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C. Dearlove  
BAE Systems ATC  
T. Clausen  
LIX, Ecole Polytechnique  
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**An Optimization for the MANET Neighborhood Discovery Protocol (NHDP)**  
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Abstract

The link quality mechanism of the MANET Neighborhood Discovery Protocol (NHDP) enables "ignoring" some 1-hop neighbors if the measured link quality from that 1-hop neighbor is below an acceptable threshold, while still retaining the corresponding link information as acquired from HELLO message exchange. This allows immediate reinstatement of the 1-hop neighbor if the link quality later improves sufficiently.

NHDP also collects information about symmetric 2-hop neighbors. However it specifies that if a link from a symmetric 1-hop neighbor ceases being symmetric, including while "ignored" as described above, then corresponding symmetric 2-hop neighbors are removed. This may lead to symmetric 2-hop neighborhood information being permanently removed (until further HELLO messages are received) if the link quality of a symmetric 1-hop neighbor drops below the acceptable threshold, even if only for a moment.

This specification updates NHDP, and the Optimized Link State Routing Protocol version 2 (OLSRv2) to permit retaining, but ignoring, symmetric 2-hop information when the link quality from the corresponding 1-hop neighbor drops below the acceptable threshold. This allows immediate reinstatement of the symmetric 2-hop neighbor if the link quality later improves sufficiently, thus making the symmetric 2-hop neighborhood more "robust".

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## 1. Introduction

The MANET Neighborhood Discovery Protocol (NHDP) [[RFC6130](#)], [Section 14](#), contains a link admission mechanism known as "link quality" that allows a router using that protocol to "take considerations other than message exchange into account for determining when a link is and is not a candidate for being considered as HEARD or SYMMETRIC". Specifically, [[RFC6130](#)] permits a router to disallow consideration of some of its 1-hop neighbors, for as long as the quality of the link from that 1-hop neighbor is below an acceptable link quality threshold.

A feature of this mechanism is that while the link quality remains too low, the link information, established by the exchange of HELLO messages, is retained. Thus if the link quality later goes above the required threshold (note that a hysteresis mechanism means that two thresholds are used) then the link is immediately established and will be immediately available for use.

[[RFC6130](#)] collects not just 1-hop neighbor information, but also information about symmetric 2-hop neighbors. However [[RFC6130](#)] specifies that if a 1-hop neighbor was, but no longer is, considered symmetric, then the corresponding 2-Hop Tuples that may have been recorded for that 2-hop neighbor, are to be removed, without a retention mechanism for a (possibly temporary) loss due to link quality.

This means that if there is a short period in which link quality is too low, then when the link quality is reestablished, all 1-hop neighbor information is immediately available for use again. However, the corresponding symmetric 2-hop neighbor information has been removed, and is not available for use until restored by receipt of the next corresponding HELLO message.

This specification describes how [[RFC6130](#)] can be modified to avoid this situation, by retaining (but not using) 2-hop information, similar to what is done with 1-hop information. This modification is strictly optional, and routers that do and do not implement it can interwork entirely successfully (as they also can with different link quality specifications). In addition, by a suitable interpretation (that ignored 2-Hop Tuples are not externally advertised), this change can be invisible to any other protocols using [[RFC6130](#)], in particular [[RFC7181](#)]. However the impact on [[RFC7181](#)] when 2-Hop Tuples are not so handled is also described, in particular owing to the existence of implementations of that protocol that are not modularly separated from [[RFC6130](#)].

This specification therefore updates [[RFC6130](#)] and [[RFC7181](#)].



## **2. Terminology**

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

Additionally, this document uses the terminology of [\[RFC6130\]](#) and [\[RFC7181\]](#).

## **3. Applicability Statement**

This specification updates [\[RFC6130\]](#). The optimization presented in this specification is simply permissive, as it allows retaining information which otherwise would have been removed, but does not use that information except when it could have been used by [\[RFC6130\]](#).

This can, in some cases, ensure that the symmetric 2-hop neighborhood is more robust against temporary link quality changes, and consequently yield a more stable network. The only other consequence of this optimization is that state for some otherwise expired 2-Hop Tuples may be maintained for longer.

This specification also updates [\[RFC7181\]](#). This could be avoided by simply noting that this specification describes how the updates to [\[RFC6130\]](#) may be handled so as to be invisible to any other protocol using it. However as it is known that some implementations of [\[RFC7181\]](#) are not independent of the implementation of [\[RFC6130\]](#) that they use, it is useful to indicate the direct impact on [\[RFC7181\]](#).

A router that implements the optimization described in this specification will interoperate successfully with routers that implement [\[RFC6130\]](#), but do not implement this optimization.

## **4. Changes to NHDP**

The following changes are made to [\[RFC6130\]](#) if using this specification. Note that while this specification is OPTIONAL, if any of these changes are made then all of these changes MUST be made.

### **4.1. Interface Information Bases**

The 2-Hop Set is modified by adding this additional element to each 2-Hop Tuple:





N2\_lost is a boolean flag, which indicates the state of the corresponding Link Tuple. If L\_status = SYMMETRIC (and thus L\_lost = false), then N2\_lost = false. If L\_SYM\_time has not expired, and L\_lost = false (and hence L\_status = LOST), then N2\_lost = true.

In all other cases, including other cases with L\_status = LOST, there will be no such 2-Hop Tuples.

#### **4.2. HELLO Message Processing**

In [Section 12.6 of \[RFC6130\]](#) make the following changes:

- o In point 2, change "L\_status = SYMMETRIC" to "L\_SYM\_time not expired".
- o When creating a 2-Hop Tuple, set N2\_lost := L\_lost.

#### **4.3. Information Base Changes**

In [Section 13](#), replace the second bullet point by:

- o A Link Tuple's L\_status changes from SYMMETRIC, L\_SYM\_time expires, or the Link Tuple is removed. In this case, the actions specified in [Section 13.2](#) are performed.

and replace the paragraph after the bullet points by:

If a Link Tuple is removed, or if L\_HEARD\_time expires and either L\_status changes from SYMMETRIC or L\_SYM\_time expires, then the actions specified in [Section 13.2](#) MUST be performed before the actions specified in [Section 13.3](#) are performed for that Link Tuple.

In [Section 13.2 of \[RFC6130\]](#), add the following, before all other text:

For each Link Tuple that has L\_SYM\_time not expired:

1. If L\_SYM\_time then expires, or if the Link Tuple is removed:
  1. Remove each 2-Hop Tuple for the same MANET interface with:
    - + N2\_neighbor\_iface\_addr\_list contains one or more network addresses in L\_neighbor\_iface\_addr\_list.
2. If L\_status then changes from SYMMETRIC to LOST because L\_lost is set to true:



1. For each 2-Hop Tuple for the same MANET interface with:

- + N2\_neighbor\_iface\_addr\_list contains one or more network addresses in L\_neighbor\_iface\_addr\_list;

set N2\_lost := true.

Also in [Section 13.2 of \[RFC6130\]](#), remove point 2, renumbering point 2 as point 1.

#### **4.4. Constraints**

In [Appendix B](#), under "In each 2-Hop Tuple:" change the first bullet point to:

- o There MUST be a Link Tuple associated with the same MANET interface with:
  - \* L\_neighbor\_iface\_addr\_list = N2\_neighbor\_iface\_addr\_list; AND
  - \* L\_SYM\_time not expired; AND
  - \* L\_lost = N2\_lost.

#### **5. Changes to OLSRv2**

If the implementation of [\[RFC6130\]](#) conceals from any protocol using it the existence of all 2-Hop Tuples with N2\_lost = true, then no changes are required to any protocol using [\[RFC6130\]](#), in particular no changes are required to [\[RFC7181\]](#).

However if instead the implementation of [\[RFC6130\]](#) makes all 2-Hop Tuples visible, including those with N2\_lost = true, then protocols using [\[RFC6130\]](#) MUST ignore such 2-Hop Tuples.

For [\[RFC7181\]](#), given that this protocol uses 2-hop information for MPR Set and Routing Set calculation, but not includes that information in control traffic, this means that an implementation must be (i) behaving as if a 2-Hop Tuple only exists if N2\_lost=false, and (ii) as if a change of N2\_lost (from false to true, or true to false) corresponds to a 2-Hop Tuple appearing or being removed. Specifically, this means behaving as if all of the following changes were to be made to [\[RFC7181\]](#):

- o In [Section 17.6 of \[RFC7181\]](#), point 1, replace the final two bullet points with:



- \* A 2-Hop Tuple with N2\_out\_metric != UNKNOWN\_METRIC and N2\_lost = false is added or removed, OR;
  - \* A 2-Hop Tuple with N2\_out\_metric != UNKNOWN\_METRIC has N2\_lost changed, OR;
  - \* The N2\_out\_metric of any 2-Hop Tuple with N2\_lost = false changes, and either the flooding MPR selection process uses metric values (see [Section 18.4](#)) or the change is to or from UNKNOWN\_METRIC.
- o In [Section 17.6 of \[RFC7181\]](#), point 3, replace the final two bullet points with:
    - \* A 2-Hop Tuple with N2\_in\_metric != UNKNOWN\_METRIC and N2\_lost = false is added or removed, OR;
    - \* A 2-Hop Tuple with N2\_in\_metric != UNKNOWN\_METRIC has N2\_lost changed, OR;
    - \* The N2\_in\_metric of any 2-Hop Tuple with N2\_lost = false changes.
  - o In [Section 17.7 of \[RFC7181\]](#), in the fifth bullet point, add "and N2\_lost = false" after "N2\_out\_metric != UNKNOWN\_METRIC".
  - o In [Section 18.4 of \[RFC7181\]](#), in the third bullet point, add ", N2\_lost = false" after "N2\_out\_metric != UNKNOWN\_METRIC".
  - o In [Section 18.5 of \[RFC7181\]](#), in the third bullet point, add ", N2\_lost = false" after "N2\_in\_metric != UNKNOWN\_METRIC".
  - o In [Section 19.1 of \[RFC7181\]](#), in the final main bullet point (marked as "(OPTIONAL)"), add "and N2\_lost = false" after "N2\_out\_metric != UNKNOWN\_METRIC".
  - o In [Appendix C.7 of \[RFC7181\]](#), in point 1, add "and N2\_lost = false" after "N2\_out\_metric != UNKNOWN\_METRIC".

## 6. MIB Considerations

This update to [\[RFC6130\]](#) does not change the definition of a symmetric 2-hop neighbor. It adds new information and states for each symmetric 2-hop neighbor, recorded in the Neighbor Information Base of a router and to be reflected in the appropriate tables of the corresponding NHDP-MIB module [\[RFC6779\]](#).



### 6.1. Updates to the State Group

This update introduces, to the state of each 2-Hop Tuple, the boolean flag N2\_lost. In order to reflect this, the updates in this section are to be made to the State Group (nhdpStateObjGrp) of the NHDP-MIB module [[RFC6779](#)].

The DESCRIPTION of nhdpIib2HopSetEntry Object Type is to be updated, so as to read as follows:

```
nhdpIib2HopSetEntry  OBJECT-TYPE
    SYNTAX      Nhdpiib2HopSetEntry
    MAX-ACCESS   not-accessible
    STATUS      current
    DESCRIPTION
        "nhdpIib2HopSetTable consists of 2-Hop Tuples, each
         representing a single network address of a symmetric
         2-hop neighbor and a single MANET interface of a
         symmetric 1-hop neighbor.

         (N2_neighbor_iface_addr_list,
          N2_2hop_addr, N2_lost, N2_time).

         The entries include the 2-hop neighbor addresses, which
         act as the table index, and associated symmetric 1-hop
         neighbor address set, designated through nhdpDiscIfIndex,
         an expiration time, and a flag indicating if the 1-hop
         neighbor, through which this 2-hop neighbor is reachable,
         is considered lost due to link quality, or not.

         The nhdpIfIndex in the INDEX is the interface index of
         the local interface through which these 2-hop addresses
         are accessible. The nhdpDiscIfIndex in the INDEX
         represents the 1-hop neighbor interface through which
         these 2-hop neighbor addresses are reachable."
    REFERENCE
        "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
         Discovery Protocol (NHDP), Clausen, T., Dearlove,
         C., and J. Dean, April 2011"
    INDEX { nhdpIfIndex,
            nhdpDiscIfIndex,
            nhdpIib2HopSetIpAddressType,
            nhdpIib2HopSetIpAddress
          }
    ::= { nhdpIib2HopSetTable 1 }
```

The SEQUENCE of Nhdpiib2HopSetEntry is to be updated, so as to read as follows:





```
NhdpIib2HopSetEntry ::=
  SEQUENCE {
    nhdpIib2HopSetIpAddressType
      InetAddressType,
    nhdpIib2HopSetIpAddress
      InetAddress,
    nhdpIib2HopSetIpAddrPrefixLen
      InetAddressPrefixLength,
    nhdpIib2HopSet1HopIfIndex
      NeighborIfIndex,
    nhdpIib2HopSetN2Time
      TimeStamp,
    nhdpIib2HopSetN2Lost
      TruthValue
  }
```

The nhdpIib2HopSetN2Lost OBJECT-TYPE is to be defined as follows:

```
nhdpIib2HopSetN2Lost OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "nhdpIib2HopSetN2Lost corresponds to N2_lost of NHDP and
        is a boolean flag, describing if for a 2-Hop Tuple, the
        corresponding Link Tuple currently is considered lost
        due to link quality."
    REFERENCE
        "draft-dearlove-manet-nhdp-optimization-01"
    ::= {nhdpIib2HopSetEntry 5}
```

## 6.2. Updates to the Notification Group

This update introduces an additional state for each 2-Hop Tuple. Whereas [[RFC6130](#)] has two states for 2-Hop Tuples, 'up' (a 2-Hop Tuple exists) and 'down' (a 2-Hop Tuple expires), this update introduces a third state for a 2-Hop Tuple: it exists, but (due to the link quality of the link to the corresponding 1-Hop neighbor) is not currently considered.

To reflect this, the SYNTAX and DESCRIPTION of nhdp2HopNbrState OBJECT-TYPE are to be updated, so as to read as follows:



```
nhdp2HopNbrState  OBJECT-TYPE
    SYNTAX  INTEGER {
        down(0),
        up(1),
        notconsidered(2)
    }
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "NHDP 2-hop neighbor states. In NHDP, it is not necessary
        to remove Protocol Tuples from Protocol Sets at the
        exact time indicated, only to behave as if the Protocol
        Tuples were removed at that time. This case is indicated
        here as 'down(0)'; otherwise, it is either 'up(1)', if
        N2_lost for the 2-Hop Tuple is equal to false, or
        'notconsidered(2)' otherwise."
    ::= { nhdpNotificationsStates 2 }
```

## **7. IANA Considerations**

This document has no actions for IANA.

[This section may be removed by the RFC Editor.]

## **8. Security Considerations**

The update to [[RFC6130](#)] enables the retention and reuse of some information collected by that protocol, for only the duration that it could have been used in any case. As such, this protocol introduces no new security considerations to an implementation of [[RFC6130](#)] or of any other protocol that uses it, such as [[RFC7181](#)].

## **9. Acknowledgments**

The authors would like to thank Liz Cullen (BAE Systems) for first illustrating the issue addressed in this specification.

## **10. Normative References**

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC6130] Clausen, T., Dean, J., and C. Dearlove, "Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP)",



[RFC 6130](#), April 2011.

[RFC6779] Herberg, U., Cole, R., and I. Chakeres, "Definition of Managed Objects for the Neighborhood Discovery Protocol", [RFC 6779](#), October 2012.

[RFC7181] Clausen, T., Dearlove, C., Jacquet, P., and U. Herberg, "The Optimized Link State Routing Protocol version 2", [RFC 7181](#), April 2014.

#### Authors' Addresses

Christopher Dearlove  
BAE Systems Advanced Technology Centre  
West Hanningfield Road  
Great Baddow, Chelmsford  
United Kingdom

Phone: +44 1245 242194  
Email: [chris.dearlove@baesystems.com](mailto:chris.dearlove@baesystems.com)  
URI: <http://www.baesystems.com/>

Thomas Heide Clausen  
LIX, Ecole Polytechnique

Phone: +33 6 6058 9349  
Email: [T.Clausen@computer.org](mailto:T.Clausen@computer.org)  
URI: <http://www.ThomasClausen.org/>

