早稲田大学大学院理工学研究科

博　士　論　文　概　要

論　文　題　目

Protocol Enhancement for
Advanced Usages of the Internet

プロトコルの増強によるインターネットの機能向上

申　請　者

氏　名		
	Hongbo	SHI
	史	虹波

専攻・研究指導
(課程内のみ)　情報科学専攻　情報アーキテクチャ

2004 年　5 月

The well-known protocols in the Internet, TCP/IP, have been used since 1983. The number of nodes in the Internet is still increasing everyday. And the users of the Internet cover all over the world. TCP/IP are old network protocols, and they are not functional well for the extended modern Internet. In the last ten years, many new protocols have been proposed and implemented in the Internet.

This paper proposes new methods to enhance the network protocols for advanced usages of the Internet. This project focuses on the following two specific protocols: Internationalized Domain Name in DNS (Domain Name System), and Mobile IPv6 in Mobile IP (MIP). This paper gives advanced functions to the existing Internet so that the users can enjoy the international domain names. It also realizes the dependable mobile communication through multiple home agents and home links.

Chapter 2 describes the existing mechanism of DNS (Domain Name System). It also explains the present problems in DNS. Domain Name System is widely used in the Internet. It is originally defined in RFC 1034 and RFC 1035 in 1987.

Due to the increasing number of the Internet users in the world, there is a strong demand for multilingual domain names. Multilingual domain names cover Japanese, Chinese and Korean names. In the existing domain name system, only the English name is allowed. The current DNS is restricted to a subset of 7-bit ASCII names. There has been a working group, Internationalized Domain Name (IDN) in IETF to provide a solution to the multilingual domain names. There are several IDN schemes proposed, including IDNS in Singapore, mDNS in Taiwan, cDNS in China and mDNkit in Japan. This paper proposes a new method, which is superior to those proposals.

Chapter 2 mentions several issues in IDN. IDN is basically bilingual. DNS is modified to cover each local language as well as English. In the current DNS, the mapping from an IP address to the domain name is limited to a canonical domain name. A new system would choose either an IDN name or an English ASCII domain name as the canonical name. Although the two domain names identify the same single host, one should select only one domain name as canonical. It is desirable to have all the local languages together. There is another problem. The existing IDN systems are designed without considering a mixed usage of local domain names.

In Chapter 3, this paper proposes a new method for realizing a set of internationalized domain names. It is a method called Global Domain Name System (GDNS). GDNS extends the usage of alias records, and gives reverse mapping information for multilingual domain names. The resource records (RRs)

used in our GDNS are the same as in the original IDN.

Our new system can use mixed language domain names in fully qualified domain names (FQDNs). For example, www.後藤研.情報.早稲田大学.jp and www.後藤研.info.waseda.ac.jp are valid domain names. In Japanese, there are several phonetically equivalent names, like www.後藤研.情報学科.早稲田大学.にほん (where the word “Japan” is given in Japanese Hirakana), www.後藤研.情報学科.早稲田大学.にっぽん (where the word “Japan” is given in an alternate pronunciation), www.後藤研.情報学科.早稲田大学.日本 (where the word “Japan” is giving in Chinese characters). Our new method allows these representations.

Chapter 4 presents yet another new method, which introduces new Resource Record types to cover multilingual domain names. The first new record is INAME and the other is IPTR. Through using INAME, one can improve the existing usage of the CNAME and DNAME records. INAME is used to relate two names simply. There is no difference nor classification between an alias and a canonical name. There is no difference in a primary name and a secondary name. In the new INAME record, there is one simple relation that means a cross reference among domain names.

Though GDNS has suggested to extend the tree structure in DNS to provide the reverse mapping for the IDN. It is not easy to allocate much domain space under the root in-addr.arpa. Moreover, the current PTR record cannot tell which kind of language is used in an internationalized domain name. This paper suggests an extension of PTR called IPTR. The language tag is added to the new IPTR record. By the use of the new IPTR record, a client can request an Internationalized Domain Name in a specified language. These two new RR types enhance IDN in DNS to provide a set of internationalized domain names.

Chapter 5 describes mobile IP (MIP) technology. Many Internet users have laptop personal computers and they are using wireless media to connect to the Internet. Several mobility supporting mechanisms are already proposed and actually implemented. They include wireless LAN 802.11x, cellular phone of 2.5G/3G, and PHS. A general solution called Mobile IP (Mobility Support on IP) is suggested at the network layer.

Mobile IP protocol is an extension to the standard IP protocol. The main goal of Mobile IP is to enable a mobile station to roam transparently throughout the Internet. It can maintain the proper IP-based connection to their home networks. A mobile node can keep the connections while it is moving freely in the Internet. Each mobile node has a home address as the unique identifier of the current

location. It takes the form of a routable unicast IP address. This address belongs to the home link of the mobile node. When a mobile node moves away from its home link and locates at a foreign link, it needs a new IP address of the current location inside the foreign link. A foreign link is a network other than the home link of the mobile node. The new IP address is called a care-of address. In order to keep the network connection, a mobile node has to register the current care-of address at the home agent. Then, the home agent can forward packets bound for the home address to the mobile node. A home agent works as a router in the home link of a mobile node. If a correspondent node has the valid binding information of a mobile node, then it can send the packet directly to the care-of address of the mobile node.

Chapter 6 proposes to have multiple home agents. In the original Mobile IPv6 specification, a mobile node has only one home agent at a time. If some troubles happen in the home agent, a mobile node uses the Dynamic Home Agent Address Discovery (DHAAD) to find a new home agent. It takes time to find a new home agent and to make it work properly. The most serious problem is that a mobile node cannot notice that its home agent is down until the mobile node registers or updates the binding information at the home agent. If a home agent is down, the mobile node that is located away from its home link cannot receive the newly arriving packets from the correspondent node (CN). The new method enhances the current Mobile IPv6.

Chapter 7 proposes to have multiple home links. In the current Mobile IP specification, a mobile node can have one single home link. Multiple Home Links mechanism is an extension of Multiple Home Agents. It allows a mobile node to have multiple home links instead of one single home link in the current Mobile IPv6 (MIP6). The multiple home agents in Chapter 6 can provide backups when a home agent is not working properly, all the home agents should reside on one single network segment. If we use multiple home links, a mobile node can use working home agents at a reachable home link. Thus, multiple home links mechanism provides more dependable mobile networks.

This paper gives advanced functions to the existing Internet so that the users can enjoy the international domain names. New resource records enable a set of Internationalized Domain Names. It also realizes the dependable mobile communication through multiple home agents and home links.

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研　究　業　績

種 類 別	題名、　　発表・発行掲載誌名、　　発表・発行年月、　　連名者（申請者含む）

研　究　業　績

種 類 別	題名、　　発表・発行掲載誌名、　　発表・発行年月、　　連名者（申請者含む）