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Prefix Assignment in DHCPv6
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Abstract

This document introduces a generic host-oriented prefix assignment mechanism using DHCPv6. In this new address configuration procedure, the prefix is assigned from a DHCPv6 server to hosts through DHCPv6 message exchanging while the interface identifiers are independently generated by the hosts. It enables both integral address assignment and self-generated addresses in one single mechanism, DHCPv6. It also enables stateless address configuration without RA attendance. The technique described in this document can be used in networks which assign IPv6 addresses using DHCPv6, e.g. WiMAX.

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1. Introduction

A host IPv6 address is combined by a prefix and an interface identifier. Currently, there are two mechanisms to configure a host IPv6 address. [RFC3315] describes the operation of address assignment by a DHCPv6 server. The operation assumes that the server is responsible for the assignment of an integral address which includes both prefix and interface identifier parts as described in [RFC4291]. In the Stateless Address Autoconfiguration (SLACC, [RFC4862]) model, the interface Identifier is generated by the host itself while the prefix is configured through Router Advertisement message defined in [RFC4861].

However, in a DHCPv6-managed network, assigning 128-bit address is insufficient. Some hosts may want to use self-generated address, which are combined by prefixes obtained from network configuration and interface identifiers generated by hosts. The applicable user cases include CGA [RFC3972], modified EUI-64 interface identifier [EUI-64], temporary addresses for privacy [RFC4941] and etc.

In these scenarios, the address configuration precedure has to be splitted in two motheds: integral address assignment through DHCPv6 and prefix announcement by RA advertisement. Some ISPs desire to manage address configuration using one set of protocol, rather than mixture of DHCPv6 and Neighbor Discovery.

There are also some network environments in that perfix annoucement through RAs may not be the best choice. For example, hosts may connect through tunnels, either layer 2 tunnels or layer 3 tunnels.

While a RA is only able to announce prefix on a single link, DHCPv6 configuration can be used to manage multiple links by setup DHCPv6 relay.

Up to now, there is no mechanism for host-oriented prefix assignment in DHCPv6. [RFC3633] defines Prefix Delegation options providing a mechanism for automated delegation of IPv6 prefixes using the DHCPv6. This mechanism is intended for delegating a long-lived prefix from a delegating router to a requesting router. This mechanism "is not bound to the assignment of IP addresses or other configuration information to hosts" [RFC3633]. It delegates prefixes to a routable device for itself use only. It does not support the host-generated interface identifiers model, in which prefix(es) need to be propagated to hosts.

This document introduces a generic prefix assignment mechanism using DHCPv6. In this new address configuration procedure, the prefix is propagated from a DHCPv6 server to hosts through DHCPv6 message

exchanging while the interface identifiers are independently generated by the hosts. It enables both integral address assignment and self-generated addresses in one single mechanism, DHCPv6. Note, in many scenarios, Neighbor Discovery [RFC4861] is still needed for routing and reachability. In other scenarios, this mechanism enables stateless address configuration while RA absents.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

The terminology in this document is mainly based on the definitions in [RFC3315] and [RFC3633].

Prefix assignment: a DHCPv6 server propagates prefix information to hosts in unicast model.

3. Applicability

In point-to-point link model, DHCPv6 operation with host-generated interface identifier, described in this document, may be used. [RFC4968] provides different IPv6 link models that are suitable for 802.16 based networks and a point-to-point link model is recommended. Also, 3GPP and 3GPP2 have earlier adopted the point-to-point link model based on the recommendations in [RFC3314]. In this model, one prefix can only be assigned to one interface of a host (mobile station) and different hosts (mobile stations) can't share a prefix. The unique prefix can be used to identify the host. It is not necessary for a DHCPv6 server to generate an interface identifier for the host. The host may generate its interface identifier as described in [RFC4941]. An interface identifier could even be generated via random number generation.

[RFC3972] defines Cryptographically Generated Addresses (CGA), which is generated from a giving prefix and a public signature key. For security reasons, it is only proper to be generated the user, the host itself. It requests a prefix before the interface identifier can be computed.

Modified EUI-64 interface identifier [EUI-64] is also typically generated by hosts. [RFC4941] has defined temporary addresses for privacy purposes. The temporary addresses is also generated by hosts using random algorithm.

The DHCPv6 operations defined in this document supports abovementioned address methods, and the host-generated addresses that may defined in the future.

4. Address Auto-configuration

Router Advertisements in ND [RFC4861] allow routers to inform hosts how to perform Address Auto-configuration. For example, routers can specify whether hosts should use DHCPv6 and/or stateless address configuration. In Router Advertisement message, M and O bits are used for indication of address auto-configuration mode.

Whatever address auto-configuration mode a host uses, the following two parts are necessary for the host to formulate it's IPv6 address:

- o A prefix. "A bit string that consists of some number of initial bits of an address" [RFC4861]. The prefixes can be announced through Router Advertisement message. Prefix assignment from a DHCPv6 server is not currently support.
- o An interface identifier. "From address autoconfiguration's perspective, an interface identifier is a bit string of known

length" [RFC4862]. Modified EUI-64 interface identifier [EUI-64] is a widely-used host generated interface identifier. It generates interface identifier from the host MAC address. The interface identifier of CGA [RFC3972] is generated by computing a preifx that will be used to form the CGA and a cryptographic hash of a public key of a host. The host is responsible for interface identifier generation.

In the ND-managed environment, RA is used to assign the prefix.

So far, there is no mechanism to support the scenario that prefixes are managed by a DHCPv6 server. This document targets to meet this gap. The DHCPv6 operation defined in this document enables the DHCPv6 server to assign a prefix, rather than a integral address, to the host, so that the host can obtain an IPv6 address by combining the prefix with its own generated interface identifier. It enables the auto address configuration through DHCPv6.

5. DHCPv6 Operation

Figure 1 shows the operation of separating prefix assignment and interface identifier generation in the DHCPv6.


```
    +-------------+         +--------------+
    |Host(Client)|         |DHCPv6 Server|
    +-------------+         +--------------+
          |  1 Solicit/Request    |
          |---------------------> |
          |  2 Reply with IA_PA   |
          |<--------------------- |
 3 Combination of Prefix          |
 and Interface Identifier         |
          |                       |
```

Figure 1: DHCPv6 Operation

1. A host uses a Solicit message to discover DHCPv6 servers. Indications of information requests can be included in the

Solicit message or a Request message after discovery procedure. If a host that wants to use host generated addresses, it SHOULD request prefix assignment explicitly by including an IA_PA in a Solicit or a Request message, in which an IAID is provided by the host.

2. The DHCPv6 server assigns one or more prefixes to the host in the Reply messages responding to the prefix requests from the hosts. A server MUST return the same set of prefixes for the same IA_PA (as identified by the IAID) as long as those prefixes are still valid. After the lifetimes of the prefixes in an IA_TA have expired, the IAID may be reused to identify a new IA_PA with new prefix. If there is not a proper prefix available, a NoPrefixAvail (defined in [RFC3633]) status-code is returned to the host and the procedure is terminated.
3. The host generates an interface identifier and formulates a combined IPv6 address by concatenating the assigned prefix and the self-generated interface identifier.

After the host generates an IPv6 address using the above procedure, the host may send a Request message to the DHCPv6 server in order to confirm the usage of the new address. The confirmation procedure may be completed together with the address registration procedure [I-D.ietf-dhc-addr-registration]. However, the confirmation procedure is out of scope.

When the host reaches T1 or T2 defined in Section 6.1, it SHOULD use the same message exchanges, as described in section 18, "DHCP Client-Initiated Configuration Exchange" of [RFC3315], to obtain or update prefix(es) from a DHCPv6 server.

A DHCPv6 server MAY initiatively send a reconfiguration message to the host, as described in section 19, "DHCP Server-Initiated Configuration Exchange" of [RFC3315], to cause prefix(es) information

update.

If an IA_PA capable client connects to a network, and the DHCPv6 server is not IA_PA capable, the Solicit or Request message with IA_PA Option will result in no Reply, Reply without IA_PAs, or Reply with a Status Code containing UnspecFail. The client MAY decide the network does not support IA_PA immediately or after a period of soliciting (with limited retransmissions times). Then, it MAY "failover" to IA_NA/IA_TA requests.

6. DHCPv6 IA_PA Option

In this section, one new option is defined, Identity Association for Prefix Assignment Option . The format of this new DHCPv6 IA_PA Option has been deliberately designed to be the same with IA_PD option[RFC3633]. The IA_PD Prefix and IA Address sub-options from IA_PD option are also reused. However, the two options are different on the semantics and usage models.

Comparing with Prefix Information Option in ND, Section 4.6.2 of [RFC4861], the IA_PA option does not provide L flag and A flag. The A (autonomous address-configuration flag) isn't need obviously because the IA_PA is implicit for stateless address configuration. Because the IA_PA is only address relevant, it does not relevant to reachability or routing and the DHCPv6 server may not sure the on-link state. So L (on-Link) flag is not include. The DHCPv6 client should treat the prefix as same as L flag not set, which makes no statement about on-link or off-link properties of the prefix.

6.1. Identity Association for Prefix Assignment Option

The IA_PA option is used to carry a prefix assignment identity association, the parameters associated with the IA_PA and the prefixes associated with it.

The format of the IA_PA option is:


```
        0                   1                   2                   3
```

```
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |          OPTION_IA_PA         |         option-length         |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                        IAID (4 octets)                        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                              T1                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                              T2                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    .                                                               .
    .                         IA_PA-options                         .
    .                                                               .
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

option-code: OPTION_IA_PA (TBA1)

option-length: 12 + length of IA_PA-options field.

IAID: The unique identifier for this IA_PA; the IAID must be unique among the identifiers for all of this host's IA_PAs. The number space for IA_PA IAIDs is separate from the number spaces for IA_TA and IA_NA IAIDs

T1: The time at which the host should contact the DHCPv6 server from which the prefixes in the IA_PA were obtained to extend the lifetimes of the prefixes assigned to the IA_PA; T1 is a time duration relative to the current time expressed in units of seconds.

T2: The time at which the host should contact any available DHCPv6 server to extend the lifetimes of the prefixes assigned to the IA_PA; T2 is a time duration relative to the current time expressed in units of seconds.

IA_PA-options: Options associated with this IA_PA.

The details of the fields are similar to the IA_PD option description in [RFC3633]. The difference is here a DHCPv6 server and a host involved, while a delegating router and requesting router involved in [RFC3633].

6.2. IA_PA Prefix Option

OPTION_IAPREFIX (26) "IA_PD Prefix Option" defined in Section 10 of [RFC3633] is reused.

Originally, the option is used for conveying prefix information between a delegating router and a requesting router. Here the IA_PD Prefix option is used to specify IPv6 address prefixes associated with an IA_PA in Section 6.1. The IA_PD Prefix option must be encapsulated in the IA_PA-options field of an IA_PA option.

Note, the PD_EXCLUDE option [RFC6603] SHOULD NOT be encapsulated in the IAPREFIX options that are encapsulated in an IA_PA.

7. IANA consideration

This document defines a new DHCPv6 [RFC3315] option, which must be assigned Option Type values within the option numbering space for DHCPv6 messages:

The OPTION_IA_PA Option (TBA1), described in Section 6.1.

8. Security Considerations

Security considerations in DHCPv6 are described in [RFC3315].

To guard against attacks through prefix assignment, a host and a DHCPv6 server SHOULD use DHCPv6 authentication as described in Section 21, "Authentication of DHCP messages" of [RFC3315] or Secure DHCPv6 [I-D.ietf-dhc-secure-dhcpv6] .

9. Acknowledgements

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