Harmless IPv6 Address State Extension (Uncertain State)

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Abstract

This document describes a new IPv6 address state called "Uncertain" address state as an extension of IPv6 address state specification. "Uncertain" address state is designed to introduce two functionalities. One is to achieve "Temporary Address Reservation" function. The other is to avoid a DAD (Duplicate Address Detection) time consuming problem for dynamically created addresses.

New "Uncertain" Address State is inserted between "Tentative" address state and "Valid" address state. After "Tentative" address state (DAD operation has finished) for a newly created address, its state will enter to "Uncertain" address state. While an address stay at "Uncertain" address state, the address is behaved as if it is temporary reserved by the node exclusively. (The other nodes can not obtain such a reserved address.) When it becomes really necessary for the node to utilize the temporary reserved address, its address state is changed into "Valid" address state without accompanying time consuming DAD operation. By these procedures, we can avoid the DAD problem.
1. Introduction

This document describes a new IPv6 address state called "Uncertain" address state as an extension of IPv6 address state specification. "Uncertain" address state is designed to introduce two functionalities. One is to achieve "Temporary Address Reservation" function. The other is to avoid a DAD (Duplicate Address Detection) time consuming problem for dynamically created addresses.

New "Uncertain" Address State is inserted between "Tentative" address state and "Valid" address state. After "Tentative" address state (DAD operation has finished) for a newly created address, its state will enter to "Uncertain" address state. While an address stay at "Uncertain" address state, the address is behaved as if it is temporary reserved by the node exclusively. (The other nodes cannot obtain such a reserved address.) When it becomes really necessary for the node to utilize the reserved address, its address state is changed into "Valid" address state without accompanying time consuming DAD operation. By these procedures, we can avoid the DAD problem.

"Uncertain" address state is realized by not replying to NS (Neighbor Solicitation) query messages for L2 address resolving for temporary reserved addresses. Since this method is achieved by just changing current NS messages handling implementation from reply to ignore (not reply), it is very simple and easy to implement. Furthermore, "Uncertain" address state extension is harmless and can coexist with current implementations without causing any problems, because it is realized by ignoring existing NS messages for L2 address queries.

The Uncertain address state specification has been implemented, and its basic functionalities have been verified.

2. Problems on Dynamically Generated Addresses

There are two types of problems on dynamically generated addresses (e.g., CoA (care of address) of Mobile IP [RFC3775], Ephemeral Address [Ephemeral]).

One is DAD time consuming problem.

The other is temporary address reservation function missing problem.
2.1 DAD time consuming problem

In the IPv6 specifications [RFC4861][RFC4862], the DAD procedure is defined. All addresses verified their values’ uniqueness before they become "Valid" address state by using the DAD operation. While the DAD operation is running, their address state is called "Tentative". So, state of all addresses are changed into "Tentative" -> "Valid" -> "Invalid". (See left figure of Fig.1.)

Since the DAD operation adopts NO-reply type duplicate verification method, it takes long time. (In typical Ethernet situation, it takes one second.) This becomes a big problem for a user who would like to use dynamically generated addresses soon after they are generated.

In order to meet this problem, two types of solution approaches are known. One is to "SKIP" DAD operation. It is based on an optimistic assumption that address collision rate is too low. Optimistic DAD method [RFC4429] is categorized into this type. This method is very effective from realistic viewpoints, but this method would not become a perfect solution. If address collision happens, we have to pay much cost to fix the case.

The other is to "DO" DAD operation every time, but timing when DAD operation is done is changed. In this method, address collision never happens, and we don’t have to worry about address collision cases. No bad effects to the existing implementations are found in this method. This document chooses the latter method, and DAD operation timing is changed.

2.2 Temporary address reservation function missing problem

In the IPv6 specifications, no temporary address reservation function is defined. Therefore, it is impossible for nodes to reserve addresses for future use with current IPv6 specification. (In the DHCPv6, address pool function exists. However, addresses are not truly reserved in such a pool. Even if an address is located at the pool, it can be used (robbed) by a node that is not related with the pool.) It is required that true address reserving function is achieved.

3. Design and Definitions of Uncertain Address State

In order to meet above described two problems, an idea "Uncertain" address state is introduced. "Uncertain" Address State is inserted
between "Tentative" address state and "Valid" address state. Fig. 1 shows an overview of "Uncertain" Address State.

After "Tentative" address state (DAD operation has finished) for a newly created address, its state will enter to "Uncertain" address state. While an address stay at "Uncertain" address state, the address is behaved as if it is temporary reserved by the node exclusively. (The other nodes can not obtain such a reserved address.) When it becomes really necessary for a node to utilize
the reserved address, its address state is changed into "Valid" address state without accompanying time consuming DAD operation. By these procedures, we can avoid the DAD problem and achieve address reserving function.

3.1 How to Implement "Uncertain" Address State

```
+--------+              +----------+     +-----------+
|Node who|   +-------+  | Node who |     | Node who  |
|reserves|   | Node  |  | set Addr.X|     | tries to  |
| and set|   | on Link|  | lately   |     | talk with |
| Addr.X |   |       |  | Addr.X Node |
+--------+   +-------+  +----------+     +-----------+

DAD Query  | NS  |
-------------|-----|
(Beginning) |(src = ::) |
-------------|-----|
[           ]<.............|
[           ]<...................|
Tentative<   |<......................................|
[           ]<No Reply NA|
-------------|-----|
[           ]<DAD Query|
Uncertain<   |<-----------------------|
(Temp. Reserv | Reply NA   |
in Pool)      |-----------|
              | L2 Address Query for |
              |     Addr. X         |
              | *                   |
              | *@*<--------------------<---------------------->
              | *                       |
              | !Not! Reply            |
              | NA to tell             |
              | L2 Address             |
(Pop from Pool and Set) |<-----------------------|
--------------|-----------|
[             ]<-----------------------<---------------------->
[             ]<---------------------------------------->
Valid<       |!!Reply!!|
[             ]< NA to tell|
[             ]< L2 Address|
```

Fig. 2 ND messages handling sequences
In order to implement "Uncertain" address state, we analyze behaviors and operations at Tentative and Valid address state and how Neighbor Discovery messages are handled on nodes.

Fig. 2 shows ND messages handling sequences. We notice that there are two types of NS (Neighbor Solicitation) messages.

One is NS messages for DAD query. The other is NS messages for L2 Address query.

These messages are distinguishable, because source address of the NS for DAD query message IS unspecified (::) and that of the NS for L2 Address query IS NOT unspecified (::).

At Tentative address state:
- a node issues NS for DAD query message(s) only

At "Uncertain" address state:
- a node receives NS for DAD query messages, and replies them by NA messages.
- a node receives NS for L2 Address query messages, but does NOT reply them.

At Valid address state:
- a node receives NS for DAD query messages, and reply them by NA messages.
- a node receives NS for L2 Address query messages, and REPLY them by NA messages.

Difference between "Uncertain" and Valid address states exist on behaviors when a node receives NS for L2 Address query messages.

By replying to NS for DAD query message, an address is not obtained (robbed) by other nodes, and a temporary address reserving function is achieved.

By NOT replying to NS for L2 Address query messages, an address is never utilized by any nodes.

Essential part of the Uncertain State is achieved by not replying the NS for L2 Address query messages. Since the state is achieved by just not replying method, it does not cause any problems to communicate the existing nodes that do not implement the Uncertain State specifications.
4. Security Considerations

Security Considerations of IPv6 address [RFC4861][RFC4862] can also be applied to Uncertain address state. There is nothing special on the Uncertain address state. However, Uncertain address state can provide new feature (temporary address reserving function). Temporary address reserving related considerations may be needed.

5. IANA Considerations

This document has no actions for IANA.

Appendix A. Implementations

The Uncertain address state specification has been implemented under the following environments, and its basic functionalities have been verified

OS: FreeBSD6.2R (32bit / 64bit)
CPU: i386 / amd64

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References

Normative References


Informative References


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