NETWORK TRAFFIC LOAD BASED HANDOFF ALGORITHM (NTL-HA) FOR GGSN-BASED TIGHT COUPLING ARCHITECTURE

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ABSTRACT: *Nowadays the attention of the standardization bodies and research groups is shifting towards the integration of wireless access networks such as, the UMTS and Wireless LAN networks. These networks show complimentary characteristic to each other by avoiding the weakness of each individual network. Therefore, the integration of these networks can come up with the better performance. The support of smooth call connectivity and effective resource management is the cores issue in the heterogeneous network platform. Therefore, in this paper the Network Traffic Load based Handoff Algorithm (NTL-HA) for GGSN-based Tight coupling Architecture is introduced. The NTL-HA use the advance handoff algorithm, in which the network load is regarded as the key parameter for the network selection. The NTL-HA can successfully improve the network performance in terms of the average-user throughput of data users, the end-to-end delay of voice users, furthermore decreases wrong handoff probability and wrong admission probability of wireless users in comparison to the existing tight coupling architecture (ETCA).*

Keywords: UMTS and Wireless LAN; interworking architecture; handoff algorithm

1. INTRODUCTION

The focus of the Next Generation Wireless Network is to make the handoff possible among the dissimilar wireless networks, without service degradation or interruption [1,2] as well as to reuse the prime part of the existing network infrastructure [3]. The internetworking architecture can be divided into loose, tight and very tight coupling [4,5, 6]. The very tight coupling mechanism (VTCM) can satisfy the condition of the seamless handoff, whereas it is the most complex technique [6]. Despite the loose coupling mechanism (LCM) is the simplest technique, however suffers from high handoff delay and packet loss [7]. On the contrary, the tight coupling mechanism (TCM), can support the moderate handoff delay and network complexity [8,3]. TCM can be further sub-divided into GGSN-level TCM (GTCM) and SGSN-level TCM (STCM) [9].

In [10], the authors present the GTCM architecture, in which the new entity serving GPRS access router (SGAR) is introduced to make network compatibility. The author can reduce the network complexity, however the handoff delay is still high. In [11], the cellular and Wireless LAN networks are integrated using STCM. The Wireless LAN Adaptation Function (WAF) is introduced in the MS, and the reciprocal GPRS Interworking Function (GIF) is introduced in the core network. However neither simulation nor experimental results are provided for validation. In [8],

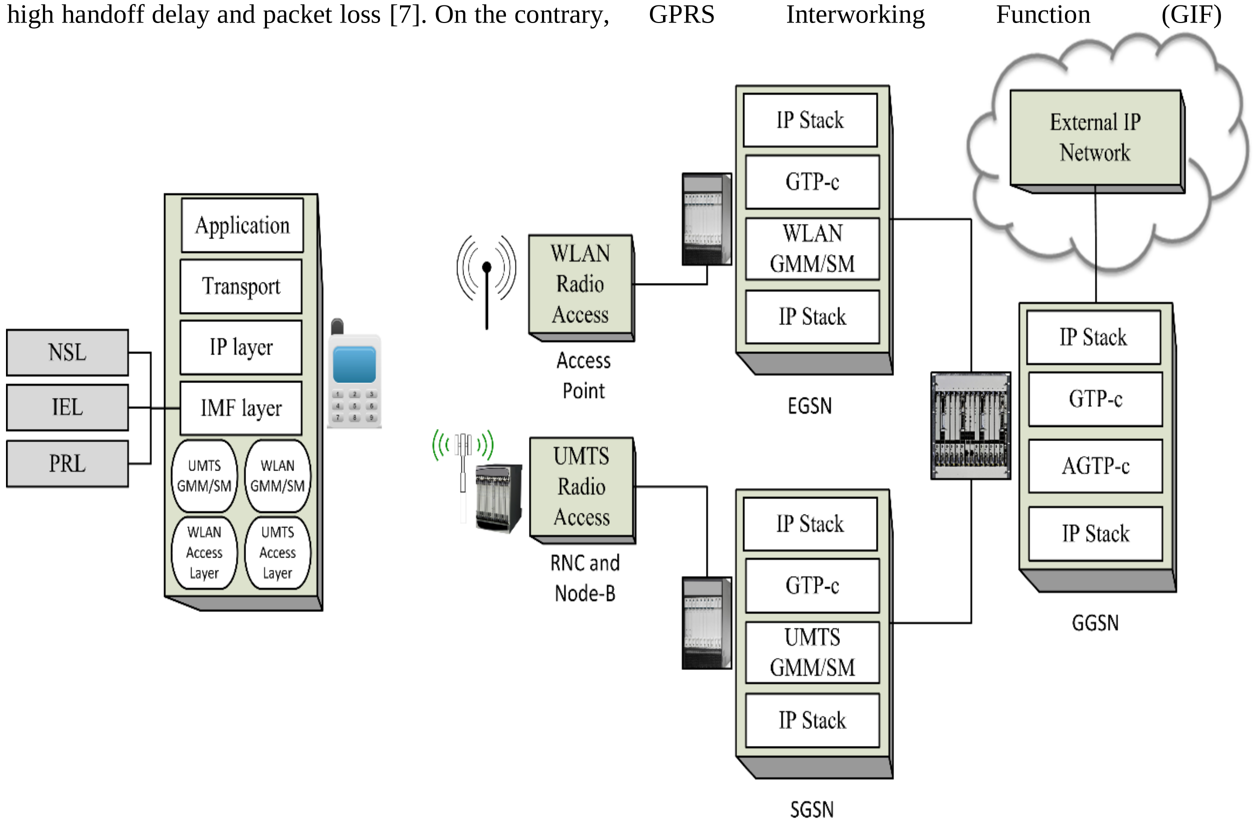

Fig # 1. Proposed GGSN-based Tight coupling Internetworking Architecture

the STCT architecture is used, the aim of this work is to reduce the handoff delay. However, no other parameters are being considered during the handoff.

The contribution of this paper is two-folded. On the one hand, "Network Traffic Load based Handoff Algorithm (NTL-HA)" is introduce. While, on the other hand, "GGSN-based Tight coupling Architecture (GTCA)" is also presented. The NTL-HA considered the network traffic load as the major parameter in order to improve the network performance in terms of average-user throughput for data services, end-to-end delay for voice over IP (VoIP) users and probability of wrong handoff during the handoff.

2. PROPOSED GTCA ARCHITECTURE

The proposed internetworking architecture is illustrated in the above Fig # 1. Some new entities and functions are necessary to setup the integrated network, such as, Enhance GPRS support node (EGSN), Artificial GTP layer (AGTP), Multi Interface Mobile Device (MIMD).

2.1 The Enhance GPRS support node (EGSN)

It is the communication bridge between the two networks. The EGSN links the Wireless LAN users to the UMTS GGSN, whereas its operations can be classified as:

- ***Core network connectivity*** emulates the SGSN operations to communicate with the UMTS GGSN.
- ***Access network connectivity*** communicates with the Wireless LAN AP.
- ***WLAN-GMM/SM*** provide the compatibility between the two networks and deals with the GMM/SM functions.

2.2 Artificial GTP (AGTP)

The AGTP resides in the GGSN and it communicates with the existing standard GTP-c module of the EGSN, SGSN and GGSN. Both GTP of SGSN (GTP-S) and GTP of EGSN (GTP-E) communicate with the AGTP instead of GTP of GGSN (GTP-G), while assuming it is a GTP-G. On the other hand, the GTP-G communicates with the AGTP, while considering it is either GTP-S or GTP-E. With the help of AGTP the handoff delay can be decreased significantly.

2.3 Multi Interface Mobile Device

The Multi-Interface Mobile Device (MIMD) is introduced with advance call switching mechanism. The MIMD is equipped with the WLAN-MM layer, in order to handle the PDP context procedure towards the Wireless LAN network, Moreover for handoff and packet routing intelligence, the Convergence and Multi-Functional (CMF), layer is introduced after the IP layer. The CMF is sub divided into: (a) *Connection Initiation and Execution Layer (CIE)* initiate the new or handoff call process by sending the PDP Activate Request (PAReq), to the UMTS or WLAN MM layer. (b). Packet Routing Layer performs the data routing from the higher layer to the active network access layer and vice versa.

3. NTL-HA

The proposed algorithm has been illustrated in Fig # 2. The focus of the propose algorithm is to measure the effect of the network traffic load (NTL) to enhance the performance of the call. Hence, it is assumed that the MIMD either activate a new call in the coverage of both UMTS and Wireless LAN network (CUWN) or the roaming MIMD with an active call with UMTS network enters in the CUWN region from the coverage of only UMTS network (CUN).

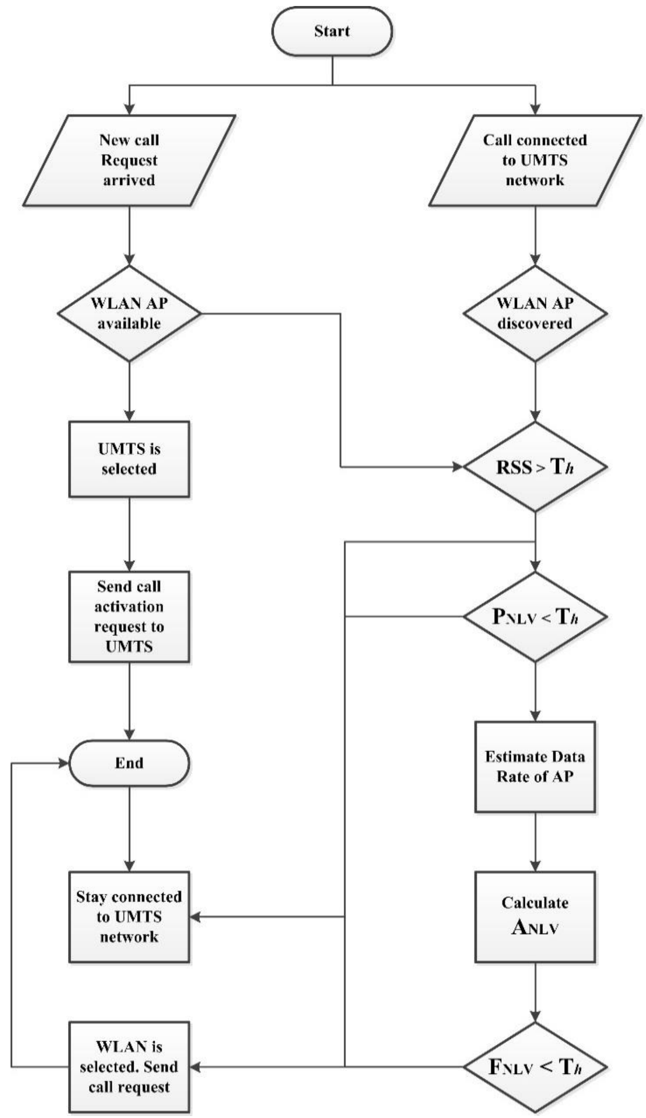

Fig # 2. NTL-HA based admission algorithm

Prior to the initiation of both the new and handoff call the network will be evaluated with the help of the proposed NTL-HA algorithm. The Wireless LAN Access Point (AP), transfer its network traffic load (NTL) within the periodic beacon messages.

The MIMD extracts the NTL from the beacon message and compare the present NTL (P_{NLV}) value with the threshold NTL (T_h) value. In the subsequent step the MIMD calculates the data rate of the AP with respect to the available SNR (Signal to Noise), value from the AP. Now the increased NTL (I_{NLV}) due to the requested call will be calculated, using the available data rate. Now in order to accept the call the sum of I_{NLV} and P_{NLV} i.e. final NLV (F_{NLV}) must be less than T_h, otherwise the call admission to the Wireless LAN network will be rejected.

Mathematically,

$$F_{NLV} = P_{NLV} + I_{NLV} \quad (1)$$

$$call_{admin} = \begin{cases} Admin_{WLAN}, & F_{NLV} < T_h \\ Admin_{UMTS}, & Otherwise \end{cases} \quad (2)$$

Simulation parameter

In Fig. 3, the network simulation scenario is illustrated. The data rates of the UMTS and Wireless LAN network are set to 2Mbps and 54Mbps, respectively. Additionally in order to analysis the effects on the wrong admission probability, VoIP End-to-end delay and average-FTP throughput different wireless client and traffic load density has been implemented.

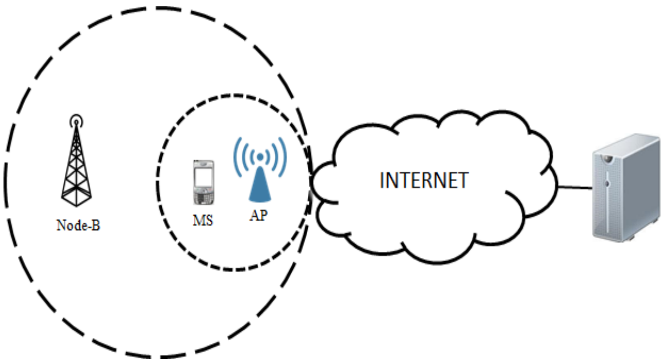

Fig. # 3. Simulation scenario

The two major services (i.e. File transfer Protocol (FTP) and Voice-Over IP (VoIP)), are being deployed to measure the performance of the NTL-HA for GTCA compared to the existing tight coupling architecture (ETCA).

Initially the five VoIP and twenty FTP users are activated in the simulation. However five more VoIP users are deployed with every simulation run, besides the FTP users are fixed throughout the simulation.

4. Results and Discussion

Fig # 4, 5, 6 and 7 represent the probability of wrong admission probability, wrong handoff probability, VoIP end-to-end delay and average-user FTP throughput of the ETCA and NTL-HA for GTCA technique under varying number of users. It can be seen that all three parameters are approximately remain same, till the numbers of MIMD remain less than 55. However, when the number of MIMD exceeds from 55-MIMD, the ETCA technique shows that the wrong admission probability and VoIP end-to-end delay gradually increase, whereas average-ftp throughput is steadily decreased.

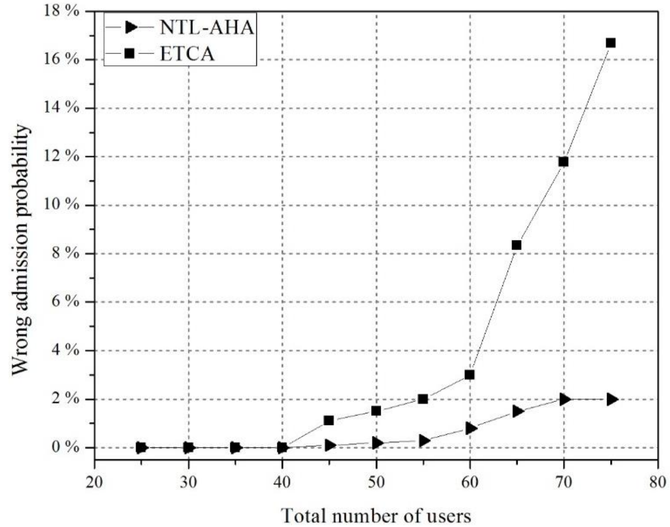

Fig. # 4. Wrong admission probability

On the other hand, after 55 users in NTL-HA for GTCA technique there is no rapid increment in the end-to-end delay or wrong admission probability, or decrement in the average-ftp throughput is being observed. This is due to the fact that in the NTL-HA for GTCA technique besides RSS value the Network Traffic Load of Wireless LAN network is considered in the network selection. Therefore, when the NTL reaches to the threshold value, the new call will be forwarded to the UMTS network. Therefore, the network performance remains stable.

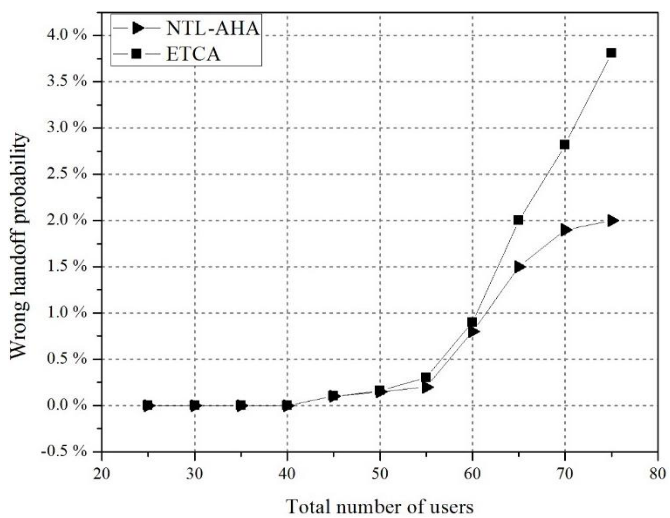

Fig. # 5. Wrong handoff probability

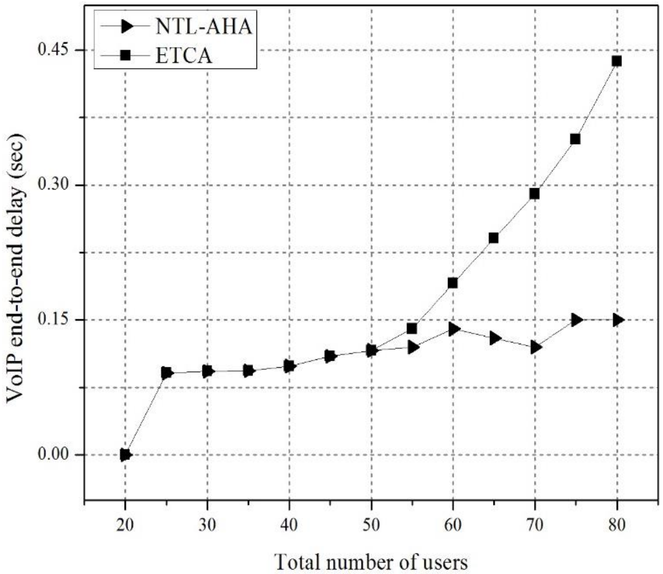

Fig. # 6: Average per user VoIP delay

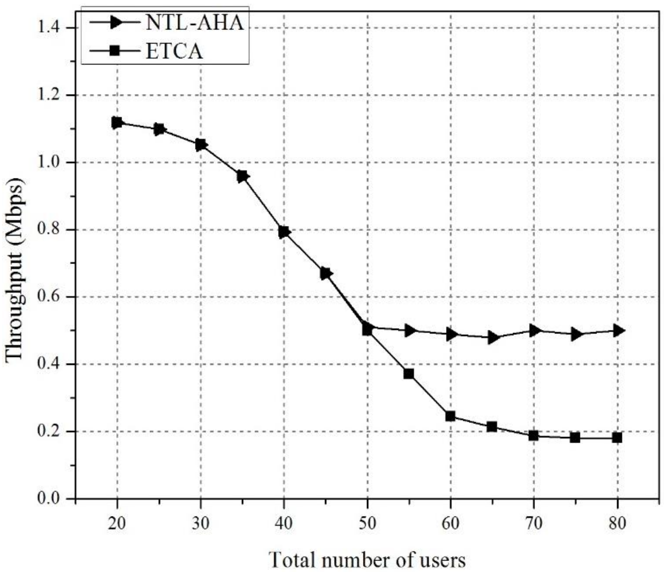

Fig. # 7: FTP average user throughput

CONCLUSION

In this paper, the NTL-HA for GTCA architecture with advance handoff algorithm is presented. The NTL-HA for GTCA introduces the some new entities and functions in the network. As discussed in the paper these entities have some dedicated functions, which leads towards the smooth handoff process. The NTL-HA for GTCA allow MIMD to calculate the network traffic load during handoff decision in order to utilize network resource effectively. The results shows that the NTL-HA for GTCA can significantly improves the wrong admission probability, FTP user throughput and VoIP end-to-end delay compare to the ETCA architecture.

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