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Relocation Strategies in 802.16 Heterogeneous Networks

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Abstract

IEEE 802.16-series are expected to provide broadband wireless access for a variety of multimedia services. The WiMAX Forum has defined a two-tiered mobility management to minimize handover delay and packet loss. The standards only define the Access Service Network Gateway ASN GW relocation procedures without specifying when the ASN GW relocation should be performed. So to address it previously Gateway Relocation Admission Control (GRAC) was developed, which combines ASN GW relocation and Admission Control (AC) algorithm to maximize system capacity. GRAC incorporates traditional Admission Control (AC) and Wiener Process (WP)-based prediction algorithms to determine when to carry out ASN GW relocation. Unfortunately, it is suitable only for Inter-ASN communications because of the inability to support vertical hand off communications (heterogeneous networks). The decision for vertical handover depends on many factors (cost, load, network bandwidth, coverage, security speed, power consumption etc.) that need to be considered together with the signal strength in the complex heterogeneous wireless environment. Therefore, we propose to use a vertical handover decision algorithm based on the user's speed and session's priority (non-real-time or real-time service) of the mobile nodes. Delivers had better channel utilization and preserves QoS requirements of the mobile subscribers and a practical implementation validates our claim.

Keywords: *Access Service Network, Gateway Relocation Admission Control, Wiener Process, Vertical handover decision algorithm*

1. Introduction

The IEEE 802.16-series standards are expected to provide broadband wireless access for a variety of multimedia services. IEEE new standard based on Broadband Wireless Access (BWA) systems, Worldwide Interoperability for Microwave Access (WiMAX) is an air Interface for Fixed BWA Systems validated by IEEE as a Wireless Metropolitan Area Network (WMAN) Technology. IEEE 802.16 working group standardizes physical (PHY) layer and Medium Access Control (MAC) layer only. IEEE 802 splits the OSI Data Link Layer into two sub-layers namely Logical Link Control (LLC) and Media Access Control (MAC). One of the major objectives of WiMAX Forum is to develop and standardize the WiMAX Forum Network Architecture that is evolving into Internet Protocol (IP)-based wireless network [3]. As shown in the fig.1 the Access Service

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Network (ASN) provides wireless radio access for WiMAX subscribers. The WiMAX Forum has defined a two-tiered mobility management:

- **ASN Anchored Mobility**

  It refers to the procedures associated with the MS's movement between BSs that belong to the same or different ASN GWs.

- **CSN Anchored Mobility**

  It refers to the process of changing the traffic anchor point, is independent of the MS's link layer handover, and referred as ASN GW relocation.

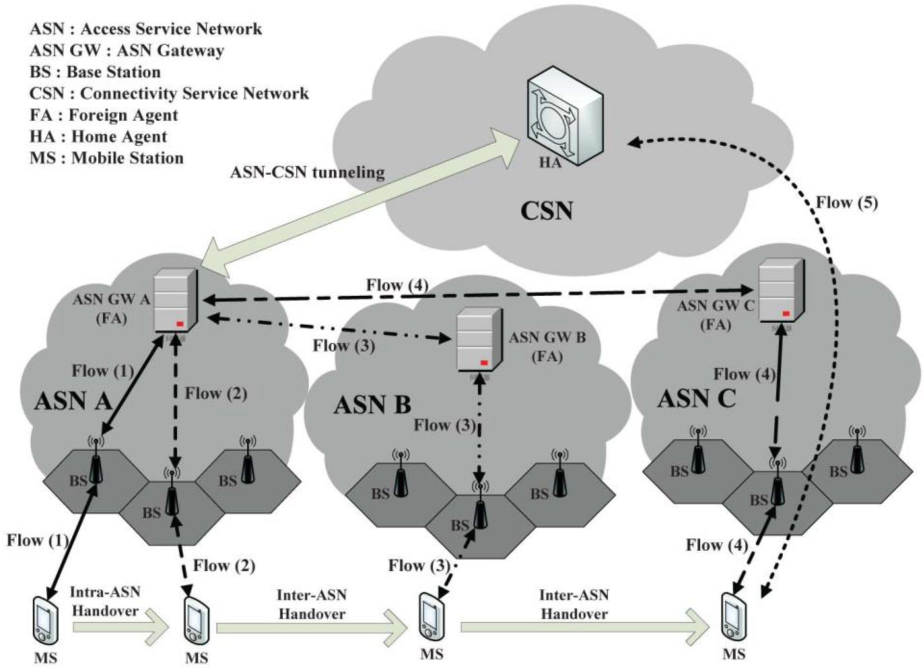

Figure 1. ASN Anchored Mobility and CSN Anchored Mobility in WiMAX Networks

It consists of one ASN Gateway (ASN GW) and many base stations (BSs) and each ASN is connected to Connectivity Service Network (CSN), which provides IP connectivity services. The Home Agent (HA) of a Mobile Station (MS) is located in the CSN of the MS's Home Network Service Provider (H-NSP). IEEE 802.16 standard defines two possible network topologies - PMP (Point-to-Multipoint) topology and Mesh topology or Mesh mode. Although the two-tiered mobility management defined in WiMAX potentially can minimize handover delay and packet loss. The WiMAX standards define the procedures for ASN Anchored Mobility and CSN Anchored Mobility. We propose Gateway Relocation AC (GRAC), which combines ASN GW relocation and AC algorithm to maximize system capacity. The AC algorithm cooperates with the ASN GW relocation, when a new MS arrives and there is no resource for the newly arrived MS. We develop an analytical model to investigate the performance of the proposed GRAC. The contributions of this paper include:

- The proposed GRAC provides a systematic way to solve the problem effectively.
- The proposed GRAC is fully compatible with the WiMAX standards and can be used with other AC algorithms.

- We derive the performance bounds mathematically and show that the performance of the proposed GRAC approaches the lower bound.

2. Related Work

Many issues in mobile WiMAX have been studied [1-2, 5-6]. In [1-4] the authors provide an overview of the WiMAX technology and WiMAX network architecture. The authors discuss the mobility management in WiMAX networks and several optimization procedures for ASN Anchored Mobility management. In [5] the author proposes a fast intra-network and cross-layer handover protocol to support fast and efficient handover in WiMAX. A seamless IP mobility scheme is proposed and evaluated in the flat architecture of WiMAX networks. In [7], the authors propose an analytical model to study the cost of Anchor Paging Controller (APC) reassignment in ASN GW for location update. The two-tiered mobility management defined in WiMAX is similar to that in Hierarchical MIP (HMIP) [8]. The multiple levels of FA hierarchy can reduce handover latency and localize the MIP signaling traffic. Distributed dynamical regional location management to determine the size of a regional network based on the MS's traffic load and mobility patterns. Each MS dynamically determines the hierarchy of FAs according to the call-to-mobility ratio. In WiMAX, an MS is served at most by two ASN GWs (FAs) simultaneously due to the specific two-tiered mobility management procedures. The Serving Radio Network Controller (SRNC) relocation is discussed for the Universal Mobile Telecommunications System (UMTS). The SRNC in UMTS networks is similar to the ASN GW in WiMAX. When an MS no longer connects to the BS under the RNC then serving the MS currently, SRNC relocation is immediately initiated by the new SRNC. In WiMAX, the MS only performs ASN Anchored Mobility because of both ASN Anchored Mobility and CSN Anchored Mobility is performed simultaneously. The MSs may also need to perform both ASN Anchored Mobility and CSN Anchored Mobility during an inter-ASN handover. When performing ASN GW relocation the load of the anchored ASN GW is reduced but the load of the serving ASN GW is not affected. Admission Control (AC) is one of the resource management techniques to limit maximum amount of traffic in the network to guarantee service quality for subscribers. An MS served in current network may move to another network. Connection of the MS may be dropped if the required resources in the target network cannot be supported.

In the cutoff priority algorithm both new MS and handover MS can be admitted if the total number of new MSs and handover MSs in the network is equal to or less than a predefined threshold (Tcp). Once the number of new MSs and handover MSs in the network reaches Tcp then new MS is blocked. Once the total number of MSs exceeds C, handover MSs are dropped. The handover MSs use the resources in C - Tncp first. The number of new MSs is always less than Tncp or the remainder resources the handover MSs have not used. In the cutoff priority algorithm a newly arrived MS will be blocked and a handover MS will be admitted. The ideas are similar although they may have different names. Due to the specific mobility, two ASN GWs may serve management techniques in WiMAX an MS simultaneously. When two ASN GWs serve many MSs in the system, then a newly arrived MS or handover MS may easily be blocked or dropped by the AC algorithm. In our scheme two vertical handover, decision schemes (VHDS) [9]:

- Distributed handover decision scheme (DVHD)
- Trusted Distributed vertical handover decision schemes (T-DVHD)

DVHD is advanced than the centralized vertical handover decision scheme and TDVHD is the extended work of DVHD [11]. We compare the distributed and trusted vertical handover decision schemes as distributed decision tasks among networks to decrease the processing delay caused by exchanging information messages between mobile terminal and neighbor networks. Distributed vertical handover decision (DVHD), Centralized vertical handover decision (CVHD), Trusted Distributed vertical handover decision (T-DVHD) are the schemes used to reduce the processing delay between the mobile node and neighbor network while exchanging the information during the handover.

3. Existing System

IEEE 802.16-series are expected to provide broadband wireless access for a variety of multimedia services. Like other IEEE 802-series standards, IEEE 802.16 working group standardizes physical (PHY) layer and Medium Access Control (MAC) layer only. To build a complete system, higher layers are still necessary. One of the major objectives of WiMAX Forum [10], thus, is to develop and standardize the WiMAX Forum Network Architecture, which is evolving into Internet Protocol (IP)-based wireless network. The architecture consists of the Access Service Network (ASN) providing wireless radio access for WiMAX clients. The ASN consists of one ASN Gateway (ASN GW) and many base stations (BSs). Each ASN is connected to Connectivity Service Network (CSN), which provides IP connectivity services. To support IP mobility, Mobile IP (MIP) is adopted. The Home Agent (HA) of a Mobile Station (MS) is located in the CSN of the MS's Home Network Service Provider (H-NSP). The WiMAX Forum has defined a two-tiered mobility management to minimize handover delay and packet loss:

- ASN Anchored Mobility
- CSN Anchored Mobility

The standards only define the ASN GW relocation procedures without specifying when the ASN GW relocation should be performed. It is left for vendors and operators to develop their own proprietary solutions leading to in-coherent mobile client handoffs between base stations leading to disruptions and loss of signal. A better system is required that can support automated ASN GW relocation procedures to support mobile client handoffs between base stations efficiently.

In Gateway Relocation AC (GRAC), which combines ASN GW relocation and Admission Control (AC) algorithm to maximize system capacity? GRAC incorporates traditional Admission Control (AC) and Wiener Process (WP)-based prediction algorithms to determine when to carry out ASN GW relocation. When a new Mobile subscriber(MS) arrives and there is no resource for the newly arrived MS, the proposed GRAC will request an Anchored MS to perform ASN GW relocation if there are Anchored MSs in the system. Simulations are also conducted to evaluate the performance of the proposed algorithm. The results show that the proposed algorithm can improve the performance significantly in terms of blocking probability, dropping probability, average serving rate, and average signaling overhead leading to better communication in 802.16 networks. This is suitable only for Inter-ASN communications because of the inability to support vertical hand off communications (heterogeneous network). A better system is required that can support both vertical and horizontal handoff models yet offering the same performance.

4. Proposed Method

Previously, we use Gateway Relocation AC (GRAC) that combines ASN GW relocation and Admission Control (AC) algorithm to maximize system capacity. GRAC incorporates traditional Admission Control (AC) and Wiener Process (WP)-based prediction algorithms to determine when to carry out ASN GW relocation. Simulations are also conducted to evaluate the performance of the existing algorithm. A better system is required that can support both vertical and horizontal handoff models yet offering the same performance. Hence, we propose vertical handover decision algorithm based on the user's speed and session's priority (non-real-time or real-time service) of the mobile nodes. We use the IEEE 802.21 standard as a layout for implementing the algorithm.

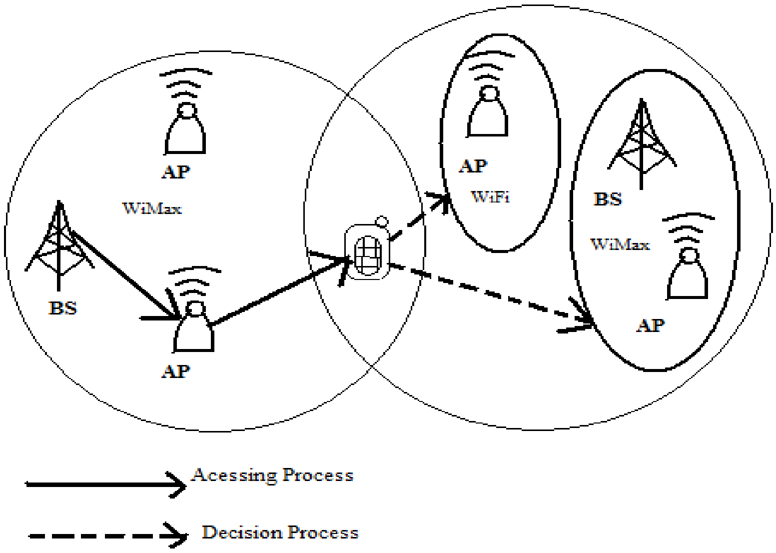

Figure 2. Scenario of Vertical Handover

The vertical handover decision strategy is a key factor in the handover management of the heterogeneous wireless networks. The decision for vertical handover depends on many factors (cost, load, network bandwidth, coverage, security speed, power consumption etc.) that need to be considered together with the signal strength in the complex heterogeneous wireless environment. As shown in the Figure 2 it explains that a cell coverage the area by WiMax technology and another cell coverage the area by WiFi and WiMax technology. The mobile terminal is overlapping with VoIP application between the cell coverage now mobile terminal intend to connect the appropriate visited network with the decision process.

5. Vertical Handover

Applying the algorithm, we achieve better channel utilization when using WiMAX/WLAN networks while still satisfying the QoS requirements of the users. As shown in the fig.3 our proposed vertical handover decision is simulated. Here initially it starts with the mobile node with the WiMAX interface, and then it starts the detection of the new interface of the WLAN. Then calculate the speed of the mobile node (let as 'v'). Then compare the speed of the mobile node with the threshold value. If the threshold value is greater than the mobile speed then the scenario of the bandwidth is compared. Else, it remains with the current/same interface. If the bandwidth scenario, session bandwidth is greater than the available bandwidth then the mobile node stays with the current interface. Else, it moves to the session priority. If the session has lower priority then it connects with the newly detected interface. Else, it stays with the current/same interface.

5.1. Algorithm of Vertical Handover

Algorithm: Vertical Handover Decision
Requirements: A new Handover MS, wlan Interface, WiMax interface

1. Mobile node starts with the current WiMax interface.

2. Detect the WLAN interface to handover the Mobile node.
3. Calculate the speed of the mobile node (say 'V').
4. Compare 'V' over 'T' *i.e.* (V<=T), then move to step 5 //T = Threshold Value of the interface.
    a. Else, move to step 7
5. Compare Session Bandwidth (SB) over the Available Bandwidth (AB) i.e. (SB<=AB), then move to step 6.
    a. Else, move to step 7
6. Check the priority of the session, if priority is low, then it moves to connect to the newly detected interface.
7. Else remains to current interface.

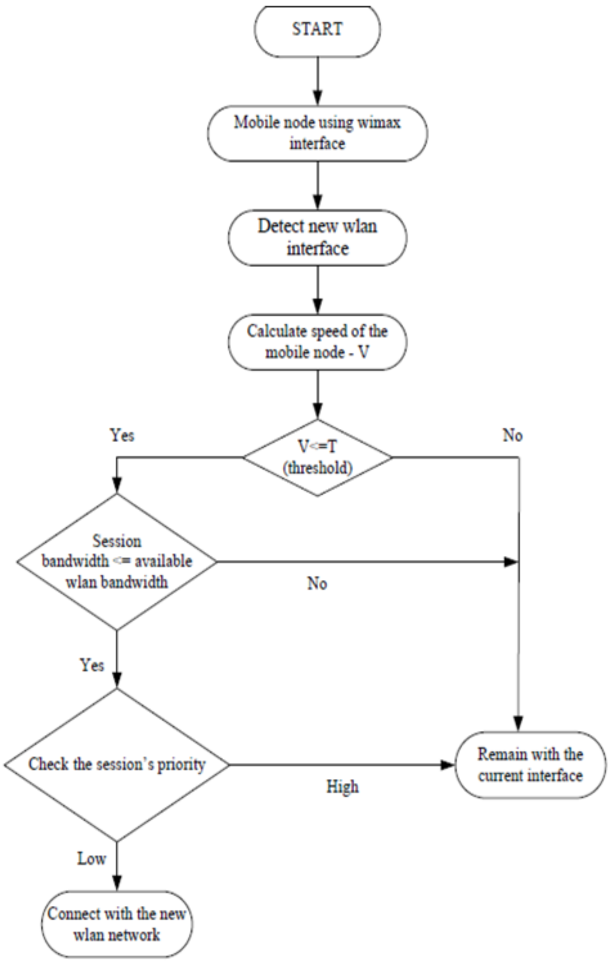

Figure 3. Proposed Vertical Handover Decision Algorithm

6. Simulation Results

We propose an analytical model to investigate the performance of the proposed algorithm. We assume each ASN GW has two arrival processes, which are Poisson distributed with rate n and h for new MSs and handover MSs. To analyze the GRAC three major factors to be considered

- The number of Serving MSs
- The number of handover MSs
- The number of Anchored MSs

The computational complexity of a 3-D Markov chain will be increased dramatically when the number of MSs in the system becomes large. We calculate the upper bound and lower bound of the proposed GRAC. We aim at getting the upper and lower bounds, the WP-based prediction algorithm are irrelevant to the mathematical analysis. The traditional AC algorithms cannot be used directly when the two-tiered mobility management is deployed in WiMAX because some MSs may be served by two ASN GWs.

In this paper we simulate the results of processing Asynchronous processing results with simulative data processing in commercial event management. We simulate the results of each processing unit for exploring data from one mobile node other mobile node transmission efficiency in data sending from one to other network processes.

Construction of ACN GW Network: By using technical language specification in real time application development, we construct an efficient network that contains different ACN networks for signal accessing. We release different mobile nodes for transferring data from various feature processes between commercial event management progressions. And then we process different mobile nodes in ACN networks. Simulation can be done in between different process generation in mobile node data transmission efficiency which includes different processing units with semantic data relations in commercial event management between each mobile data transmission.

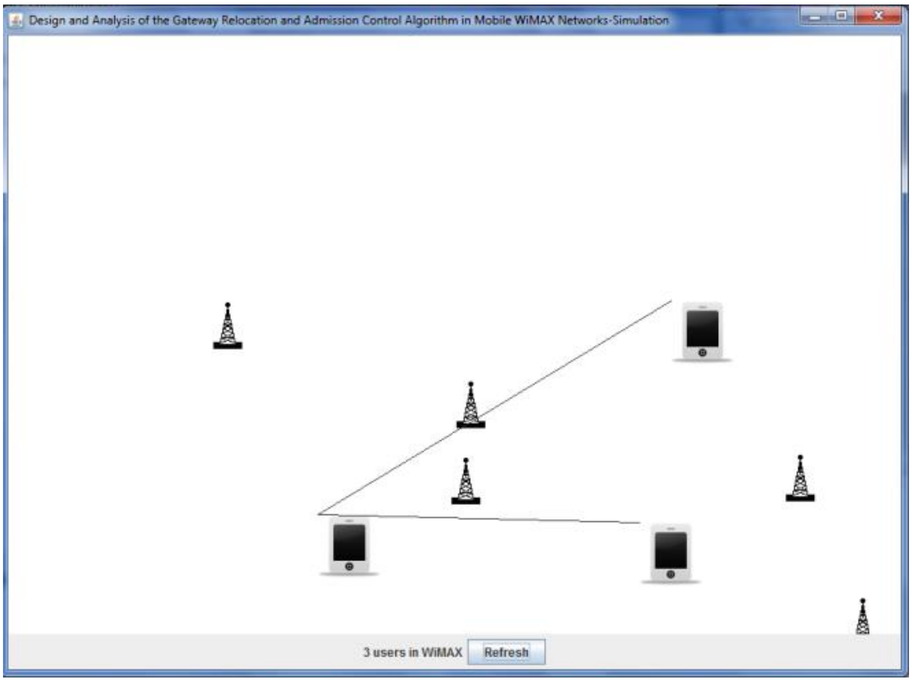

Figure 4. Gateway network Progression for each ACN Specifications

As shown in the above Figure 4, it process the systematic data event management specification between different ACN network data transmissions with including data transmission for transferring data in the form of efficiency processing between each network specification. Mobile nodes are also move in the data transmission processing commercial event management progression for data transmission between each mobile node data transmission.

If mobile node1 is going to nearby ACN network, it identifies automatically on that particular node data transmission from one to other ACN networks.

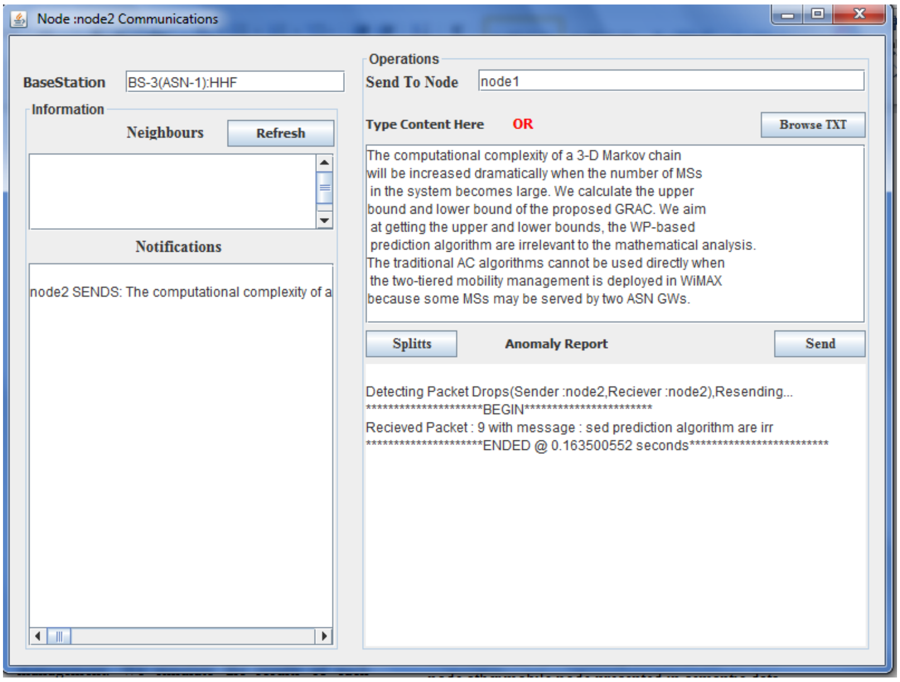

Figure 5. Data Transmission from One to Other Mobile Nodes

If we send data from one mobile node to other mobile node presented in semantic data process, Data was split into number of packets present in the network data transmission. If any packet is not received by the other mobile node then the system automatically invites processing system application development in data transmission from one to other mobile nodes presented in ACN network data transmission process.

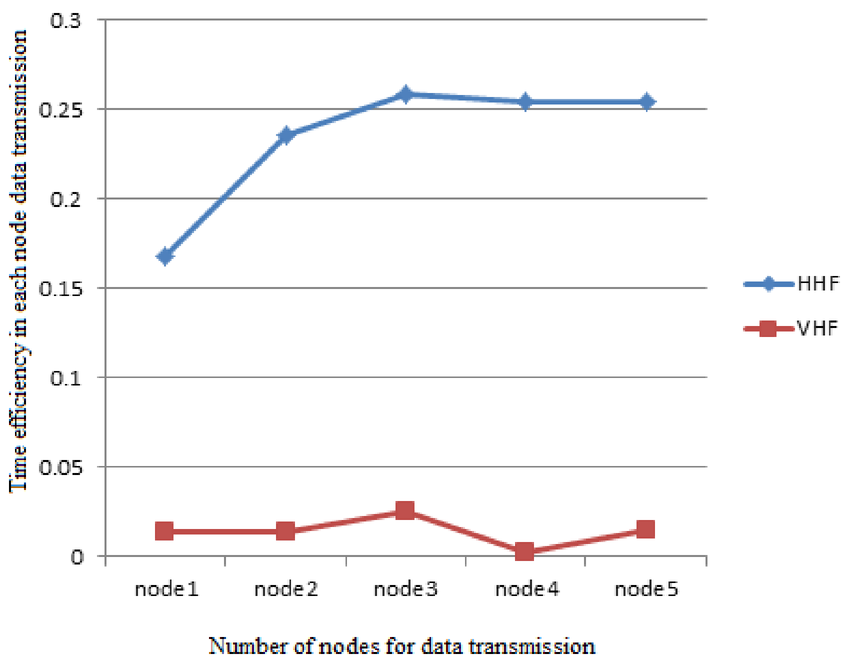

Figure 6. Experimental Results of Data Transmission in ACN Network Using Relative Admission Control Algorithm Specification

Data transmission can be done using the relative path in ACN network process generation in gate way application frame work network progression. In this requirement specification of processing data from one to other mobile node specification we transfer data from other specifications presented in the commercial event data transmission. In this paper we propose to admission control algorithm with vertical handover decision algorithm for transferring data from one to other mobile node specifications. Figure 6 shows best efficient processing between every user specifications in data transmission from one to other mobile nodes with commercial event management with suitable processing in each node, vertical decision handover in commercial event processing between each mobile node. Our experimental results show efficient data transmission in different processing of each mobile node.

7. Conclusion

We consider that the system load is heavy. We propose GRAC, which considers admission control and ASN GW relocation jointly to improve the performance of WiMAX networks. In the proposed GRAC, the AC algorithm cooperates with the ASN GW relocation. We develop an analytical model to investigate the performance of the proposed GRAC. Extensive simulations are also conducted to validate the analysis and evaluate the performance of the proposed GRAC. We have compared the schemes of vertical handover decision in the heterogeneous wireless networks. The observation of the schemes to reduce the processing delays and a trust handover decision is done in a heterogeneous wireless networks. Our main goal is in the decision phase of the handover phases to take decision to which VN the mobile terminal to connect by different decision algorithms.

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