFIS is a more efficient and optimal way, one can use the best parameters that have learning capability to approximate nonlinear functions. Further, the fuzzy technique for this method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. It introduces the multi-criteria ranking index based on the particular measure of ''closeness'' to the ''ideal'' (ANFIS-VIKOR) solution.

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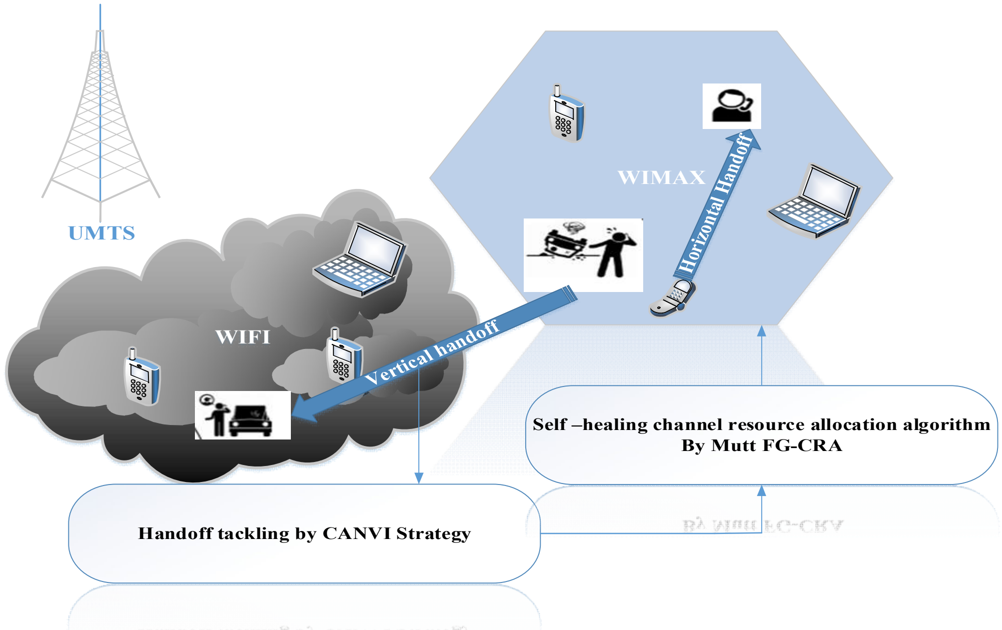

Figure 1: Schematic diagram of proposed work

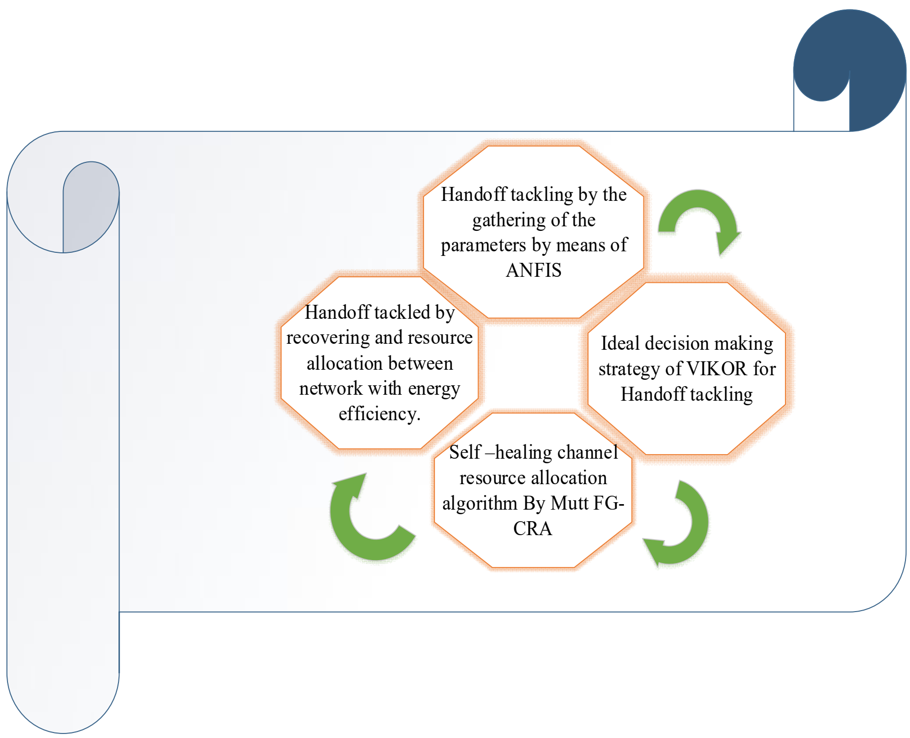

Figure 2: CEAM protocol strategies

Ranking method is used to select the best network during the target network selection stage of the handover process. The various steps in this ranking method are as follows:

- Calculate the normalized value: Here for every criterion normalized values are taken instead of original best and worst values. For the process of normalized value, when xij is the original value of the ith option and the jth dimension, the formula is as follows:

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$$f_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^{2}}} \quad (1)$$

Where $i = 1,2,\ldots\ldots m$
$j = 1,2,\ldots\ldots n$

- Determine the best and worst values: For all the criteria functions find the best value f_j^* and the worst value f_j^- using the relation as:

$$f_j^* = \underset{i}{Max}\ (f_{ij}, i = 1,2,\ldots, m) \quad (2)$$

$$f_j^- = \underset{i}{Min}\ (f_{ij}, i = 1,2,\ldots, m) \quad (3)$$

- Compute the values Si and Ri for i = 1, 2, 3, ….m: This step is to calculate the distance from each attribute value to the positive ideal solution and then get the sum to obtain the final value.

$$S_i = \sum_{j}^{n} Wj(f_j^* - f_{ij})/(f_j^* - f_j^-) \quad (4)$$

$$R_i = \underset{j}{Max}[Wj(f_j^* - f_{ij})/(f_j^* - f_j^-)] \quad (5)$$

Here S_i represents the utility measure of the i^{th} alternative, R_i represents the utility measure of the i^{th} alternative and W_j is the weight of parameter j. Compute the values Q_i for i = 1, . . .m: Using the relation given by Equation (6).

$$Q_i = \vartheta\frac{(S_i - S^*)}{S^- - S^*} + (1-\vartheta)\frac{(R_i - R^*)}{R^- - R^*} \quad (6)$$

Where $S^* = Min(S_i)$, $S^- = Max(S_i)$,
$R^* = Min(R_i)$, $R^- = Max(R_i)$,
and ϑ is a weighting reference with $0 \le \vartheta \le 1$

$[(S_i - S^*)/ (S^- - S^*)]$ represents the distance rate from the positive ideal solution of the i^{th} attribute. In other words, the majority agrees to use the rate of the i^{th} attribute. Also, $[(R_i - R^*)/ (R^- - R^*)]$ represents the distance rate from the negative ideal solution of the i^{th} attribute this means the majority disagree with the rate of the i^{th} attribute. Generally this reference is taken as 0.5. Thus when the ϑ reference is larger (>0.5), the index of Qi will tend to the majority rule and if ϑ<0.5 it will tend to the minority rule.

ANFIS modelling is more systematic and less reliant on expert knowledge, thus creating more objective. Without loss of generality and for simplicity, it is assumed that the ANFIS under consideration has two inputs x and y, and one output f. Suppose that the rule base contains only two if–then rules of first order Sugeno type, the given concept of ANFIS structure can be explained using a simple example whose rule base is given as follows:

$$Rule\ 1 = If\ x\ is\ A_1\ and\ y\ is\ B_1, Then\ f_1 = P_1x + q_1y + r_1 \quad (7)$$

$$Rule\ 2 = If\ x\ is\ A_2\ and\ y\ is\ B_2, Then\ f_2 = P_2x + q_2x' + r_2 \quad (8)$$

where x and y are the inputs, A1; A2; B1 and B2 are fuzzy sets which represents the range of the RKC features that are determined during the training process, p1; q1; r1; p2; q2 and r2 are design parameters that are also determined during the training process.

- Rank the alternatives by Qi: The lesser the value of Qi is, the better is the decision of the alternatives.

A flowchart of the CANVI algorithm showing the steps is shown in Figure 3.

3.1.2 Effective resource allocation by Mutt FG-CRA

In order to improve the throughput of network, we are employing a hybrid method for resource allocation by hybridizing FA-CRA (Fairness-Aware Cooperative Resource Allocation) and CG-CRA (Coalition Game Based Resource Allocation Algorithm). A fairness-aware cooperative resource allocation (FA-CRA) which aims at the effective management of failure as well as the improvement of network performance. In the FA-CRA algorithm, the concept of healing channels (HCs) for serving users in faulty indoor cells is proposed and the set of HCs is determined adaptively, indoor cells cooperate on the HCs to overcome the degradation of network throughput, and sub channels and power are allocated sub optimally for guaranteeing user fairness.

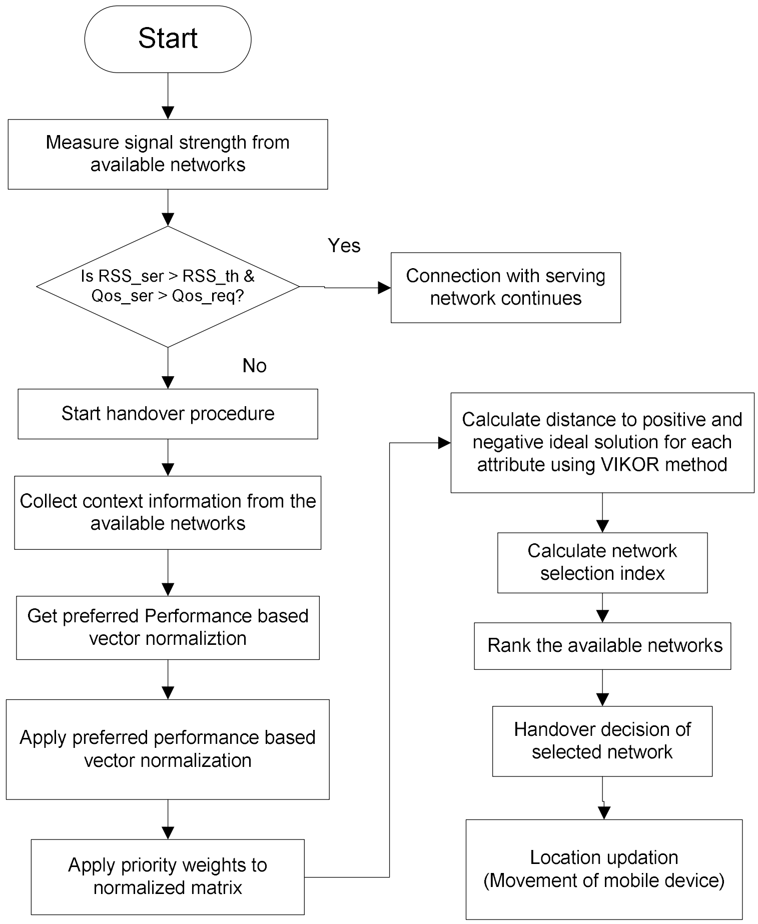

Figure 3: CANVI Algorithm steps and Flow chart

By the use of FA-CRA, a weighted sum rate maximization problem was considered and proportional fair (PF) scheduling was used to serve all users fairly. However, the using of dedicated healing channels, on which all cells cooperatively serve only one user in faulty cell, will bring in loss in network capacity as well as user fairness. For serving all clients fairly and use organize assets efficiently in the meantime, a Coalition Game based Cooperative Resource Allocation (CG-CRA) is consolidated into the FA-CRA (Fairness-Aware Cooperative Resource Allocation). In coalition diversion based agreeable asset assignment calculation, every coalition of little cells serves a client helpfully with streamlined power designation, it is of benefit for little cells to shape appropriate coalitions and serve in excess of one client on a sub channel agreeably under the cell blackout situation. This hybridization can deal with the system failure, and both cell limit and client fairness are enormously enhanced particularly when loads of cells are faulty.

Thus the Vertical handoff can be tackled out with energy efficiency and better throughput which aids for enhanced multi streaming schemes for the application of the video streaming, conversation for handling handoff with energy consumption and reduction of delay.

3.1.3 Mathematical calculation for Proposed Methodology

Let us consider the matrix A as the measure of every criterion j=1,…,n, for candidate networks i=1,….,m, at the time of network selection. Each row represents a network and the columns represent a network parameter,

$$A = \begin{bmatrix} 100 & 2 & 0.2 & 10 & 400 & 50 & 100 \\ 20 & 11 & 1 & 20 & 200 & 25 & 20 \\ 10 & 54 & 2 & 20 & 100 & 15 & 15 \\ 5 & 100 & 5 & 40 & 150 & 30 & 20 \\ 30 & 100 & 5 & 20 & 100 & 20 & 15 \end{bmatrix}$$

- Calculate the normalized value: Here for every criterion normalized values are taking instead of original best and worst values. For the process of normalized value, when x_{ij} is the original value of the i^{th} option and the j^{th} dimension, the formula is as follows:

$$f_{ij} = X_{ij} \Big/ \sqrt{\sum_{i=1}^{m} X_{ij}^{2}}$$

$$f_{11} = 100 \Big/ \sqrt{100^2 + 20^2 + 10^2 + 5^2 + 30^2}$$
$$= 100 \Big/ \sqrt{11425}$$
$$= 100 / 106.89$$
$$= 0.9355$$

$$f_{11} = 0.9355$$

Similarly, all the values for corresponding f_{ij} value is been calculated with that values we can frame matrix f.

$$f = \begin{bmatrix} 0.9355 & 0.0132 & 0.0270 & 0.1857 & 0.8123 & 0.7332 & 0.9428 \\ 0.1871 & 0.0725 & 0.1348 & 0.3714 & 0.4061 & 0.3666 & 0.1886 \\ 0.0936 & 0.3557 & 0.2696 & 0.3714 & 0.2031 & 0.2200 & 0.1414 \\ 0.0468 & 0.6588 & 0.6740 & 0.7428 & 0.3046 & 0.4399 & 0.1886 \\ 0.2807 & 0.6588 & 0.6740 & 0.3714 & 0.2031 & 0.2933 & 0.1414 \end{bmatrix}$$

2^{nd} *Step* : *Finding Max and Min*

- Determine the best and worst values: For all the criteria functions find the best value f_j^* and the worst value f_j^- using the relation as:

$$f_j^{\,*} = \underset{i}{Max}\ (f_{ij}, i = 1,2,\ldots\ldots, m)$$
$$f_j^{\,-} = \underset{i}{Min}\ (f_{ij}, i = 1,2,\ldots\ldots, m)$$

$$f^* = [0.9356 \quad 0.6588 \quad 0.6740 \quad 0.7428 \quad 0.8123 \quad 0.7332 \quad 0.9428]$$
$$f^- = [0.0468 \quad 0.0132 \quad 0.0270 \quad 0.1857 \quad 0.2031 \quad 0.2200 \quad 0.1414]$$

3^{rd} *Step*

- Compute the values S_i and R_i for i = 1, 2, 3, ….m: This step is to calculate the distance from each attribute value to the positive ideal solution and then get the sum to obtain the final value.

$$S_i = \sum_{j}^{n} Wj(f_j^{\,*} - f_{ij})/(f_j^{\,*} - f_j^{\,-})$$
$$R_i = \underset{j}{Max}[Wj(f_j^{\,*} - f_{ij})/(f_j^{\,*} - f_j^{\,-})]$$

Here, W_j is the weight assigned to each parameter. It is defined as the following for example:

$$W_j = [0.2 \quad 0.15 \quad 0.15 \quad 0.2 \quad 0.05 \; 0.15 \quad 0.10]$$

Let us first find the matrix, $(f_j^* - f_{ij})/(f_j^* - f_j^-)$. The matrix obtained is as follows:

$$\begin{bmatrix} 0 & 0.1500 & 0.1500 & 0.2000 & 0 & 0 & 0 \\ 0.1684 & 0.1362 & 0.1250 & 0.1333 & 0.0333 & 0.1071 & 0.0941 \\ 0.1895 & 0.0704 & 0.0938 & 0.1333 & 0.0500 & 0.1500 & 0.1000 \\ 0.2000 & 0 & 0 & 0 & 0.0417 & 0.0857 & 0.0941 \\ 0.1474 & 0 & 0 & 0.1333 & 0.0500 & 0.1286 & 0.1000 \end{bmatrix}$$

Now, we multiply each row with the weights for respective parameters and obtain the values of S_i and obtain R_i by finding the maximum value in each row of the matrix obtained above.

$$S = 0.5000 \quad 0.7976 \quad 0.7870 \quad 0.4215 \quad 0.5593$$

$$R = 0.2000 \quad 0.1684 \quad 0.1895 \quad 0.2000 \quad 0.1474$$

From this, we find S^*, S^-, R^*, R^-. Here,

$$S^* = Min(S_i),\ S^- = Max(S_i),$$

$$R^* = Min(R_i),\ R^- = Max(R_i)$$

Therefore, $S^* = 0.4215$, $S^- = 0.7976$, $R^* = 0.1474$ & $R^- = 0.2000$.

Next, find the value Q_i for each alternative.

$$Q_i = \vartheta \frac{(S_i - S^*)}{S^- - S^*} + (1-\vartheta)\frac{(R_i - R^*)}{R^- - R^*}$$

The value of weighing reference ϑ can be between 0 and 1 i.e. $0<\vartheta<1$. If $\vartheta<0.5$, the results tend to the majority rule otherwise the results tend to the minority rule. For simplicity, here we have taken the weighting reference $\vartheta = 0.5$.

$$Q = [0.6044 \quad 0.7000 \quad 0.8859 \quad 0.5000 \quad 0.1832]$$

The alternatives are now ranked according to the ascending order of Qi. The alternative with the lowest value of Q_i is the best available alternative and so on. Thus, according to our example, alternative 5 is the best available alternative.

Thus the attributes of each network will be fed into this process and at last ranking will be done to find the best network available for handover. The handoff execution is now done with the help of suitable resource allocation scheme.

4. RESULTS AND DISCUSSION

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All the technologies must be compatible to operate together for successful seamless vertical handover. To test the compatibility and to find the attribute values for underlying network we have designed several simulation results with the help of NS3 on the basis of model.

The Simulation Results of the Proposed Vertical hand over algorithm for tackling the handoff with energy efficiency and content aware decision making between the networks WIFI and WI-MAX are considered. The Simulation scenarios are shown in Figures 4-7.

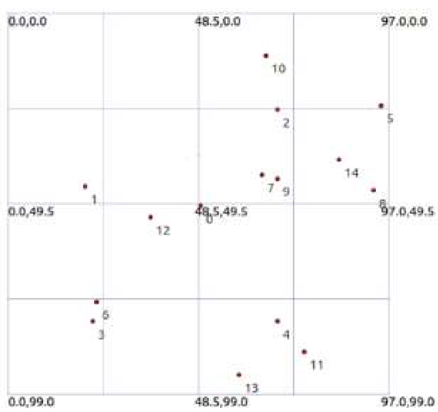

Figure 4: Network Initiation

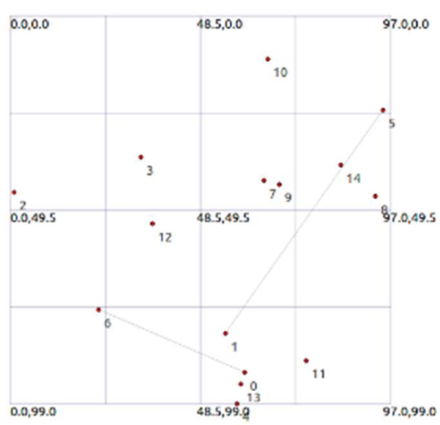

Figure 5: Connection between two networks

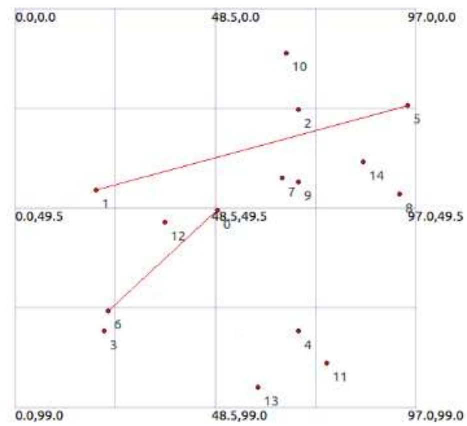

Figure 6: Handoff Occurrence between networks

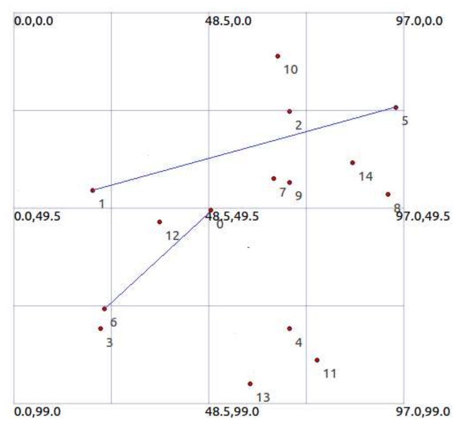

Figure 7: Handoff Tackled between networks

The figures 4-7 describe the communication between the nodes. At the time of Handoff occurrence, the red line indicates the handoff problem. Our proposed approach CEAM Protocol technique was used to solve the problem based on selected parameters, weight of the criteria and Rank methodology based on user and network criteria and allocates the network. A comparison for number of handovers using the proposed method and existing methods for different traffic classes is shown in Figure 8. The results show that there is reduction in the number of handovers when compared with the existing methods for different traffic classes. For the Streaming class, V-ANP performs better than the proposed technique. For all the other traffic classes, the results show that the number of unnecessary handovers is reduced using our proposed methodology. A comparison for Ranking

Abnormality using the proposed method and existing methods for different traffic classes is shown in Figure 9. The results show that there is reduction in percentage of Ranking Abnormality when compared with the existing methods for different traffic classes. For the Streaming class, again V-ANP performs better than the proposed technique. For all other traffic classes, ranking abnormality reduces.

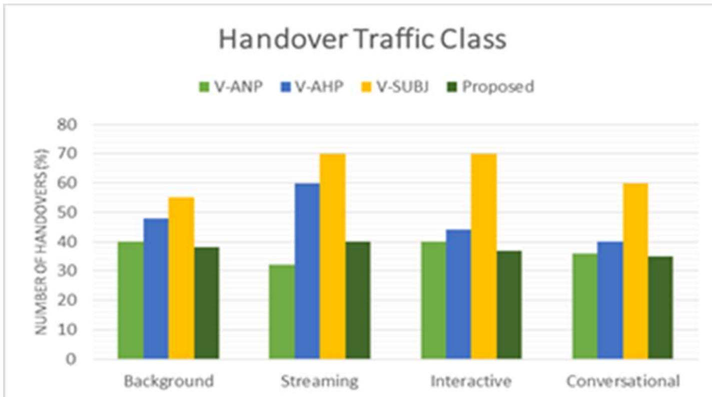

Figure 8: Comparison of Handover Traffic Class

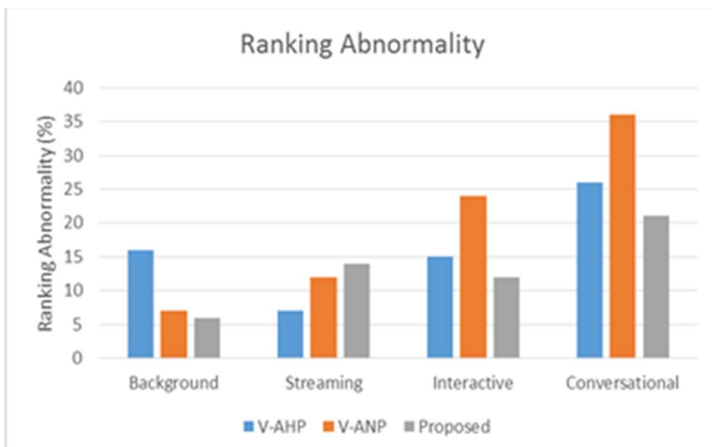

Figure 9: Comparison of Ranking Traffic class

5. CONCLUSION

Context and Energy awareness is the desired property for vertical handover in today's era of heterogeneous environment. Different kinds of networks offer variable network conditions in accordance with changing location of mobile user. The Signal strength of mobile terminal plays important role in decision making phase of vertical handover. In view of these two factors, context and movement aware handover technique has been proposed and analysed with four different service classes to analyse robustness and effectiveness of proposed technique. Simulation results show that proposed technique selects optimum network for conversational traffic with minimum number of handovers in four different service classes. Thus our objective of selecting optimal network with best quality of service (QoS) by means of the proposed methodology is reasonably achieved.

REFERENCES

[1] F. Cuadrado, and J.C. Dueñas, "Mobile application stores: success factors, existing approaches, and future developments", *IEEE Communications Magazine*, Vol.50, No.11, pp.160-167,2012.
[2] E. Obayiuwana, and O.E. Falowo, "Network selection in heterogeneous wireless networks using multi-criteria decision-making algorithms: a review", *Wireless Networks*, Vol.23, No.8, pp.2617-2649,2017.
[3] E. Ndashimye, S.K. Ray, N.I. Sarkar, and J.A. Gutiérrez, "Vehicle-to-infrastructure communication over multi-tier heterogeneous networks: a

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

survey", *Computer Networks*, Vol.112, pp.144-166,2017.

[4] B. Wang, and K.R. Liu, "Advances in cognitive radio networks: A survey", *IEEE Journal of selected topics in signal processing*, Vol.5, No.1, pp.5-23,2011.

[5] S.K. Sarkar, T.G. Basavaraju, and C. Puttamadappa, "Ad hoc mobile wireless networks: principles, protocols, and applications", *CRC Press*.2016.

[6] K. Piamrat, A. Ksentini, J.M. Bonnin, and C. Viho, "Radio resource management in emerging heterogeneous wireless networks", *Computer Communications*, Vol.34, No.9, pp.1066-1076,2011.

[7] K. Shafiee, A. Attar, and V.C. Leung, "Optimal distributed vertical handoff strategies in vehicular heterogeneous networks", *IEEE Journal on Selected Areas in Communications*, Vol.29, No.3, pp.534-544,2011.

[8] M. Zekri, B. Jouaber, and D. Zeghlache, "Context aware vertical handover decision making in heterogeneous wireless networks", *In Local Computer Networks (LCN), 2010 IEEE 35th Conference on IEEE,* pp. 764-768,2010.

[9] R. Ferrus, O. Sallent, and R. Agusti, "Interworking in heterogeneous wireless networks: Comprehensive framework and future trends", *IEEE Wireless communications*, Vol.17, No.2,2010.

[10] J. Márquez-Barja, C.T. Calafate, J.C. Cano, and P. Manzoni, "An overview of vertical handover techniques: Algorithms, protocols and tools", *Computer communications*, Vol.34, No.8, pp.985-997,2011.

[11] R. Jeyapaul, P. Shahabudeen, and K. Krishnaiah, "Quality management research by considering multi-response problems in the Taguchi method–a review", *The International Journal of Advanced Manufacturing Technology*, Vol.26, No.11-12, pp.1331-1337,2005.

[12] M. Kassar, B. Kervella, and G. Pujolle, "An overview of vertical handover decision strategies in heterogeneous wireless networks", *Computer Communications*, Vol.31, No.10, pp.2607-2620,2008.

[13] X. Yan, Y.A. Şekercioğlu, and S. Narayanan, "A survey of vertical handover decision algorithms in Fourth Generation heterogeneous wireless networks", *Computer networks*, Vol.54, No.11, pp.1848-1863,2010.

[14] M. Zekri, B. Jouaber, and D. Zeghlache, "A review on mobility management and vertical handover solutions over heterogeneous wireless networks", *Computer Communications*, Vol.35, No.17, pp.2055-2068,2012.

[15] A. Hadi-Vencheh, and M. Mirjaberi, "Fuzzy inferior ratio method for multiple attribute decision making problems", *Information Sciences*, Vol.277, pp.263-272,2014.

[16] E. Obayiuwana, and O.E. Falowo, "Network selection in heterogeneous wireless networks using multi-criteria decision-making algorithms: a review", *Wireless Networks*, Vol.23, No.8, pp.2617-2649,2017.

[17] Y. Peng, Y. Zhang, Y. Tang, and S. Li, "An incident information management framework based on data integration, data mining, and multi-criteria decision making", *Decision Support Systems*, Vol.51, No.2, pp.316-327, 2011.

[18] S. Bhosale, and R. Daruwala, "Multi-criteria Vertical Handoff Decision Algorithm Using Hierarchy Modeling and Additive Weighting in an Integrated WLAN/WiMAX/UMTS Environment-A Case Study", *KSII Transactions on Internet & Information Systems*, Vol.8, No.1,2014.

[19] L. Wang, and G.S.G. Kuo, "Mathematical modeling for network selection in heterogeneous wireless networks—A tutorial", *IEEE Communications Surveys & Tutorials*, Vol.15, No.1, pp.271-292, 2013.

[20] N. Omheni, F. Zarai, M.S. Obaidat, I. Smaoui, and L. Kamoun, "A MIH-based approach for best network selection in heterogeneous wireless networks", *Journal of Systems and Software*, Vol.92, pp.143-156, 2014.

[21] M. Zekri, B. Jouaber, and D. Zeghlache, "Context aware vertical handover decision making in heterogeneous wireless networks", In *Local Computer Networks (LCN), 2010 IEEE 35th Conference on* IEEE, pp. 764-768, 2010.

[22] J.R. Li, X.Y. Li, and R. Zhang, "Cross-layer collaboration handoff mechanism based on multi-attribute decision in mobile computation offloading", *Soft Computing*, pp.1-19,2017.

[23] H. Petander, "Energy-aware network selection using traffic estimation", In *Proceedings of the 1st ACM workshop on Mobile internet through cellular networks ACM,* pp. 55-60,2009.

[24] I. Chamodrakas, and D. Martakos, "A utility-based fuzzy TOPSIS method for energy efficient network selection in heterogeneous wireless networks", *Applied Soft Computing*, Vol.12, No.7, pp.1929-1938,2012.

[25] M.A. Hassoune, Z.M. Maaza, and S.M. Senouci, "Vertical Handover Decision Algorithm for Multimedia Streaming in VANET", *Wireless Personal Communications*, Vol.95, No.4, pp.4281-4299,2017.

[26] S. Baghla, and S. Bansal, "Performance of VIKOR MADM method for Vertical Handoffs in Heterogeneous networks with various weighting methods", In *8th International Conference on Advanced Computing and Communication Technologies ICACCT,* pp. 29-34, 2014.