Proposal of proxy mechanisms from general node in NTMobile networks

Fumihito Sugihara*, Katsuhiro Naito†, Hidekazu Suzuki‡, Akira Watanabe‡, Kazuo Mori*, Hideo Kobayashi*
*Department of Electrical and Electronic Engineering, Mie University, Tsu, Mie 514-8507, Japan
†Faculty of Information Science, Aichi Institute of Technology, Toyota, Aichi 470-0392, Japan
‡Graduate School of Science and Technology, Meijo University, Nagoya, Aichi 468-8502, Japan

I. Introduction

Connected various types of devices can create a new ecosystem of devices known as the Internet of Things (IoT). Specifically, the potential of Machine to Machine (M2M) has been attracting attention for household appliances, automobiles, vending machines, industrial machinery, and other equipment because M2M communication enables devices to communicate with each other directly and without human operations. The exhaustible address number in IPv4 is well known topics in Internet. IPv6 is the new solution for the issues and will be introduced into various networks in the near future. As the results, both IPv4 and IPv6 will be used for Internet communication. The compatibility between IPv4 and IPv6 is not supported due to difference of the address structures. Therefore, direct communication between devices in IPv4 and IPv6 networks is difficult in M2M services. Additionally, Network Address Translation (NAT) is usually employed in IPv4 networks due to the shortage of address space. Hence, both devices behind NAT routers cannot communicate each other due to the block function for incoming communication.

The authors think that IP mobility mechanisms are a good solution for these issues about the lack of accessibility in M2M services. Dual Stack Mobile IPv6 (DSMIPv6) [1] is the well known IP mobility protocol. However, it generally requires public addresses for home addresses. The authors also have proposed another IP mobility called Network Traversal with Mobility (NTMobile) that achieves mobility and connectivity between IPv4 and IPv6 networks by using virtual IP addresses [2], [3]. NTMobile can provides direct accessibility between devices behind NAT routes and between IPv4 and IPv6 networks. However, communication services for general nodes, which do not support NTMobile, are not enough to be discussed. The paper proposes proxy mechanisms of web services for general nodes. Therefore, we introduce NTMobile Proxy Server (NPS) which supports two types of proxy mechanisms. Finally, we evaluate the implementation performance of NPS on Linux systems and show the feasibility of the proposed mechanisms.

II. Overview of NTMobile

The system of NTMobile consists of Direction Coordinators (DC), Relay servers (RS) and NTMobile end-nodes. The function of DC is to manage the mobile information of each NTMobile end-node and to direct a tunnel construction process to them. Relay servers are used for a replay operation of a tunnel between them when they cannot communicate directly due to NAT traversal and different of IP protocol version. The NTMobile network assigns a virtual IP address pool to each DC, and each DC assigns a virtual IP address in the pool to its NTMobile end-node. Therefore, each NTMobile end-node can be uniquely identified by the virtual IP address in the NTMobile network. Applications use it as a communication IP address because it is also allocated to a virtual interface. IP datagrams including the virtual IP address from applications are encapsulated by NTMobile functions, and are exchanged through the UDP tunnel.

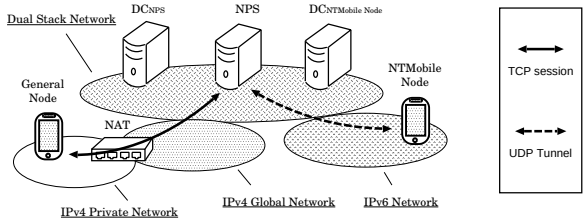

Fig. 1. Overview of NTMobile network with NTMobile Proxy Server

III. NTMobile Proxy Server

The conventional NTMobile supports only communication between NTMobile end-nodes. However, communication from a general node to a NTMobile end-node is also important function in practical usage. Fig. 1 shows overview communication with NTMobile Proxy Server (NPS). We assume that the M2M device employing NTMobile is used for services and it is controlled from the general node via web applications. Therefore, the connection from the general node is transfered to the M2M device through NPS. NPS consists of the NTMobile end-nodes function and a proxy server function, and supports two types of the proxy function.

A. Hostname lookup function

Hostname lookup process in the NTMobile network employs DNS (Domain Name System). NPS requires general nodes to access NTMobile end-nodes through itself. Therefore, the physical IP address of NPS is registered as A and AAAA records according to the FQDN of the destined NTMobile end-node. As the results, the general nodes try to access NPS instead of the destined NTMobile end-node.

B. NTMobile end-node function

NPS should exchange communication between NTMobile end-nodes and general nodes. Therefore, NPS implements the

TABLE I. APPLICATION VERSION

	Embedded board	NPS
OS	Linux	Linux
HTTP Server	Apache 2.2.22	Apache 2.2.22
Proxy Server	-	Squid 3.1.19

TABLE II. EXPERIMENTAL RESULT

	Response time [ms]		
	min	avg	max
Transparent proxy NPS (Squid)	5.7	6.6	12.1
Application proxy NPS (Apache)	23.5	28.5	41.6

function of NTMobile end-nodes to communicate NTMobile end-nodes in the NTMobile network. As the results, NPS has two types of interface: a virtual interface for the virtual IP address in NTMobile network and a physical interface for the physical global IP address in general Internet.

C. Proxy function

We assume two types of web applications. The web applications in the first type exist on M2M devices. Therefore, NPS should transfer HTTP communication between general nodes and M2M devices. This type of applications requires high performance devices to achieve sophisticated functions in itself. In the second type of the web applications, applications are separated to be implemented for M2M devices and NPS. Therefore, web applications on NPS should transfer HTTP communication by themselves. The benefit of the second type is easy to implement a separated part of all functions on M2M devices with a small computer resource and to implement a highly-functional web applications on NPS.

Transparent proxy NPS: The function of transparent proxy NPS is to transfer HTTP communication directly between a general node and a NTMobile end-node. We employ squid proxy server as the transparent proxy function. General nodes can communicate with NTMobile end-nodes with HTTP in the following process.

- A general node looks up a physical IP address by a FQDN of a destined NTMobile end-node, and obtains a physical IP address of NPS because the NPS address is registered as A and AAAA records for the NTMobile end-node.
- The general node accesses to NPS by HTTP. The transparent proxy function on NPS tries to communicate with the destined NTMobile end-node according to the host information in HTTP header.
- The NTMobile end-node function creates an UDP tunnel to the destined NTMobile end-node. Then, the transparent proxy function communicates through the created UDP tunnel.

Application proxy NPS: The function of application proxy NPS is to prepare a web application platform for each NTMobile end-node because the proxy function is performed by an original web application. We employ the virtual server function in apache web server for this purpose. General nodes can communicate with NTMobile end-nodes with HTTP in the following process.

- The application proxy NPS prepares web service for each FQDN of NTMobile end-nodes by the virtual server function in apache web server. Therefore, each application gets executed on the each virtual server space. It also implements the function to access NTMobile end-nodes by original protocol including HTTP etc. item A general node looks up a physical IP address by a FQDN of a destined NTMobile end-node, and obtains a physical IP address of NPS.
- The general node accesses to NPS by HTTP. The virtual server function executes an appropriate web application according to the FQDN of the destined NTMobile end-node.
- The web application on NPS tries to communicate with the destined NTMobile end-node.
- The NTMobile end-node function creates an UDP tunnel to the destined NTMobile end-node. Then, the web application communicates through the created UDP tunnel.

IV. IMPLEMENTATION AND EVALUATION

We have developed a sample web application to check sensor values and to control switches on an embedded board. The web application is implemented only on the embedded board for the transparent proxy NPS, and is implemented separately on the embedded board and NPS for the application proxy NPS. In the evaluation, we have measured the response time in the HTTP session. Tab. I shows the application version in the evaluation environment. Tab. II shows HTTP response time. From the results, we can find that the response time with squid is shorter than that with apache because the squid version just transfers a HTTP request, does not require to generate a new HTTP request.

V. CONCLUSION

In this paper, as a new feature of NTMobile, was introduced NTMobile Proxy Server (NPS). NPS supports two types of proxy functions: Transparent proxy NPS and Application proxy NPS. In the experiment, we can find that the proxy functions are performed well and communication overhead introduced by the NPS was small. In the final manuscript, we will show the more details of the implementation and evaluation results.

REFERENCES

[1] H. Soliman, "Mobile IPv6 Support for Dual Stack Hosts and Routers," RFC 5555, IETF, 2009.

[2] H. Suzuki, K. Kamienoo, T. Mizutani, T. Nishio, K. Naito and A. Watanabe, "Design and Implementation of Establishment Method of Connectivity on NTMobile," IPSJ Journal, Vol. 54, No. 1, pp. 367–379, Jan. 2013.

[3] K. Naito, K. Kamienoo, T. Nishio, T. Mizutani, H. Suzuki, A. Watanabe, K. Mori and H. Kobayashi, "Realization and Implementation of IP Mobility in NTMobile," IPSJ Journal, Vol. 54, No. 1, pp. 380–393, Jan. 2013.