AUTOCONFIGURATION TECHNOLOGIES FOR IPv6 MULTICAST SERVICE IN MOBILE AD-HOC NETWORKS

Jaehoon Jeong, Jungsoo Park

Protocol Engineering Center, ETRI,
161 Gajong-Dong, Yusong-Gu, Daejon 305-350, Korea
{paul, pjs}@etri.re.kr

ABSTRACT

This paper presents the autoconfiguration technologies that can be used for the service of multicast applications such as video conferencing in IPv6-based mobile ad-hoc networks. Because the mobile node can configure a unicast address through IPv6 unicast address autoconfiguration and some applications that need multicast address allocation can get a unique multicast address through IPv6 multicast address autoconfiguration, the user of mobile node can use some kinds of multicast services easily with zeroconfiguration.

1. INTRODUCTION

Mobile Ad-hoc Networks (MANET) are the networks where mobile nodes can communicate with one another without communication infrastructure such as base station or access point [1]. When mobile nodes communicate in the environments such as battle field, airplane and boat where are separated from the Internet, they need to construct a temporary and infrastructureless network. Recently, according that the necessity of MANET increases, the development of ad-hoc routing protocols for multi-hop MANET is activated very strongly. Multicast routing protocols for multicast service such as video conferencing are also being developed. With this trend, if IPv6 that has lots of good functions such as stateless address autoconfiguration for address configuration is adopted well in MANET, users in MANET will be able to communicate more easily. So we have become to want to maximize the autoconfiguration facility of IPv6 which is known as what is called zeroconfiguration that provides easy configuration [2].

This paper suggests two mechanisms related to autoconfiguration technology for supporting IPv6 multicast service in MANET. The first is unicast address autoconfiguration through which a unique unicast address is configured in mobile node and the second is multicast address autoconfiguration through which a unique multicast address is allocated to application that needs a new multicast address.

This paper is organized as follows;
In Section 2, related work is presented. In Section 3, we describe two mechanisms related to autoconfiguration technology for multicast service in MANET. In Section 4, we suggest the method of applying these mechanisms to multicast applications over MANET through the service scenario of a multicast application and then provide the guide to the implementation for such a multicast application and the kernel. Finally, in Section 5, we conclude this paper and present future work.

2. RELATED WORK

We describe the ad-hoc routing protocols that are being researched and developed for ad-hoc network and then summarize the autoconfiguration in IPv6.

2.1 Ad-hoc Routing Protocols

As shown in Table. 1, ad-hoc unicast routing protocols may be generally categorized as two kinds; (a) Table-driven Routing Protocols and (b) Demand-driven Routing Protocols [1]. In Table-driven, mobile nodes exchanges routing information in advance and are ready to communicate. In Demand-driven, when mobile nodes start to communicate, the route discovery is initiated by source and the route between source and destination is set up.

Table 1. Classification of Ad-hoc Routing Protocols

Table-driven Routing Protocols	Demand-driven Routing Protocols
DSDV, CGSR, WRP, OLSR	AODV, DSR, LMR, TORA, ABR, SSR

For ad-hoc multicast routing protocols, the multicast routing protocols that are based on DSR or AODV are being developed [3]-[6].

2.2 Autoconfiguration in IPv6

IPv6 unicast address can be configured in network interface card (NIC) through Neighbor Discovery Protocol (NDP) and Stateless Address Autoconfiguration [7][8].

In MANET, mobile node is not only host but also router.

0-7803-7533-5/02/$17.00 ©2002 IEEE.

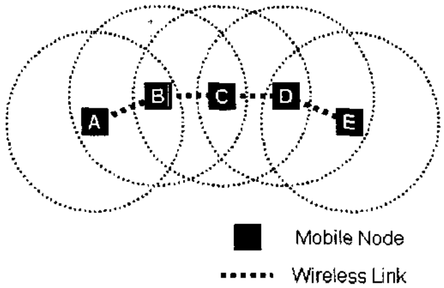

Figure 1. Network Topology

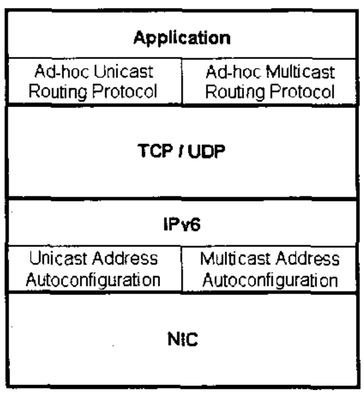

Figure 2. Protocol Stack of Mobile Node

The current NDP that for unicast address configuration, sends RA (Router Advertisement) messages periodically in link-local all node multicast address is not suitable to MANET that has dynamic topology. The current Duplicate Address Detection (DAD) that checks whether tentative unicast address is being used by other mobile node can not work well in MANET without some modifications, either. Therefore NDP is also necessary to extend [9][10].

3. AUTOCONFIGURATION FOR MULTICAST SERVICE IN MANET

The protocol stack of mobile node and the autoconfiguration technologies for the unicast address configuration which is indispensable for the communication over MANET and the multicast address allocation which is needed for some multicast services in MANET are presented in this section.

3.1 Network Topology

In MANET shown in Figure 1, the following five mobile nodes (i.e. A, B, C, D and E) are connected through ad-hoc routing protocol. A is adjacent to B, B is adjacent to A and C and so on.

Table 2. MANET Prefixes

Prefix Name	Prefix Value
MANET_INIT_PREFIX	fec0:0:0:fffe::/64
MANET_PREFIX	fec0:0:0:ffff::/64

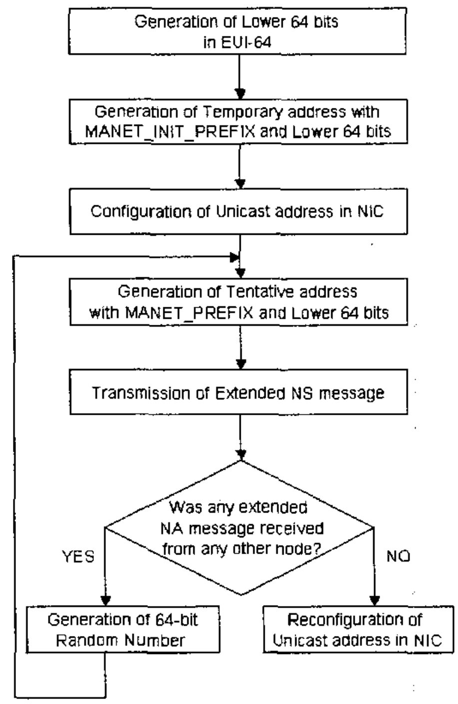

Figure 3. Procedure of Site-local Unicast Address Autoconfiguration

When A communicates with E, the intermediate mobile nodes (i.e. B, C and D) should play the role of router. This topology will be changed according to the movement of mobile nodes.

3.2 Protocol Stack

The structure of the protocol stack that is needed in order to provide mobile node with multicast service is shown in Figure 2.

In Application layer, both ad-hoc unicast routing protocol and ad-hoc multicast routing protocol are executed. In IPv6 layer, unicast address autoconfiguration for unicast address configuration and multicast address autoconfiguration for multicast address allocation are implemented. In this environment, the mobile node that executes the multicast application which needs multicast address allocation can configure a unicast address in its NIC through stateless address autoconfiguration and then can allocate a multicast address to the application through multicast address autoconfiguration by itself, namely without multicast address allocation server.

3.3 Unicast Address Autoconfiguration

Because this paper doesn't consider the global connectivity to the Internet, it assumes that MANET is a temporary network isolated from the Internet and the scope of addresses used in MANET is site-local [9][10]. MANET exclusive prefixes are defined like Table 2. Unlike [9], we use two prefixes of length 64; MANET_INIT_PREFIX is for temporary unicast address and MANET_PREFIX is for actual unicast address. The subnet ID of MANET_INIT_PREFIX is fffe and that of MANET_PREFIX is ffff.

MANET_INIT_PREFIX is the prefix for temporary source address that is used temporarily in order that mobile node configure a unique site-local unicast address of prefix MANET_PREFIX in NIC. The lower 64 bits of the temporary source address are configured in EUI-64 [11].

After mobile node configures a temporary unicast address in its NIC, it reconfigures a unique site-local unicast address in its NIC through the procedure of Figure 3.

In the last step of Figure 3, when an actual unicast address is configured in NIC of mobile node, the temporary source address is not used any more as the source address.

The important point in Figure 3 is that when a unicast address is composed of MANET_PREFIX and the lower 64 bits, it is only a tentative address of which the uniqueness of the address has not been verified in MANET yet. Mobile node must check the uniqueness of the address with DAD [7][8]. Because the current DAD works only in link-local scope, NDP should be extended so that it work in site-local scope. Therefore this paper uses the extended NS (Neighbor Solicitation) message and NA (Neighbor Advertisement) message which are suggested in [9].

3.4 Multicast Address Autoconfiguration

The format of site-local unicast address and that of site-local multicast address are shown in Figure 4 [12][13].

A unique site-local scoped multicast address is formed as follows;

So that we indicate the multicast address of Figure 4 (b) is based on network prefix, P-bit (Prefix bit) is set to 1. So that we indicate the address is used temporarily, T-bit (Temporary bit) is set to 1. Because the scope of the address is site-local, the Scope field is set to 5. The Subnet ID field of the multicast address is set to the value of that of the site-local scoped unicast address of Figure 4 (a), ffff (the subnet ID of MANET_PREFIX). The Interface ID field of the multicast address is set to the value of that of the unicast address, the lower 64 bits of site-local scoped unicast address configured in Figure 3. The Group ID field is set to a 32-bit random number generated by mobile node.

If a multicast application requests the allocation of a multicast address to the kernel, it is allocated a multicast address by the kernel in the procedure of Figure 5.

In this way, as a unique site-local multicast address can be constructed by mobile node itself, namely without multicast address allocation server, this mechanism for multicast address allocation is suitable to MANET [13][14].

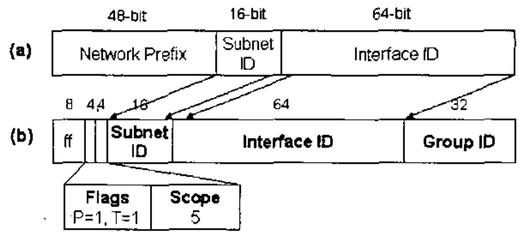

Figure 4 (a) Format of Site-local Unicast Address

Figure 4 (b) Format of Site-local Multicast Address

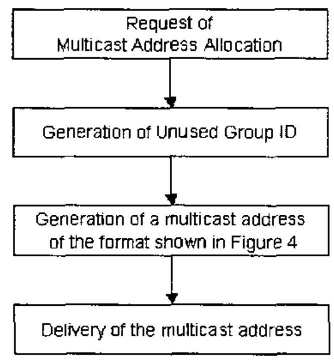

Figure 5. Procedure of Site-local Multicast Address Autoconfiguration

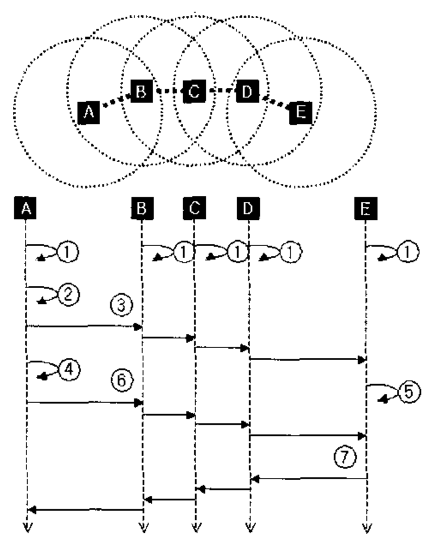

Figure 6. Multicast Service Scenario

4. SERVICE OF MULTICAST APPLICATION

After mobile node configures site-local unicast address in its NIC through unicast address autoconfiguration of Section 3.3, mobile nodes can communicate with one another through ad-hoc routing protocol in the multi-hop ad-hoc network. When a multicast application over mobile node needs the allocation of a unique multicast address, it can be allocated a multicast address through multicast address autoconfiguration of Section 3.4.

In this section, we show the usage of these two mechanisms presented in this paper through the service scenario of video conferencing application that is one of famous multicast applications.

4.1 Service Scenario

When the configuration of unicast address in each mobile node has been completed and ad-hoc routing protocols for unicasting and multicasting start to work, all the mobile nodes of the upper side of Figure 6 become to be connected through ad-hoc routing protocols.

The lower side of Figure 6 describes the service scenario of video conferencing in MANET. Table 3 explains the service scenario of Figure 6 step by step.

Table 3. Steps of Multicast Service Scenario

Step	Related Nodes	Description of the Step
1	A, B, C, D, E	Each mobile node autoconfigures its site-local unicast address through the extended DAD.
2	A	When a videoconferencing application of mobile node A creates a session named as S, a site-local multicast address for session S is autoconfigured.
3	A, B, C, D, E	A multicasts the information for session S and the rest of the nodes receive it.
4	A	A joins session S.
5	E	When E joins session S, the multicast route between E and A is set up.
6	A, B, C, D, E	A sends videoconferencing data to E in multicast. B, C and D relay the data packet of A to E through multicasting.
7	A, B, C, D, E	E sends videoconferencing data to A in multicast. D, C and B relay the data packet of E to A through multicasting.

4.2 Guide to Implementation

When a multicast application such as SDR (Session Directory) that is one of UCL Mbone conferencing applications needs a multicast address for a new session, it can be allocated a site-local multicast address from API function allocmcastaddr() shown in Figure 7 [15].

The parameter socket of which type is int is Socket Descriptor. The parameter mcastaddr of which type is struct in6_addr* is used for getting a site-local multicast address [16].

```
int allocmcastaddr (int socket, struct in6_addr* mcastaddr);

                                 Returns: 0 if OK, -1 on error
```

Figure 7. API Function for Multicast Address Allocation

The kernel maintains the information of multicast address allocation through multicast address table of which the fields consist of a socket descriptor, a list of allocated multicast addresses and a list of used Group IDs.

5. CONCLUSION

Mobile Ad-hoc Networks (MANET) that are temporarily constructed networks and have dynamic topology support the communication among mobile nodes in the infrastructureless environment. Until now the research of MANET has been focused on the development of ad-hoc routing protocols.

This paper presented two IPv6 autoconfiguration technologies that help users to use some kinds of multicast services easily in MANET, which is assumed as site-local network in this paper.
The first is the unicast address autoconfiguration which configures a unique IPv6 site-local unicast address in mobile node. The second is the multicast address autoconfiguration which allocates a unique IPv6 site-local multicast address to a multicast application without multicast address allocation server. If these technologies are used in MANET, users can not only communicate easily with one another in MANET but also use easily some kinds of multicast service that need multicast address allocation.

In near future, after we implement IPv6-based ad-hoc unicast/multicast routing protocols and the autoconfiguration technologies presented in this paper, we will construct the integrated mobile ad-hoc environment for the support of the multicast services such as videoconferencing, multi-party networked games and real-time collaborative applications.

6. REFERENCES

[1] Elizabeth M. Royer and Chai-Keong Toh, "A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks", IEEE Personal Communications, April 1999.

[2] M. Hattig, "Zeroconf IP Host Requirements", (work in progress) draft-ietf-zeroconf-reqts-09.txt, August 2001.

[3] David B. Johnson et al., "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks (DSR)", (work in progress) draft-ietf-manet-dsr-07.txt, February 2002.

[4] Jorjeta G et al., "A Simple Protocol for Multicast and Broadcast in Mobile Ad Hoc Networks", (work in progress) draft-ietf-manet-simple-mbcast-01.txt, July 2001. .

[5] Charles E. Perkins, Elizabeth M. Belding-Royer and Samir R. Das, "Ad hoc On-Demand Distance Vector (AODV) Routing", (work in progress) draft-ietf-manet-aodv-10.txt, January 2002.

[6] Elizabeth M. Royer and Charles E. Perkins, "Multicast Ad hoc On-Demand Distance Vector (MAODV) Routing", draft-

ietf-manet-maodv-00.txt, July 2000.
[7] T. Narten, E. Nordmark and W. Simpson, "Neighbor Discovery for IP Version 6 (IPv6)", RFC2461 , December 1998.
[8] S. Thompson and T. Narten, "IPv6 Stateless Address Autoconfiguration" , RFC2462 , December 1998.
[9] Charles E. Perkins et al., "IP Address Autoconfiguration for Ad Hoc Networks", draft-perkins-manet-autoconf-01.txt, Nov 2001.
[10] Jung-Soo Park, Yong-Jin Kim and Sung-Woo Park, "Stateless address autoconfiguration in Mobile Ad Hoc Networks using site-local address", draft-park-zeroconf-manet-ipv6-00.txt, July 2001.
[11] Matt Crawford, "Transmission of IPv6 Packets over Ethernet Networks", RFC2464, December 1998.
[12] R. Hinden and S. Deering, "IP Version 6 Addressing Architecture", (work in progress) draft-ietf-ipngwg-addr-arch-v3-07.txt, November 2001.
[13] Jung-Soo Park and Myung-Ki Shin, "Link Scoped IPv6 Multicast Addresses", (work in progress) draft-ietf-ipv6-link-scoped-mcast-02.txt, July 2002.
[14] B. Haberman and D. Thaler, "Unicast-Prefix-based IPv6 Multicast Addresses", (work in progress) draft-ietf-ipngwg-uni-based-mcast-03.txt, October 2001.
[15] UCL Mbone Conferencing Applications, http://www-mice.cs.ucl.ac.uk/multimedia/software/
[16] R. Gilligan et al., "Basic Socket Interface Extensions for IPv6", RFC2133, April 1997.