Integrating Heterogeneous Wireless Networks By Soft And Hard Handoff

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Abstract

Wireless technology eradicated the networks that use cables. Wireless networks use microwaves and other radio signals for communication. One of the basic requirements is to support seamless mobility in wireless networks. Seamless means smooth transition, such that user does not perceive any delay or interruption of service. The main objective is to design a handoff decision criterion suitable to the situation. The purpose of the handoff is to keep continuous or seamless service to mobile users through different cells or network coverage .It is consequently of special importance for wireless networks. This work uses soft and hard hand off for implementation.

Keywords : WLAN ,UMTS, Handoff, MIP, MSCTP

1. Introduction

Wireless technology uses electromagnetic waves to communicate information from one point to another. Although wireless technologies have been used in specific applications for decades, wireless networks have recently become much more widespread due to better technology and lower prices. Wireless networking offers various advantages over wired connections, including mobility, connectivity, adaptability, and ease of use in locations that prohibit wiring. The major problems of wireless communication are highererror rates, lower bandwidth and more frequent spurious disconnection. As a result of these factors, communication latency rises due to higher retransmission, retransmission time-out delay increases, and more error-control protocol processing is required. Communication through radio waves presents more problem than wired communication because of potential interference from the environment [esi-topic.com]. The main challenges during integration of the two wireless services are, inter working architectures, billing issues, mobility and roaming, security/authentication, Session Persistence. Depending on how much inter-dependence is required between two wireless networks, there are two different ways of integrating the two wireless technologies called loosely coupling and tightly coupling. With seamless roaming the end user will not be aware of any change in the network they are using and will not be required to interact with the system to enable handoff [Ronan Morrissey et al 2002].

2. Related Work

No existing wireless networks technology can provide high bandwidth, low latency, low power consumption and wide area data service to a large number of mobile users simultaneously. Mobile node must consider three factors when performing vertical handoff to support network applications. They are mobility, load balancing and user preference. Many micro mobility design and lower layer supported protocols have been proposed, but still there is a room for further improvements [Cheng Wei Lee et al 2005]. Lima and Tejinder describes vertical

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handoff using SCTP by having client server model (i.e. between the machine and the fixed server). They use only loosely coupled architecture. The performance metrics they considered is only handoff delay and through put. (Mohammed Jaseemuddin 2003) has proposed architecture of integrating UMTS & 802.11 WLAN which allows a mobile node to maintain data (packet switched) connection through WLAN and voice (circuit switched) connection through UMTS in parallel. (Shiao –LI Tsao et al 2002) describes three possible UMTS – WLAN inter networking strategies. They got very poor performance (200ms latency and packet loss) while the user is more than 2000. (Shaojian et al 2004) had worked on TRASH, a new transport layer seamless handoff for mobile network and they considered various aspects such as handoff signaling, location management, data transfer and security considerations using multi homing feature of SCTP.

2.1 Need for the Proposed Work

The concept of receiving Internet connectivity through the mobile devices has only recently gained public familiarity. The mobile user is demanding more from the wireless industry with respect to real time application such as voice and video and non real time applications such as data services. It is designed to supplement the concept of using WLAN network "Hotspots" to extend and enhance UMTS networks in high traffic areas. Both technologies reveal that they are complementary to each other in their characteristics.

Integrating these two different technologies by handoff can lead to significant benefits to service providers and end users [Rohan Morrisssey et al 2002.]. The parameters that influence the WLAN hardware's behaviors are indicators of the signal quality. These quality parameters are usually provided by the driver of the WLAN hardware and can be gathered easily. This leads to the main idea to continuously monitor the signal quality and upon exceeding or falling below certain thresholds, alert concerned applications. With these abilities, a mobile node can control the handoff process and perform fast handoffs. The primary goal is to design the decision criterion for vertical handoff between UMTS and WLAN coverage.

2.2 Methodology Adopted

As shown in the fig [1] WLAN in the hotspot is a closed room, where one or two entrance is available for entry and exit. So a mobile user could move out and move in only via that entrance. WLAN is placed arbitrarily anywhere inside the UMTS networks There are two possibilities of occurring handoff here. They are:

i) The mobile user is moving towards the entrance of the hotspot from the WLAN. Instantly the signal strength of the mobile node is getting decreased. So, an inter technology handoff is initiated by the mobile node between WLAN and UMTS networks.

ii) A mobile user from UMTS is moving towards the hotspot entrance. Even if the signal strength is strong enough, in order to utilize the bandwidth of the network, it is necessary to have a handoff from UMTS to WLAN.

To solve this problem a handoff decision criterion is designed for the mobile users.

2.3 The criteria for WLAN to UMTS handoff are:

1. The mobile user is in WLAN network.
2. RSS is measured.
3. If RSS>=Th, then we wait for T seconds

else vertical handoff from WLAN to UMTS network is initiated.

4. We go to step 2.

The above criteria can be made more adaptive by anticipating the RSS in the next sampling time and making the next sample earlier.

1. RSS (n) is measured.

2. Is RSS (n) < Th then vertical handoff from WLAN to UMTS network is initiated.*//Where, RSS(n) is the RSS measured at the n th sampling*

   else if ((2*RSS(n)-RSS(n-1)) < Th) then we wait for T_{ad} = T (RSS (n)-Th)/RSS (n)-RSS (n-1). // *Where, 'T_{ad}' is the ad hoc sampling period for the next observation of RSS*

   else we wait for T seconds.

3. go to step 1

   Procedure for estimating sampling time T

   i) Estimated maximum velocity is V_{max} .
   ii) Estimated minimum distance is d_{min}
   iii) Proposed sampling time T <V_{min}/V_{max}
   iv) Frequency of sampling is 1/T.

2.4 The criteria for UMTS to WLAN handoff are:

1. Mobile user is in UMTS network.
2. If the MN receives the beacon signal from an AP, then we set the flag as 1,otherwise we set the flag as 0.
3. The flag is checked.
4. If the flag=1, inter technology handoff from UMTS to WLAN is initiated // *in order to utilize the maximum bandwidth.*
   else continue in the UMTS network itself.
5. We wait for T1 seconds.
6. We go to step2.

We are using a dual mobile mode terminal with both WLAN and UMTS interface. The software inside the dual mobile mode can switch between WLAN and UMTS networks, depending upon the availability of networks. Here the WLAN network is within the coverage area of the UMTS networks.

When the user is in UMTS networks, and it is near to the coverage area of the WLAN (i.e. when it receives the beacon signal), the WLAN MAC layer of the dual mobile node computes the signal strength of the received signal. Even if the signal strength is greater than the threshold value, the mobile node initiates the handoff, in order to utilize the maximum bandwidth. It is called as Soft handoff.

When the mobile node moves out of the coverage area of the WLAN network, the WLAN interface detects the reduced strength of the signal and gives the information to the dual mobile node software. Immediately the mobile node initiates the handoff from WLAN to UMTS networks. It is also called as hard handoff .Now the information is accessed from the internet via UMTS networks [Siddiqui et al 2005]

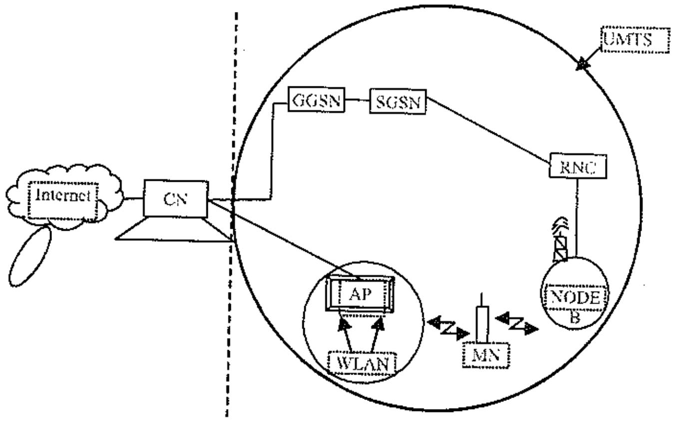

Figure 1: Integrated Architecture of UMTS -UMTS Network

Figure 1 Scenario used for the integrated environment the specifications used in this work are given in Table 1.

Table 1 : Specifications Used For Vertical Handoff

Mobility scenario	Vertical intersystem handoff
Handoff strategies	Seamless handoff
Handoff initiator	Mobile node
Methods used	Mobile IPv4,mSCTP
Mobility parameters	Handoff rate, velocity
Performance measures	Throughput, handoff delay, Packet loss
Performance metrics	Received signal strength

We have used two protocols to implement the proposed handoff criterian. They are MIP and mSCTP.

2.5 A Network Layer Handoff Mechanism

Here the method adopted is terminal initiated handoff [Cheng et al 2005.]. WLAN and UMTS are entirely different technologies. Since this work uses infrastructure based WLAN, it is directly connected to internet via access point. Based on the network layer mobility, MIP (Mobile IP) became a standard protocol for the mobile users. In view of its registration and authentication procedures, this protocol suffers significant handoff delay and packet loss. Our work introduces some enhancement procedures to increase the performance of MIP. In order to reduce the handoff delay and packet loss, the following enhancements are made:

i) A buffer of capacity 20 is introduced in CN (Correspondent node) and in the agents.

ii) When the rate of MN (Mobile Node) movement increases or if there is a ping-pong effect between WLAN and UMTS networks, the registration of MN with a home agent increases. This will causes a high handoff delay. In order to reduce this, new agent was defined [Ian et al 2004, Eva et al 2004, Hesham Soliman et al 2004.].

The steps involved will be agent discovery, authentication, registration and handoff. We have used the TCP segments for data transfer.The delay,packet loss, end to end throughput are calculated using the following formulas.

Handoff delay(MIP) = Agent Discovery Period

+

Registration period.

End to end Throughput(MIP) = (Total Traffic offered-Total data loss)/Total transmission duration

Packet loss (MIP) = Sum of data loss incurred by each handoff/Packet size

2.6 Transport Layer Seamless Handoff Mechanism

mSCTP is a transport layer handoff solution with Dynamic Address Reconfiguration (DAR) extension. It uses the multi homing features of SCTP (Stream Control Transmission Protocol), whereas two end hosts hold two transport layer connection identities at the same time.

We assume that WLAN and UMTS networks are overlapped. Initially, the mobile user is accessing the internet via the access point from the correspondent node using its own IP address called primary address IP1. As he/she is moving away from the boundary of the network, the received signal strength (RSS) gets reduced. It is noticed by the mobile node using the link layer signaling or by the signal given by the correspondent node by using the previous data loss pattern of the old path. So the mobile node will get a new IP address by requesting the server or by using the DHCP protocol. This IP address is also called as secondary address IP2 and is sent to the CN using the Asconf Add IP address parameter.To avoid signaling overhead ,Asconf Add IP address is sent along with set primary address.Inturn ,the CN will reply with Asconf Ack message. Immediately the CN will update its local routing table. Once it is updated, all packets will be routed only to the secondary IP address, because the primary IP Address is not reachable [Li Ma et al.2004, Shaojian et al 2004.].

Once the mobile node moves towards the boundary of the WLAN network, as it is mandatory to make use of the bandwidth of the local network, the mobile node will give a Asconf deactivate message to the CN instead of giving the Asconf delete IP address as the signaling may over burden the network. Now the packets will be routed only to primary IP address (IP1). The buffer of capacity 20 sizes is introduced in the correspondent node to reduce the packet loss during the handoff. So, even if the packet loss occurs, the packets will be retransmitted to the exact path. A central database is also introduced here to store all the addresses.We have used the SCTP segments for data transfer.The delay,packet loss, end to end throughput are calculated using the following formulas.

Handoff delay(mSCTP) = Router Discovery Period + DAR period(Using dual homing)

DAR period = (Add IP+Set-primary+ Asconf –Ack period)+ Deactivate IP period

End to end Throughput(mSCTP) = (Total Traffic offered-Total data loss+DAR chunk overhead)/Total transmission duration

Packet loss (mSCTP) = Sum of data loss incurred by each handoff/Packet size

3. Simulation Results And Discussions

To test the performance of the integrated network architecture, the work is implemented in NS2 2.26 version. The simulated results are shown in Figure 2 through 5.The handoff rate is the number of handoffs during the simulation in unit time.

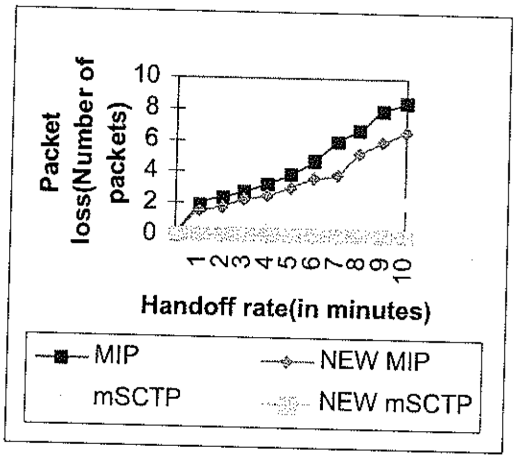

Figure 2: Packet Losses in UMTS-WLAN Network

The Figure 2 shows the number of packets loss over the handoff rate. Here, the total packet loss of MIP increases proportional to handoff rate, while that of mSCTP does not increase as that of MIP.

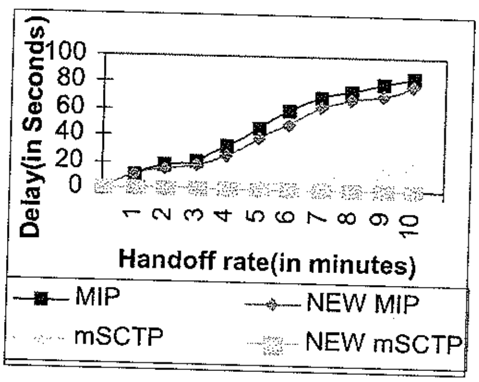

Figure 3 : Handoff Delay In UMTS-WLAN802.11b

Figure 3 shows that, due to the registration procedure of MIP, there is a increase in delay over the handoff rate, while that of mSCTP keeps the handoff delay as very low compared to MIP.Figure 4 shows clearly that END-to-END throughput of MIP decreases as the handoff rate increases. The mSCTP maintains a constant value irrespective of the handoff rate.

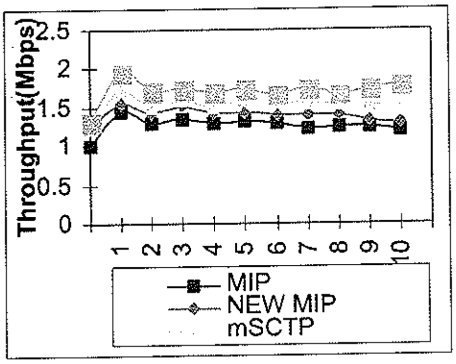

Figure 4: End To End Throughput UMTS-WLAN 802.11b

The packet loss can be totally eliminated, if the buffer size is very large. On the other hand, the number of packets loss decreases as buffer size increases, which is shown in the Figure 5

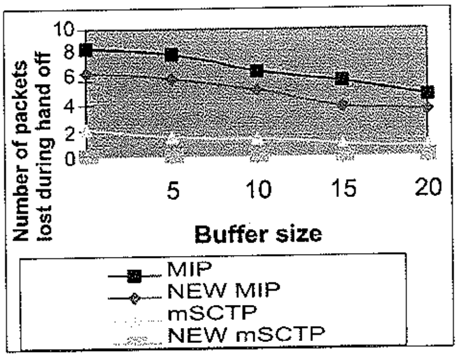

Figure 5 : Packet Losses Vs Buffer Size

4. Conclusion

Both WLAN and UMTS can be viewed as competing and or complementary technologies. There fore an integration of WLAN s with UMTS will bring advantages to the users as well as the service providers. We have considered the problem of seamless handoff of WLAN and UMTS networks. A novel scheme is proposed to improve the handoff performance. The proposed handoff scheme uses a MIP and mSCTP protocols for implementation. The analysis of performance of the proposed scheme was presented. Although currently this scheme is verified only with IEEE802.11b and UMTS networks, it does not depend on any specific protocols details. Our proposed scheme reduces the signaling overhead on the internet and minimizes packet loss for the mobile node during handoff.

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