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Network Selection Algorithm for Vertical Handover in Co-operative Wireless Network

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***Abstract:** Wireless networks are emerging towards a heterogeneous co-operative architecture to support communication needs of the end user. In this paper a centralized spectrum manager is presented which calculates the traffic load on each network and allocates another network to the user by using the network selection algorithm. Simulation results shows that the centralized spectrum manager handover the end user to another network seamlessly and improve the global spectrum efficiency*

***Keywords:** Co-operative Network, Resource allocation, Traffic Prediction.*

I. INTRODUCTION

The success of wireless and mobile communications has resulted in the creation of a large variety of wireless technologics, including second- and third-generation (2G and 3G) cellular, satellite, Wi-Fi, and Bluetooth. Each technology is tailored to reach a particular market, or a particular type of user with a specific service need, with the continuous increase of users and operators requirements, the needs for better support for reduced network architecture, different quality of service (QoS), higher spectral efficiency, and higher data rates for packet-switched services greatly increase in order to further enhance user experience while maintaining efficient utilization of system resources.

Given the characteristics of 3G techniques, these demands cannot be satisfied. As a result, more and more researchers and companies are paying attention to research on beyond 3G systems, which are supposed to be compatible wideband wireless communication systems.

In a co-operative network a channel sensing mechanism is used by one network to look for unused spectrum which can be borrowed from another network [3]. There exist several wireless networks, such as Bluetooth, wireless LANs (WLANs), Universal Mobile Telecommunications System (UMTS) [5], Cellular networks, Zigbee, WiFi, WiMax, Long Term Evaluation(LTE) etc. These networks are designed for specific service needs and vary in terms of bandwidth, cost, latency, area of coverage, and quality of service (QoS). For example, satellite networks can provide global coverage, but limited by high cost and long propagation. Third-generation (3G) wireless systems like Universal Mobile Telecommunications System (UMTS) can deliver a maximum data rate of 2 Mb/s at lower cost and have wide coverage. WLANs support bandwidth up to 54 Mb/s at very low cost. The future generation of WLANs is expected to provide data rates of 100 Mb/s. WLAN can support low-mobility users and have small coverage area [8][9].

Universal wireless access refers to the ability of a user to connect anywhere at any time from any network. The change in connection may be initiated by the user or may he initiated by the network, transparent to the user. For example, a user may choose to access a wireless LAN (WLAN) to send a large data file, but may choose the cellular network to carry on a voice call [7]. On the other hand, a network may decide to hand off a stationary data user to a WLAN in order to increase bandwidth availability for mobile users in a 3G cellular network [1]. Personal mobility allows a user to receive services at any terminal device, while terminal mobility allows the device to receive services even as it moves between network access points. To achieve seamless mobility, network management operations must he conducted without causing degradation of services, and without need for user intervention [1].

As various networks generate different types of traffic it is necessary for traffic controllers to deal with different type of traffic characteristics. The prediction algorithms must be able adapt to range of traffic patterns predicted and various traffic flows with best accuracy. Wireless network design scenario is changing rapidly [1] in future wireless services will be provided through heterogeneous networks [2, 3], customers of any subscribed network can connect to any other network when the capacity of its subscribed network goes below a certain threshold value [2]. The organization of the paper is as follows, Section 2 describes related work Section 3 presents co-operative networks. Section 4 describes performance analysis Section 5 describes result analysis and the conclusions are drawn in section 6.

II. RELATED WORK

Handoff can be categorized into Horizontal HandOff (HHO) and Vertical HandOff (VHO). In contrast to HHO, in which handoff is performed between the access network of the same technology, VHO is performed between the access network interfaces which represent different technologies [6].

Vertical handoff decision involves a tradeoff among many handoff metrics including QoS requirements (such as network conditions and system performance), mobile terminal conditions, power requirements, application types, user preferences, and a price model. Using these metrics involves the optimization of key parameters (attributes), including signal strength, network coverage area, data rate, reliability, security, battery power, network latency, mobile velocity, and service cost. These parameters may be of different levels of importance to the vertical handoff decision.

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Some categories of vertical handoff decision algorithm are proposed in the current research literature.

The first category is based on the traditional strategy of using the received signal strength (RSS) combined with other parameters. RSS condition represents traditional handover in homogeneous wireless environment when mobile user moves to a new base station only if the current signal level drops below a threshold and if signal level from target base station is stronger than the current one by a given hysteresis margin. Network selection based on this condition is necessary but insufficient condition for network selection in heterogeneous environment.

The second category of handoff decision algorithm uses multiple criteria for handover decision. An integrated network selection algorithm using two multiple attribute decision making methods, Analytic Hierarchy Process and Grey Relational Analysis However, computational intelligence techniques were not used[10].

Existing network selection schemes can be categorized into two types, i.e., distributed or hybrid schemes, in both types of schemes, it is assumed that, there is a central network entity like the network interoperating agent (NIA) in the backbone, broadcasting system information periodically to all the MHs (Mobile Hosts) in the heterogeneous networks.

In distributed schemes the MH periodically updates the cost functions of its reachable networks, using the broadcasted system information and by the user preference of itself. The network with the minimum cost function is selected and a vertical handoff will be triggered if it is different from the current serving network. The end users care about the sharing of the radio spectrum and system is interested in the optimization in global spectrum efficiency, and this conflict is influenced by the increasing freedom given to the end users. Therefore, network selection based on distributed schemes cannot result in optimal use of the global radio spectrum, and the advantages in the target network may get destroyed due to handoff and load unbalance.

A hybrid network selection scheme is used, the basis of which is a two-level cost function model. First, the optimal distribution of user number throughout the whole heterogeneous system is determined according to the system-level cost function, and then, an adjustment value of user number distribution in each network is calculated and passed to all the MHs, together with the broadcasting information. Then the MHs update their user-level cost functions and make network selection, just like the processes in, except that the adjustment value is added to the user-level cost function as a special parameter.

This scheme tries to influence the individual decision with system optimization advice, hoping that the actual user distribution can converge to the optimal distribution.

The end users desire for bandwidth and their personal preferences still place a decisive role in network selection. In addition, the assumption of identical service request of each MH limits the practicability of the scheme. In this paper we are proposing a centralized spectrum manager scenario which will communicate with all the other networks which are connected to it and has the state information such as traffic on the network, future traffic requirement predicted by the network etc. After having the state information of the network, the centralized spectrum manager chooses the network for vertical handover [2] having the less traffic flow on it.

As different networks generate different types of traffic it is necessary for traffic controller module to deal with variety of traffic characteristics. The prediction algorithms must be able adapt the range of traffic patterns predict various traffic flows with best accuracy. To cope with this issue we use RLS (Recursively Least Square) [4] adaptive tracking algorithm to track different traffic.

III. CO-OPERATIVE NETWORK

A. Heterogeneous wireless network

In a heterogeneous network scenario different networks will cooperate with each other via the centralized spectrum manager (CSM) and provide best connectivity for users as well as to maximize utilization of their own network capacity.

The co-operative networking concept has been developed with a view that each secondary network on its own will find available unused capacity from other primary network and utilize them as required. We propose a different scenario for co-operative networks where all the networks will cooperate by exchanging their network status information and share available spare capacity with the centralized spectrum manager. A co-operative network will allow networking entities to share aggregate network resources in different geo-clusters.

Users whose QoS requirements are not satisfied by the existing network can handover to a different network [2]. A co-operative approach will allow networks to temporarily borrow network resources from other networks in a more efficient manner. In a physical layer spectrum sensing approach a secondary spectrum could sense free spectrum from other networks and could use the spectrum without knowing the future requirements of the primary network. This approach may lead to QoS degradation in both networks.

First, operators have reservations for the technologies they are using for their communication (which is required for authentication, billing, and service provisioning when an SLA [5] is established between operators) to all other operators.

Second, each time a new operator implements its wireless network, a SLA has to be created with every other operator separately. The number of operators of wireless networks is very large; there are a large number of operators for several wireless networks. Given the large number of operators, it is almost impractical for network operators to create direct SLAs with every other operator. Therefore, there is a need for a new architecture to achieve roaming among heterogeneous [11].

An IP based resource allocation technique [2] will eliminate the need for continuous physical layer channel sensing which may lead to increased power consumption of mobile terminals. Using a scheduled allocation technique the SM will match the resource requests with the available spectrum and send a resource offer to a requesting network based on the best match, request arrival time and the priority of the request. The offered resource will be allocated for a fixed duration based on the prediction. Each network resource will have a finite lifetime. If the secondary network accepts the request then the SM will remove the resource from the available resource list and then inform the serving network about the allocation[12].

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In case of a contention based allocation [3], the SM advertises available resources and its parameters to all requesting networks. A number of requesting networks sends requests to the SM using a contention mode. The SM will allocate the resource to the first successfully received request. In an auction based approach each channel is advertised with a minimum price and then kept resource open for certain duration so that requesting networks can bid for the resource. The highest bidder from the list is allocated the resource.

B. Network selection algorithm for vertical hand over

To find the traffic load on each network on each network the prediction based algorithm is used, to generate predictions, information about past events, time-series data, is collected. Time series is a sequence of observations y(t), y(t □1), ... , y(1) of a random process Y at discrete time intervals, where an observation at time t is given by y(t).

After finding the traffic on each network it is selected for hand over using fallowing network selection algorithm.

Step I: Let Br be the required bit rate of a node for vertical hand over

Step II: B_w is bandwidth of the target network.

Step III: B_{max} be the maximum bandwidth available.

Step IV: σ^2 be the variance of Additive White Gaussian Noise (ADWN).

Step V: If Network traffic load (N_L) > Network Capacity (N_C)

Step VI: Then find network load on rest two networks.

Step VII: If traffic load on first networks (N_{1L}) > Traffic load on second network (N_{2L}).

Step VIII: Then handover to network 2 else handover to network 1.

IV. PERFORMANCE ANALYSIS

This paper introduces the technique to share the resources of different networks for this simulation is performed in vb.net platform on three different networks i.e wifi, wimax, zigbee calculated traffic load on each network & making vertical handover.

In results, simulation is performed to find bandwidth allocation, data rate, switching delay and signal to noise ratio for vertically handed over node.

Using such system, network resources can be shared optimally to improve the quality of service for end user.

The simulator is designed using vb.net platform to measure the spectrum manager performance and to design the cooperative network using centralized spectrum manager, the system consisting of the centralized spectrum manager and three different networks (Wifi, WiMax and Zigbee), nodes for different networks can be created by selecting the network type in the simulator, once the nodes are created the simulator calculates the network traffic on each network and display the result simultaneously.

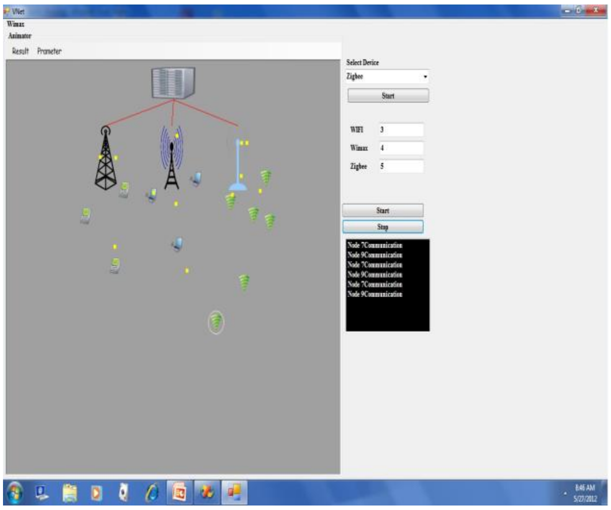

Fig 1: vertical handover

Now on increasing the number of end user on a network if the number of end user exceeds the network capacity, it is the condition of vertical handoff i. e the network for which the user is subscribe is heavily loaded and the network cannot provide the service to the newly generated request, here the vertical hand off take place as follows:

- If a network is heavily loaded and exceeds its capacity it is unable to provide service to new request.
- In this situation centralized spectrum find the network traffic load on rest of the two networks.
- New node is handed over to the network whose traffic load is minimum.

V. RESULTS ANALYSIS

Simulation is performed using vb.net platform on three different networks i.e wifi, wimax, zigbee calculated traffic load on each network and to find bandwidth allocation, data rate, switching delay and signal to noise ratio for vertically handed over nodes.

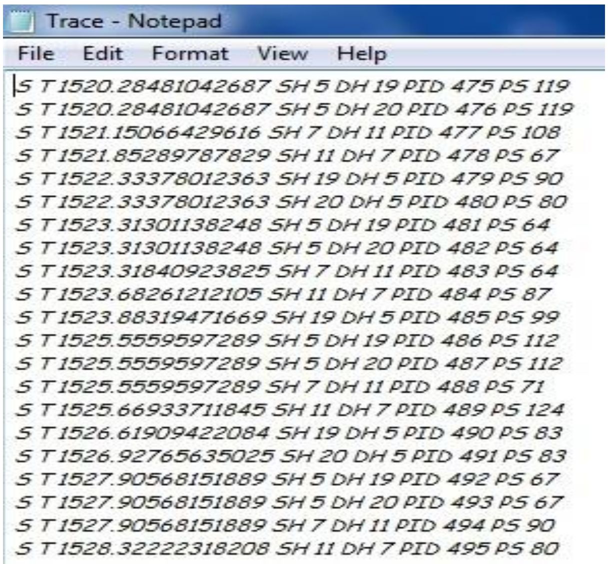
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Fig 2: Trace file

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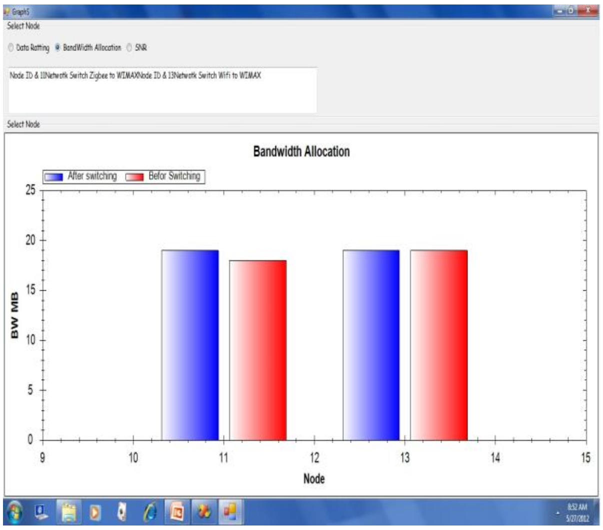
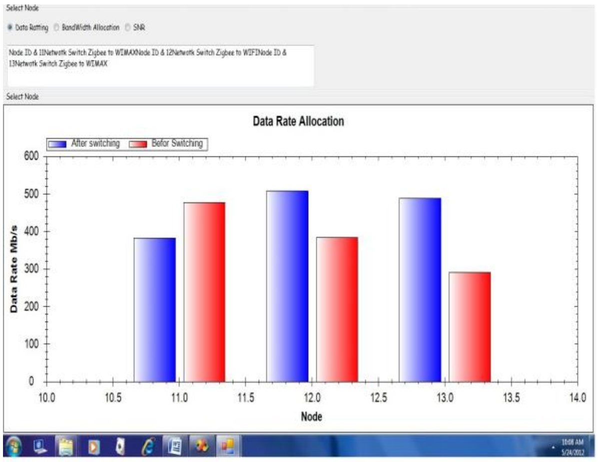
The trace file is generated while running the simulation trace file contains status of all the events taken place during the simulation, as we can see in figure 2. Trace file contains T for Time, SH as source host from which the packet is generated for sending, DH as destination host to which packet is to be send, PID as packet id it is the unique packet identifier and PS for size of packet. All the results are plotted according to the trace file.



Graph 1: Bandwidth Allocation

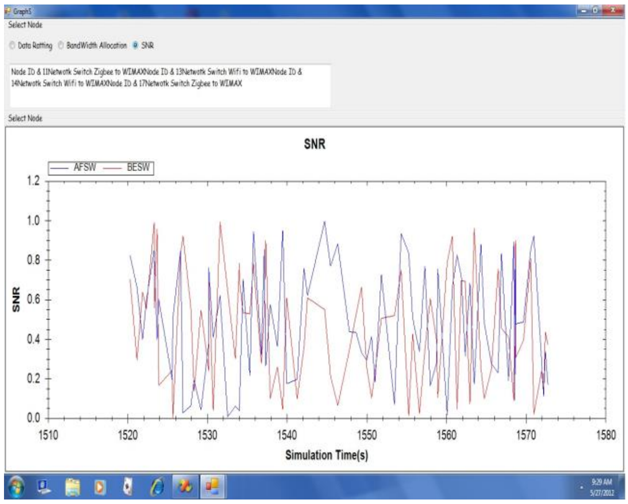
The bandwidth allocation graph is plotted for the vertically handed over node as vertically handed over node versus bandwidth.

node number 11 is handed over from zigbee to wimax and node number 13 is handed over from wifi to wimax, blue graph shows the bandwidth used by the node before handover and the red graph shows the bandwidth allocated after the handover, the bandwidth used by the node changes according to the network where the node is operating.



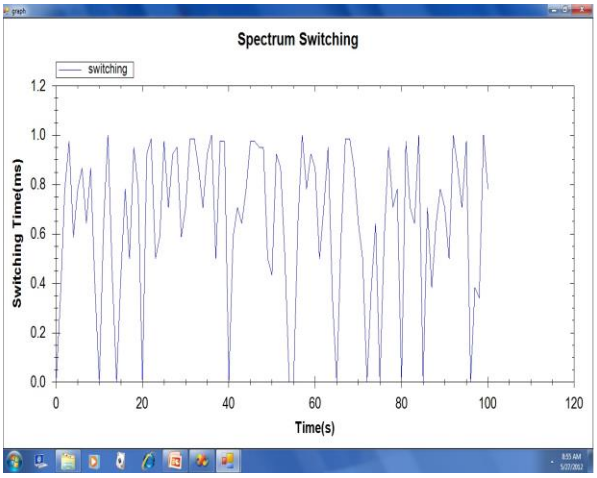
Graph 2: Data rate

The data rate allocation graph is plotted for the vertically handed over node as handed over node versus data rate, node number 11 is handed over from zigbee to wimax, node number 12 is handed over from zigbee to wifi and node number 13 is handed over from zigbee to wimax, blue graph shows the data rate of the node before handover and the red graph shows the data rate after the handover, the data rate of the node changes according to the network where the node is operating.



Graph 3: Signal to Noise ratio

As the nodes are switching from one network to another network the additive white Gaussian noise is added while switching this graph is plotted to find noise ratio, here node number 11 is handed over from zigbee to wimax, node number 12 is handed over from zigbee to wifi and node number 13 is handed over from zigbee to wimax, blue graph shows the signal to noise ratio before handover and the red graph shows the signal to noise ratio after the handover.



Graph 4: Spectrum switching delay

The data rate allocation graph is plotted for the vertically handed over node as simulation time (in seconds) versus spectrum switching time (in mili-seconds) , As the nodes are switching from one network to another network there will be the delay in switching as the delay is in mili-seconds the user can be seamlessly connect to the another network.

VI. CONCLUSION

The system consist the low complexity centralized spectrum manager which is the heart of the system, which seamlessly handover the end users to another network for providing QoS to user and maximize the global spectrum efficiency. It also helps to minimize the load unbalancing problem in co-operative networks.

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