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Reinforced Q learning for WiFi/WiMAX Network in Heterogeneous Environment

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Abstract

In wireless communication maintaining QoS is a very challenging issue .In heterogeneous environment WiFi & WiMAX technologies are integrated together. Integrating different technologies such as WiFi,WiMAX ,3G,4G,5G focuses to provide users with better (QoS)and seamless mobility.QoS is determined by throughput, end to end delay, jitter and packet loss. In any integrated heterogeneous network ,the user requirements are wide coverage, high bandwidth and access cost should be low. Proposed work uses Machine level algorithm as an intelligent technique to collaborate WiFi and WiMAX in heterogeneous environment. Due to dynamic operating system designers, Q algorithm eliminates the redesign of the existing network. It also maximizes the network utilization and also helps to design various machine learning results for various applications.

Keywords — **HetNet, Wi-Fi,Wi-Max ,Routing, Machine learning, Cellular networks, heterogeneous**

I .Introduction

In today's wireless technology no single network fulfils all conditions. Advancement in technology and up gradation of system design is the requirement of the era .Due to increased data capacity and multimedia traffic the network redesign is required to implement any new technology. Maximizing the network capacity and efficiently Utilizing the network resource with unbalanced traffic load parameters should be considered before designing the network. The user yields enhanced benefits from integrated technology. Integrating various technologies such as Wi-Fi and Wi-Max should provide users with better QoS and seamless handover. In wireless communication satellite and mobile communication are commonly used and are in focus with very high requirement of data capacity. Different technologies and different coverage areas play vital role.

Wireless fidelity (Wi-Fi) technology gives narrow area coverage and small-cell networks. It is available only in a smaller area called as hotspots. The worldwide interoperability for microwave access (Wi-Max) technology yields high data rate, wide area coverage, and built-in support for mobility and security [1]. Users give more priority to Wi-Fi than Wi-Max, because of its low cost and reduced power consumption. Recently, many developments are made in Wi-Fi and Wi-Max integration. The major aspect of Wi-Fi & Wi-Max integration is to handover the packet without any loss [2].Mobility produces handover data between Wi-Fi and Wi-Max technologies in a HetNet (heterogeneous network) environment. Major disturbances faced by handover process are unbalanced traffic energy of Wi-Fi and delivery through the access points (APs) and base station sub-system (BSS) covered by hotspot. There is high variation of traffic at Wi-Fi access points that fluctuates with time, as some AP are extensively used under traffic scenario but other AP remain free.

Each cellular node should have two connections, one is for Wi-Fi and another is for Wi-Max in cellular network. A group of overlying APs creates a Wi-Fi inside the Wi-Max coverage area. It creates number of Wi-Fi area inside Wi-Max area to enable Wi-Fi as well as Wi-Max. In Wi-Max coverage, BS can have more than one Wi-Fi spots. Multiple Wi-Fi spots shall cover the whole Wi-Max area. If there will be multiple data flow in the network, the unbalanced traffic load may occur. In this case, based on the priority, the Wi-Fi and Wi-Max split the data and transfers to the receiver for maintaining the Quality of Service. To avoid any lack in the quality of service, the bandwidth management algorithm is used to distribute the bandwidth properly across the networks by using AP and BS. Data flow control mechanism is designed in this paper to overcome the situation when more than one data flow in multiple paths with traffic scenario.

When a user switches from Wi-Fi to Wi-Max, the network should accommodate all the users and adjust in the given network automatically without any drop in QoS (long form) and QoE (long form). This paper aims to enlighten network capacity with balanced energy and handover that the users faced in the heterogeneous network. This paper also represents efficient distribution of unbalanced traffic load among APs or BSS. Sufficient reliability should be maintained as there is variation in receiver signal strength in Wi-Fi and Wi-Max networks.

ORGANIZATION OF PAPER

The paper is organized as follows. Section 2 contains prior related work to the proposed work. The proposed system is given in section 3. Section 4 provides the results and discussion of the presented system and section 5 concludes the paper.

2. RELATED WORK

The researchers have raised new motivation to migrate between Wi-Fi and Wi-Max technology in a HetNet environment, as load balancing mechanism allows maximum users to connect Wi-Fi and Wi-Max network [2]-[4]. It can be applied to any integrated network; however it does not specify any protocol design aspect. By using the IP layer, handover protocols transfer the data from WiFi to Wi-Max network and vice-versa [5]-[6]. The cellular stack communication transfer protocol helps in data handover policy [7]-[8]. Many processes should be performed before a node establishes link layer connectivity to Wi-Fi or Wi-Max network [9]-[10]. Wi-Fi and Wi-Max have defined MAC as contention-free layer [11]-[12].

A framework that combines IEEE 802.11 WLANs and IEEE 802.16 WMANs on the basis of the IEEE 802.21 is proposed in [13]. This framework is known as media independent handover (MIH). The MIH is capable of performing handover in both homogenous as well as heterogeneous networks. This technique minimizes the service distribution time (SDT). The user centric network selection decision scheme is proposed in [14]-[15]. In this scheme, the users and the network operators negotiate with each other based on the game theory technique. It is developed on the basis of IEEE 802.21 standard and used for analysis of the utility function of the users as well as network operators. The protocols used in this scheme are the session initiation protocol (SIP) and mobile internet protocol (MIPv6) [16]. The IEEE 802.21 MIH framework is further improved for the heterogeneous wireless networks in [17]. A network component called as handover agent (HA) is included in MIH framework to simplify the handover process by reducing overheads involved in the mobile node. This provides aweless vertical handover in the mobile nodes. This framework provides solution to many issues faced in heterogeneous networks like the context-aware handover, load balancing and signaling overhead [18]-[19].

The system presented in [20]-[21] provides an enhanced handover decision mechanism. This mechanism uses features which take into account the mobile node status and conditions of the network at the time of handover decision. The network performance is enhanced due to minimized unwanted handovers by avoiding the ping pong effect. An enhanced MIH architecture which performs vertical handover between wireless heterogeneous networks is developed in [22]. This architecture design shows interoperation between WLAN and LTE network by using MIH signaling to indicate accurate vertical handover process. In [23]-[24], a dynamic multiple attribute decision mechanism is presented on the basis of the priority of traffic classes for constant bit rate (CBR) and variable bit rate (VBR). In this mechanism, handover is the IEEE 802.21 MIH standard.

3. PROPOSED WORK

Integrated Wi-Fi and Wi-Max Network in a Heterogeneous environment is a distributed network consisting of set of resource constrained devices. These devices are called as nodes or motes [1]. Each node consists of three subsystems i.e. sensor subsystem, processing subsystem and communication subsystem. Sensor subsystem senses the information from environment, processing subsystem performs local computation on sensed information and computational subsystem exchanges information with other nodes [2].

The aim of machine algorithm is to send any types of information, multimedia data to all nodes and minimizing failure rate of vertical handoff and increasing the throughput of existing system. In the controller machine learning algorithm is running.

Based on traffic type, mobility of the terminal, network load conditions. Reinforcement Learning (RL) is a machine learning algorithm are autonomous for various network access environment. It enables an agent to learn which actions it can take when it is executing a task in order to maximise a long-term reward. A RL based routing algorithm requires little information about its environment and it is able to adjust its routing behaviour to dynamical conditions during the network's lifetime.

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3.1 Reinforced Learning Algorithm Strategy

A learning algorithm has two customizable parameters, the learning rate and the discount factor . The learning rate determines how important newly acquired information is, a value of 0 discards new information, resulting in the agent not learning anything, while a value of 1 result in an agent only considering new information. The discount factor determines how important estimated future rewards are. A discount factor of 0 results in a very opportunistic behavior considering only immediate rewards while a value approach 1 results in an agent attempting to maximize the long term reward.

The reinforcement machine learning algorithm has the system of learning ability. It becomes the agent. It has the control strategy by interacting with the controlled environment. The basic learning models are of following elements. The agent checks the environment state each time and decides

1) The Set of possible state s={s1,s2,...,sm}

2) The set of possible action a={a1,a2,...,an}

3) Reward (payoff)r

4) The strategy of agent π: S→a

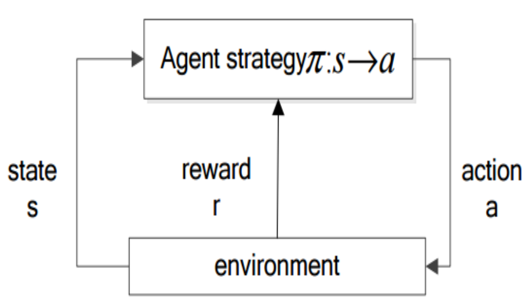

Figure1. Reinforcement Learning (RL) scenario

In Figure 1.we show that for Network selection, Q learning agent will update the strategy according to the change in network each time.

$$Q_{t+1}(s,a) = (1-\alpha)Q_t(s,a) + \alpha(r_t + \gamma \max_{a' \in A} Q_t(s',a')) \quad (1)$$

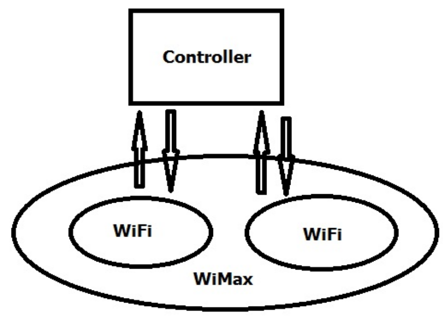

Figure 2.Wi-Fi/Wi-Max Integrated Environment

In figure 2, we show that it is an integrated environment of Wi-Fi and Wi-Max environment. In the controller the decision strategy algorithm is implemented .In order to learn decision strategy; the agent will select probability based on stored Q values. The value of Q is obtained from Q value table depending on the state and the network .The decision will be selected with maximum reward value. After transition the next state of Q-values will be updated using equation (1).

The algorithm procedure

1) Initialize Set Q=0, discount factor γ, the initial learning α_0 and initial probability exploration ε_0.

2) Acquire the current state s. The controller will collect the related state used in each network, traffic type and bandwidth request.

3) The agent will choose an action to perform depending on action function of current state $Q_1(s,a)$,based on ε-greedy state.

4) Obtain reward r and the sate s' of next instant. The reward value is 0 if session request is rejected by the network.

5) Update (s,a)according to equation(1)

6) Update the parameters after each iteration of learning rate α and exploring probability ε must be updated as per the need of the network. The two parameters are set to reduce to 0 according to a function inverse to learning process.

7) Return to2.

In this reinforcement learning scenario, is based upon a learned agent taking an action and interpreting its reward whether migrate to Wi-Fi or Wi-Max Environment .The reward maximizing is a representation of various state environments and is also a feedback to the agent. The feedback of the agent decides upon the parameter of receiver signal strength of Wi-Fi and Wi-Max Network cluster. Due to various technologies different traffic scenario and various states are involved during handover.

4. SIMULATION RESULTS

The reinforcement is a model free technique and discovers the most favorable action selection policy for any given time .It is based upon iterative algorithm of various environments ,moving to new state S_{t+1} and reward r_{t+1} and correlated with transformation of next states.

This paper considers the session of real and non-real data traffic that are uniformly and non uniformly distributed. The QoS parameter is in terms of throughput, Packet delivery ratio and delay is plotted. The proposed machine level algorithm uses intelligent technique to collaborate Wi-Fi and Wi-Max in heterogeneous environment. Due to dynamic operating system designers, machine level algorithm eliminates the redesign of the network. Proposed Intelligent reinforced mechanism is analyzed with the existing handover technique.

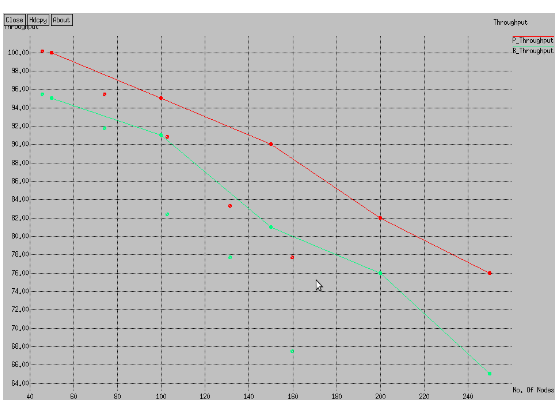

Figure 3 .Throughput comparisons for different number of nodes

Figure-3 shows that the different throughput values in cellular nodes. Throughput defines the output of how much speed (KBPS) the packet is delivering to the destination. The proposed work gives best throughput values in a high speed comparing with other protocols

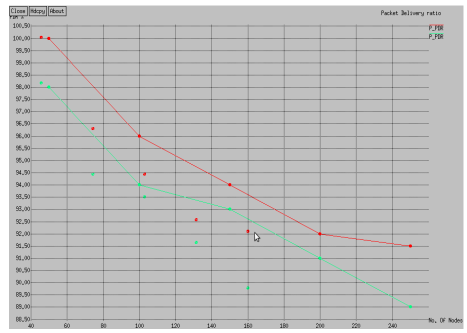

Figure 4. Packet delivery ratio comparisons for different number of nodes

Figure 4 shows that the different packet delivery ratio in cellular nodes. Packet delivery ratio delivers the output of number of packets delivering to the destination in terms of percentage. The proposed intelligent reinforced learning mechanism gives the transmission of data from the source to the destination without any packet loss and in a high speed when compared with other protocol.

Conclusion

This paper aims to enlighten Wi-Fi/Wi-Max network in heterogeneous environment based on the transmission range with dynamic bandwidth. Proposed work provides seamless handover to balance the multimedia traffic. In addition to this algorithm can also provide the best throughput values in a high speed, without any delay and packet loss. This paper proposes a dynamic selection strategy in heterogeneous wireless network based on reinforced learning .It is autonomous for network access and adaptable for real and non real traffic network environment.

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