Mobile Ad hoc Networking (MANET)
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MANET Generalized Location Signaling Format
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Status of this Memo

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Abstract

This document decribes a generalized format for transmitting mobility information, which MAY be used by mobile ad hoc network routing and other protocols.

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1. Introduction

In recent months, a growing interest has been observed in location information for improving routing in mobile ad hoc networks, by trying to improve links stability, periodic maintenance, power consumption or even security.

Indeed, by peeking into the recent litterature, we see that between 2004 and 2006, 3 IEEE transactions and 38 IEEE conference proceedings are related to mobility predictions, while ACM published 11 papers.

The common point of all these new directions are the requirement of mobile nodes' mobility information. Some proposals needs nodes velocity, others moving directions, or nodes position. The most complex ones require nodes position and velocity in order to extract mobility prediction patterns.

The Intelligent Vehicule Community already understood the benefits safety provisionings could obtain from proactive visions as they started standardizing the informations cars should share. For example, the VII consortium (Vehicle Infrastructure Integration) is standardizing the information that should be transmitted between vehicles. As routing protocols and eventually internet will come on top of intervehicular communications, a similar and possiblity collaborative approach should be undergone within the IETF.

However, we do not know yet what kind of information are required to be transmitted, and it is quite clear that the community might not even all agree on a common framework.

The aim of this document is to extend the recent internet drafts [PacketBB] and [NHDP] to include mobility information in TLV messages. Accordingly, this specification proposes a generalized mobility-based signaling framework, which may be employed by both mobile ad hoc networks routing protocols and other protocols with similar signaling requirements and which requires mobility information.

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].

Additionally, this document uses the following terminology:

Address - an address of the same type and length as the source IP address in the IP datagram carrying the packet.

TLV - Type-Length-Value structure as described in [PacketBB]

Mobility - mobility information related to a specific address, which consists of a set of coordinates followed by the velocity and the time this mobility information has been sampled. It will also be related to a TLV type that contains mobility information.

3. Applicability Statement

This specification describes an extension to message signaling based on TLV packets. This specification has been based on [PacketBB].

This specification is designed to provide MANET routing protocols with a common framework for carrying mobility information. Extending the specification of MANET packet format [PacketBB], this specification keeps the same applicability and simply accomodates a new Mobility Type TLV attribute in message signaling.

Although the TLVs are generic and could possiblity be adapted to any kind of structure, no specific TLV type has been defined in [PacketBB] for mobility information. Therefore, in the case of interoperability, nodes would not be able to know they are dealing with localization data unless some common agreements are defined.

The objective of this draft is primarily to define a common agreement on the type and structure of packets containing mobility informations. Then, we provide examples of the mobility information structure in MANET standardized protocols.

4. Protocol Overview and Functioning

This specification does not describe a protocol. It describes an extension to MANET message signaling that MAY be used by protocols for mobile ad hoc networks to exchange mobility information. It is based on the Generalized MANET Packet/Message Format [PacketBB] specification which is the common packet format to be used by MANET routing protocols.

5. The Generalized MANET Message Format Signaling Framework

This section provides a general description of message and packet format. A more precide description may be found in [PacketBB]

5.1. Packet Format

Information in MANET are carried in a general packet format and MAY piggyback several independant messages in a single packet transmission

The packet format conforms to the following specification

```
<packet> = {<packet-header><pad-octet>*}?
           {<message><pad-octet>*}*
```

where <message> in defined in Section Section 5.2, and <pad-octet> conforming to [PacketBB]

The packet header is defined as

```
<packet-header> = <zero>
                  <packet-semantics>
                  <packet-seq-number>?
                  <tlv-block>?
```

with the elements of <packet-header> conformed to the definition in [PacketBB]

5.2. Message Format

Information is carried through "messages". Messages may contain:

- A message header.
- A message TLV block that contains zero or more TLVs, associated with the whole message.
- Zero or more address blocks, each containing one or more addresses.
- A TLV block, containing zero or more TLVs, following each address block.

<message> is defined by:

```
<message>        = <message-header>
                   <tlv-block>
                   {<addr-block><tlv-block>}*

<message-header> = <msg-type>
                   <msg-semantics>
                   <msg-size>
                   <msg-header-info>

<msg-header-info> = <originator-address>?
                    <hop-limit>?
                    <hop-count>?
                    <msg-seq-number>

<tlv-block>      = <tlv-length>
                   <tlv>*
```

with the elements conformed to the definition in [PacketBB]

5.2.1. Address Blocks

An address is specified as a sequence of octets of the form head:mid: tail. An address block is an ordered set of addresses sharing the same head and tail, and having individual mids.

<address-block> is defined by:

```
<address-block> = <num-addr>
                  <head-octet>
                  <head>?
                  <tail-octet>?
                  <tail>?
                  <mid>*
```

with the elements defined as in [PacketBB]

6. MANET Neighborhood Discovery Protocol (NHDP)

[NHDP] describes a general neighborhood discovery protocol that MAY be used by MANET protocols that require neighborhood knowledge without localization information. It uses the packet formats defined in [PacketBB] and introduced two new TLV types 'VALIDITY_TIME' and 'INTERVAL_TIME'.

A TLV is a carrier of information, relative to a message or to addresses in an address block. When related to addresses in address blocks, a TLV MAY be associated with a single address or all address in the address block.

6.1. TLV types

This specification defines two Message TLV types, which must be allocated from the "Assigned Message TLV Types" repository of [PacketBB]

TLV Type		Default Value
VALIDITY_TIME	The time (in seconds) from receipt of the message during which the information contained in the message is to be considered valid	N/A
INTERVAL_TIME	The maximum time (in seconds) between two successive transmissions of messages of the appropriate type	N/A

This specification defines three Address Block TLV types, which must be allocated from the "Assigned Address Block TLV Types" repository of [PacketBB]

Mnemonic	Value	Description
OTHER_IF	TBD	Specifies that the address, in the Local Interface Block of the message, is an address associated with a MANET interface other than the one on which the message is transmitted
LINK_STATUS	TBD	Specifies a given link's status (LOST, SYMMETRIC or HEARD)
OTHER_NEIGHB	TBD	Specifies that the address is, or was, of a MANET interface of a symmetric 1-hop neighbor of the node transmitting the HELLO message, but does not have a matching or better LINK_STATUS TLV

7. Mobility Specific TLVs

A TLV is a carrier of information, relative to a message or to addresses in an address block. When related to addresses in address blocks, a TLV MAY be associated with a single address or all address in the address block. This specification extends the TLV definition in [PacketBB] to include Mobility TLVs.

All TLVs are conformed to the following specification:

```
<tlv> = <tlv-type>
        <tlv-semantic>
        <index-start>?
        <index-stop>?
        <length>?
        <value>?
```

where the elements are defined as:

<tlv-type> is an 8 bit field which the type of TLV.

bit 0 (location bit): TLV with this bit cleared ('0') does not contains the location of the address in the respective address block. TLVs with this bit set ('1') contains location information.

bit 1 (velocity bit): TLV with this bit cleared ('0') does not contains the velocity of the address in the respective address block. TLVs with this bit set ('1') contains the velocity.

bit 2 (azimuth bit): TLV with this bit cleared ('0') does not contains the azimuth of the address in the respective address block. TLVs with this bit set ('1') contains the azimuth.

bit 5 (mobility bit): TLV with this bit set ('1') contains mobility information according to this specification.

bit 6 (tlvprot): for TLV types with the tlv-user bit cleared ('0'), this bit specifies, if cleared ('0'), that the TLV type is protocol independent, i.e. is not specific to any one protocol, or, if set ('1'), that the TLV type is specific to the protocol for which it is defined.

bit 7 (user bit): This bit is always set as this specification is introducing a new TLV type not covered in [PacketBB]

<tlv-semantic> is an 8-bit field which specifies the semantics of the TLV accoridng to Section 5.3.1 in [PacketBB].

<index-start> and <index-stop> are each an 8 bit field, interpreted as specified in Section 5.3.1 in [PacketBB]

<length> is interpreted as specified in Section 5.3.1 in [PacketBB]

<value> if present (see Table 1), this is a field of length <length> octets. In an address block TLV, <value> is associated with the addresses from index-start to index-stop, inclusive. If the multivalue bit is cleared ('0') then the whole of this field is associated with each of the indicated addresses. If the multivalue bit is set ('1') then this field is divided equally into number-values fields, each of length single-length octets and these are associated, in order, with the indicated addresses. If the mobility bit is set ('1'), the value field has the following general layout

<value> = {<loc>?<azi>?<velo>?<stab><time>}*

with the usual notion of "?" indicating "zero or one" occurence of the preceding element, the notion of "*" indicating "zero or more" occurence of the preceding element, and the element defined thus:

<loc> is a block containing the coordinates of a node following the general layout

<loc> = <Longitude><Latitude><Elevation>

<velo> is a block containing the node's velocity in m/s

<azi> is a block containing the node's azimuth

<stab> is a block containing the node's stability , which represents the node eagerness to keep the current mobility parameters, and which MAY be used as a measure of the relative confidence of the mobility parameters.

<time> is a block containing the time these mobility parameters has been sampled last. In conjunction with <stab>, it MAY be able to provide a confidence predictor of the mobility parameters.

7.1. Constraints

- An address SHALL NOT appear more than once in the same message with the same prefix length (an address without a PREFIX-LENGHT TLV is considered to have a prefix length equal to the address length).

- In any kind of mobility TLV, the <stab> and <time> MUST always be present.

- If the bit <azi> is set ('1'), the bit <speed> MUST also be set ('1').

- For TLVs carying mobility information, the user bit and the mobility bit MUST be set ('1') in the <type> field..

- For TLVs carying mobility information, each mobility parameter applies to a single and unique address. Accordingly, if multiple addresses are aggregated in a TLV address block, the multivalue bit MUST be set ('1') and the noindex bit MUST be unset ('0').

- For TLVs carying mobility information, two or more TLVs of the same type MUST NOT be included in the same TLV block or TLV address block.

- Non-mobility specific constrains MAY be found in [PacketBB]

8. IANA Considerations

8.1. TLV Types

This document specifies 5 new TLV types which must be allocated from the "Assigned Message Types" repository of [PacketBB].

Mnemonic	Value	Description
LOCATION	161	Mobility TLV with location only
SPEED	162	Mobility TLV with speed only
LOCATION_SPEED	163	Mobility TLV with speed and location
SPEED_AZIMUT	166	Mobility TLV with speed and azimuth
LOC_SPEED_AZIMUT	167	Mobility TLV with speed, azimuth and location

Figure 10

9. Security Considerations

This document is subject to similar security issues as [PacketBB]. Accordingly, similar security considerations may be undertaken.

10. References

10.1. Nominative References

[PacketBB] Clausen, T., "Generalized MANET Packet/Message Format", <www.ietf.org/internet-drafts/draft-ietf-manet-packetbb-02.txt>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

10.2. Informative References

[DYMO] Chakeres, I., "Dynamic MANET On-demand (DYMO) Routing", <www.ietf.org/internet-drafts/draft-ietf-manet-dymo-06.txt>.

[NHDP] Clausen, T., "MANET Neighborhood Discovery Protocol (NHDP)", <www.ietf.org/internet-drafts/draft-ietf-manet-nhdp-00.txt>.

[OLSRv2] Clausen, T., "The Optimized Link State Routing version 2", <www.ietf.org/internet-drafts/draft-ietf-manet-olsrv2-02.txt>.

[SMF] Macker, J., "Simplified Multicast Forwarding for MANET", <www.ietf.org/internet-drafts/draft-ietf-manet-smf-03.txt>.

Appendix A. Message Layout

This section specifies the translation from the abstract descriptions of messages employed in the protocol specification, and the bit-layout messages actually exchanged between nodes. The section only focuses on Mobility TLVs as other parts are described in details in [PacketBB]

A.1. Mobility TLVs

The basic layout of the <type> field in a Mobility TVL is as follows:

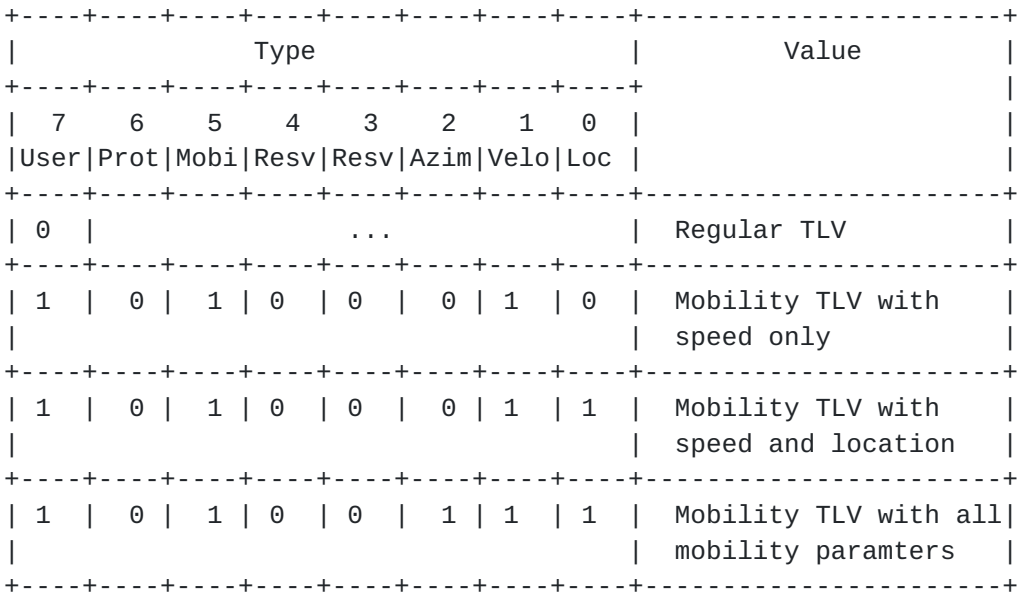

Figure 11

where, according to the bits cleared or set in the <type> field and the related constraints, any combinations are possible.

The basic layout of a Message Mobility TVL is as follows:

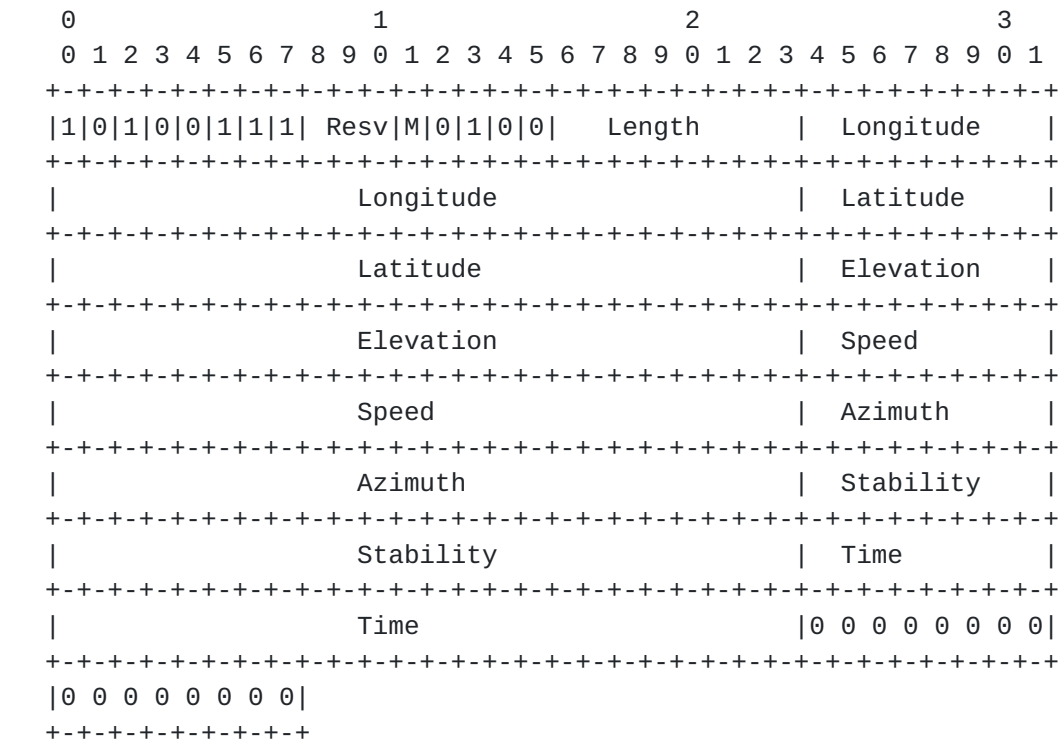

Figure 12

where all mobility parameters have been displayed. According to the bits cleared or set in the <type> field and the related constraints, any combinations are possible, yet adding padding bits ('0') at the end to ensure that the total length is a integer multiple of 4 bytes.

The basic layout of a Address Blocks Mobility TVL is as follows:

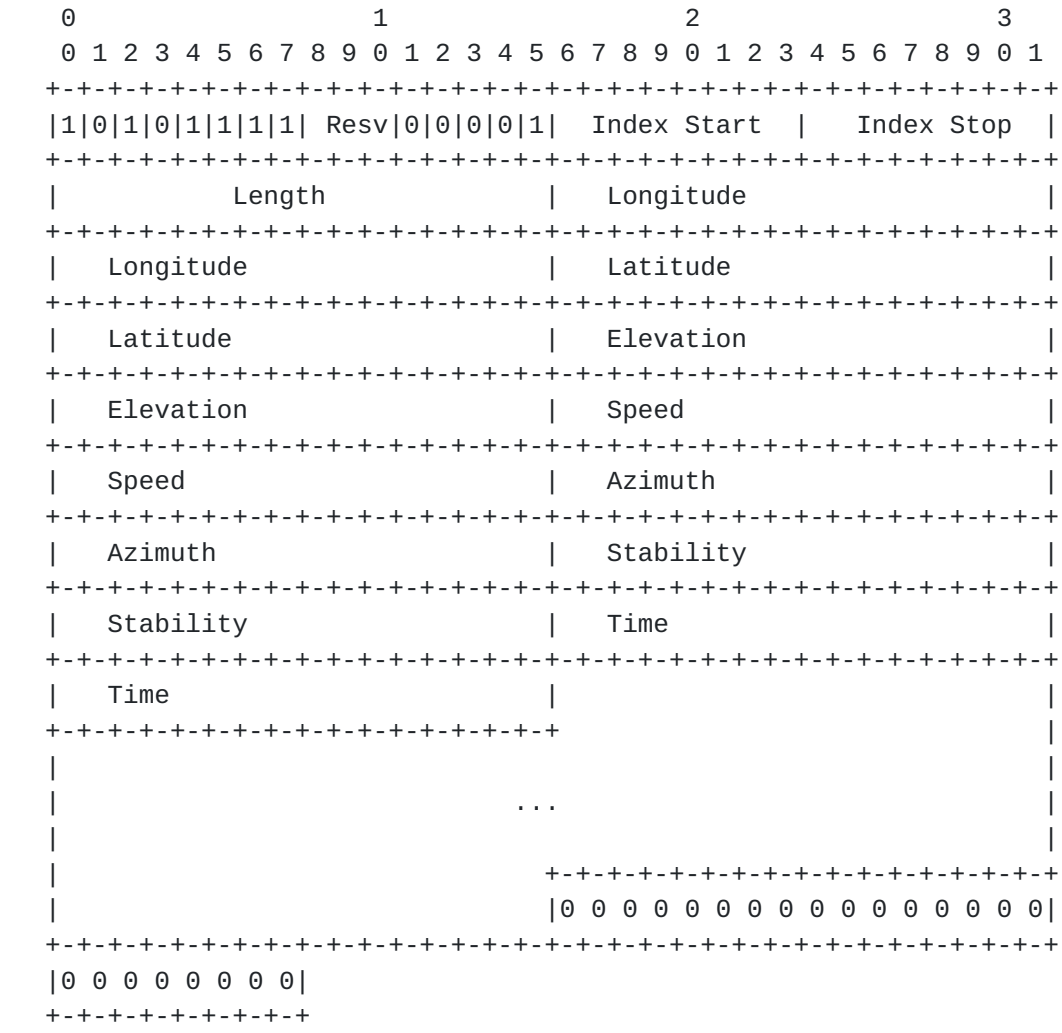

Figure 13

with as many mobility structures as the number of addresses in the address block, and where all mobility parameters have been displayed. Accoring to the bits cleared or set in the <type> field and the related constraints, any combinations are possible, yet adding padding bits ('0') at the end to ensure that the total length is an integer multiple of 4 bytes.

Appendix B. Message Layout of MANET routing protocols using Mobility TLVs

B.1. MANET Neighborhood Discovery Protocol (NHDP)

This section specifies the translation from the abstract descriptions of Mobility TLVs in Section Section 7 to the application in the MANET Neighborhood Discovery Protocol [NHDP].

NHDP is a neighborhood discovery protocol (NHDP) for a mobile ad hoc network (MANET). The protocol provides each MANET node with local topology up to two hops distant, describing a node's 1-hop neighbors and symmetric 2-hop neighbors. NHDP employs HELLO messages for neighborhood discovery and are locally scoped. For a detailed description, the reader is referred to [NHDP].

HELLO messages are exchanged between neighbor nodes only, ie. they MUST NOT be forwarded by any node. A HELLO message is conformed to the following layout:

<hello> = <hello-msg-tlvs>*{<addr_block><addr_block_tlv>+}*

B.1.1. HELLO Message: Message TLVs

If Mobility information are convoyed by HELLO messages, a node MUST generate a HELLO message with at least the message TLVs specified in Figure 15.

TLV Type		Default Value
VALIDITY_TIME	The time (in seconds) from receipt of the message during which the information contained in the message is to be considered valid	N/A
INTERVAL_TIME	The maximum time (in seconds) between two successive transmissions of messages of the appropriate type	N/A
MOBILITY	sender mobility information.	N/A

Figure 15

Assigned HELLO message TLV types and bit layout in NHDP:

Mnemonic	Type	Value
Fragmentation	00000000	Specifies behavior in case of content fragmentation.
Content Seq. Number	00000001	A sequence number, associated with the content of the message
VALIDITY_TIME	TBD	The time (in seconds) from receipt of the message during which the information contained in the message is to be considered valid
INTERVAL_TIME	TBD	The maximum time (in seconds) between two successive transmissions of messages of the appropriate type
MOBILITY	10100...	Specifies the mobility parameter of the sender node

Figure 16

Assigned HELLO address TLV types and bit layout in NHDP:

Mnemonic	Type	Value
OTHER_IF	TBD	Specifies that the address, in the Local Interface Block of the message, is an address associated with a MANET interface other than the one on which the message is transmitted
LINK_STATUS	TBD	Specifies a given link's status (LOST, SYMMETRIC or HEARD)
OTHER_NEIGHB	TBD	Specifies that the address is, or was, of a MANET interface of a symmetric 1-hop neighbor of the node transmitting the HELLO message, but does not have a matching or better LINK_STATUS TLV
Mobility	10100...	Specifies the mobility parameter of the node with the given address

Figure 17

B.1.2. HELLO Message: Address Blocks and Address TLVs

If Mobility information are convoyed by HELLO messages, for each transmitting interface, a node MUST generate a HELLO message with address blocks and address TLVs accoridng to Figure 18.

Addresses:	TLVs (Type=Value)
The set of neighbor interfaces which are...	
HEARD over the interface over which the HELLO is being transmitted	(Link Status=HEARD); (Interface=TransmittingInterface) (Mobility=Neighbor Mobility)
SYMMETRIC over the interface over which the HELLO is being transmitted	(Link Status=SYMMETRIC); (Interface=TransmittingInterface) (Mobility=Neighbor Mobility)
LOST over the interface over which the HELLO is being transmitted	(Link Status=LOST); (Interface=TransmittingInterface)
SYMMETRIC over ANY interface of the node other than the interface over which the HELLO is being transmitted	(Link Status=SYMMETRIC); (Interface=TransmittingInterface) (Mobility=2-hops Neighbor Mobility)

Figure 18

B.1.2.1. HELLO Message Example with Mobility Informations

A simple example HELLO message, sent by an originator node with a single MANET interface, is as follows. The message uses IPv4 (four octet) addresses without prefix TLVs, i.e. with all addresses having maximum length prefixes. The message is sent with a full message header (message semantics octet is 0) with a hop limit of 1 and a hop count of 0. The overall message length is 168 octets (it does not need padding).

The message has a message TLV block with content length 8 octets containing three message TLVs, of types VALIDITY_TIME, INTERVAL_TIME, and MOBILITY. Each uses a TLV with semantics value 4, indicating no start and stop indexes are included, and the first two has a value length of 1 octet. The MOBILITY TLV has a length of 28 octet. The values included (0x68 and 0x50) represent the default values of 6 seconds and 2 seconds, respectively.

The first address block contains 1 local interface address, with head

length 4 and no address tail or mid parts. This address block has no TLVs (TLV block content length 0 octets).

The second, and last, address block contains 4 neighbor interface addresses, with head length 3 octets, no address tail part and each address mid part having length one octet. The following TLV block (content length 7 octets) includes one TLV which reports the link status of all neighbors in a single multivalue TLV: the first two addresses are HEARD, the third address is SYMMETRIC and the fourth address is LOST. The TLV semantics value of 12 indicates, in addition to that this is a multivalue TLV, that no start and stop indexes are included, since values for all addresses are included. The TLV value length of 4 octets indicates one octet per value per address.

In the Message TLV, we add the coordinate of the source node and in the address block TLV we add a multivalue TLV which contains the coordinates of each MID.

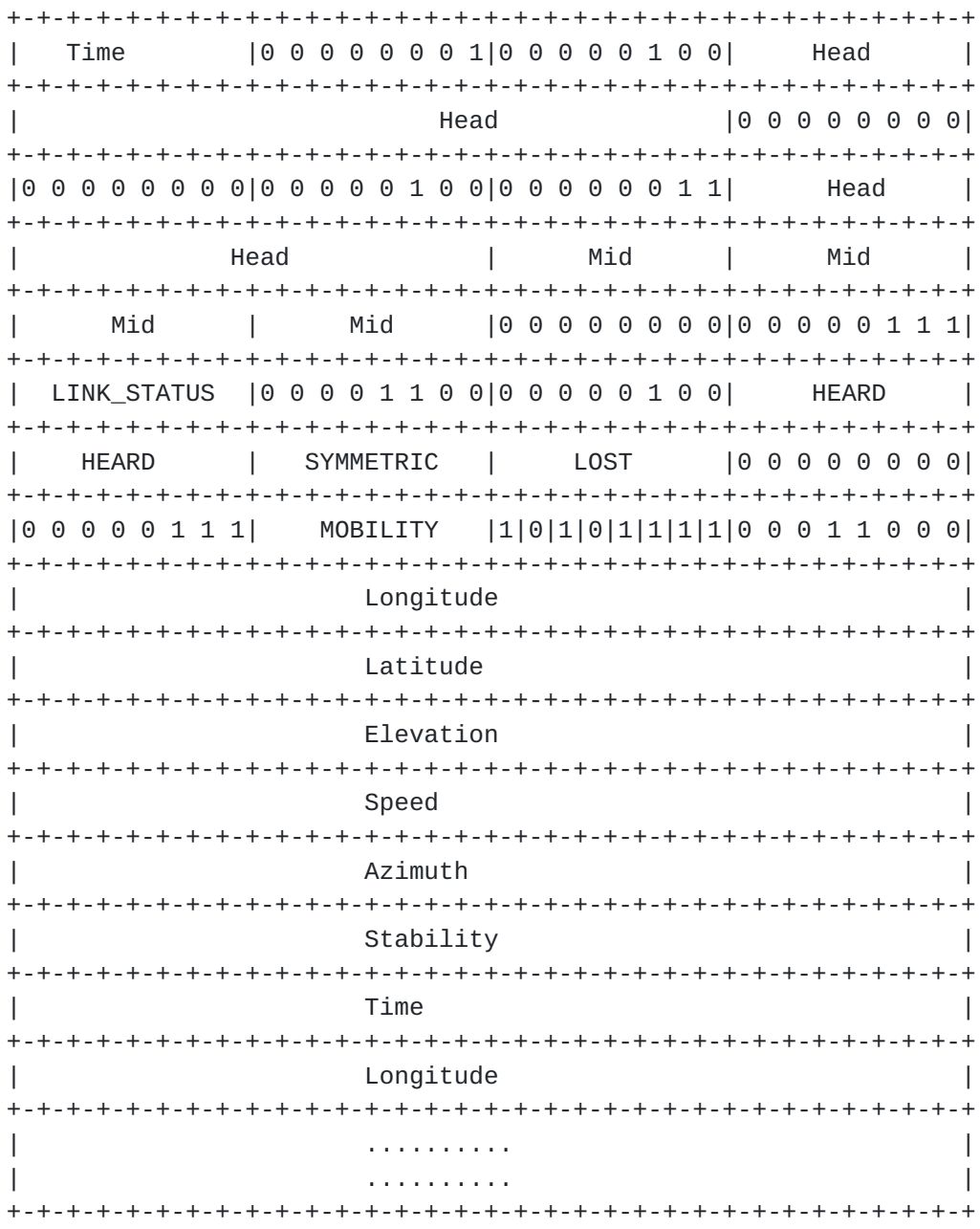

Figure 19

B.2. OLSR version 2

This section specifies the translation from the abstract descriptions of Mobility TLVs in Section Section 7 to the application in OLSR version 2 routing protocol [OLSRv2].

OLSRv2 employs two different message types for exchanging protocol information. Those are the HELLO message which are locally scoped

and the TC messages, which are globally scoped. For a detailed description, the reader is referred to [OLSRv2].

B.2.1. HELLO

Hello messages are exahnged between neighbor nodes only, ie. they MUST NOT be forwarded by any node. A HELLO message is conformed to the following layout:

<hello> = <hello-msg-tlvs>*{<addr_block><addr_block_tlv>+}*

B.2.1.1. HELLO Message: Message TLVs

If Mobility information are convoyed by HELLO messages, for each OLSRv2 interface a node MUST generate a HELLO message with at least the message TLVs specified in Figure 21.

TLV Type		Default Value
Willingness	willingness to be selected as MPR.	WILL_DEFAULT
Mobility	sender mobility information.	N/A

Figure 21

Assigned HELLO message TLV types and bit layout in OLSRv2:

Mnemonic	Type	Value
Fragmentation	00000000	Specifies behavior in case of content fragmentation.
Content Seq. Number	00000001	A sequence number, associated with the content of the message
Willingness	00000011	Specifies a nodes willingness [0-7] to act as a realy and take part in the network formation
Mobility	1010....	Specifies the mobility parameter of the sender node

Figure 22

Assigned HELLO address TLV types and bit layout in OLSRv2:

Mnemonic	Type	Value
Link Status	00000000	Specifies a given link's status asymmetric, verified bidirectional, lost)
MPR	00000001	Specifies that a given address is selected as MPR
Mobility	10100...	Specifies the mobility parameter of the node with the given address

Figure 23

B.2.1.2. HELLO Message: Address Blocks and Address TLVs

If Mobility information are convoyed by HELLO messages, for each OLSRv2 interface a node MUST generate a HELLO message with address blocks and address TLVs accoridng to Figure 24.

Addresses:	TLVs (Type=Value)
The set of neighbor interfaces which are...	
HEARD over the interface over which the HELLO is being transmitted	(Link Status=HEARD); (Interface=TransmittingInterface) (Mobility=Neighbor Mobility)
SYMMETRIC over the interface over which the HELLO is being transmitted	(Link Status=SYMMETRIC); (Interface=TransmittingInterface) (Mobility=Neighbor Mobility)
LOST over the interface over which the HELLO is being transmitted	(Link Status=LOST); (Interface=TransmittingInterface)
SYMMETRIC over ANY interface of the node other than the interface over which the HELLO is being transmitted	(Link Status=SYMMETRIC); (Interface=TransmittingInterface) (Mobility=2-hops Neighbor Mobility)
selected as MPR for the interface over which the HELLO is transmitted	(Link Status=MPR); (Interface=TransmittingInterface) (MPR Selection=True) (Mobility=2-hops Neighbor Mobility)

Figure 24

B.2.2. TC Messages

TC messages are, in OLSRv2, transmitted to the entire network with the purpose of populating a topology information base as described in [OLSRv2]. A TC message is conformed to the following layout:

<tc> = <tc-msg-tlvs>*{<addr_block><addr_block_tlv>*}*

B.2.2.1. TC Message: Message TLVs

If Mobility information are convoyed by TC messages, each node selected as MPR MUST generate TC messages with message TLVs according to the following table:

TLV Type		Default Value
Seq. no	The current value of the ASSN of the node	N/A

Figure 26

Assigned TC message TLV types and bit layout in OLSRv2:

Mnemonic	Type	Value
Content Seq. Number	00000000	Specifies the current value of the ASSN of the node
Mobility	10100...	Specifies the mobility parameter of the sender node

Figure 27

B.2.2.2. TC Message: Message TLVs

If Mobility information are convoyed by TC messages, each node selected as MPR MUST generates TC messages with address block and address TLVs according to the following table:

Addresses:	TLVs (Type=Value)
The set of neighbor interfaces which have selected the node as MPR	(Mobility= Neighbors Mobility)

Figure 28

Assigned TC address TLV types and bit layout in OLSRv2:

Mnemonic	Type	Value
MPR Selector	00000000	Specifies that a given address has selected the sender node as MPR
Mobility	10100...	Specifies the mobility parameter of the nodes with the given address

Figure 29

B.3. SMF

In [SMF], due to similar use of Hello messages as in OLSRv2, mobility TLVs MAY be applied as in Section Appendix B.2 and considering the new TLVs defined in [NHDP].

B.4. AODV

The current specification of AODV is overridden by DYMO

B.5. DYMO

[DYMO] is planned to use the mesage structure defined in [PacketBB] as well as the hello structure defined in [NHDP]. Accordingly, mobility TLVs MAY be applied as in Section Section 6

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