An Efficient Soft Handoff Scheme Using Enhanced Resource Reservation Technique in Wireless MIPv6 Networks

Tae-Hyun Park[1] , Ho-Ryong Choi[2], Sang-Hun Chun[3] , and Kyung-Sup Kwak[1]
[1] School of Info. And Comm. Engineering, Inha University,
253 YoungHyun3-Dong, Nam-Gu, Incheon, 402-751, Korea
Tel: +82-32-864-8935, Fax : +83-32-868-3654
[2] Dept. of Electronic Engineering, Inha University,
253 YoungHyun3-Dong, Nam-Gu, Incheon, 402-751, Korea
[3]Dept. of Electronic Communication, Jaeneung College,
8 Songlim-dong, Dong-Gu, Incheon, Korea
e-mail : arrra@hanmail.net

Abstract: In a recent wireless network environments, dynamic host configuration protocol (DHCP) service is used to assign IP addresses to mobile terminals. In IPv6 networks, it is necessary to introduce the concept of handoff to support a seamless service to mobile terminals. In a general soft handoff technique used by code-division multiple acces (CDMA) communication systems, the powers received to base station are simply compared to determine which base station will handle the signal to and from each mobile termins. However, in IPv6 network, to transmit data-oriented services, it is necessary to support an enhanced soft handoff technique with more security and quality of service.

In this paper, we propose a scheme to reduce a signaling process of handoff in IPv6 network. Also, we propose a technique to reduce wasted reservation resources and to guarantee quality of service (QoS) using DHCP.

1. Introduction

In a recent wireless network environments, dynamic host configuration protocol (DHCP) service is used to allocate IP addresses to mobile terminals. A DHCP server has a particular IP address area to assign IP address to mobil terminals. On requesting from a mobile terminal, DHCP server assigns an IP address, and the IP address takes back at the end of the mobile terminal. Also, about the IP address which is already allocated, resources management is achieved so that the IP address is not reassigned. DHCP is defined to RFC 2131 [4] by communication rules to allocate automatically and manage configuration information necessary to execute TCP/IP communication. DHCP provides administration service of IP address in communication network of TCP/IP environment. DHCP server based on user datagram protocol (UDP) allocates IP address according to DHCP client's request.

In this paper, we propose a method to reduce wasted reservation resources that is a problem of soft handoff in existing wireless communication. Also, we propose a method which is able to guarantee quality of service by seamless IP address allocation using DHCP when a mobil terminal move from one cell to another.

In section 2, we describe the proposed method to reduce wasted reservation resources. In section 3, we propose a method to guarantee security and quality of service using DHCP and encapsulation after handoff. In section 4, we investigate the performance of the proposed scheme and compare it with that of a conventional scheme .

2. An Efficient Resource Reservation Scheme in Soft Handoff

In the existing handoff schemes, if a mobile terminal sends a handoff request message to a base station within a cell, the handoff request messages are broadcasted to inter-cell base stations to reserve resources. In this section, we propose a scheme to increase entire networks capacity. For an efficient resource management, the proposed scheme uses a method to decrease the number of inter-cell base stations receiving a handoff request message.

2.1 Location Scan of User Terminal for an Enhanced Resource Reservation

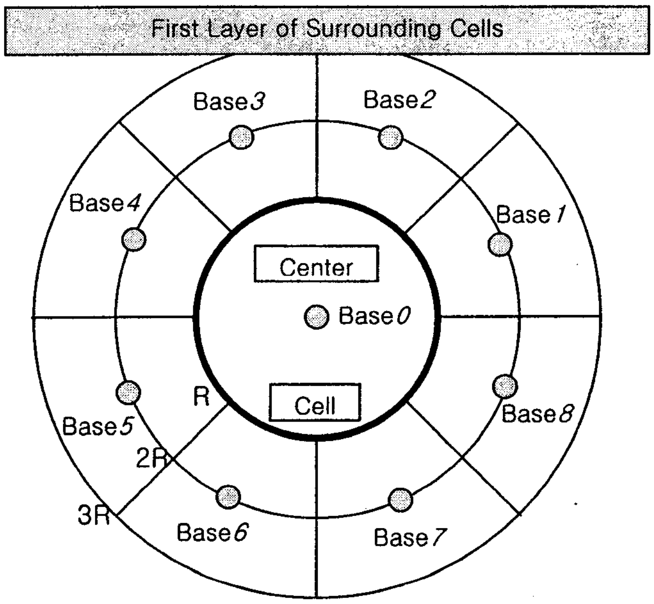

Fig. 1. The wedge cell geometry proposed in [8] shows a central cell surrounded by eight wedge-shaped cells that have the same area as the central cell.

In IPv6 networks, base station must find the location of a mobile terminal for an efficient resource management when the soft handoff is occurd. In the previous work [7][8], it is shown to a method to find a location of a user using distance and power intensity. Fig. 1 shows a central cell surrounded by eight wedge-shaped cells that have the same area as the central cell. In Fig. 1, the central cell's base station *Base0* finds the location of user through the cell's next base stations *BaseN* where integer *N* varies from 1 to 8. *Base0* knows the distance to each *BaseN*, and each *BaseN* knows the location of user[7][8].

In Fig. 2., we can find distance between *Base0* and *Useri* through distance between *Useri* and Base*j* and distance between *Base0* and *Basej*. Base*0* gets the location information of *Useri* through *Basej*. Here, the power $P_{r;i,j}$ that is received to the base station *Basej* from *Useri* is as follows:

$$P_{r;i,j} = G_{sub} G_m P_{t;i} \left(\frac{\lambda}{4\pi d_{ref}} \right)^2 \left(\frac{d_{ref}}{d_{i,j}} \right)^n L_{i,j} \qquad (2.1)$$

where n is the path loss exponent, and d_{ref} is a close-in reference distance[8]. The term $L_{i,j}$ represents a log-normally distributed shadowing loss on the link between *Useri* and *Basej*. We assume that *Basej* applies perfect power control to all users in *Cellj* and the power $P_{c;j}$ is received to *Basej*. In that case, for each user in *Cellj*, the transmitting power $P_{t;i}$ required by *User i* is as below:

$$P_{t;i} = P_{c;j} \left(\frac{4\pi d_{ref}}{\lambda} \right)^2 \left(\frac{d_{i,j}}{d_{ref}} \right)^n \frac{1}{G_m L_{i,j}} \qquad (2.2)$$

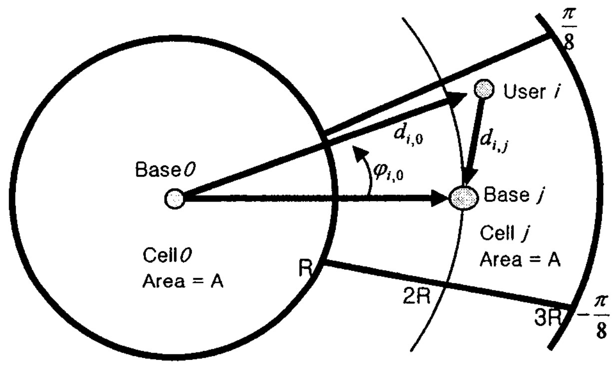

Fig. 2. Geometry for determining $d_{i,j}$ as a function of $d_{i,j,}$ distance between out-of-cell *Useri* and the central base station *Base0*. The angle of *User i* relative to the line between *Base0* and *Base j* is $\Phi_{i,0}$.

The reverse link power received to *Base0* from *User i* , $P_{r;i,0}$ is given by

$$P_{r;i,0} = L_{i,0} G_m P_{t;i} \left(\frac{\lambda}{4\pi d_{ref}} \right)^2 \left(\frac{d_{ref}}{d_{i,0}} \right)^n \qquad (2.3)$$

Substituting (2.2) into (2.3), the reverse link power $P_{r;i,0}$ is

$$P_{r;i,0} = \frac{L_{i,0}}{L_{i,j}} P_{c;j} \left(\frac{d_{i,j}}{d_{i,0}} \right)^n \qquad (2.4)$$

To analyze (2.4), we consider the geometry shown in Fig 2. From the law of cosines,

$$d_{i,j}^2 = (2R)^2 + (d_{i,0})^2 - 2(2RD_{i,0}) \cos \varphi_{i,0} \qquad (2.5)$$

Substituting (2.5) into (2.4), the reverse link power $P_{r;i,0}$ is found by

$$P_{r;i,0} = \frac{L_{i,0}}{L_{i,j}} P_{c;j} \left(1 + \left(\frac{2R}{d_{i,0}} \right)^2 - \frac{4R}{d_{i,0}} \cos \varphi_{i,0} \right)^{\frac{n}{2}} \qquad (2.6)$$

Base0 can find the location of *Useri* using above equations. In the case of the existing handoff schemes, *Base0* broadcasts a handoff message to inter-cells after finding *User i*. In this paper, we propose a method to reduce wasted resources. The proposed scheme reserves the resources only to the base station of direction that user *i* is located among inter-cell base stations. In Fig. 2., *User i* between 2R and 3R informs handoff request messages to *Base0*. In the following section, we introduce a method to advertise a handoff message to inter-cell base stations from *Base0* and we describe base stations receiving the handoff messages.

3. Address Allocation Scheme of DHCP for IPv6 with ERRT

In this section, we introduce an efficient address allocation scheme in the MIPv6 networks which applies enhanced resource reservation technique (ERRT) proposed in section 2 to DHCP server.

3.1 Address Allocation Technique by DHCP Server in Standard

In network environmets using DHCP, an agent of the networks is a server or a relay. Relay operates as a communication repeater between a terminal and a server. For the purpose of obtaing address of a DHCP server, terminal sends a DHCP solictation message to Relay. Relay forwards the DHCP solictation message to a DHCP server. The DHCP server which receives the DHCP solictation message sends a advertisemet message to Relay. The Relay forwards the advertisement message to terminal. In the result, connection between terminal and DHCP server is setup through Relay [1][2][5].

3.2 Call Management Process

In Fig. 3, a call management process is shown. Handoff of T1 is completed at the first dotted line. In this case, if RB4 receives T1HO_OK message before transmitting RSC_T1_rte message to RA1, RA1 transmits RSC_T1_rte_OK message to RG5 and RC3. Therefore, handoff of T1 is completed in the end of all process and reserved resources are restored such as RG5 and RC3.

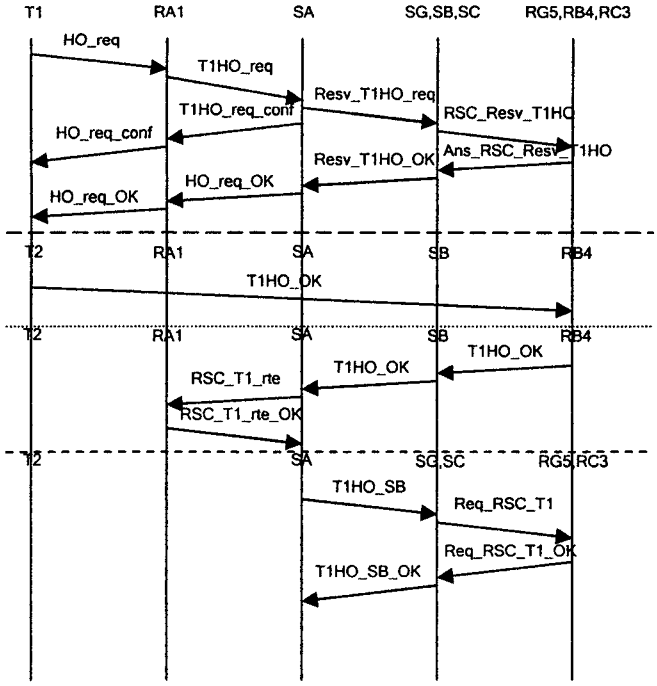

Figure 3. Call Management Process of the proposed scheme.

Table 1. Contents of Transmission message

Messages	Details of Messages
HO_req	Handoff request
T1HO_req	Handoff request for T1
Resv_T1HO_req	-Current BS(base station) connected with T1 -Current power of T1 -Current service class of T1
T1HO_req_conf	Confirm the handoff request of T1
HO_req_conf	Confirm the handoff request
RSC_Resv_T1HO	-Require of bandwidth allocation -Require of address allocation -Require of resource state information
ANS_RSC_Resv_T1HO	-Allocated of bandwidth allocation -Allocated address -Current resource state for each relay -Require of information of T3 to SC
Resv_T1HO_OK	BSs enable to handoff for T1
HO_req_OK	Handoff enabled
T1HO_OK	T1 moved to T2
RSC_T1_rst	Used resource restoration require for T1
RSC_T1_rst_OK	Used resource restoration complete for T1
T1HO_SB	Handoff of T1 complete to sB
Req_RSV_T1	Reserved resource restoration require for T1
Req_RSC_T1_OK	Reserved resource restoration complete for T1
T1HO_SB_OK	Handoff of T1 complete to SB

Table 1 shows the details of transmitting messages that for handoff of T1 is completed to T2. In Fig.4, we show a network constitution proposed in this paper.

3.3 Soft Handoff by ERRT in the MIPv6

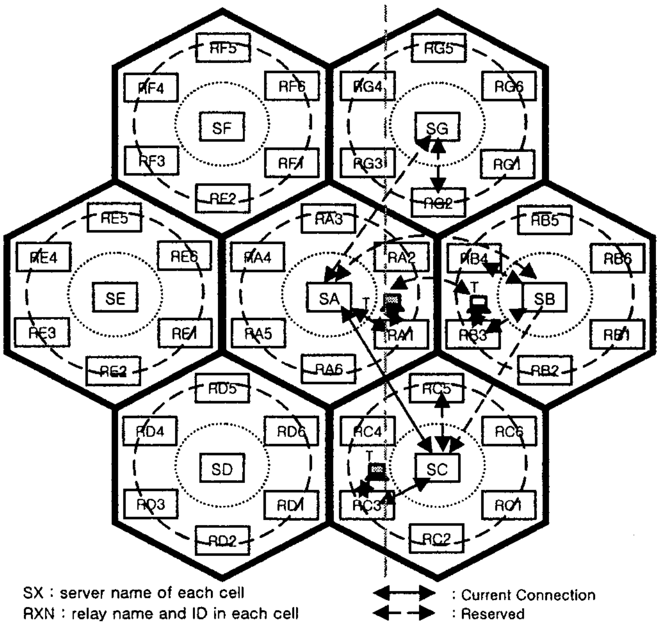

Fig. 4. Resource Reservation for Soft Handoff using a ERRT in the MIPv6

As shown in Fig. 1 and Fig. 2, if a terminal location is found, we are able to manage resources efficiently. In this section, we introduce an efficient soft handoff scheme which uses ERRT to improve the existing resource reservation schemes.

In Fig. 4, the network constitution proposed in this paper is shown. We assume that each DHCP server knows Relay's location within its own cell and the location of inter-cell base stations. In Fig. 4., we assume that T1 in SA communicates with T3 in SC and moves to T2 in SB. T1 sends a handoff request signal to RA1 because T1 is outside boundary line of the hadnoff request of SA. RA1 forwards the handoff request message to SA. SA finds the location of RS1 and advertises the handoff request messages to a server on RA1's direction. In Fig. 4, the servers on RA1's direction are SG, SB and SC that is on right of the dotted line which is vertically drawn. SA forwards the handoff request messages to these servers. SG knows Relay on SA's direction and reserves resources, for example, bandwidth and address, to RG5. As SG, SB and SC reserve resources to RB4 and RC3 each. In Fig 4., because terminal moves to SB area, when SB sends a handoff completion message about T2 to SA, SA sends information that there is no handoff about T1 to SG and SC. In the result, resources that is allocated SG and SC area are discarded. If the handoff is perfectly completed from T1 to T2, SA takes back the resources for T1. Accordingly, we can reduce the wasted reservation resources.

4. Simulation Results

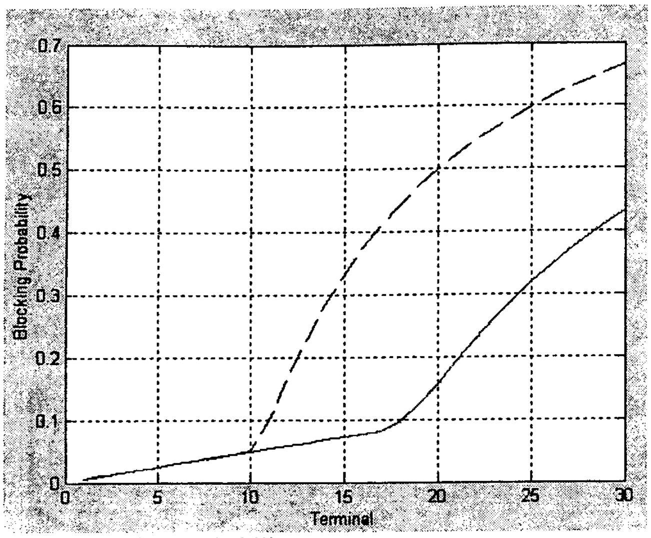

Fig 5. Blocking Probability
(Dashed line: Conventional, Solid line: Proposed)

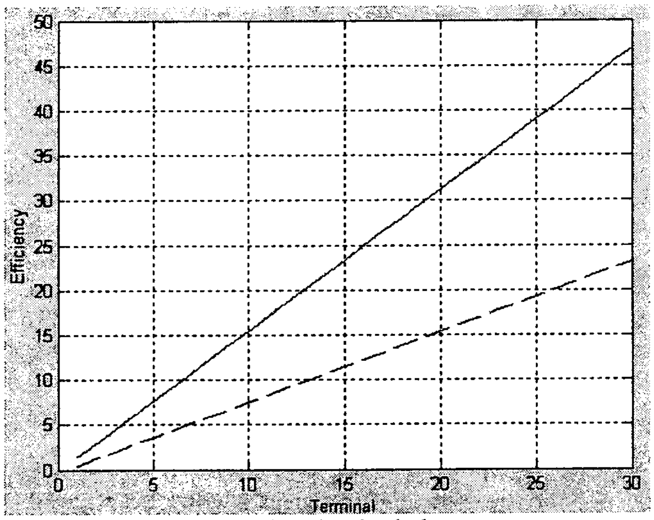

Fig 6. Efficiency – Margin 4dB, Scaled
(Dashed line: Conventional, Solid line: Proposed)

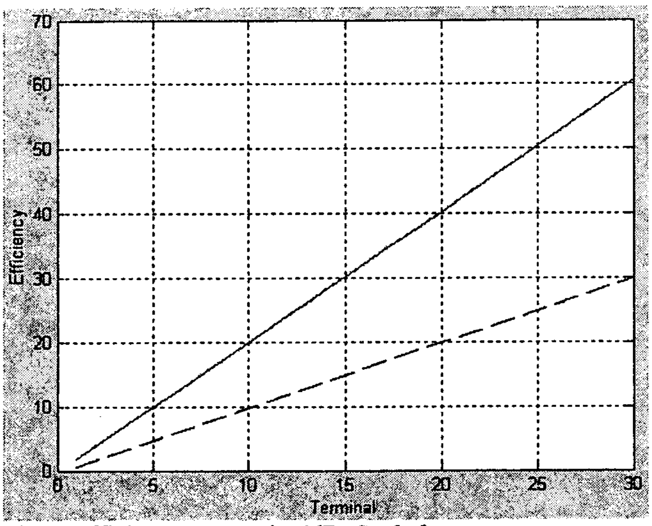

Fig 7. Efficiency – Margin 6dB, Scaled
(Dashed line: Conventional, Solid line: Proposed)

In wireless network, one of the most important thing provides seamless connection. Important requirements of handoff are things such as low latency, quality of service guarantee, and low signaling traffic. By requiring handoff on necessary cell, the proposed method can reduce resources that is reserved on adjacent cells and can satisfy above handoff requirements. Therefore, the proposed scheme can increase whole capacity of networks. In this paper, we apply techniques that is proposed in IS-95 and DS-CDMA to wireless IPv6 network. In the existing scheme, resources are wasted by broadcasting resource reservation message to inter-cell base stations when soft handoff arises.

In this paper, to reduce wasted resources we proposed an efficient method which uses enhanced resource reservation technique. Simulation results presented in section 4 show that the proposed scheme can reduce reserved resources and wasted resources.

References

[1] Charles E. Perkins, Jim Bound., "DHCP for IPv6," *IEEE computers and communications*, pp 493-497, Sep., 1998. [2] K. Hwang, *Computer Arithmetic*, John Wiley, 1997.

[2] J. Bound et al,. "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)," *IETF draft-ietf-dhc- dhcpv6-19.txt*, Jul., 2001

[3] Bill Croft, John Gilmore, "BOOTSTRAP PROTO COL (BOOTP)," *IETF http://www.ietf. org/rfc/ rfc0951.txt*, Sep., 1985.

[4] R. Droms, "Dynamic Host Configuration Protocol," *IETF http://www.ietf.org/rfc/ rfc2131.txt*, March, 1997.

[5] Charles E. Perkins, "Mobile Networking Through Mobile IP," *IEEE Internet* Computing vol.2, no.1, 1998.

[6] Seiichi Sampei, *Applications of Digital Wireless Technologies to Global Wireless Communications*, Prentice Hall, pp.355-374, 1997.

[7] Joseph C. Liberti, JR., Theodore S. Rappaport, *Smart antennas for wireless communications: IS-95 and Third Generation CDMA Applications*, pp 140-149, Prentice Hall, 1999..

[8] T.S. Rappaport and L.B. Milstein, "Effects of Radio Propagation Path Loss on DS-CDMA Cellular Frequency Reuse Efficiency for the Reverse Channel," *IEEE Trans. on Vehicular Technology*, Vol. 41, No.3, Aug. 1992.