

# A Study on End-to-End Multihoming in IP version 6 Network

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## 1. Introduction

As organizations realize their Internet connectivity critical to their business mission, they seek ways of making their internet connectivity more robust against the operational outage. The multihoming often means of providing the fault-tolerant connectivity to the Internet-site. Recently, not only internet service providers (ISP) but also private organizations (e.g., universities or corporations) are often in multihoming environment. In other words, many networks in the Internet are connected to the Internet with multiple points.

It is generally said that the multihoming could achieve a redundant connectivity provisioning or a load balancing for each site. However, at this time, there are wide variety of mechanisms to provide multihoming, e.g., naming or directory services, routing, or physical connectivity, and the multihoming architecture is still under study.

It is realized that the multihoming is one of important function in IPv6. With the address allocation policy of IPv6 (i.e., IP address space is allocated by the upper service provider), each site that is connected with multiple providers are expected to be allocated multiple prefixes.

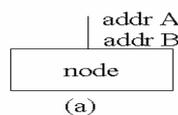
In this paper, we discuss (1) a definition of multihoming, (2) the set of functional requirements for multihoming system, and (3) mechanisms / architectures to achieve multihoming in IPv6 network. Though the multihoming support proposed in RFC2260 is dependent on routing behavior of providers' border routers, we propose a new multihoming architecture that is based on "end-to-end multihoming". With the end-to-end multihoming system, a fault-tolerant connectivity relies only on the pair of end-nodes, not on routers. The proposed architectures are based on the "mobility"

supporting protocols for IPv6, i.e., LIN6 and MIPv6.

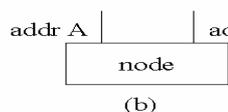
## 2. Definition and Motivations for Multihoming

The multihoming generally implies that there are multiple paths to reach a "home" destination. The technical challenge for this requirement is "How to establish multiple paths to reach home destination?". With this context, we can categorize the definition of multihoming by the following four cases.

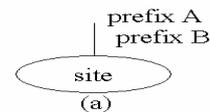
- Node multihoming
  - a node having more than one unicast address (Fig.1a).
  - a node having more than one interface (Fig.1b).
- Site multihoming
  - a site allocated more than one address prefix (Fig.2a).
  - a site having more than one external connectivity (with same or different prefixes) (Fig.2b).



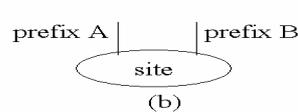
(a)



(b)



(a)



(b)

Fig.1 Node Multihoming

Fig.2 Site Multihoming

A site or host may establish its Internet connectivity from more than one Internet Service Provider due to the following reasons.

- (1) Maintaining connectivity via more than one ISP could be realized as a way to make connectivity to the Internet more reliable. When a connectivity through one of the ISPs is down, the connectivity via the other ISPs could preserve the site or host connectivity

to the Internet.

- (2) Maintaining connectivity via more than one ISP could allow the site or host to distribute traffic load among multiple connections/paths.

### 3. Multihoming Requirements

The followings would be the system requirements for multihoming system.

- (1) Redundancy

By multihoming, a site/host must be able to insulate itself from certain failure modes within one or more transit providers.

- (2) Load Sharing

By multihoming, a site/host must be able to distribute both incoming and outgoing traffic among multiple transit providers.

- (3) Simplicity

Multihoming solution should be as simple as possible.

- (4) Transport-Layer Survivability

Multihoming solutions should be able to provide re-homing<sup>1</sup> transparency for transport-layer sessions.

### 4. Categorization of Multihoming Architecture

We define the multihoming architecture into the following two categories.

#### 4.1 Exit Router Approach (RFC2260)

Exit router approach[1] tries to deliver the packets of any source and destination pair during failure on corresponding exit link. With the exit router approach, the border routers establish secondary links (tunnels), between ISPs and site exit border routers, as shown in Fig.3.

1. Obtain addresses from multiple ISPs. An end host in the multihome IPv6 network can get addresses from multiple ISPs, or can get a single address.
2. Configure backup link over other physical link.
3. In the ordinary operation, the primary link is applied for packet routing.
4. When a primary link is down, the corresponding secondary link is selected as the alternative route to the destination, in order to preserve the

<sup>1</sup>The term "re-homing" denotes a transition of a host/site between two states of connectedness, due to a change in the connectivity between the host/site and its transit providers.

connectivity to the destination node.

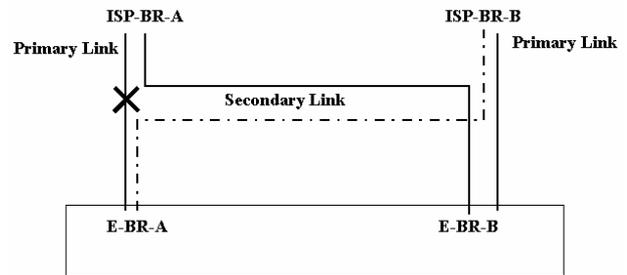


Fig.3 Exit Router Approach (RFC2260)

The drawbacks of this approach are;

- No available tools for ISP selection to achieve a load sharing.
- Co-operation among the ISPs are mandatory requirement. This approach may have management complexity because of the need of tunnel configuration among ISPs.
- Can not provide a fault tolerant operation in case of ISP failure

#### 4.2 End-to-End Approach

With the end-to-end approach, end hosts provide the multihoming. A fault-tolerant connection can be achieved relying not on routers but on the pair of end-nodes only (Fig. 4).

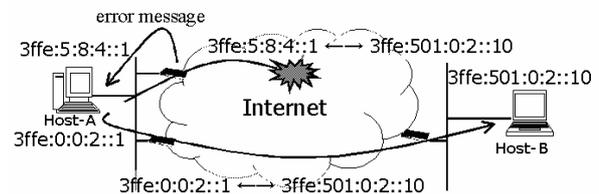


Fig.4 End-to-End Approach

In this approach, end hosts have to manage the different addresses and they need to know each other which address pair is used for every connection.

The hardest issue of this approach would be the lack of network status information at the end nodes so as to select the address pair to be used for. At this moment of time, there is no useful solution, i.e. if an address fails, just try with another one.

#### 4.3 Exit Router Approach vs End-to-End Approach

It's clear that the exit router approach is only dependent on the routing protocol coordination applied in boarder routers. Therefore, it requires no host changes, it

needs no implementation change, and it requires the implementation changes only in specific nodes. But, it needs the coordination among ISPs to establish the secondary links (tunnel).

On the other hand, the end-to-end approach tries to find the best source and destination pair during the connection establishment phase and switch to better source and destination pair during connection when the failure is detected by the end host. Multihoming provision depends on the end terminal, i.e., it does not depend on routers. This means that the end-to-end approach requires no change to router configuration, but it only requests the implementation change to end hosts requiring multihoming capability.

### 5. End-to-End Multihoming Solutions

We realize that most mobility mechanisms, such as LING and MIPv6, can be used for multihoming. Especially, these mechanisms would be useful to solve the issue for the transport layer survivability, because of its capacity to support two addresses for the same node.

#### 5.1 Multihoming with LING Mechanism

LING (Location Independent Network Architecture for IPv6) [2] is one of the mobile network architectures for IPv6 network. In LING, 128bit-long IPv6 address is divided into two parts. The first half is called "locator" and the second half is "identifier". In LING, 64-bit LING ID is used as the node identifier. Each LING node has a unique LING ID in addition to the traditional IPv6 address. The resolution of IDs to locators are provided by Mapping Agents (MA). MA discovery is performed by a newly defined DNS resource record pointing to a corresponding MA associated to names of the nodes it serves.

Assume that a Mobile Node (MN) is in a multihomed network and obtains multiple locators (Loc1, Loc2, Loc3). Corresponding Node (CN) is the communication partner of the Mobile Node. The mechanism (Fig.5) are

1. MN registers all the locators (Loc1, Loc2, Loc3) to MN's MA which manages MN's location.

2. CN which wants to communicate with a MN makes a AAAA-query to a DNS server, and obtains the IP address of the MN's MA.
3. CN queries MA where MN is located.
4. MA replies to CN that "MN is located under Loc1, Loc2 and Loc3".
5. CN communicates with MN directly.
6. The packet which was transmitted by MN did not reach at the CN because any causes.
7. The CN changing the locator and transmits the packet for the second time.

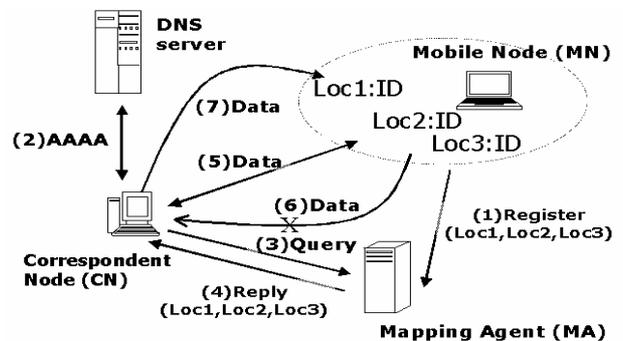


Fig.5 Multihoming with LING Mechanism

The concerns of this mechanism are;

- (1) It introduces modifications in the protocol, both on network layer and on transport layer.
- (2) LING installation is required for both hosts regarding the connection, i.e., not only for the host belonging to the multihomed site but also for the host belonging to the non-multihomed site.
- (3) This mechanism does not provide any tool for load sharing or ISP selection.
- (4) This mechanism also could have impact on security issues, like connection hijacking.

#### 5.2 Multihoming with MIPv6 Mechanism

MIPv6 (Mobile IP for IPv6) [4] is a well-known mobility solution in IPv6 with a global scale. We propose that multihoming is achieved by the use of care-of-address to switch from delegated addresses (i.e., home address) in case of failure. (Fig.6)

1. Suppose that there is an established communication between hostA belonging to the multihomed site and hostC, somewhere

in the Internet. The connection is being routed through ISPA and PrefA:X:ID is used.

2. ISPA goes to be down with any reasons.
3. HostA packets contain the home address destination option with PrefA:X:ID and PrefB:X:ID as source address, so that for every device on the path source address is PrefB:X:ID and only hostB replaces this source address by PrefA:X:ID.
4. HostA sends a binding update containing PrefB:X:ID as a care-of address. Note that authentication header must be included in this packet.
5. HostC sends a binding acknowledgement. This packet and all next packets are sent with PrefA:X:ID as final destination included in a routing header and PrefB:X:ID as next destination included as destination address. Consequently, all packets are sent towards HostA using ISPB, and address translation is performed at destination host (HostA) when packets reach HostA.

The advantages of this mechanism are

- The mechanism provides complete fault tolerance.
- It uses existing protocols.
- It allows ISP selection for load sharing.

On the other hand, the concerns are

- Needs MIP features on destination host.
- A security association is needed in both hosts, which must be established before the failure.

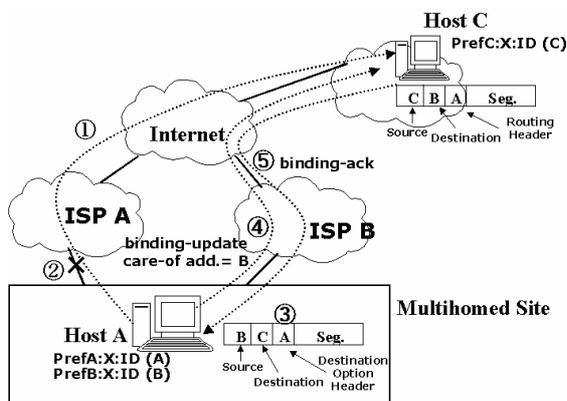


Fig.6 Multihoming with MIPv6 Mechanism

### 5.3 Comparison between Multihoming with LIN6 and MIPv6

Table 1 compares the multihoming with LIN6 and MIPv6 .

	Multihoming with LIN6	Multihoming with MIPv6
Redundancy	Support	Support
Load Sharing	Not provide	Allow
Simplicity	Needs modifications in the protocol	Uses existing protocol
Transport-Layer Survavibility	Support	Support

Table 1: Comparison between Multihoming with LIN6 and MIPv6

### 6. Conclusions and Future Works

We discuss a new multihoming mechanism approach called “end-to-end multihoming” which achieves a fault-tolerant connection that relies only on the pair of end-nodes. Then, we propose the end-to-end multihoming architectures using the protocols to support “mobility” for IPv6, i.e., LIN6 and MIPv6.

For the future works, we plan to develop and implement multihoming solution with MIPv6 mechanism and propose solutions for unsolved problems such as failure detection and the mechanism to choose the best path should be used to send or receive data traffic when multiple path exist.

### References

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