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Dual Stack Hosts using "Bump-in-the-API" (BIA)
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Abstract

This document specifies a mechanism of dual stack hosts using a technique called "Bump-in-the-API"(BIA) which allows for the hosts to communicate with other IPv6 hosts using existing IPv4 applications. The goal of this mechanism is the same as that of the Bump-in-the-stack mechanism [[BIS](#)], but this mechanism provides the translation method between the IPv4 APIs and IPv6 APIs. Thus, the goal is simply achieved without IP header translation.

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1. Introduction

[RFC2767](#) [[BIS](#)] specifies a host translation mechanism using a technique called "Bump-in-the-Stack". It translates IPv4 into IPv6, and vice versa using the IP conversion mechanism defined in [[SIIT](#)]. BIS allows hosts to communicate with other IPv6 hosts using existing IPv4 applications. However, this approach is to use an API translator which is inserted between TCP/IP module and network card driver, so that it has the same limitations as the [[SIIT](#)] based IP header translation methods. In addition, its implementation is dependent upon the network interface driver.

This document specifies a new mechanism of dual stack hosts called Bump-in-the-API(BIA) technique. The BIA technique inserts an API translator between the socket API module and the TCP/IP module in the dual stack hosts, so that it translates the IPv4 socket API function into IPv6 socket API function and vice versa. With this mechanism, the translation can be simplified without IP header translation.

Using BIA, the dual stack host assumes that there exists both TCP(UDP)/IPv4 and TCP(UDP)/IPv6 stacks on the hosts.

When IPv4 applications on the dual stack communicate with other IPv6 hosts, the API translator detects the socket API functions from IPv4 applications and invokes the IPv6 socket API functions to communicate with the IPv6 hosts, and vice versa. In order to support communication between IPv4 applications and the target IPv6 hosts, pooled IPv4 addresses will be assigned through the name resolver in the API

translator.

This document uses terms defined in [IPv6], [[TRANS-MECH](#)] and [[BIS](#)].

2. Dual Stack Host Architecture using BIA

Figure 1 shows the architecture of the host in which BIA is installed.

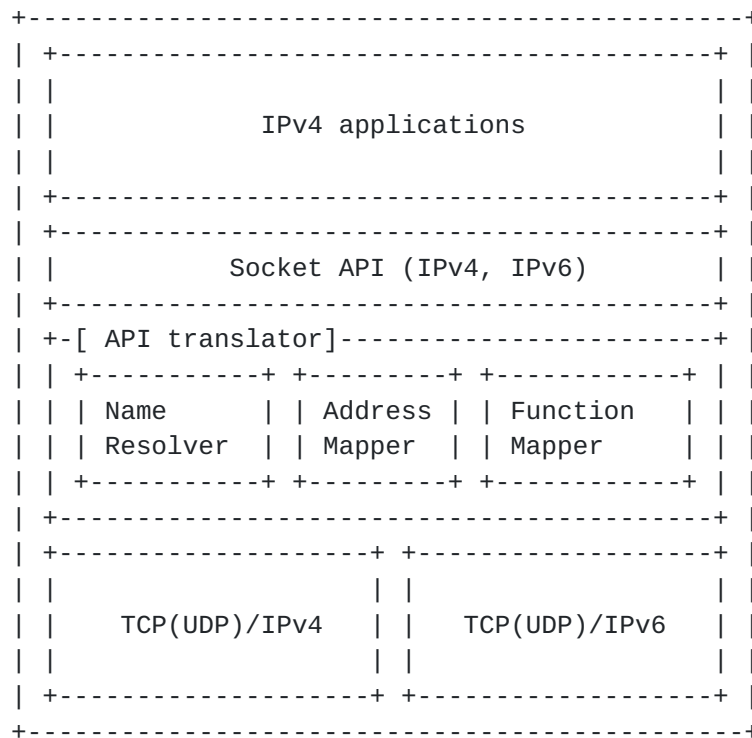


Figure 1 Architecture of the dual stack host using BIA

Dual stack hosts defined in [RFC1933](#) [[TRANS-MECH](#)] need applications, TCP/IP modules and addresses for both IPv4 and IPv6. The proposed hosts in this document have an API translator to communicate with other IPv6 hosts using existing IPv4 applications. The API translator consists of 3 modules, a name resolver, an address mapper and a function mapper.

2.1 Function Mapper

It translates IPv4 socket API function into IPv6 socket API function, and vice versa.

When detecting the IPv4 socket API functions from IPv4 applications, it intercepts the function call and invokes new IPv6 socket API functions which correspond to the IPv4 socket API functions. Those IPv6 API functions are used to communicate with the target IPv6 hosts. When detecting the IPv6 socket API functions from the data received from the IPv6 hosts, it works symmetrically in relation to the previous case.

2.2 Name Resolver

It returns a proper answer in response to the IPv4 application's request.

When the IPv4 application sends a query to a name server with A records, it detects the query, then creates another query to resolve both A and AAAA records for the host name, and sends the query to the server.

If only the AAAA record is available, it requests the address mapper to assign an IPv4 address corresponding to the IPv6 address, then creates the A record for the assigned IPv4 address, and returns the A record to the application.

NOTE: This action is the same as that of the Extension Name Resolver in [\[BIS\]](#).

[2.3](#) Address Mapper

It internally maintains a table of the pairs of an IPv4 address and an IPv6 address. The IPv4 addresses are assigned from an IPv4 address pool. It uses the unassigned IPv4 addresses (e.g., 0.0.0.0 ~ 0.0.0.255).

When the name resolver or the function mapper requests it to assign an IPv4 address corresponding to an IPv6 address, it selects and returns an IPv4 address out of the pool, and registers a new entry into the table dynamically. The registration occurs in the following 2 cases :

(1) When the name resolver gets only an 'AAAA' record for the target host name and there is not a mapping entry for the IPv6 address.

(2) When the function mapper gets a socket API function call from the data received and there is not a mapping entry for the IPv6 source address.

NOTE: This is the same as that of the Address Mapper in [\[BIS\]](#).

[3.](#) Behavior Examples

This section describes behaviors of the proposed dual stack host called "dual stack", which communicates with an IPv6 host called "host6" using an IPv4 application.

In this section, the meanings of arrows are as follows :

- > A DNS message for name resolving created by the applications and the name resolver in the API translator.
- +++> An IPv4 address request to and reply from the address mapper for the name resolver and the function mapper.
- ===> Data flow by socket API functions created by the applications and the function mapper in the API translator.

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3.1 Originator Behavior

This sub-section describes the behavior when the "dual stack" sends data to "host6".

When an IPv4 application sends a DNS query to its name server, the name resolver intercepts the query and then creates a new query to resolve both A and AAAA records. When only the AAAA record is resolved, the name resolver requests the address mapper to assign an IPv4 address corresponding to the IPv6 address.

The name resolver creates an A record for the assigned IPv4 address and returns it to the IPv4 applications.

In order for the IPv4 application to send IPv4 packets to host6, it calls the IPv4 socket API function.

The function mapper detects the socket API function from the application. If the result is from IPv6 applications, it skips the translation. In the case of IPv4 applications, it requires an IPv6 address to invoke the IPv6 socket API function, thus the function mapper requests an IPv6 address to the address mapper. The address mapper selects an IPv4 address from the table and returns the destination IPv6 address. Using this IPv6 address, the function mapper invokes an IPv6 socket API function corresponding to the IPv4 socket API function.

When the function mapper receives an IPv6 function call, it requests the IPv4 address to the address mapper in order to translate the IPv6 socket API function into an IPv4 socket API function. Then, the function mapper invokes the socket API function for the IPv4 applications.

Figure 2 illustrates the behavior described above:

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it.

The function mapper requests the IPv4 address to the address mapper in order to invoke the IPv4 socket API function to communicate with for

IPv4 application. Then the function mapper invokes the corresponding IPv4 socket API function for the IPv4 applications corresponding to the IPv6 functions.

Figure 3 illustrates the behavior described above:

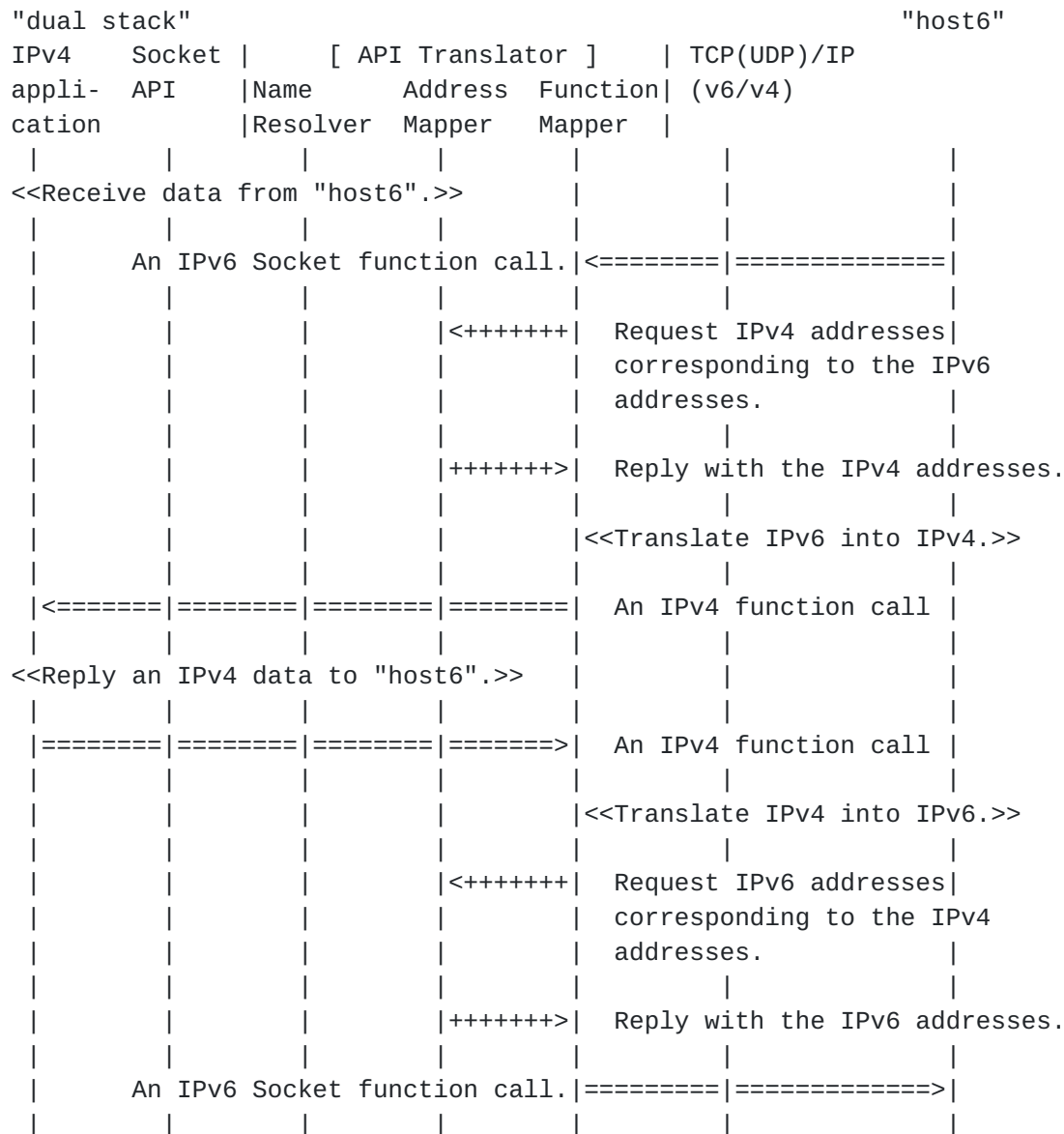


Figure 3 Behavior of Receiving data from IPv6 host

4. Considerations

4.1 Socket API Conversion

IPv4 socket API functions are translated into semantically the same IPv6

socket API functions and vice versa. It depends on operating systems. IP addresses embedded in application layer protocols (e.g., FTP, DNS, etc.) can be translated in API functions.

NOTE: Basically, IPv4 socket API functions are not fully compatible with IPv6 since the IPv6 has new advanced features.

[4.2](#) ICMP Message Handling

When an application needs ICMP messages values (e.g., Type, Code, etc.) sent from a network layer, ICMPv4 message values SHOULD be translated into ICMPv6 message values based on [[SIIT](#)], and vice versa. It can be implemented using raw socket.

[4.3](#) IPv4 Address Pool and Mapping Table

The address pool consists of the unassigned IPv4 addresses. However, if a number of IPv4 applications communicate with IPv6 hosts, the available address spaces will be exhausted. As a result, it will be impossible for IPv4 applications to communicate with IPv6 hosts. It requires smart management techniques for address pool. For example, it is desirable for the mapper to free the oldest entry and re-use the IPv4 address for creating a new entry. This issues is the same as [[BIS](#)].

[4.4](#) Internally Assigned IPv4 Addresses

The IPv4 addresses, which are internally assigned to IPv6 target hosts out of the pool, are the unassigned IPv4 addresses (e.g., 0.0.0.0 ~ 0.0.0.255). There is no potential collision with another use of the private address space when the IPv4 address flows out from the host.

[4.5](#) Implementation Issues

Some operating systems support the pre-load library functions, so it is easy to implement the API translator by using it. For example, user can replace all existing socket API functions with user-defined socket API functions which translate the socket API function. In this case, every IPv4 application has its own translation library using pre-load library which will be bound into the application before executing it dynamically.

The other operating systems support the user-defined layered protocol allowing a user to develop some additional protocols and put them in the existing protocol stack. In this case, the API translator can be implemented as a layered protocol module.

In the above two approaches, it is assumed that there exists both TCP(UDP)/IPv4 and TCP(UDP)/IPv6 stacks and there is no need to modify or to add a new TCP-UDP/IPv6 stack.

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5. Limitations

This mechanism supports unicast communications only. If it can support multicast functions, some other additional functionalities must be considered in the function mapper module.

Since the IPv6 API has new advanced features, it is difficult to translate this kind of IPv6 APIs into IPv4 APIs. Thus, IPv6 inbound communication with advanced features may be discarded.

6. Applicability Statement and Disclaimer

6.1 Applicability

The main purposes of this mechanism are the same as BIS [[BIS](#)]. It makes IPv4 applications communicate with IPv6 hosts without any modification of IPv4 applications. Since it uses the API level translation, the translation is simpler than the IP packet level translation. It is also possible to translate system independently through the socket level translation if the socket API can be supported at the same level on the IPv4 and IPv6.

6.2 Disclaimer

We strongly recommend that application programmers SHOULD use this mechanism only when an application source code is not available.

7. Security Considerations

Since the mechanism use the API translator at the socket API level, hosts can utilize the security of network layer (e.g., IPsec) when they communicate with IPv6 hosts using IPv4 applications via the mechanism.

8. Acknowledgments

We would like to acknowledge the implementation contributions by Wanjik Lee.

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