Improving the Reaction of Customer Edge Routers to Renumbering Events
draft-ietf-v6ops-cpe-slaac-renum-04

Abstract

   In scenarios where network configuration information becomes invalid
   without any explicit signaling of that condition (such as when a
   Customer Edge Router crashes and reboots without knowledge of the
   previously-employed configuration information), hosts on the local
   network will continue using stale network configuration information
   for an unacceptably long period of time, thus resulting in
   connectivity problems. This document specifies improvements to
   Customer Edge Routers that help mitigate the aforementioned problem
   for typical residential and small office scenarios. This document
   updates RFC7084.

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1. Introduction

   In scenarios where network configuration information becomes invalid
   without any explicit signaling of that condition, nodes on the local
   network will continue using stale information for an unacceptably
   long period of time, thus resulting in connectivity problems. This
   problem is documented in detail in [I-D.ietf-v6ops-slaac-renum].

   This document specifies improvements to Customer Edge (CE) Routers
   that help mitigate the aforementioned problem for residential and
   small office scenarios. It specifies recommendations for the default
   behavior of CE Routers, and does not preclude the availability of
   configuration knobs that might allow an operator or user to manually-
   configure the CE Router to deviate from these recommendations. This
   document updates [RFC7084](RFC7084).

2. Requirements Language

   Take careful note: Unlike other IETF documents, the key words "MUST",
   "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT",
   "RECOMMENDED", "MAY", and "OPTIONAL" in this document are not used as
   described in [RFC2119]. This document uses these keywords not
   strictly for the purpose of interoperability, but rather for the
   purpose of establishing industry-common baseline functionality. As
   such, the document points to several other specifications (preferable
   in RFC or stable form) to provide additional guidance to implementers
   regarding any protocol implementation required to produce a
   successful CE router that interoperates successfully with a
   particular subset of currently deploying and planned common IPv6
   access networks.

   Note: the aforementioned terms are used in exactly the same way as in
   [RFC7084], with the above explanation copied verbatim from
   Section 1.1 of [RFC7084].

3. Improved Customer Edge Router Behavior

   This section specifies and clarifies requirements for Customer Edge
   Routers that can help mitigate the problem discussed in Section 1,
   particularly when they employ prefixes learned via DHCPv6-Prefix
   Delegation (DHCPv6-PD) [RFC8415] on the WAN-side with Stateless
   Address Autoconfiguration (SLAAC) [RFC4862] or DHCPv6 [RFC8415] on
   the LAN-side. The recommendations in this document help improve
   robustness at the Customer Edge Router (on which the user or ISP may
   have no control), and do not preclude implementation of host-side
   improvements such as those specified in [I-D.gont-6man-slaac-renum].

   This document specifies additional LAN-side requirements to
   requirements L-1 through L-14 specified in [RFC7084]:

   o L-15: CE routers MUST NOT advertise prefixes via SLAAC or assign
      addresses or delegate prefixes via DHCPv6 on the LAN-side,
      employing lifetimes that exceed the remaining lifetimes of the
      corresponding prefixes learned from the WAN-side via DHCPv6-PD.
      For more details, see Section 3.1.

   o L-16: CE routers SHOULD advertise capped SLAAC option lifetimes
      and capped DHCPv6 IA Address Option and IA Prefix Option
      lifetimes, as specified in Section 3.2.

   o L-17: CE routers MUST signal stale configuration information as
      specified in Section 3.3.

   o L-18: CE routers SHOULD NOT automatically send DHCPv6-PD RELEASE
      messages upon reboot events.

3.1. Interface Between WAN-side and LAN-side

   The "Preferred Lifetime" and "Valid Lifetime" of Prefix Information
   Options (PIOs) [RFC4861] corresponding to prefixes learned via
   DHCPv6-PD MUST NOT span past the remaining preferred and valid
   lifetimes of the corresponding DHCPv6-PD prefixes. This means that
   the advertised "Preferred Lifetime" and "Valid Lifetime" MUST be
   dynamically adjusted such that they never span past the remaining
   preferred and valid lifetimes of the corresponding prefixes delegated
   via DHCPv6-PD on the WAN-side.

   Similarly, the "preferred-lifetime" and "valid-lifetime" of DHCPv6 IA
   Address Options and DHCPv6 IA Prefix Options employed with DHCPv6 on
   the LAN-side MUST NOT span past the remaining preferred and valid
   lifetimes of the corresponding prefixes leased via DHCPv6-PD on the
   WAN-side. This means that the advertised "Preferred Lifetime" and
   "Valid Lifetime" MUST be dynamically adjusted such that the
   advertised lifetimes never span past the remaining preferred and
   valid lifetimes of the corresponding prefixes delegated to the CE
   Router on the WAN-side via DHCPv6-PD.

   This document RECOMMENDS that CE Routers providing stateful address
   configuration via DHCPv6 sets the DHCPv6 IA Address Option preferred-
   lifetime to the lesser of the remaining preferred lifetime and
   ND_PREFERRED_LIMIT, and the valid-lifetime of the same option to the
   lesser of the remaining valid lifetime and ND_VALID_LIMIT.

   This document RECOMMENDS that a CE Router providing DHCPv6-PD on the
   LAN-side sets the DHCPv6 IA Prefix Option preferred-lifetime to the
   lesser of the remaining preferred lifetime and ND_PREFERRED_LIMIT,
   and the valid-lifetime of the same option to the lesser of the
   remaining valid lifetime and ND_VALID_LIMIT.

   RATIONALE:

      * The lifetime values employed for the "Preferred Lifetime"
         (AdvPreferredLifetime) and "Valid Lifetime" (AdvValidLifetime)
         of SLAAC Prefix Information Options must never be larger than
         the remaining lifetimes for the corresponding prefix (as
         learned via DHCPv6-PD on the WAN-side). This is in line with
         the requirement from Section 6.3 of [RFC8415], which states
         that "if the delegated prefix or a prefix derived from it is
         advertised for stateless address autoconfiguration [RFC4862],
         the advertised preferred and valid lifetimes MUST NOT exceed
         the corresponding remaining lifetimes of the delegated prefix."

* The lifetime values of prefixes advertised on the LAN-side via
  SLAAC must be dynamically updated (rather than static values),
  otherwise the advertised lifetimes would eventually span past
  the DHCPv6-PD lifetimes.

* The same considerations apply for the valid-lifetime and
  preferred-lifetime of IA Address Options and IA Prefix Options
  employed with DHCPv6 on the LAN-side.

3.2. LAN-side Option Lifetimes

CE Routers SHOULD override the default PIO "Preferred Lifetime" and
"Valid Lifetime" values from [RFC4861], and employ shorter lifetime
values to improve the robustness to renumbering events, while
complying with the requirements from Section 2.1 of this document and
the recommendations in [RFC7772].

This document RECOMMENDS that CE routers set the Router Lifetime to
ND_PREFERRED_LIMIT. This document also RECOMMENDS that the CE router
set the PIO Preferred Lifetime to the lesser of the remaining
preferred lifetime (see Section 3.1) and ND_PREFERRED_LIMIT, and the
PIO Valid Lifetime to the lesser of the remaining valid lifetime and
ND_VALID_LIMIT. Additionally, this document RECOMMENDS that the
Route Lifetime of Route Information Options (RIOs) [RFC4191], the
Lifetime of Recursive DNS Search Options (RDNSSO) [RFC8106], and the
Lifetime of DNS Search List Options (DNSSLO) [RFC8106] be set to the
lesser of the longest valid-lifetime in a DHCPv6 IA Prefix Option
(received via DHCPv6 on the WAN-side) and ND_VALID_LIMIT, if any of
these options are included in Router Advertisement messages.

This document RECOMMENDS that a CE Router providing stateful address
configuration via DHCPv6 set the DHCPv6 IA Address Option preferred-
lifetime to the lesser of the remaining preferred lifetime (see
Section 3.1) and ND_PREFERRED_LIMIT, and the valid-lifetime of the
same option to the lesser of the remaining valid lifetime and
ND_VALID_LIMIT.

This document RECOMMENDS that a CE Router providing DHCPv6-PD on the
LAN-side set the DHCPv6 IA Prefix Option preferred-lifetime to the
lesser of the remaining preferred lifetime (see Section 3.1) and
ND_PREFERRED_LIMIT, and the valid-lifetime of the same option to the
lesser of the remaining valid lifetime and ND_VALID_LIMIT.

RATIONALE:

* The Valid Lifetime and Preferred Lifetime of PIOs have a direct
  impact on three different aspects:

+ The amount of time hosts may end up employing stale network
  configuration information (see
  [I-D.ietf-v6ops-slaac-renum]).

+ The amount of time CE Routers need to persist trying to
  deprecate stale network configuration information (e.g. to
  handle cases where nodes miss Router Advertisements and thus
  still consider the stale information as valid).

+ The amount of information that CE Routers need to maintain
  when e.g. multiple crash-and-reboot events occur in the
  timespan represented by the option lifetimes employed on the
  LAN-side.

* CE Routers need not employ the (possibly long) DHCPv6-PD
  lifetimes for the Valid Lifetime and Preferred Lifetime of PIOs
  sent in Router Advertisements messages to advertise sub-
  prefixes of the leased prefix. Instead, CPE Routers SHOULD use
  shorter values for the Valid Lifetime and Preferred Lifetime of
  PIOs, since subsequent Router Advertisement messages will
  nevertheless refresh the associated lifetimes, leading to the
  same effective lifetimes as specified by the WAN-side DHCPv6-PD
  lifetimes.

* Similarly, CE Routers need not employ the (possibly long)
  DHCPv6-PD lifetimes for the valid-lifetime and preferred-
  lifetime of IA Address Options and IA Prefix Option employed by
  DHCPv6 on the LAN-side, since the renewal of bindings by DHCPv6
  clients will lead to the same effective lifetimes as specified
  by the WAN-side DHCPv6-PD lifetimes.

3.3. Signaling Stale Configuration Information

In order to phase-out stale SLAAC configuration information:

o A CE router sending RAs that advertise dynamically-learned
   prefixes (e.g. via DHCPv6-PD) SHOULD record, on stable storage,
   the list of prefixes being advertised on each network segment, and
   the state of the "A" and "L" flags of the corresponding PIOs.

o Upon changes to the advertised prefixes, and after bootstrapping,
   the CE router advertising prefix information via SLAAC SHOULD
   proceed as follows:

   * Any prefixes that were previously advertised via Router
     Advertisement (RA) messages, but that have now become stale,
     MUST be advertised with a "Valid Lifetime" and a "Preferred
     Lifetime" set to 0, and the "A" and "L" bits unchanged.

   * The aforementioned advertisement SHOULD be performed for at
      least the "Valid Lifetime" previously employed for such prefix.
      Note: If requirement L-16 ([Section 3.2](#)) is followed, the Valid
      Lifetime need not be saved and the prefix can simply be
      advertised for a period of ND_VALID_LIMIT.

   o CE Routers receiving DHCPv6 Prefix Delegations with a 0 valid-
      lifetime MUST advertise the corresponding sub-prefixes (as they
      would be generated for the same leased prefix with a non-zero
      lifetime) with a PIO with both the Preferred Lifetime and the
      Valid Lifetime set to 0, for at least the WAN-side DHCPv6-PD
      valid-lifetime, or for a period of ND_VALID_LIMIT if the
      recommended lifetimes from [Section 3.2](#) are employed.

   This document RECOMMENDS that if a CE Router provides LAN-side DHCPv6
   (address assignment or prefix delegation), the following behavior be
   implemented:

   o The CE Router SHOULD record, on stable storage, the DHCPv6 address
      and delegated-prefix bindings corresponding to the LAN-side.

   o If the CE Router finds that the prefix to be employed for address
      assignment and/or prefix delegation has changed (e.g., upon a
      crash-and-reboot event) or the CE Router receives DHCPv6 Prefix
      Delegations with 0 lifetimes, the CE Router MUST:

      * In Replies to DHCPv6 Request, Renew, Rebind messages, send 0
         lifetimes for any address assignments or prefix delegations for
         the deprecated prefixes for at least the valid-lifetime
         previously employed for them, or for a period of ND_VALID_LIMIT
         if the recommended lifetimes from [Section 3.2](#) are employed.

      * Initiate sending Reconfigure messages (if possible - i.e.,
         client requests Reconfigure support and the CE Router offers
         it) to those clients with address assignments or prefix
         delegations for the deprecated prefixes.

   RATIONALE:

      * IPv6 network renumbering is expected to take place in a planned
         manner, with old/stale prefixes being phased-out via reduced
         prefix lifetimes while new prefixes (with normal lifetimes) are
         introduced. However, a number of scenarios may lead to the so-
         called "flash-renumbering" events, where the prefix being
         employed on a network suddenly becomes invalid and replaced by
         a new prefix [[I-D.ietf-v6ops-slaac-renum](#)]. One such scenario
         is when a DHCPv6 server employs dynamic prefixes and the
         Customer Edge Router crashes and reboots. The requirements in

       this section are meant to allow Customer Edge Routers to
       deprecate stale information in such scenarios.

    * The recommendations in this section expand from requirement
       L-13 in [Section 4.3 of [RFC7084]](#).

    * Host configuring addresses via SLAAC on the local network may
       employ addresses configured for the previously advertised
       prefixes for at most the "Valid Lifetime" of the corresponding
       PIO of the last received Router Advertisement message. Since
       Router Advertisement messages may be lost or fail to be
       received for various reasons, Customer Edge Routers need to try
       to deprecate stale prefixes for a period of time equal to the
       "Valid Lifetime" of the PIO employed when originally
       advertising the prefix.

    * The requirement in this section is conveyed as a "SHOULD" (as
       opposed to a "MUST"), since we acknowledge that the requirement
       to store information on stable storage may represent a
       challenge for some implementations.

    * Advertising DHCPv6-leased prefixes with zero lifetimes on the
       LAN-side would handle the case where a CE Router has no stable
       storage but receives the prefixes via DHCPv6 with 0 lifetimes.

4. Recommended Option Lifetimes Configuration Values

   o ND_PREFERRED_LIMIT: 2700 seconds (45 minutes)

   o ND_VALID_LIMIT: 5400 seconds (90 minutes)

5. IANA Considerations

   This document has no actions for IANA.

6. Security Considerations

   This document discusses a problem that may arise in scenarios where
   dynamic IPv6 prefixes are employed, and proposes improvements to
   Customer Edge Routers [RFC7084] to mitigate the problem for
   residential or small office scenarios. It does not introduce new
   security issues.

7. Acknowledgments

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   Lemon, for their valuable help in improving this document via
   successive detailed reviews.

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