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Optimized Handoff Algorithms for WLAN and UMTS NETWORKS

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Abstract: Supporting seamless roaming between heterogeneous wireless networks is one of the key issues in the future mobile communication systems. UMTS and hotspot wireless LAN will complement each other to provide ubiquitous high-speed wireless Internet connectivity to mobile users. In such environment it will be required to support inter technology Handoff of mobile terminals without causing disruptions to their ongoing Internet Session Though there is a handoff technique between wireless LAN and UMTS Networks, this proposal aims to give a smooth optimized handoff between Wirelesses LAN and UMTS network by rectifying the drawbacks (like delay in latency and Packet loss) which is present in the already existing techniques. One problem towards such utilization is the current technological shortcomings of cellular systems that limit the data rate. One way to bypass this limitation is to use Wireless LAN in cooperation with cellular network such as UMTS networks, an increasing number of wireless telecommunication providers are now offering both voice and data services to their users. These services and the emerging multimedia services demand higher data rates to achieve a better Quality of Service (QOS) The implemented algorithm are validated by means of NS2 simulators that clearly show the impact of this technique to major system performance metrics.

Key words: Wlan, umts, aaa, mn, ggsn

INTRODUCTION

Universal mobile telecommunications system: A new mobile system for worldwide use is now being developed to enhance and supersede current systems. The Universal Mobile Telecommunications System (UMTS) will be an enhanced digital communications system that will provide universal communications to anyone, regardless of their whereabouts. UMTS will allow for wireless Internet access, video-conferencing and other bandwidth intensive applications. Benefits from this new system of wireless communications are expected to be:

- Support to existing mobile services and fixed telecommunications services up to 2Mb/s;
- Support to unique mobile services such as navigation, vehicle location and road traffic information services, which will become increasingly important in world market;
- The ability to enable the use of the system terminal from multiple environments - in the home, the office and in the public environments -in both rural areas and city centers; and
- Provision of a range of mobile terminals- from a low cost pocket telephone to sophisticated terminals to provide advanced video and data services[1,2].

Wireless local area network: Compared with a wired infrastructure, Wireless LAN (WLAN) has unique advantages, such as broadband bandwidth capability and low deployment cost. Thanks to the technology provided by IEEE 802.11, the WLAN market is experiencing explosive growth in hot spots such as hotels, hospitals and campuses, to mention just a few. With WLAN being deployed in an un limited way as access points, wireless users can access real-time and Internet services virtually anytime, anywhere, while enjoying the flexibility of mobility and guaranteed connectivity. IEEE 802.11 is designed for best effort services only. The lack of a built-in mechanism for support of real-time services makes it very difficult to provide Quality of Service (QOS) guarantees for throughput-sensitive and delay-sensitive multimedia applications. Therefore, modification of existing 802.11 standards is necessary. Although IEEE 802.11e is being proposed as the upcoming standard for the enhancement of service differentiation, QOS guarantee in 802.11 is still a very challenging problem and needs further study primarily for high speed best-effort data service only. For integrating UMTS with WLAN there is more than one point of integration in the UMTS network that may define a workable solution. The applicability of integration architecture management and inter-system handover procedures[3,4].

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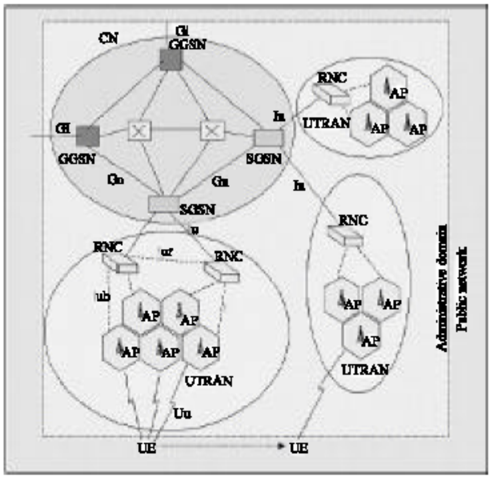
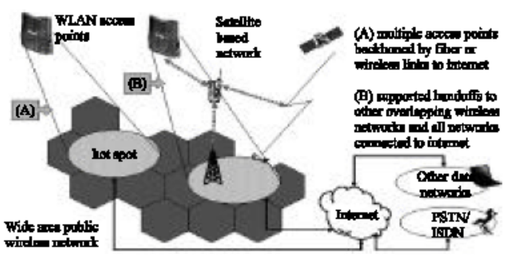


Fig. 1: UMTS network components



WLAN architecture

INTEGERATION OF UMTS AND WLAN

The 3G cellular networks, e.g. UMTS are designed to provide voice and data services to mobile users. The sustainable per user data rate is hundreds of kbps limited by the total cell capacity of up to 2-3 Mbps[5]. Multimedia users are known to exhibit asymmetric bandwidth usage behavior, where the download bandwidth is usually two to three order of magnitude higher than the upload bandwidth. Furthermore, the high-speed usage is clustered in certain areas. For example, in internet cafés, office buildings and apartment buildings etc. These clusters of high-speed usages are called hot spots fortunately these areas are scattered within a wireless operator's domain. The operators would like to deploy low cost high-speed solution to cover the hot spots that is either an extension of UMTS or inter-workable with UMTS. So that they can use ,they can maximally utilize the already deployed infrastructure. Wireless LANs, e.g. 802.11, offers a viable and attractive choice as being high-speed (up to 54Mbps) and low-cost (hundreds of dollars an AP) for this space.. This is especially attractive because WLAN is currently used primarily for high speed best-effort data service only. Integrating UMTS with WLAN,there is more than one point of integration in the UMTS network that may define a workable solution. The applicability of integration architecture management and inter-system handover procedures[6,7].

RELATED WORK

The requirements for the deployment of effective solutions to the internetworking between WLAN and 3G networks may be identified by following many methods of integration. There are three classes of integration regarding UMTS and WLAN[4,8].

No coupling: In this type of coupling the UMTS and the WLAN network are independent to each other. Rapid introduction of the nodes from one network to other is possible. No impact will be on the internal nodes. Disadvantage of this Scheme is poor handoff as well as they lack the capability of common billing

Loose coupling: In this type of coupling the UMTS and the WLAN network uses the same database for authorization, accounting and authentication. Rapid introduction of the nodes from one network to other is possible. No impact will be on the internal nodes. Disadvantage of this scheme is poor handoff.

Tight coupling: In this type of coupling the UMTS and the WLAN network are connected to each other by a special interface. Rapid introduction of the nodes from one network to other is possible. No impact will be on the internal nodes. Advantage of this scheme is good Handoff and this type of interconnection is possible only when the operator has control over the two networks[9,10].

Proposed solutions: The proposed solution has taken in to consideration of the loose coupling integration ie:(Independent architecture) and basic scheme of seamless handoff has been implemented along with optimized seamless handoff scheme. The proactive, reactive, spurious trigger problems have been rectified using the optimized seamless handoff scheme.

Proposed architecture

Description of the architecture: Figure 2 shows the default network deployment case, where the WLAN access and the UMTS access are independently managed and no trust relationship (such as common ownership or roaming agreement) exist between them. An example would be a WLAN hot spot in a bookstore that charges access fees to user's readership account. Another example would be an enterprise WLAN, which only the employees are authorized to access (there may not be access fees for the employees). Or, in some cases, WLAN

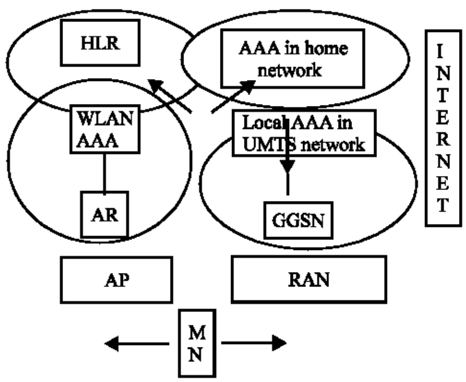


Fig. 2: Proposed architecture

access at the hot spot could be free of charge and hence, no local AAA (authentication, authorization and accounting) functionality is required at the WLAN. This could be the case for WLAN hot spot in a small restaurant. On the other hand, UMTS cellular access would typically always be charged to user's subscription account with the (home) cellular operator. In this environment, suppose the mobile user initiates an Internet application session such as VoIP (Voice over IP) call or multimedia call from the WLAN and later slowly moves away from the hot spot coverage area. Then, before attempting an inter-technology handoff from the WLAN to a wide area UMTS network, the mobile terminal has to perform authentication and service authorization procedures with the UMTS network. Note that the home agent may reside in the same domain as that of the WLAN (enterprise case) or in a different domain from the WLAN as well as the UMTS network (bookstore or free access case).

Smart detection algorithm: We propose to reserve a bit, that we call the border bit, in the beacons transmitted by the WLAN APs. The border bit is set to 1 for those APs from which it is physically possible to exit the hot spot coverage. The WLAN APs near the front and parking doors of the hotel (whose coverage is indicated in dark gray color), will have the border bit set to 1 in their beacons. Then, the mobile terminals can use the method which has been implemented here, to generate robust inter technology handoff triggers[6,9]

if (border bit of current AP = 1)
//Inter-technology handoff is a high possibility//
while (WLAN signal strength > Th1) wait;
Initiate Phase 1 of handoff; //Be proactive//
while (WLAN signal strength > Th2) wait;
//Th1 > Th2//
Initiate phase 1 of handoff;
end

if (border bit of current AP = 0)
//Inter-technology handoff is a small possibility//
while (WLAN signal strength > Th3) wait;
//Th1 > Th3//
Wait for T1 second;
//Signal strength can go down due to discontinuous coverage, waiting avoids spurious handoff triggers as the signal strength may come back during time T1//
Initiate Phase 1 of handoff process;
while (WLAN signal strength > Th4) wait;
//Th3 > Th4//
Wait for T2 second;
//To filter spurious handoff triggers//
Initiate Phase 2 of handoff;
end

Seamless handoff Phase 1:

- The mobile terminal decides to initiate inter technology handoff from WLAN to UMTS network, it sends a Proxy Router Solicitation message (Proxy RtSol) to AR.
- AR in turn sends a Router Solicitation to the GGSN.
- In addition, the mobile terminal arranges to transfer what we call the bearer context to the GGSN via the AR.
- The bearer context contains information required to establish access network bearers in the UMTS network for the mobile terminal's ongoing Internet sessions.
- Bearer context contains
  QOS requirements of mobile terminal's ongoing applications.
  MSID: Mobile Station Identity recognizable by UMTS network.
  LCP configuration parameters such as MRU, ACCM, quality control parameters to facilitate the creation of PPP state in GGSN.
  TFT (Traffic Flow Templates) to enable establishment of packet filters in GGSN.
- The GGSN responds to this message using the Router Advertisement that is forwarded to the mobile terminal via the AR (as the Proxy Router Advertisement or Proxy Rt Adv).
- The Proxy RtA dv contains, challenge (MN-FA challenge extension) for authentication and authorization purposes.
- The mobile terminal responds by sending a Registration Request (Reg Req) to the GGSN via AR.

- Upon the receipt of the Registration Request, the GGSN uses the NAI extension to determine the home AAA domain of the mobile terminal and queries the home AAA.
- The GGSN actually queries the local (visited) AAA in the UMTS access network.
- The visited AAA then forwards the query to the home AAA, possibly via broker AAAs in the middle.
- The GGSN supplies the home AAA with the challenge issued by the GGSN in the MN-FA challenge extension and the mobile terminal's reply to it obtained in the MN-Radius extension.
- The GGSN also provides the home-AAA with the description of access service (e.g QOS) requested by the mobile terminal.
- Upon successful authentication and service authorization, the home AAA sends a success indication to the GGSN, authorizing the mobile terminal's access.
- It also sends a ticket to the GGSN in clear text as well as in encrypted form. The latter is encrypted using the shared secret between the home AAA and the mobile terminal.

Seamless handoff Phase 2:

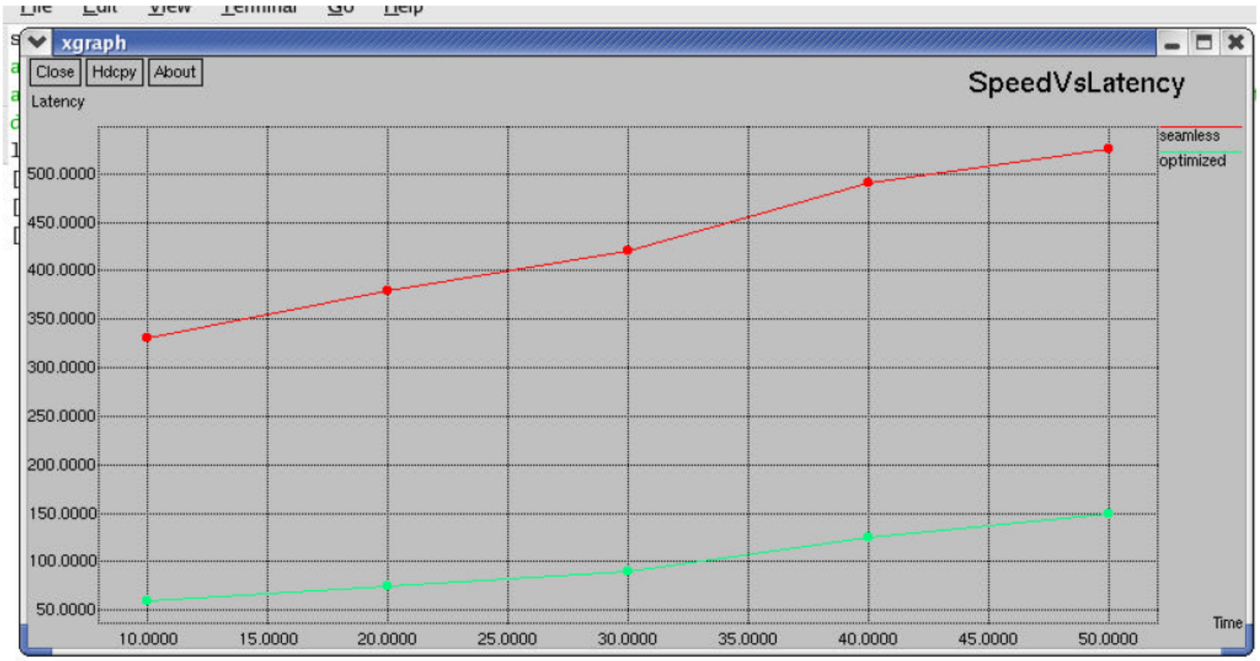
- Phase 2 of the handoff process is started when the mobile terminal sends an ACK to the GGSN via the AR and includes the ticket in clear text form in it.
- This proves to the GGSN that the ACK indeed comes from the mobile terminal. This is a security measure.
- After sending ACK, the mobile terminal waits to hear from the UMTS network over the cellular air interface.
- While the mobile terminal is waiting, the UMTS network performs the A10/A8/A1 bearer set up In addition, the GGSN performs registration procedure with the mobile terminal's HA.
- Upon receiving the Registration Reply (Reg Rep) from the HA, the GGSN forwards it to the mobile terminal upon one of the established access bearers.
- The home AAA can generate a session key and forward it in clear text as well as encrypted form to the GGSN.
- The GGSN stores the clear text key and forwards the encrypted key to the mobile terminal (via GGSN and AR).
- The mobile terminal can then use this key to authenticate or encrypt future message transactions with the GGSN (e.g. ACK).

Implementation: The proposed design has been implemented using the Tcl language and NS2 simulator Tcl was originally intended to be a reusable command language. Its developers had been creating a number of interactive tools, each requiring its own command language. Since they were more interested in the tools themselves than the command languages they would employ, these command languages were constructed quickly, without regard to proper design. After implementing several such quick-and-dirty command languages and experiencing problems with each one, they decided to concentrate on implementing a general-purpose, robust command language that could easily be integrated into new applications. Thus Tcl (Tool Command Language) was born.

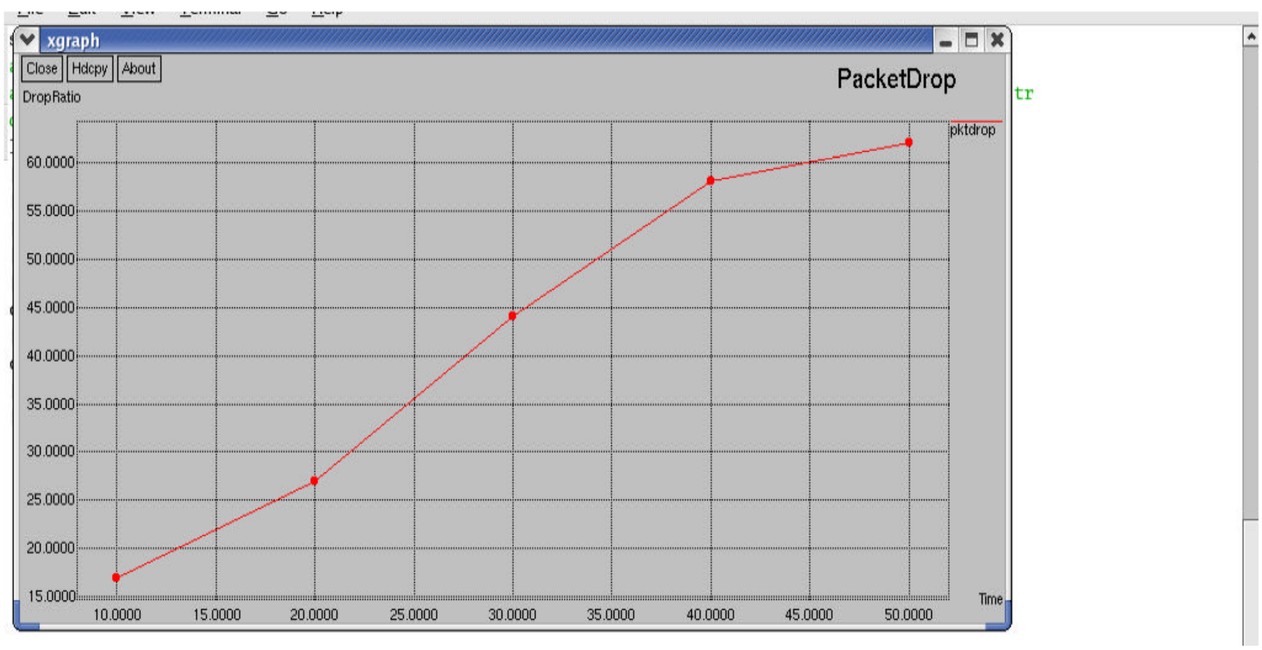
Tcl has been widely used as a scripting language. In most cases, Tcl is used in combination with the Tk ("Tool Kit") library, a set of commands and procedures that make it relatively easy to program graphical user interfaces in Tcl.One of Tcl's most useful features is its extensibility. If an application requires some functionality not offered by standard Tcl, new Tcl commands can be implemented using the C language and integrated fairly easily. Since Tcl is so easy to extend, many people have written extension packages for some common tasks and made these freely available on the internet.

Simulation results: As this paper focused on to reduce handoff delay using Latency, Graph (1) clearly shows an improvement in the handoff latency and Graph (2) shows a reduced packet drop ratio. The percentage of packet delivery ratio is plotted in Graph (3). In summary, the graphs shows a clear indication of the improvement of handoff delay and reasonable amount of packet loss using the Smart detection algorithm. The experimental study was done using NS2 simulator. Future work of this paper is to minimize more number of packets drops by enhancing the efficiency of the algorithms.

Seamless handoff of mobile terminal from WLAN to UMTS network:



Graph 1: Speed VS Latency



Graph 2: Packet drop ratio

Graph 3: Packet delivered ratio

CONCLUSION

This study presented the integration of optimized handoff techniques between WLAN hotspots into UMTS networks, using Loosely coupled method. Simulation results showed in relation to the mobile node velocity and the handoff delay in the moving –in and the moving-out vertical handoff scenarios. Here the number of continuous beacon signals whose signal strength from the WLAN falls below the predefined threshold values was used. This paper completely dealt with a mobile node moving from WLAN to UMTS network not vice versa.

REFERENCES

1. Jochen, H. Schiller, Mobile Communications, Pearson Eduation,6th Indian Reprint.
2. Entland, S. 1999. Planning for UMTS, Telecommunication, pp: 29.
3. Li ma, Fei Yu 2 and Victor C.M, Leung, 2004. The University of British Columbia Institute of Technology. A new method to support UMTS/WLAN Vertical Handover using SCTP, IEEE Wireless Communication.
4. Minji Nam, Nakjung Choi, Yongho seok and Yanghee choi, 2004. WISE: Energy-Efficient Interface selection on Vertical Handoff between 3G Networks and WLAN, School of Computer Science and Engineering, National University, Seoul, Korea.
5. Leino, A., 1999. UMTS/IMT-2000 spectrum. Telecommunications, pp: 23.
6. Hemish Parikh, Hemanth Chaskar, Dirik Trossen and Govind Krishnamurthi, 2002. Seamless Handoff of mobile terminal from WLAN to CDMA 2000 networks, IEEE.
7. Shiao-Li T. and L. Chia-Ching, 2002. Design and Evaluation of UMTS-WLAN Internetworking strategies, IEEE.
8. Su-En Tan, Dan Saugstrup and Henning Olesem, 2004. WLAN vs UMTS-The European scene Centre for Tele-Information.
9. Hector Velayos and Gunnar karlsson, 2002. Techniques to reduce the IEEE 802.11b Handoff time, KTH, Royal Institute of Technology, SE-16440 Kista, Swedan.
10. Yuan-Kai chen and Yi-Bing Lin, 2005. IP Connectivity for Gateway GPRS Support Node, IEEE Wireless Communications.