                    IS-IS Minimum Remaining Lifetime

Abstract

   Corruption of the Remaining Lifetime field in a Link State Protocol
   Data Unit (LSP) can go undetected. In certain scenarios, this may
   cause or exacerbate flooding storms. It is also a possible denial-
   of-service attack vector. This document defines a backwards-
   compatible solution to this problem.

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1. Problem Statement

   [ISO10589] defines the format of a Link State PDU (LSP) that includes
   a Remaining Lifetime field. This field is set by the originator
   based on local configuration and then decremented by all systems once
   the entry is stored in their LSP Database (LSPDB) consistent with the
   passing of time. This allows all Intermediate Systems (ISs) to age
   out the LSP at approximately the same time.

   Each LSP also has a checksum field to allow receiving systems to
   detect errors that may have occurred during transmission. [ISO10589]
   mandates that the checksum is calculated by the originator of the LSP
   and cannot be modified by other routers. Therefore, the Remaining
   Lifetime is deliberately excluded from the checksum calculation. In
   cases where cryptographic authentication is included in an LSP
   ([RFC5304] or [RFC5310]), the Remaining Lifetime field is also
   excluded from the hash calculation. If the Remaining Lifetime field
   gets corrupted during flooding, this corruption is therefore
   undetectable. The consequences of such corruption depend upon how
   the Remaining Lifetime is altered.

   In cases where the Remaining Lifetime becomes larger than the
   originator intended, the impact is benign. As the originator is
   responsible for refreshing the LSP before it ages out, a new version
   of the LSP will be generated before the LSP ages out, so no harm is
   done.

   In cases where the Remaining Lifetime field becomes smaller than the
   originator intended, the LSP may age out prematurely (i.e., before
   the originator refreshes the LSP). This has two negative
   consequences:

   1. The LSP will be purged by an IS when the Remaining Lifetime
       expires. This will cause a temporary loss of reachability to
       destinations impacted by the content of that LSP.

   2. Unnecessary LSP flooding will occur as a result of the premature
       purge and subsequent regeneration/flooding of a new version of
       the LSP by the originator.

   If the corrupted Remaining Lifetime is only modestly shorter than the
   lifetime assigned by the originator, the negative impacts are also
   modest. If, however, the corrupted Remaining Lifetime becomes very
   small, then the negative impacts can become significant, especially
   in cases where the cause of the corruption is persistent so that the
   cycle repeats itself frequently.

A backwards-compatible solution to this problem is defined in the
following sections.

1.1. Requirements Language

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 RFC 2119 [RFC2119].

2. Solution

As discussed in the previous section, the problematic case is when
the Remaining Lifetime is corrupted and becomes much smaller than it
should be. The goal of the solution is then to prevent premature
purging.

Under normal circumstances, updates to an LSP -- including purging,
if appropriate -- are the responsibility of the originator of the
LSP. There is a maximum time between generations of a given LSP.
Once this time has expired, it is the responsibility of the
originator to refresh the LSP (i.e., issue a new version with a
higher sequence number) even if the contents of the LSP have not
changed. [ISO10589] defines maximumLSPGenerationInterval to be
sufficiently less than the maximum lifetime of an LSP so that the new
version can be flooded network wide before the old version ages out
on any IS.

[ISO10589] defines two cases where a system other than the originator
of an LSP is allowed to purge an LSP:

1. The LSP ages out. This should only occur if the originating IS
    is no longer reachable and therefore is unable to update the LSP.

2. There is a Designated Intermediate System (DIS) change on a LAN.
    The pseudonode LSPs generated by the previous DIS are no longer
    required and may be purged by the new DIS.

In both of these cases, purging is not necessary for correct
operation of the protocol. It is provided as an optimization to
remove stale entries from the LSPDB.

In cases where the Remaining Lifetime in a received LSP has been
corrupted and is smaller than the Remaining Lifetime at the
originating node, when the Remaining Lifetime expires on the
receiving node, it can appear as if the originating IS has failed to
regenerate the LSP before it ages out (case #1 above). To prevent
this from having a negative impact, a modest change to the storage of
"new" LSPs in the LSPDB is specified.

Section 7.3.16 of [ISO10589] defines the rules to determine whether a
received LSP is older, the same, or newer than the copy of the same
LSP in the receiver's LSPDB. The key elements are:

o Higher sequence numbers are newer.

o If sequence numbers are the same, an LSP with a zero Remaining
   Lifetime (a purged LSP) is newer than the same LSP with a non-zero
   Remaining Lifetime.

o If both the received and local copy of the LSP have a non-zero
   Remaining Lifetime, they are considered the same even if the
   Remaining Lifetimes differ.

Section 7.3.15.1.e(1) of [ISO10589] defines the actions to take on
receipt of an LSP generated by another IS that is newer than the
local copy and has a non-zero Remaining Lifetime. An additional
action is defined by this document:

vi. If the Remaining Lifetime of the new LSP is less than MaxAge, it
     is set to MaxAge.

This additional action ensures that no matter what value of Remaining
Lifetime is received, a system other than the originator of an LSP
will never purge the LSP until the LSP has existed in the database
for at least MaxAge.

It is important to note that no change is proposed for handling the
receipt of purged LSPs. The rules specified in Section 7.3.15.1.b of
[ISO10589] still apply, i.e., an LSP received with a zero Remaining
Lifetime is still considered newer than a matching LSP with a non-
zero Remaining Lifetime. Therefore, the changes proposed here will
not result in LSPDB inconsistency among routers in the network.

3. Deployment Considerations

   This section discusses some possible deployment issues for this
   protocol extension.

3.1. Inconsistent Values for MaxAge

   [ISO10589] defines MaxAge (the maximum value for the Remaining
   Lifetime in an LSP) as an architectural constant of 20 minutes (1200
   seconds). However, in practice, implementations have supported
   allowing this value to be configurable. The common intent of a
   configurable value is to support longer lifetimes than the default,
   thus reducing the periodic regeneration of LSPs in the absence of
   topology changes. See a discussion of this point in [RFC3719]. It

   is therefore possible for the value of MaxAge on the IS that
   originates an LSP to be higher or lower than the value of MaxAge on
   the ISs that receive the LSP.

   If the value of MaxAge of the IS that originated the LSP is smaller
   than the value of MaxAge of the receiver of an LSP, then setting the
   Remaining Lifetime of the received LSP to the local value of MaxAge
   will ensure that it is not purged prematurely. However, if the value
   of MaxAge on the receiver is less than that of the originator, then
   it is still possible to have an LSP purged prematurely when using the
   extension defined in the previous section. Implementors of this
   extension may wish to protect against this case by making the value
   to which the Remaining Lifetime is set under the conditions described
   in the previous section configurable. If that is done, the
   configured value MUST be greater than or equal to the locally
   configured value of MaxAge.

3.2. Reporting Corrupted Lifetime

   Reporting reception of an LSP with a possible corrupt Remaining
   Lifetime field can be useful in identifying a problem in the network.
   In order to minimize the reports of false positives, the following
   algorithm SHOULD be used in determining whether the Remaining
   Lifetime in the received LSP is possibly corrupt:

   o The LSP has passed all acceptance tests as specified in
      Section 7.3.15.1 of [ISO10589].

   o The LSP is newer than the copy in the local LSPDB (including the
      case of not being present in the LSPDB).

   o The Remaining Lifetime in the received LSP is less than
      ZeroAgeLifetime.

   o The adjacency to the neighbor from which the LSP is received has
      been up for a minimum of ZeroAgeLifetime.

   In such a case, an IS SHOULD generate a CorruptRemainingLifetime
   event.

   Note that it is not possible to guarantee that all cases of a corrupt
   Remaining Lifetime will be detected using the above algorithm. It is
   also not possible to guarantee that all CorruptRemainingLifetime
   events reported using the above algorithm are valid. As a diagnostic
   aid, an implementation MAY wish to retain the value of the Remaining
   Lifetime received when the LSP was added to the LSPDB.

3.3. Impact of Delayed LSP Purging

   The extensions defined in this document may result in retaining an
   LSP longer than its original lifetime. In order for this to occur,
   the scheduled refresh of the LSP by the originator of the LSP must
   fail to occur -- this implies that the originator is no longer
   reachable. In such a case, its neighbors will update their own LSPs
   to report the loss of connectivity to the originator. [ISO10589]
   specifies that LSPs from a node that is unreachable (failure of the
   two-way connectivity check) will not be used. Note that this
   behavior applies to ALL information in the set of LSPs from such a
   node.

   Retention of stale LSPs therefore has no negative side effects other
   than requiring additional memory for the LSPDB. In networks where a
   combination of pathological behaviors (e.g., LSP corruption and
   frequent resetting of nodes in the network) is seen, this could lead
   to a large number of stale LSPs being retained, but such networks are
   already compromised.

4. Security Considerations

   The ability to introduce corrupt LSPs is not altered by the rules
   defined in this document. Use of authentication as defined in
   [RFC5304] and [RFC5310] prevents such LSPs from being intentionally
   introduced. A man-in-the-middle attack that modifies an existing LSP
   by changing the Remaining Lifetime to a small value can cause
   premature purges even in the presence of cryptographic
   authentication. The mechanisms defined in this document prevent such
   an attack from being effective.

5. References

5.1. Normative References

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5.2. Informative References

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