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Comparison of FCM & Game Theory Based Vertical Handoff Scheme for Wireless Heterogeneous Networks

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Abstract: *Vertical Handoff Decision making problem is one of the significant technical issues in the development of Heterogeneous wireless networks. This paper presents a vertical handoff decision algorithm based on game theory & FCM approach. In this algorithm, the handoff decision problem is formulated as a non-cooperative game between the mobile users and the wireless networks that are available in the vicinity of the mobile user. It considers terminal parameters such as network loading of the mobile application along with the velocity of the mobile terminal. It also considers network parameters such as available network overload with respect to no.of nodes offered by each network. The algorithm chooses the target network with maximum network utilization that offers services at lower prices.*

Keywords: *FCM, Network Overloads, VHO.*

I. Introduction

As the development of wireless communication systems, heterogeneity has been introduced to be one of the most important features in the next generation wireless network [1]. In heterogeneous wireless networks, different wireless access technologies are integrated to complement each other in terms of coverage area, mobility support, bandwidth, and price. Based on such heterogeneous networks, some works have been proposed for extending the coverage of service availability and offering a range of connectivity alternatives, in terms of QoS support, coverage areas and service cost. For the characteristic
of different wireless technologies integrated in networks, it is necessary to develop a vertical handoff scheme so that access points (APs) always provide best connections to mobile nodes (MNs) [2].

A typical architecture of wireless heterogeneous networks integrates different technologies of wireless communication including wireless local area networks (WLANs), cellular network and worldwide inter-operability for microwave access (Wi-Max). A base station (BS) of cellular network provides wide service coverage with low performance compared with WLAN access points (APs). Covering limited areas APs implement high-speed wireless communication. Wi-Max supports the performance with balancing between communication speed and service coverage by radio access station (RAS). And all of them can communicate with wired core network which is responsible for data processing. When the mobile nodes (MNs) , etc. PC or mobile phone, move in such wireless heterogeneous networks, it has high possibility to switch from one access technology to another. It results that the RSS and QoS of MNs degrade. Vertical handoff problem is how to select a suitable AP for MNs from different wireless technologies. A high performance scheme make MNs keep seamless connectivity.

In the paper we address the problem of vertical handoff for wireless heterogeneous networks. We analyze the competitions among MNs in different service areas to share the limited resources by using game theory and propose a game theoretic vertical handoff scheme for wireless heterogeneous networks. Most of existing works focus on one MN selecting from different APs. Several of them solve the problem by taking the competition among MNs into consideration. Even though few of them consider the competition between MN and AP, by which APs maximum the utilization of resources at the same time, when MNs make decisions. Taking the behaviors of MNs and APs into consideration, we formulate vertical handoff scheme for wireless heterogeneous networks as a non-cooperative strategic game. By taking part in the game, APs and MNs perform the handoff decisions iteratively and
repeatedly, to achieve the best performance with minimum cost. Nash Equilibrium (NE) is the solution of the problem. At equilibrium point, utility functions of both APs and MNs cannot be increased by choosing other strategies unilaterally given the decisions of all the others. And utility functions can be defined according to user preferences and network capacity so that we can develop an adaptive vertical handoff schemes. In the numerical analysis, we analyze the scheme under different cases of network scenarios for approaching to reality. The simulation results suggest that our scheme increases the mean throughput of network and the bandwidth utilization of each AP.

II. FCM & Game Theory Techniques

Game theory is one of the topics of Artificial Intelligence and is used as a mathematical analysis for conditions interest and cooperation between intelligent rational decision makers to take the best decision. These decisions are based on optimization of utilities by the maximization of the profit and behavior strategies of participants. The rationality of decision makers consists in availability of all the possible alternatives and outcomes to implement.

Game theory was founded by economist Oskar Morgenstern and mathematician John von Neumann in 1944 as the result of their collaboration, and was firstly published in the book entitled “The Theory of Games and Economic Behavior”. Game theory is successfully implemented in different areas

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such as economics, political sciences, computer science and logic, biology etc.

In game theory two or more players take a decision which affects the outcome of each
other or another player on the contrary with traditional decision making which the decision is made by one player.

Game theory is set of mathematical models designed to examine the decision process, estimate the outcome and select favorable approach. Game theory is classified into non-cooperative and cooperative game theory. Cooperative game theory studies the behavior of collaboratively working rational players while non-cooperative game theory studies the interaction results of competing players where players independently choose their strategy to maintain their service and minimize cost. The players in game theory are user and the network. We have presented VHO algorithm based on game theory network selection solution, taking QoS requirements and velocity of the mobile user along with available bandwidth and cost per bit as network selection parameters. The algorithm thus designed is able to reduce the handoff delay.

Different types of games are known: cooperative and non-cooperative games, sequential game, and constant sum, static and dynamic games.

There are three forms to represent the interaction between players: 1) extensive form describes the situation of the game, the motivation, details and the available information. It also gives conditions for the movements of the players and show different stages for the interaction between players; 2) strategic form gives the possible strategies that can be used by the players along the game, and the payoff of these strategies are chosen by the players; 3) characteristic function form describes the interaction between players to represent coalitions which are used in cooperative games.

III. Methodology

A game theory is applied in handoff technique. In our technique, handoffs have three main parts, handoff initiation, handoff decision and handoff execution. Flow chart of handoff is given by fig 1. The flow chart shows that complete execution of the program & methodologies is used to find out network load of the system. The execution of handoff is done for heterogeneous network. As no. of nodes increases network overload efficiency is decreases.

IV. Result Analysis

In this case, the networks are composed by 1 cellular network BS and several WLAN APs, among which there are no overlapping areas. That means for nodes within coverage of each AP, they can just select the AP or cellular BS to connect with. This is the simplest situation and the network overloadings are shown as Fig 2. & Fig. 3.

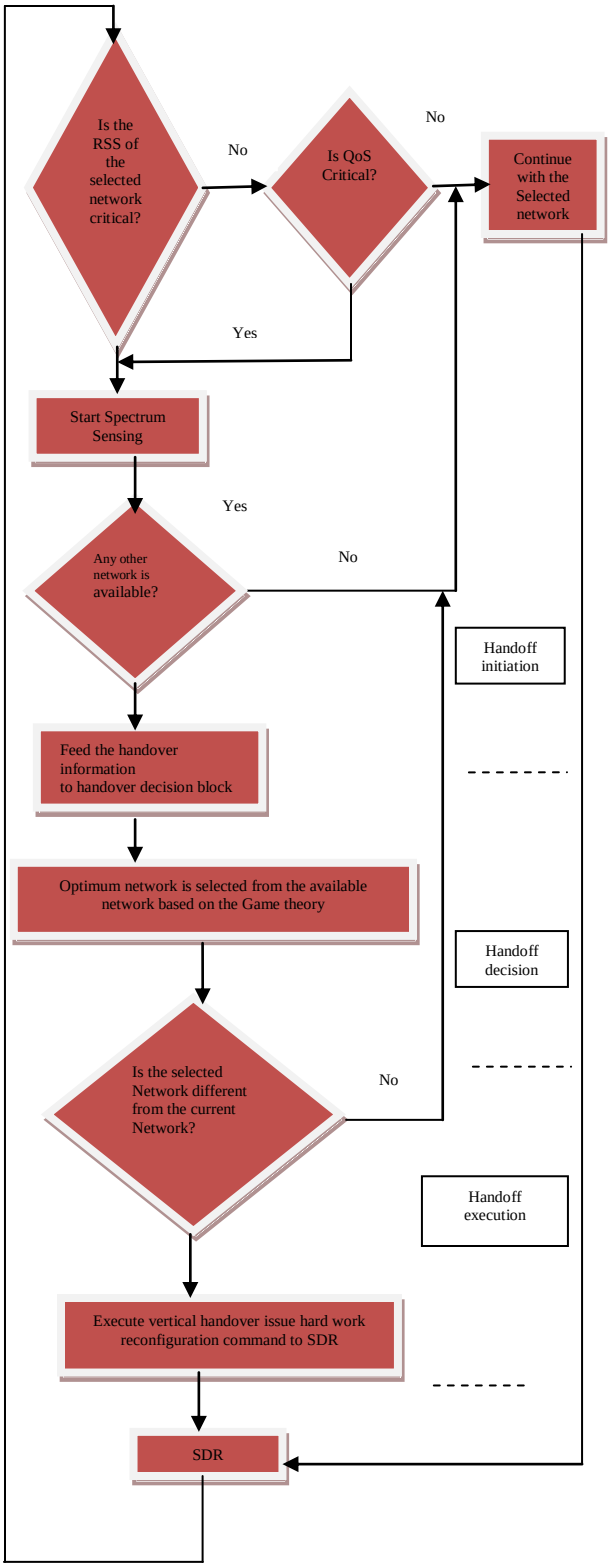

Fig. 1: Game theory based vertical handover for heterogeneous Networks

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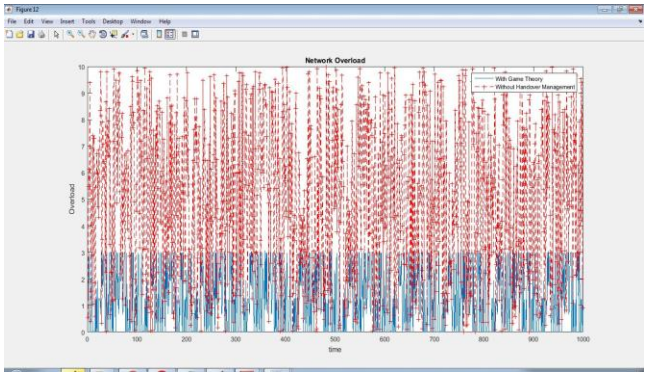

Fig. 2: Network Overload without Handover Management and with Game Theory

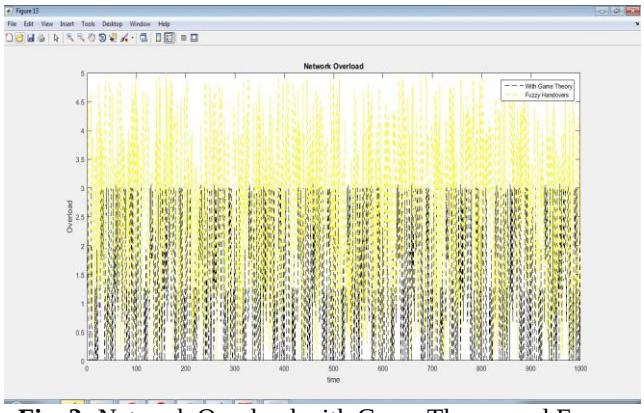

Fig. 3: Network Overload with Game Theory and Fuzzy Hanover

On the basis fuzzy logic scheme & Game theory network overloading is analyzes. As no. of nodes increases overloading efficiency decreasing. Comparison of FCM Overheads & Game theory overheads as shown in Table 1 & Fig 4

Table 1 Comparison of FCM Overheads and Game Theory Overheads

No. of Mobile Nodes	FCM Overheads	Game Theory Overheads
100	86.50%	96.09%
200	85.73%	95.72%
300	83.49%	95.70%
400	82.92%	94.60%
500	80.10%	94.40%
600	79.57%	93.65%
700	79.27%	92.99%
800	78.89%	92.97%
900	78.07%	92.71%
1000	77.52%	91.18%

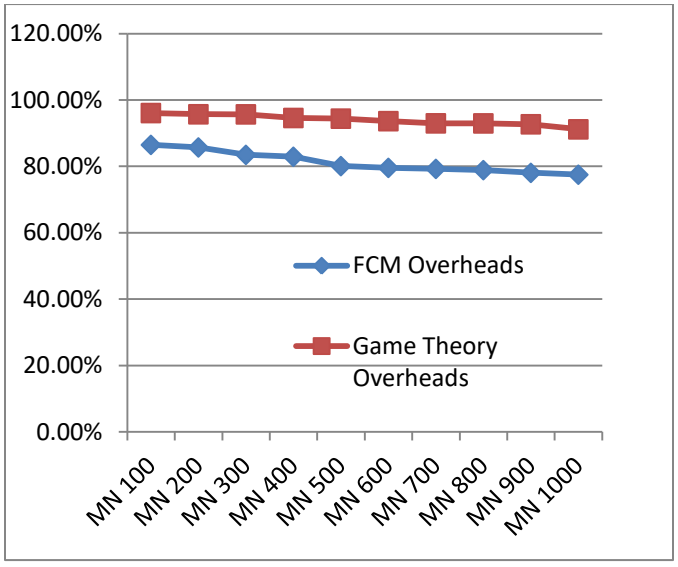

Fig. 4: Comparison of FCM Overheads and Game Theory Overhead

V. Conclusion

The vertical handoff schemes for heterogeneous networks were proposed based on some estimated network overheads earlier, which did not take into account the inputs of local terrain with multiple tiers of heterogeneous wireless networks and the quality of service. In order to improve the vertical handoff schemes for heterogeneous wireless networks, the present work proposes some novel VHOS techniques by game theory & fuzzy logic. A comprehensive study of VHO and VHO algorithms is presented in this report. These algorithms are categorized into three categories handoff initiation, handoff decision, handoff execution. VHO algorithms reported in standard literature lack a comprehensive consideration of various network parameters, like user mobility and user preferences. The Game theory technique is best as compared to Fuzzy Cluster Means. The result shows that as no. of nodes increases overheads efficiency is decreases.

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