An Optimal Vertical Handover Strategy for Vehicular Network based on IEEE 802.21 MIH standards

U.Kumaran
Department of Computer Applications
Noorul Islam Centre for Higher Education, Kumaracoil, Tamilnadu, India

M.K.Jeyakumar
Department of Computer Applications
Noorul Islam Centre for Higher Education,Kumaracoil, Tamilnadu, India

Abstract— Media Independent Handover (MIH) is a standard proposed by IEEE 802.21 working group to facilitate vertical handover support between heterogeneous wireless networks. Currently, the implementation of the IEEE 802.21 standard supported in ns2, provided by National Institute of Standards and Technology (NIST) considers only the signal strength as a parameter to determine the destination network. Selecting a destination network using only RSS as indicator does not meet the needs of all users. For more accurate choice of destination network, vertical handover decision should consider the values of different criteria of network as well as the mobility of the node. In this paper, we have proposed an improved handover decision module including additional parameters which considers the mobility of the node and network conditions during handover decision in order to improve the performance of the network. The simulation results shows that the proposed method achieves better performance in terms of throughput, handover latency and packet drop ratio over the basic handoff scheme. More over the proposed method helps to reduce the unnecessary handoffs by eliminating the ping-pong effect and thus increases overall system performance.

Keywords- Heterogeneous wireless Network, Vertical Handover, Media Independent Handover, Handover Decision, Handover Latency

I. INTRODUCTION

The perception of Next Generation Wireless Networks is based on the coexistence and the interoperability of different types of Radio Access Technologies (RATs) such as GSM, UMTS, LTE, and WiMAX has been deployed to support various communication services. Vertical handover management is one of major challenges to ensure seamless mobility in order to achieve efficient resource utilization and maintain service quality. The next generation wireless networks are expected to support the seamless vertical handoff mechanism in which users can maintain the connections even when they switch from one network to another with service continuity. For this, IEEE 802.21 provided a framework which facilitates seamless handoff in heterogeneous wireless networks. An approach to optimize these handover procedures through a novel IEEE 802.21 Media Independent Handover standard provides technology skeptic mechanism to obtain cross layer control information of network environment. The design goal of this paper is to provide an efficient vertical handover decision module based on IEEE 802.21 standards for best quality of service to wide range of applications. The proposed handover scenario is used to evaluate the vertical handover performance involving multimode terminal with WiFi/WiMAX interfaces and IEEE 802.21 entities. The proposed method takes into account the link layer and application layer information and makes decisions depending on that information. It will allow the mobile terminals to be always best connected and provide seamless mobility in vertical handoff. The proposed method is compared against the existing methods. Simulation result shows that the probability of handover failure and unnecessary handover for the proposed method are minimized by considering the velocities of mobile nodes. IEEE802.21 - Media Independent Handover (MIH) working group developed a standard to provide a frame work to facilitate the vertical handover in the heterogeneous wireless networks [5]. It defines an abstract framework that optimizes and improves handover performance by providing information about the link layer technologies to the higher layers. The goal of provisioning is to achieve low-latency handovers and intelligence in network selection. However MIH does not consider factors to efficiently make handoff initiation and find an optimal target network [1]. Also the MIH framework is a general framework, but needs to be integrated with the specific access technologies and their mobility processes, allowing for a coherent inter-technology handover process. Hence an improved framework is needed to consider the values of different criteria to take a decision and make a better choice concerning the destination network during handover. Vertical Handover Algorithms [4] involves two main things during a handover: Selecting best network and handover trigger. Network selection determines the best destination network, to which a mobile user can be handover. Handover decision may depend on various criteria to select destination network. In this paper we have proposed an efficient vertical handoff method using MIH. The proposed method takes into account the user preferences, mobile node parameters, lower layer network information and make decisions depending on that information.

The remainder of this paper is organized as follows: Section II describes the related work. Section III describes proposed method. Section IV gives overview of simulation of proposed method using NS2 simulator. Section V describes the simulation results and we conclude in Section VI.

II. RELATED WORK

Various vertical handoff decision algorithms have been proposed recently. Due to the relevance of mobility interoperability in future networks, a significant amount of related work has been published by the academic community as well. In [3] a detailed survey on existing vertical handoff algorithm, their classification and comparison is given. A detailed introduction to MIH standard is given in [8][9]. In [7] authors provided a framework for the implementation of the MIH standard and evaluated its performance in integrated 802.11/802.16e networks through simulation. A mathematical model for analyzing the performance of MIH signaling is proposed in [11]. IEEE 802.21 based vertical handover schemes are proposed in [6] and [13]. Unfortunately, the proposals lack interaction between the MIH framework and the access technologies, QoS specificities. Furthermore, performance measurements are also not given [14] and standard should be extended to further facilitate seamless handover provision. Deciding best target network is another important challenge in vertical handoff. From the literature it is found that Multi Attribute Decision Making (MADM) methods are widely used in handover decisions. Performance comparison among Simple Additive Weighting, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Grey Relational Analysis (GRA), and the Multiplicative Exponent Weighting (MEW) for vertical handoff decision is given in [12]. A context aware vertical handoff algorithm that considers both users and services requirements is proposed in [16]. A network selection algorithm based on Fuzzy Multiple Attribute Decision Making is proposed in [17]. The Network selection function is used to measure the efficiency in utilizing radio resources. Each network associated with parameters Received Signal Strength (RSS), Monetary cost(C), Band Width (BW), Velocity (V) and user preference (P). Even though there are a lot of vertical handoff algorithms in literature, these vertical handoff algorithms either lack in comprehensive consideration of various network parameters or the detailed implementation information.

III. PROPOSED WORK

Diverse processes are required in order to perform a Vertical Handover (VHO). The complete VHO process [2] is divided into three phases: i) Handover information gathering, ii) Handover decision, and iii) Handover execution. The information gathering phase is in charge of collecting relevant information from diverse context sources, such as network capabilities, access points, user equipments, and user preferences. The most critical element in a VHO process is the decision phase since, depending on the network candidate chosen, the performance of the system could improve or decrease. Once the information is gathered, the Vertical Handover Decision Algorithm (VHDA) is in charge of making a decision about When, and Where to trigger the handover. This decision should consider several parameters in order to choose the best candidate network to handover to. The execution phase is in charge of committing the VHO itself. In this process the mobile node leaves the current network and gets attached to a new network in a seamless manner, experiencing low latencies and minimal packet loss.

Here we propose a vertical handover decision algorithm using MIH. The IEEE has been making significant efforts in order to develop a protocol which may be able to homogenize VHO processes among heterogeneous networks. In that sense the IEEE 802.21 standard has been released with the aim of regulating the handover process. The Media Independent Handover Function (MIHF) protocol, defined by the IEEE 802.21 standard, establishes the messages exchanged between peer MIH entities for handover, offering a common message payload across different networking media (802.3, 802.11, 802.16, Cellular). The standard refers as lower layers to the technology dependent components, and as upper layers to the requesting modules. Lower layers can be accessed by different functions to retrieve information to detect, prepare, and execute the Vertical Handover while the upper layers demand that information; therefore, the latter are also referred to as Media Independent Handover User (MIHU). The MIHF offers to both lower and upper layers a Service Access Point (SAP) in order to exchange the service messages.

A. Handover algorithm

The algorithm includes two modules namely, handoff initiation module and handoff decision module. Handoff Initiation module: The handoff initiation module plays important role as it helps to reduce unnecessary handoff and thereby enhancing throughput and user satisfaction. It is also called as pre-handoff decision phase. Handoff initiation module consists of two parts namely estimating the necessity of handoff and selecting potential target networks which are capable of providing basic guaranteed service to the user. Handoff necessity estimation phase checks whether there is a need for handoff by using parameters like velocity of the vehicle, coverage area of the serving network. For example, in a vehicular network, if vehicle's moving speed is very high, WiFi cannot support its speed. In this case handoff to larger coverage area network would be preferable. By considering velocity of vehicle it is obvious that unnecessary handoff can be eliminated. If there is need for handoff, then the list of candidate networks which are capable of providing basic guaranteed service to the user are sent to handoff decision module. The Vertical Handover Algorithm is executed whenever there is a Link-up Link down or Link Going Down trigger from MIH.

Handoff Decision module: During handoff decision phase, the target network is selected from set of candidate network. The propose decision algorithm generally falls into two cases. The first case is that, if sole network is the current network, node stays in the current network; otherwise, the node decides to perform vertical handoff to target network. In the second case there are more than one network have been available select most preferable network as target network. After selecting the target network the traffic is rerouted from current network to target network. Choosing the optimal network is no longer just a case of QoS parameters; a variety of criteria has to be considered instead. The Multi-attribute decision making problem involves a set of alternatives Network (N1,N2,N3,N4) [15], which are evaluated based on a set of attributes (i.e. bandwidth, delay, jitter, error rate, network cost). All these important network attributes must be included as criteria for making any appropriate handoff decision. Information on these parameters is readily available via a local Media Independent Handover (MIH) server. A set of users specified weight (W), where $W=(W_{ij})$, $i=\{1,2,\ldots n\}$ for $j=\{1,2,\ldots m\}$ denotes weight that represents the relative importance of each attribute to each service. To make easier to judge the relative importance of the attribute, network traffic type is divided into four types

Traffic type		**Network Application type**
Conventional Service	-	Low latency for delay – High bit error rate
Streaming Service	-	Average Delay – Average bit error rate
Best Effort Service	-	High delay - Low bit error rate
Background Service	-	Slightly Higher than Best Effort Service

A uniform set of attributes of each candidate access network has to be provided as input to the decision algorithm to form the basis for the network selection process. Once the decision criteria have been determined, the next step is to define their importance, i.e., weight, of each one of them in the final outcome. To set a list of network application priority levels, the Network application priority is classified into levels from 1 to 7[10]. The priority level 7 represents the highest priority and 1 represents the lowest priority. The purpose of such classification is to set the order of traffic application priority in a more exact manner, so as to more sensibly weigh attributes.

Application priority

Priority Level		**Network Application Type**
Level -1 (Lowest level)	-	Best effort
Level -2	-	Background
Level -3	-	Medium load
Level -4	-	Excellent load
Level -5	-	Controlled load
Level -6	-	Voice and Video
Level -7 (Highest level)	-	Network controlled traffic

To assign weights to all of the five network attributes, the weight values are set based on the four different types of traffic and the seven priority levels of application. The weight values assigned to the attributes may vary with the different types of traffic applied for by users.

B Network Selection Procedure

TOPSIS is used to select the most suitable alternative Network using multiple attribute decision making algorithm [15] and the steps are as follows

Step-1: Specify the user weight and determine the normalized weight value using the formula

$$W_1 = X_1 \Big/ \sum_{i=1}^{n} x_i \quad i = 1, \ldots, 5$$

Step-2: Construct a decision matrix

$$\begin{array}{c|cccc|} & C_1 & C_2 & \cdots & C_n \\ \hline A_1 & d_{11} & d_{12} & \cdots & d_{1n} \\ A_2 & d_{21} & d_{22} & \cdots & d_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ A_m & d_{m1} & d_{m2} & \cdots & d_{mn} \end{array}$$

Step-3: Construct the normalized decision matrix as follows

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad i = 1, 2, \ldots, \underbrace{m}_{\text{The number of alternatives}};\ j = 1, 2, \ldots, \underbrace{n}_{\text{The number of attributes}}$$

Step-4: Construct the weighted normalized decision matrix using the equation

$$v_{ij} = (w_j)(r_{ij}) \qquad i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, n$$

Step-5: Determine the Positive ideal solution and the Negative ideal solution to represent benefit and cost criteria. For Benefit criteria and Cost criteria is given as

$$A^{+} = \left\{ \left(\max_i v_{ij} \mid j \in J \right), \left(\min_i v_{ij} \mid j \in J' \right), i = 1, 2, \ldots, m \right\} = \left\{ v_1^{+}, v_2^{+}, \ldots, v_n^{+} \right\}$$
$$A^{-} = \left\{ \left(\min_i v_{ij} \mid j \in J \right), \left(\max_i v_{ij} \mid j \in J' \right), i = 1, 2, \ldots, m \right\} = \left\{ v_1^{-}, v_2^{-}, \ldots, v_n^{-} \right\}$$

Step-6: Calculate the separation of each alternative from positive and negative ideal solutions

$$S_i^{+} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{+})^2} \quad i = 1, 2, \ldots, m$$

$$S_i^{-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{-})^2} \quad i = 1, 2, \ldots, m$$

Step-7: Calculate the closeness coefficient of each alternative

$$C_i = \frac{S_i^{-}}{S_i^{+} + S_i^{-}} \quad i = 1, 2, \ldots, m;\ 0 \le C_i \le 1$$

Step-8: The alternative network with the highest closeness coefficient value is then selected as the most suitable network for handover.

$$\text{TOPSIS} = \text{Max}(C_i)$$

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS): the chosen candidate network is the one which is the closest to ideal solution and the farthest from the worst case solution.

C. Numerical Analysis

Using TOPSIS method, first construct a decision matrix, and normalize the decision matrix using step 1 and 2.

Table 1: Normalized Decision Matrix

Traffic code	Bandwidth	Delay	Jitter	Error rate	Cost
T1	0.136	0.273	0.227	0.091	0.273
T2	0.217	0.261	0.261	0.130	0.131
T3	0.231	0.077	0.077	0.538	0.077
T4	0.333	0.167	0.167	0.167	0.167

Then construct weighted normalize decision matrix [15] using step 4. The following Table 2 presents the weighted normalized decision matrix.

Table 2: Weighted Normalize Decision Matrix

Network	Bandwidth	Delay	Jitter	Error rate	Cost
N1	0.040	0.102	0.079	0.046	0.071
N2	0.085	0.156	0.091	0.053	0.068
N3	0.181	0.052	0.041	0.246	0.060
N4	0.131	0.037	0.116	0.101	0.035

Determine the positive ideal Solution A^+ and negative ideal solution A^- is as follows

$A^+ = \{0.180 \quad 0.156 \quad 0.116 \quad 0.246 \quad 0.071\}$

$A^- = \{0.040 \quad 0.037 \quad 0.040 \quad 0.046 \quad 0.035\}$

Then determine the distance between each alternative.

The positive ideal solution is given below

$S_i+ = \{ 0.252 \;\; 0.217 \;\; 0.129 \;\; 0.197 \}$

Negative ideal solution is given below

$S_i^- = \{ 0.084 \;\; 0.141 \;\; 0.246 \;\; 0.130 \}$

Finally the closeness (C_i) of the ideal solution is calculated using equation (24) and presented as follows

$C_i = \{ 0.249 \;\; 0.394 \;\; 0.655 \;\; 0.398 \}$

From C_i , Network N3 is the best alternative network to connect the vehicle to maintain the service continuity by TOPSIS algorithm. The Ranking order of TOPSIS is N3, N4, N2, and N1 [15].

IV. RESULT AND ANALYSIS

From this scenario, Network N3 scored the highest score among the four networks; therefore it is decided to handoff to network N3. Regarding the ideal weight for bandwidth, the larger it is the better. As for the rest of the five attributes, the smaller it is the better.

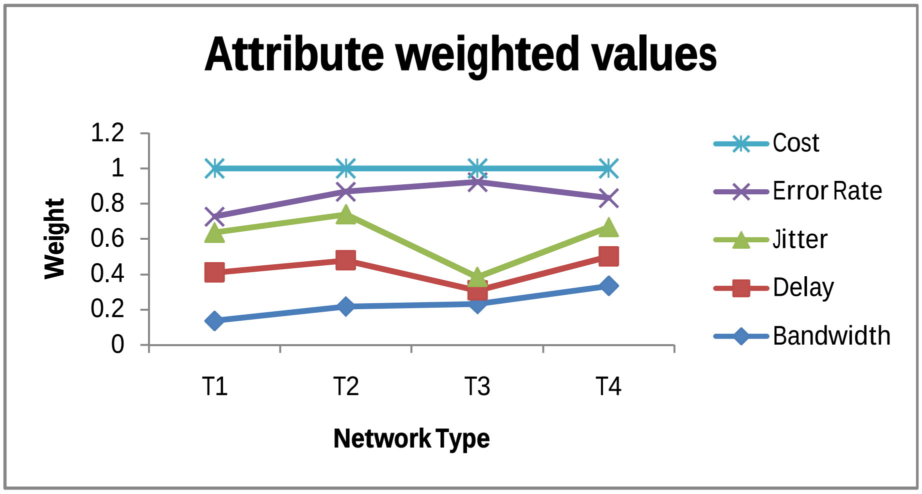

Figure 1. Attribute weighted values for the attributes

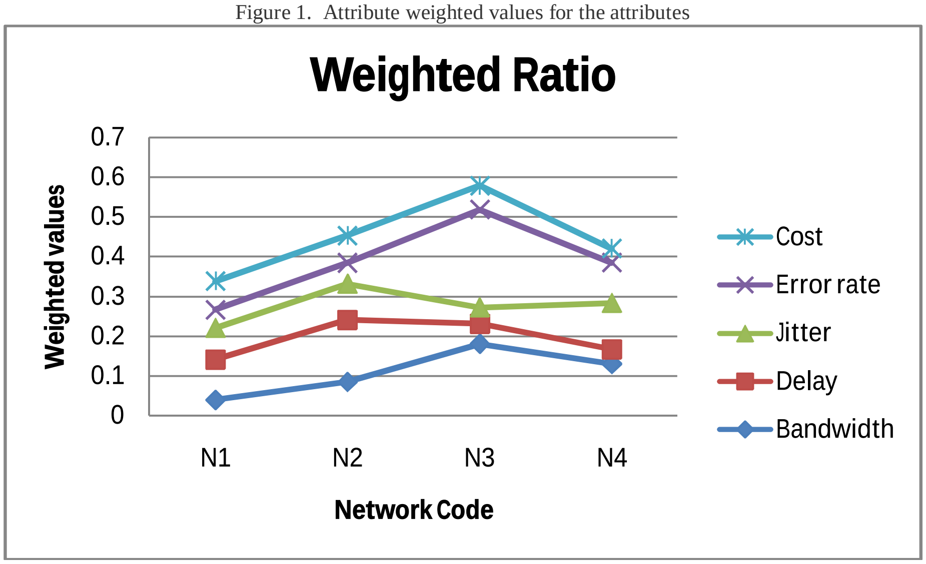

Figure 2. Weighted values assigned for the Networks

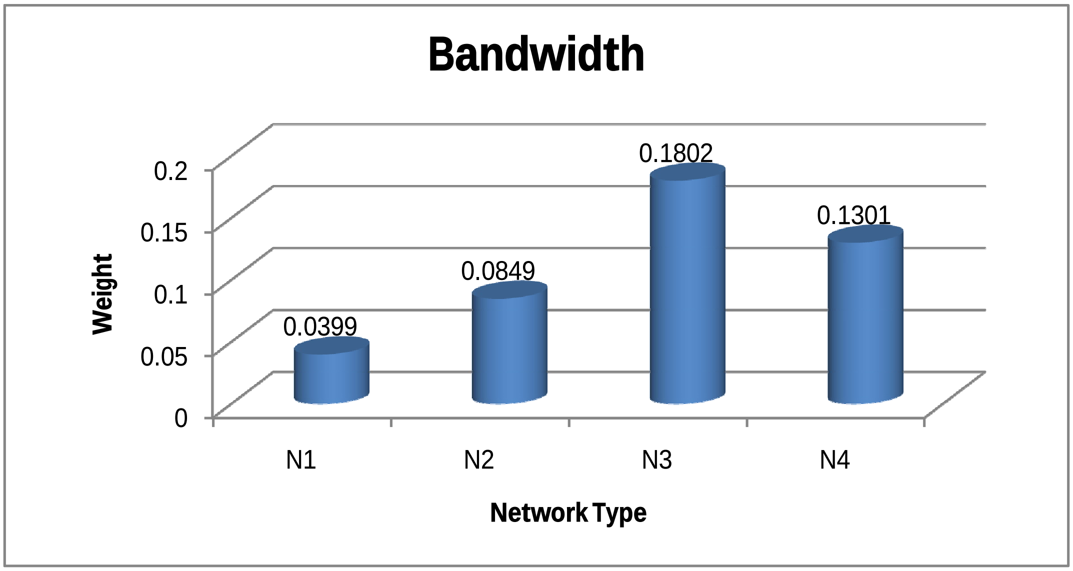

Figure 3. Bandwidth for the Networks

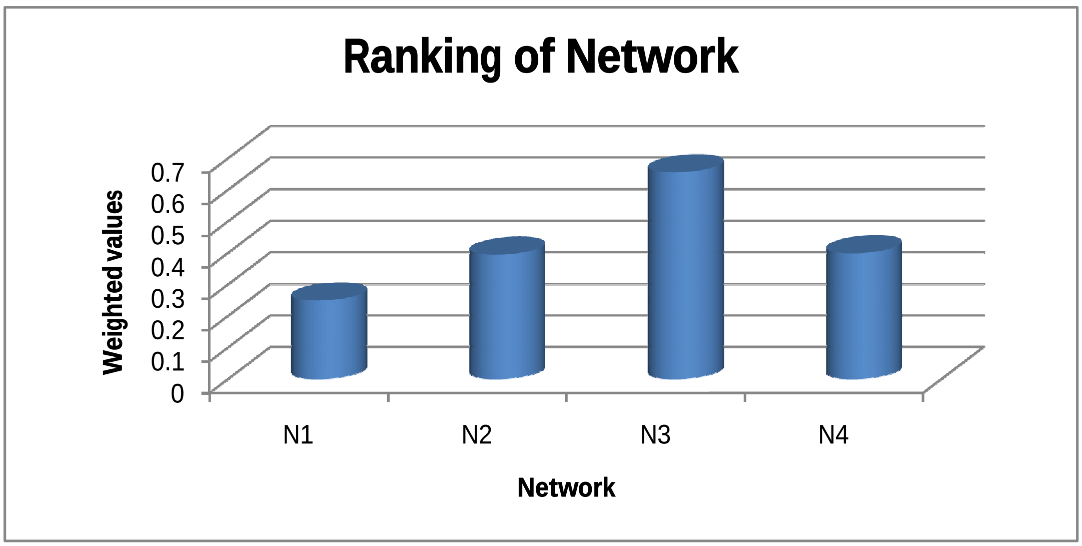

Figure 4. Ranking Order of the Networks

V. CONCLUSION

Seamless vertical handoff is key requirement for vehicular network. Vertical Handoff decision to select destination network based on the Radio Signal Strength only is not always a good strategy. Hence there is a need for a new framework taking into account different parameters to guide network selection process during handover decision. In this paper a vertical handoff model formulated as objective function of multiple parameters with dynamic weights. The proposed model helps to reduce the unnecessary handoffs. The simulation is performed using NS-2 simulator shows that the inclusion of additional parameters significantly improves the overall performance for vehicle users. Simulation results demonstrate that proposed approach achieves improvement with respect to throughput, handoff latency and packet drop. Compared with basic NIST module the proposed approach has a slight increase in throughput, and decrease of latency and packet drop.

REFERENCE

[1] Kumar, Vimal, and Neeraj Tyagi. "Media Independent Handover for Seamless Mobility in IEEE 802.11 and UMTS based on IEEE 802.21." *Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on*. Vol. 4. IEEE, 2010.

[2] Kumara.u "Vertical Handover in Vehicular Ad-hoc Networks – A Survey" International Journal of Latest Trends in Engineering and Technology (IJLTET)- Vol. 3. Issue 4 March-2014, PP 132-138.

[3] Yan, Xiaohuan, Y. Ahmet Şekercioğlu, and Sathya Narayanan. "A survey of vertical handover decision algorithms in Fourth Generation heterogeneous wireless networks." Computer Networks 54.11 (2010): 1848-1863.

[4] Li, Mo. Handover mechanisms in next generation heterogeneous wireless networks. Diss. University of Technology, Sydney, 2008.

[5] IEEE Standard for Local and metropolitan area networks - Part 21: Media Independent Handover Services

[6] Eastwood, Les, et al. "Mobility using IEEE 802.21 in a heterogeneous IEEE 802.16/802.11-based, IMT-advanced (4G) network." *Wireless Communications, IEEE* 15.2 (2008): 26-34.

[7] Lim, Wan-Seon, et al. "Implementation and performance study of IEEE 802.21 in integrated IEEE 802.11/802.16 e networks." *Computer Communications* 32.1 (2009): 134-143.

[8] De la Oliva, Antonio, et al. "IEEE 802.21 (Media Independent Handover Services) Overview." *Interface* 3 (2008): 3GPP2.

[9] La Oliva, Antonio de, et al. "IEEE 802.21: Media independence beyond handover." *Computer Standards & Interfaces* 33.6 (2011): 556-564.

[10] Kumaran.u "Vertical Handover in Vehicular networks using Multiple Parameters" International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT) – July-2014.

[11] Griffith, David, Richard Rouil, and Nada Golmie. "Performance metrics for IEEE 802.21 media independent handover (MIH) signaling." *Wireless Personal Communications* 52.3 (2010): 537-567.

[12] Stevens-Navarro, Enrique, and Vincent WS Wong. "Comparison between vertical handoff decision algorithms for heterogeneous wireless networks."*Vehicular technology conference, 2006. VTC 2006-Spring. IEEE 63rd*. Vol. 2. IEEE, 2006.

[13] Lampropoulos, George, Apostolis K. Salkintzis, and Nikos Passas. "Media-independent handover for seamless service provision in heterogeneous networks." *Communications Magazine, IEEE* 46.1 (2008): 64-71.

[14] Neves, Pedro, et al. "Enhanced media independent handover framework."*Vehicular Technology Conference, 2009. VTC Spring 2009. IEEE 69th*. IEEE, 2009.

[15] Kumaran.u, M.K.Jeyakumar "Multi-Criteria Based Network Selection Strategy in Multi-Radio Access Network for Vehicular Communications" International Journal of Applied Engineering Research (IJAER) Vol. 10. Number 16. Aug.-2015, PP 37003 – 37008