International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 5, May-2014, pp: (358-365), Impact Factor: 1.252, Available online at: www.erpublications.com

Handoff Management Issues in Heterogeneous Wireless Network: A Review

Deshbandhu[1], Suman Deswal[2]
[1]M.Tech, CSE, DCR University of Science & Technology, Sonepat, Haryana, India
[2]Assistant Professor, CSE, DCR University of Science & Technology, Sonepat, Haryana, India

Abstract: In this Paper, the study focuses on the various handoff management issues in Heterogeneous wireless network. A handoff scheme is essential to provide continuous connections whenever a mobile node moves from one coverage area of network to another. The handoff management issues consist of finding the appropriate time to perform the handoff depending upon RSS (received signal strength), traffic, bandwidth, velocity, channel conditions and cost etc. A handoff management scheme is also studied considering the current research into multicast mobility handoff between 3G mobile and WLAN. Finally, a scheme supporting group mobility is studied having a protocol for mobile groups that allows a single node to perform handoffs on behalf of all group members.

Keywords: Het Net, WLAN, 3G, MN, MMP, PMIPv6

1. INTRODUCTION

A **heterogeneous network** is a network that connects computers and other devices with different operating systems and/or protocols. For example, local area networks (LANs) that connect Microsoft Windows and Linux based computers with Apple Macintosh computers are heterogeneous. The word **"heterogeneous"** is also used in wireless networks using different access technologies. For example, a wireless network which provides a service through a wireless LAN and is also able to maintain the service when switching to a cellular network is called a wireless heterogeneous network.

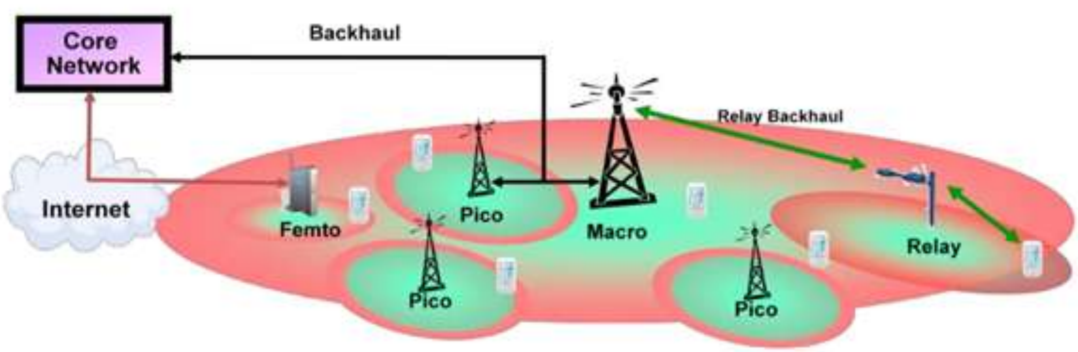

Figure 1. Heterogeneous Network utilizing mix of macro, pico, femto and relay base stations[1]

HetNet(Heterogeneous Network) indicates the use of multiple types of access nodes in a wireless network. A Wide Area Network can use macro cells, pico cells, and/or femto cells in order to offer wireless coverage in an environment with a wide variety of wireless coverage zones, ranging from an open environment to office buildings, homes, and underground areas. Mobile Experts define the HetNet as a network with complex interoperation between macro cell, small cell, and in some cases WiFi network elements used together to provide a mosaic of coverage, with handoff capability between network elements.

1.1 Features

The features of heterogeneous wireless networks are:

Heterogeneity: The infrastructure must include wireless networks that have a mixture of global and indoor coverage, thus it requires a heterogeneous collection of networks.
Scalable: The network infrastructure must scale to support millions of users.
Highly Available: The network infrastructure must be available all of the time.
Transparent Access: The detection and setup of a network connection should be automatic. Users shouldn't have to know what networks are in range.
Localized Service: The detection and setup of local network services should be automatic. Users shouldn't have to know what services are available at their current location. Access to your own stuff requires authentication. Access to local resources may also require authentication, since not all visitors are treated the same.
Global Authentication: We must authenticate users using a globally available security infrastructure, such as public-key cryptography or Kerberos.
Multimedia: The infrastructure must support graphics, audio and video in addition to text.
Performance: The user's data should arrive as fast as possible. This includes selecting the best network, optimizing the network performance, and optimizing the content at the application level.
Cost Effective: The infrastructure should be designed to minimize the costs and share, amortize resources as much as possible.
Heterogeneous Clients: Complexity should be pushed into the infrastructure, where it can be amortized over all of the active users. The infrastructure should support both inexpensive client devices, such as smart phones, and more sophisticated computers, such as high-end laptops.
Dynamic Adaptation: The data sent to the user should be optimized for timeliness, carrying the most information in the least amount of time. The nature of this adaptation depends on the current network, the preferences of the user, and the nature of the data.

1.2 Handoff in Heterogeneous Networks

For heterogeneous networks, there are two types of handoff that occur in the network.

Horizontal handoff
Horizontal handoff is the process by which mobile devices switch from one cell to another cell within the same network technology; this is also called "intra-system handoff".
Vertical handoff
In vertical handoff or "inter-system handoff", the mobile device is switching between different network technologies; for example between 3G and WLAN. That means that vertical handoff is different in several aspects such as data rate, bandwidth and frequency of operation. Moreover, vertical handoff can be divided into two sub types, which are upward-vertical handoff and downward vertical handoff.
The upward-vertical handoff is a handoff that makes a mobile device move from a network providing faster but smaller coverage to a new wireless network with a larger cell size and generally lower bandwidth per unit area. For example, the move from WLAN to 3G network.
The downward-vertical handoff is a handoff that disconnects from a cell providing broader coverage to a wireless network with a smaller cell size, and generally higher bandwidth per unit area such as from 3G network to WLAN.

2. Literature Survey

2.1 Traffic Driven Handoff Management Scheme for Next Generation Cellular Networks (NGCN)

This research presents a traffic driven handoff management scheme which control the handoff time according to the load status of cells [2]. In this approach, before accepting a new user, it requests the load information of the target cell in advance before handoff execution. Then, the value of adaptive RSS is used in the scheme to initiate the right handoff time. The results show that how the handoff initiation criteria might be set in accordance with the quality of services requested by users. It was observed that the proposed scheme can support better service quality than the scheme compared. The scheme can efficiently manage overloaded traffic in the system.

2.1.1 Adaptive Handoff Time Algorithm

In this research, an adaptive handoff algorithm for traffic load distribution in the hotspot cell is proposed. It is necessary to distribute traffic load of the hotspot cell in order to effectively use remained resources and maintain the acceptable service quality. Active communications between user and base station arise in HOLD and ON state [3]. The HOLD state has full downlink and thin uplink channel whereas ON state has both full downlink and uplink traffic channel. In this measurement, the load which is added by the handoff calls also has been considered and it is defined as HANDOFF. The handoff call is assumed in the ON state right after the handoff process completed. Thus, the traffic load can be estimated by measuring the number of users in the states, HOLD, ON and HANDOFF which is described in Equation 5 [3].

$$N_T = N_{ON} + \beta \text{ X } N_{HOLD} + N_{HO} \quad (1)$$

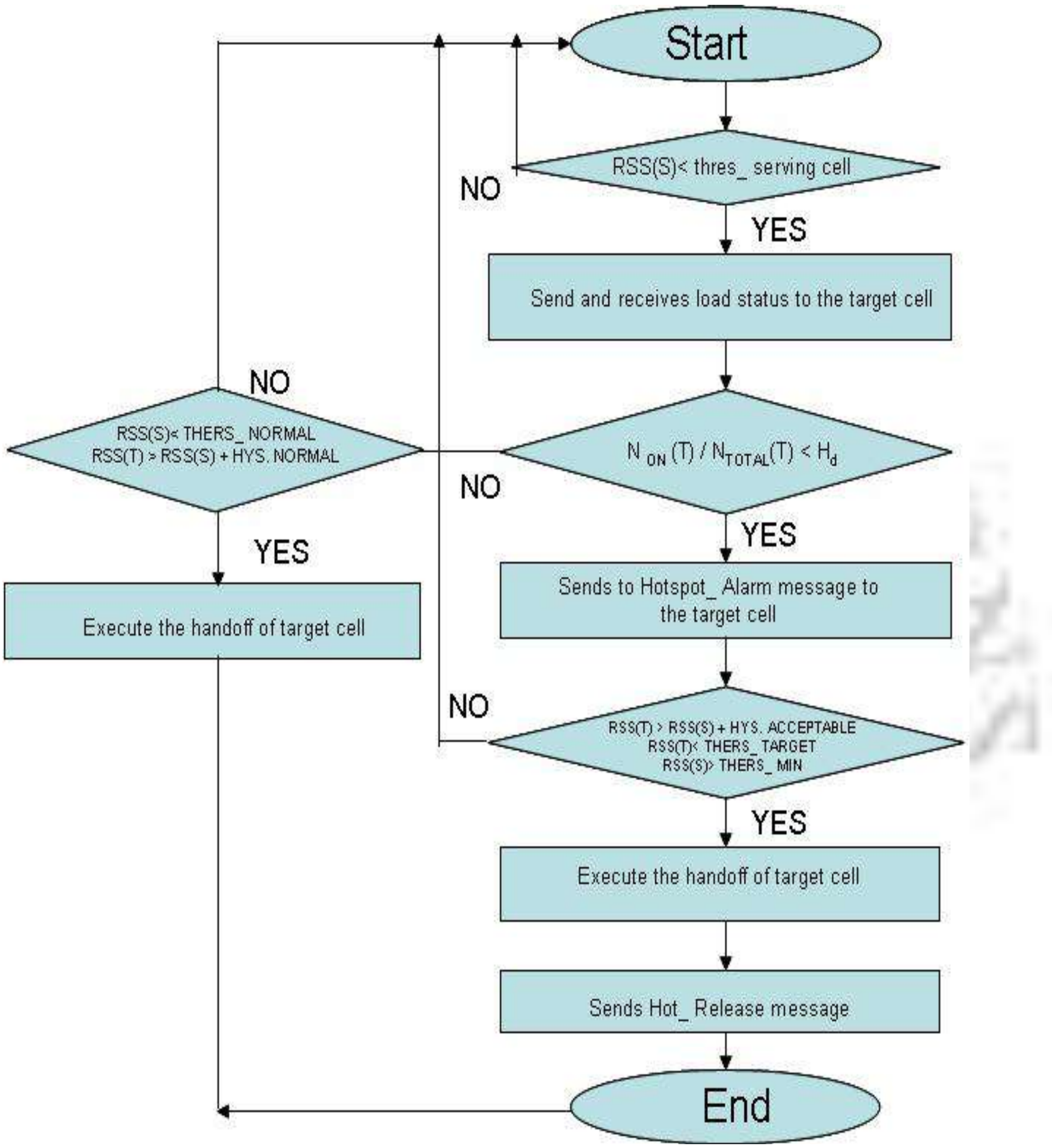

Figure 2. The handoff time algorithm[2]

Here, N_T is the amount of traffic loads, N_{ON} is the number of users in the ON state, N_{HOLD} is the number of users in the HOLD state and N_{HO} is the number of handoff calls. In Equation (1), β is an adaptive factor and the amount of traffic load varies from 0 to 1. The value of traffic load is approximated to 0 when the current cell is lightly loaded cell and as the number of mobile nodes is increased, the traffic load is approximated to 1 and the current cell becomes to be the status of hotspot. Figure 2 shows the handoff time algorithm. The handoff time algorithm is based on the handoff scheme proposed by [4]. As shown in Figure 2, when the RSS of the serving cell is less than threshold value, it sends the load information request message to the target cell and receive load information response message from the cell. The target cell calculates the amount of traffic load using Equation (1). If the amount of available resources of the target cell is less than the hotspot threshold, H_d, the current serving sends the hotspot alarm message to the target cell. After received the message, the proper threshold value is carefully selected in order to initiate the handoff process.

An adaptive RSS threshold is necessary to use so that the mobile has enough time to initiate the handoff process. So, the threshold value for initiating handoff should be carefully selected in order not to degrade the service quality of other users. The algorithm has been modified by applying a mathematical formulation for controlling the handoff time and called as an adaptive RSS threshold ($Thres_{min}$). This value avoids too early or too late initiation of the handoff process . It is completed before the user moves out of the coverage area of the serving network. Figure 2 shows the handoff time algorithm by applying the value of $Thres_{min}$.

2.2 Adaptive Load Balancing Handoff Scheme for Heterogeneous Wireless Network

In [5], we propose a vertical handoff decision algorithm in heterogeneous wireless network based on the Velocity of mobile node and the Adaptive traffic load balanced handoff management scheme which adaptively control the handoff time according to the load status of cells. The algorithm considers the handoff when the velocity increases with effective reduction of probability of handoff and efficiently manages further overloaded traffic in the system[6].

Table 1. Cellular coverage and speed limit[5]

Cell Name	Coverage	Speed	Techniques
Mega cell	100 - 500 km	> 200 km/h Airplane	Satellite 4G/WiMAX/LTE
Macro cell	1 - 33 km	20 – 200 km/h Vehicle/train	2G/3G (UMTS/CDMA)
Micro cell	100 m - 1 km	10 – 50 km/h Vehicle	2G(CDMA/WLAN/ HiperLAN)
Pico cell	10 m – 100 m	< 10 km/h Walk	WLAN/HomeRF/ Bluetooth

2.3 A Handoff Algorithm Using Pattern Recognition

Traditional handoff algorithms cannot keep both the average number of unnecessary handoffs and the handoff decision delay low. In making handoff decisions, they do not exploit the relative constancy of path loss and shadow fading effects at any location around a base station. This information can be used to improve the efficiency of handoff decision algorithms, as we do in our new handoff algorithms using pattern recognition[7]. Handoff decision algorithms with both a negligible number of unnecessary handoffs and a negligible decision delay can be realized[7,8].

2.3.1 SIGNAL STRENGTH PATTERNS

The patterns are defined by pattern class specifications.

A pattern class specification includes the following components:

Pattern stretch: This is a stretch of street for which the system wants to be informed whenever a mobile traverses it. For example, it can signify the need for a handoff-related action. Pattern templates of the class are obtained by training along the pattern stretch. The components of the pattern templates are the SSI vectors associated with surrounding base stations while a user is traveling along that pattern stretch[9].

Pattern action: This is the action connected with the pattern class, such as "Handoff from base station 0 to base station 1".

Included base station set: This is the set of M base stations whose SSI vectors in the pattern stretch make up the pattern matrix,

$$P = \begin{vmatrix} \text{SSI vector of 1st base station} \\ \text{SSI vector of 2nd base station} \\ : \quad\quad : \quad\quad : \\ \text{SSI vector of Mth base station} \end{vmatrix}$$

Because of small-scale fading, the pattern matrix is different each time when it is observed, even though the deterministic component is unchanged.

2.4 A Framework of Multicast Mobility in Heterogeneous Networks

In [10], we present an overview of the current research into multicast mobility handoff between 3G mobile network and WLAN, discuss the handoff process and problem and propose a new research programme to develop a framework for managing multicast mobility.

2.4.1 Multicast Delivery

Multicast is the delivery of information to a group of devices using a common IP multicast destination address. Once the multicast group is set up, the source starts transmitting messages to the host group address. The network infrastructure takes on the responsibility for delivering the data to the group. Multicast routers are responsible for ensuring that datagrams are transmitted over the appropriate links to ensure they reach all members of the multicast group.

2.5 Efficient Group Mobility for Heterogeneous Sensor Networks

Mobility Management protocols have traditionally supported the mobility of individual nodes and are therefore not optimized to support the migration of groups. The time required to re-establish connectivity, frequency of dropped packets and contention for the air interface increase significantly for mobile groups. In [11], the author proposes a protocol for mobile groups that reduces all of the above by allowing a single node to perform handoffs on behalf of all group members. This "gateway" node eliminates the need of multiple handoff messages by obscuring group membership to external parties.

2.5.1 Gateway Failure

The author assumes that the group mobility mechanism is executed in the presence of a single L2/gateway node. It introduces a single point of failure in the system, this is the difficulty with this approach. If the L2 node is damaged or destroyed, communication by the remaining group members with the backbone network would likely be severed[12]. In real networks, there should be multiple nodes capable of executing the duties of the gateway. However, the presence of multiple L2 nodes necessitates additional overhead.

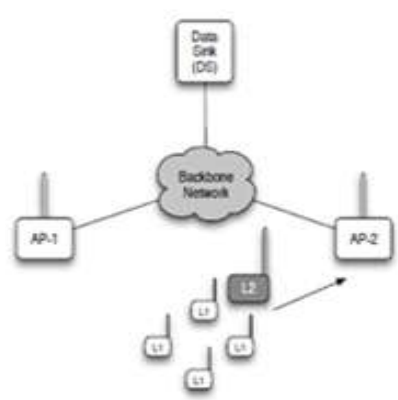

Figure 5.1 An example of heterogeneous group moving between access points (APs). As the signal strength of AP-2 becomes greater than that of AP-1, the L-2 node performs a mobile IP handoff, allowing all traffic for the group to be routed to its new location[10].

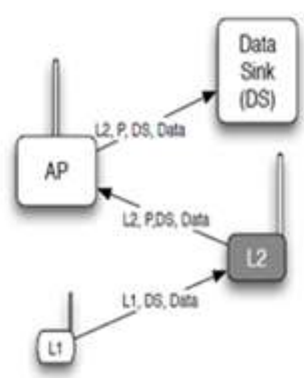

Figure 5.2 A message is sent from an L-1 translated by a NAT-like process in an L-2 and forwarded from port P via an AP to its intended destination. Commands and requests from the data sink follow the reserve path, except that the traversal of the wired network may be different due to mobile IP[10].

L2 nodes must decide which among them will execute the functions of the gateway in the network [13]. If some subset of the L2 nodes act as gateways concurrently, the gains of the group mobility approach will be reduced. The simplest approach to solve this problem would be to have all of the L2 nodes function as a multicast group. These nodes would select an L2 which act as the serving gateway. While this node is active, the remaining nodes would ignore requests to forward data to the network. If the elected node fails, a new L2 node could take the address of the former gateway (and therefore the address of the group) and allow service to continue.

2.6 USING SINR AS VERTICAL HANDOFF CRITERIA IN MULTIMEDIA WIRELESS NETWORKS

In [14], the author proposes a new vertical handoff algorithm using the receiving SINR (signal to interference and noise ratio) from various access networks as the handoff criteria. By converting the different receiving SINR values, the handoff algorithm can have the knowledge of achievable bandwidths from all access networks, and make handoff decisions with multimedia QoS consideration. The performance of RSS based vertical handoff differs under different network conditions, for different thresholds setting. Whereas, the new SINR based vertical handoff algorithm is able to consistently offer the end user with maximum available throughputs during vertical handoff. It is better adaptive to different network conditions, such as different noise level and load factor.

2.7 ARCHITECTURE OF AN INTELLIGENT INTER-SYSTEM HANDOVER MANAGEMENT SCHEME

In [15], an intelligent solution, based on the context-awareness concept, ensuring service continuity and answering user requirements is proposed. It focuses on the vertical handover decision issue. It performs whether and over which access network to hand over among available networks. It works with advanced decision algorithms (for more efficiency and intelligence) and it is governed by handover policies as decision rules (for more flexibility and optimization). It gives more flexibility in a way that the scheme is controlled by the mobile (MCHO).

2.7.1 Network Selection

This scheme needs more decision criteria from the terminal side (i.e. user preferences, service capabilities, battery status and network interfaces) as well as from the network side (i.e. QoS parameters, cost). The most appropriate access network, from available networks, has to be selected satisfying a number of objectives. So, It considers a MODM (Multiple Objective Decision Making) in which all alternatives available (access networks) are evaluated according to these objectives: Low Cost, the Preferred Interface, the Good Battery Status and the Good Quality (Maximizing Bandwidth, Minimizing Delay, Jitter and BER). A classical MODM such as AHP (Analytic Hierarchy Process) is used to assign scores to the available networks. Before using AHP method directly, two steps are performed: the **Criteria Scoring** in which the importance of each objective is evaluated according to user preferences, a pre-configuration step, and the **Network Scoring** in which the available networks are evaluated and compared according to each objective.

3. Comparison

Comparison of handoff management techniques: The comparison of different handoff management techniques is done in the following table.

Prioritization	Advantage	Disadvantage
Traffic Driven Handoff Management Scheme	• controls the handoff time according to the load status of the cells	• cannot improve the handoff probability and handoff drop call rate concurrently. • cannot keep both the average number of unnecessary handoffs and the handoff decision delay low.

Velocity Based Handoff Management Scheme	• considers the Velocity of mobile node and then Adaptive traffic load balanced handoff management scheme. • considers the number of handoff when the velocity increases with effective reduction of probability of handoff in the system. • improves the handoff probability and handoff drop call rate performance. • efficiently manages the overloaded traffic in the system as compared with existing fixed and adaptive handover time.	• cannot keep both the average number of unnecessary handoffs and the handoff decision delay low.
Handoff Management Scheme Using Pattern Recognition	• exploits the relative constancy of path loss and shadow fading effects in making handoff decisions. • negligible number of unnecessary handoffs and negligible decision delay is realized.	
Multicast Mobility For Heterogeneous(Cellular) Networks	• considers the handover issues during the delivery of multicast services. • reduce handoff latency which comprises multicast handover delay, end-to-end delivery delay to minimize packet loss.	• not well suited to support the continuity of multimedia application sessions.
Group Mobility For Heterogeneous(Cellular) Networks	• The “gateway” node eliminates the need for multiple handoff messages. • reduce messaging overhead for a mobile group from O(n) to O(c) by allowing a single node to perform Mobile IP registrations on behalf of an entire group, • significant reduction in handoff times, message complexity and packet loss. • decreases the competition for the air interface, reduce the need for retransmissions and allow the flow of data to resume more quickly.	

Future Work

Various handoff management techniques are studied which gives better result as compared to the standard ones taking different parameters in different scenarios using simulators (as NS2- Network Simulator) but there is a need of evaluating these techniques in a more realistic scenario and applying them to actual wireless scenario. These techniques need to support the continuity of multimedia application sessions in heterogeneous mobile environments and adapt to the real world communication. Moreover, in multicast mobility scheme, the framework needs to be scalable in terms of the number of mobile nodes and also the density of such nodes within the networks. Additionally, in group mobility scheme, the specific protocols used to create, join and leave mobile groups were not discussed. These algorithms may have additional effects upon this protocol and should also therefore be examined.

Conclusion

The different handoff management techniques like Traffic Driven, Velocity Based, Pattern Recognition Handoff Management Scheme, Multicast Mobility and Group Mobility Schemes for Heterogeneous Networks are studied and compared together. Each scheme has own advantages and disadvantages. Traffic driven handoff management scheme can efficiently manage overloaded traffic in the system. Velocity based handoff management scheme considered the velocity of the mobile node. It also adaptively controls the handoff time according to the load status of cells. Pattern recognition scheme exploits the relative constancy of path loss and shadow fading effects at any location around a base station. Multicast mobility scheme proposed a research into multicast mobility handoff between 3G mobile network and WLAN. Group mobility scheme is optimized to support the migration of groups.

References

[1]. http://www.qualcomm.com/media/documents/files/lte-heterogeneous-networks.pdf

[2]. Yusof, Azita Laily, Mahamod Ismail, and Norbahiah Misran. "Traffic Driven Handoff Management Scheme for Next Generation Cellular Networks (NGCN)."Computer and Network Technology (ICCNT), 2010 Second International Conference on. IEEE, 2010.

[3]. Kim, Dongwook, Namgi Kim, and Hyunsoo Yoon. "Adaptive Handoff Algorithms for dynamic traffic load distribution in 4G mobile networks." Advanced Communication Technology, 2005, ICACT 2005. The 7th International Conference on. Vol. 2. IEEE, 2005.

[4]. Kim, Dongwook, Mrinalini Sawhney, and Hyunsoo Yoon. "An effective traffic management scheme using adaptive handover time in next-generation cellular networks." International Journal of Network Management 17.2 (2007): 139-154.

[5]. Selvakumar, A., V. Vaidehi, and T. G. Palanivelu. "Adaptive load balancing handoff scheme for heterogeneous wireless network." Advanced Computing (ICoAC), 2011 Third International Conference on. IEEE, 2011.

[6]. Kassar, Meriem, Brigitte Kervella, and Guy Pujolle. "An overview of vertical handover decision strategies in heterogeneous wireless networks." Computer Communications 31.10 (2008): 2607-2620.

[7]. Wong, Daniel, and D. Cox. "A handoff algorithm using pattern recognition."Universal Personal Communications, 1998. ICUPC'98. IEEE 1998 International Conference on. Vol. 1. IEEE, 1998.

[8]. Kennemann, Olrik. "Pattern recognition by hidden markov models for supporting handover decisions in the GSM system." Proc. 6th Nordic Seminar Dig. Mobile Radio Comm. 1994.

[9]. Maturino-Lozoya, H., D. Munoz-Rodriguez, and H. Tawfik. "Pattern recognition techniques in handoff and service area determination." Vehicular Technology Conference, 1994 IEEE 44th. IEEE, 1994.

[10]. Namee, Khanista, and Nigel Linge. "A framework of multicast mobility in heterogeneous networks." Proc. The 11th Annual Postgraduate Symposium on the Convergence of Telecommunication, Networking and Broadcasting (PgNet2010). 2010.

[11]. Traynor, Patrick, et al. "Efficient group mobility for heterogeneous sensor networks." Vehicular Technology Conference, 2006. VTC-2006 Fall. 2006 IEEE 64th. IEEE, 2006.

[12]. Cano, J-C., and Pietro Manzoni. "Group mobility impact over TCP and CBR traffic in Mobile Ad Hoc Networks." Parallel, Distributed and Network-Based Processing, 2004. Proceedings. 12th Euromicro Conference on. IEEE, 2004.

[13]. Chen, Wen-Tsuen, and Po-Yu Chen. "Group mobility management in wireless ad hoc networks." Vehicular Technology Conference, 2003. VTC 2003-Fall. 2003 IEEE 58th. Vol. 4. IEEE, 2003.

[14]. Yang, Kemeng, Bin Qiu, and Laurence S. Dooley. "Using SINR as vertical handoff criteria in multimedia wireless networks." Multimedia and Expo, 2007 IEEE International Conference on. IEEE, 2007.

[15]. Kassar, Meriem, Brigitte Kervella, and Guy Pujolle. "Architecture of an intelligent inter-system handover management scheme." Future generation communication and networking (fgcn 2007). Vol. 1. IEEE, 2007.