RFC7722: Multi-Topology Extension for the Optimized Link State Routing Protocol Version 2 (OLSRv2)

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Abstract

This specification describes an extension to the Optimized Link State Routing Protocol version 2 (OLSRv2) to support multiple routing topologies, while retaining interoperability with OLSRv2 routers that do not implement this extension.

This specification updates RFCs 7188 and 7631 by modifying and extending TLV registries and descriptions.

Status of This Memo

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1. Introduction

The Optimized Link State Routing Protocol version 2 [RFC7181] (OLSRv2) is a proactive link state routing protocol designed for use in Mobile Ad Hoc Networks (MANETs) [RFC2501]. One of the significant improvements of OLSRv2 over its Experimental precursor [RFC3626] is the ability of OLSRv2 to use link metrics to select routes other than minimum hop routes.

A limitation that remains in OLSRv2 is that it uses a single link metric type for all routes. However, in some MANETs it would be desirable to be able to route packets using more than one link metric type. This specification describes an extension to OLSRv2 that is designed to permit this, while maintaining maximal interoperability with OLSRv2 routers not implementing this extension.

The purpose of OLSRv2 can be described as to create and maintain a Routing Set, which contains all the necessary information to populate an IP routing table. In a similar way, the role of this extension can be described as to create and maintain multiple Routing Sets, one for each link metric type supported by the router maintaining the sets.

1.1. Motivation and Experimentation

Multi-topology routing is a natural extension to a link state routing protocol, such as OSPF (see [RFC4915]). However multi-topology routing for OLSRv2 does not yet benefit from extensive operational, or even experimental, experience. This specification is published to facilitate collecting such experience, with the intent that once suitable experimental evidence has been collected, an OLSRv2 Multi-Topology Routing Extension will be proposed for advancement onto the Standards Track.

Any experiments using this protocol extension are encouraged. Reports from such experiments planned with pre-specified objectives and scenarios (including link, position, and mobility information) are particularly encouraged. Results from such experiments, documenting the following, are of particular importance:

- Operation in networks that contain both routers implementing this extension and routers implementing only [RFC7181]. In particular, are there any unexpected interactions that can break the network?

- Operation in networks with dynamic topologies, both due to mobility and due to link metric changes for reasons other than mobility.

- o Operation in realistic deployments, and details thereof, including how many concurrent topologies were required.

- o Behavior of Routing Sets, including measures of successful route establishment.

In addition, reports from experiments covering the following are also of value:

- o Which link metric types were useful, and how the metrics to associate with a given link were established.

- o How packet types were associated with link metric types (whether using Diffserv or an alternative mechanism).

- o Any data link-layer issues, and any cross-layer issues, including whether and how Neighborhood Discovery Protocol (NHDP) link quality was used.

- o Transport- and higher-layer issues observed, if any.

- o Resource requirements observed from running the protocol, including processing, storage, and bandwidth.

- o Network performance, including packet delivery results.

- o Any other implementation issues.

The first bullet in the list directly above applies to unextended OLSRv2 [RFC7181] as well as with this extension, and potentially to other MANET routing protocols. This specification also allows experimentation with link metric types that are not compromises for handling multiple traffic types.

2. Terminology and Notation

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].

This specification uses the terminology of [RFC5444], [RFC6130], and [RFC7181], which is to be interpreted as described in those specifications.

Additionally, this specification uses the following terminology:

Router - A MANET router that implements [RFC7181].

MT-OLSRv2 - The protocol defined in this specification as an extension to OLSRv2 [RFC7181].

This specification introduces the notation map[A -> B] to represent an associative mapping. The domain of this mapping (A) is, in this specification, always a set of link metric types that the router supports: either IFACE_METRIC_TYPES or ROUTER_METRIC_TYPES, as defined in Section 5. The codomain of this mapping (B) is a set of all possible values of an appropriate type. In this specification, this type is always one of:

- boolean (true or false),
- willingness (a 4-bit unsigned integer from 0 to 15),
- number of hops (an 8-bit unsigned integer from 0 to 255), or
- link metric (either a representable link metric value, as described in [RFC7181], or UNKNOWN_METRIC).

3. Applicability Statement

The protocol described in this specification is applicable to a MANET for which OLSRv2 is otherwise applicable (see [RFC7181], Section 3), but in which multiple topologies are maintained, each characterized by a different choice of link metric type. It is assumed, but outside the scope of this specification, that the network layer is able to choose which topology to use for each packet, for example, using the Diffserv Code Point (DSCP) defined in [RFC2474]. This selection of topology MUST be consistent; that is, each router receiving a packet must make the same choice of link metric type, in order that each packet uses a single topology. This is necessary to avoid the possibility of a packet "looping" in the network.

4. Protocol Overview and Functioning

The purpose of this specification is to extend OLSRv2 [RFC7181] so as to enable a router to establish and maintain multiple routing topologies in a MANET, each topology associated with a link metric type. Routers in the MANET may each form part of some or all of these topologies, and each router will maintain a Routing Set for each topology that it forms part of, allowing separate routing of packets for each topology.

MT-OLSRv2 is designed to interoperate with OLSRv2; a MANET can be created containing both routers that implement MT-OLSRv2 (MT-OLSRv2 routers) and routers that do not implement MT-OLSRv2 and may be unaware of its existence (non-MT-OLSRv2 routers). MANETs may also be created that are known to contain only MT-OLSRv2 routers. In both cases, but especially where a MANET contains both MT-OLSRv2 routers and non-MT-OLSRv2 routers, management may be required to ensure that the MANET will function as required, and will not, for example, unnecessarily fragment. (Such issues already arise in an OLSRv2-based MANET using multiple interfaces.)

OLSRv2 is an extension of NHDP [RFC6130]. However, the extension in this specification does not modify NHDP, it only modifies Protocol Sets that are specific to OLSRv2, or elements in Protocol Tuples that were added by OLSRv2 and that are neither included in nor used by NHDP. In addition it does not use or modify the link quality mechanism in [RFC6130].

Each router implementing this specification selects a set of link metric types for each of its OLSRv2 interfaces. If all routers in the MANET implement MT-OLSRv2, then there are no restrictions within this specification on how these sets of link metrics are selected. (However, the issues described in the preceding paragraph still apply.) On the other hand, in MANETs containing non-MT-OLSRv2 routers, the single link metric used by these non-MT-OLSRv2 routers must be included in the set of link metrics for each OLSRv2 interface of an MT-OLSRv2 router that may be heard on an OLSRv2 interface of a non-MT-OLSRv2 router in the MANET.

Each router then determines an incoming link metric for each link metric type selected for each of its OLSRv2 interfaces. These link metrics are distributed using link metric TLVs contained in all HELLO messages sent on OLSRv2 interfaces and in all TC messages. Unless using only the single metric type used by non-MT-OLSRv2 routers, both HELLO and TC messages generated by an MT-OLSRv2 router include an MPR_TYPES Message TLV that indicates that this is an MT-OLSRv2 router and which metric types it supports (on the sending OLSRv2 interface for a HELLO message).

An MT-OLSRv2 router maintains, for each supported neighbour metric type and for each symmetric 1-hop neighbor, the following:

- o link and neighbour metric values,
- o routing MPR status,
- o routing MPR selector status, and
- o advertised neighbour status.

Each router may choose a different willingness to be a routing MPR for each link metric type that it supports.

A network using MT-OLSRv2 will usually require greater management than one using unmodified OLSRv2. In particular, the use of multiple metric types across the MANET must be managed, by administrative configuration or otherwise. As also for other decisions that may be made when using OLSRv2, a bad collective choice of metric type use will make the MANET anywhere from inefficient to nonfunctional, so care will be needed in selecting supported link metric types across the MANET.

The meanings of link metric types are at the discretion of the MANET operator. They could be used, for example, to represent packets of different types, packets in streams of different rates, or packets with different trust requirements. Note that packets will generally not be delivered to routers that do not support that link metric type, and the MANET, and the packets sent in it, will need to be managed accordingly (especially if the MANET contains any non-MT-OLSRv2 routers).

5. Parameters

The parameters used in [RFC7181], and in its normative references, are used in this specification with the following changes.

Each OLSRv2 interface will support a number of link metric types, corresponding to Type Extensions of the LINK_METRIC TLV defined in [RFC7181]. The router parameter LINK_METRIC_TYPE, used by routers that do not implement MT-OLSRv2, and used with that definition in this specification, is replaced in routers implementing MT-OLSRv2 by an interface parameter array IFACE_METRIC_TYPES and a router parameter array ROUTER_METRIC_TYPES. Each element in these arrays is a link metric type (i.e., a type extension used by the LINK_METRIC TLV [RFC7181]).

The interface parameter array IFACE_METRIC_TYPES contains the link metric types supported on that OLSRv2 interface. The router parameter array ROUTER_METRIC_TYPES is the union of all of the IFACE_METRIC_TYPES. Both arrays MUST be without repetitions.

If in a given deployment there might be routers that do not implement MT-OLSRv2, then IFACE_METRIC_TYPES MUST include LINK_METRIC_TYPE as its first element, so that the OLSRv2 interface can communicate with those routers. In that case, ROUTER_METRIC_TYPES MUST also include LINK_METRIC_TYPE as its first element.

In addition, the router parameter WILL_ROUTING is extended to an array of values, one each for each link metric type in the router parameter list ROUTER_METRIC_TYPES.

6. Information Bases

The Information Bases specified in [RFC7181], which extend those specified in [RFC6130], are further extended in this specification. With the exception of the Routing Set, the extensions in this specification are the replacement of single values (boolean, willingness, number of hops, or link metric) from [RFC7181] with elements representing multiple values (associative mappings from a set of metric types to their corresponding values). The following subsections detail these extensions.

Note that, as in [RFC7181], an implementation is free to organize its internal data in any manner it chooses; it needs only to behave as if it were organized as described in [RFC7181] and this specification.

6.1. Local Attached Network Set

Each element AL_dist becomes a map[ROUTER_METRIC_TYPES -> number of hops].

Each element AL_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

6.2. Link Sets

Each element L_in_metric becomes a map[IFACE_METRIC_TYPES -> link metric].

Each element L_out_metric becomes a map[IFACE_METRIC_TYPES -> link metric].

The elements of L_in_metric MUST be set following the same rules that apply to the setting of the single element L_in_metric in [RFC7181].

6.3. 2-Hop Sets

Each element N2_in_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

Each element N2_out_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

6.4. Neighbor Set

Each element N_in_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

Each element N_out_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

Each element N_will_routing becomes a map[ROUTER_METRIC_TYPES -> willingness].

Each element N_routing_mpr becomes a map[ROUTER_METRIC_TYPES -> boolean].

Each element N_mpr_selector becomes a map[ROUTER_METRIC_TYPES -> boolean].

Each element N_advertised becomes a map[ROUTER_METRIC_TYPES -> boolean].

6.5. Router Topology Set

Each element TR_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

Note that some values of TR_metric may now take the value UNKNOWN_METRIC. When used to construct a Routing Set, where just the corresponding link metric value from this mapping is used, Router Topology Tuples whose corresponding value from TR_metric is UNKNOWN_METRIC are ignored.

6.6. Routable Address Topology Set

Each element TA_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

Note that some values of TA_metric may now take the value UNKNOWN_METRIC. When used to construct a Routing Set, where just the corresponding link metric value from this mapping is used, Routable Address Topology Tuples whose corresponding value from TA_metric is UNKNOWN_METRIC are ignored.

6.7. Attached Network Set

Each element AN_dist becomes a map[ROUTER_METRIC_TYPES -> number of hops].

Each element AN_metric becomes a map[ROUTER_METRIC_TYPES -> link metric].

Note that some values of AN_metric may now take the value UNKNOWN_METRIC. When used to construct a Routing Set, where just the corresponding link metric value from this mapping is used, Attached

Network Tuples whose corresponding value from AN_metric is UNKNOWN_METRIC are ignored.

6.8. Routing Sets

There is a separate Routing Set for each link metric type in ROUTER_METRIC_TYPES.

7. TLVs

This specification makes the following additions and extensions to the TLVs defined in [RFC7181].

7.1. Message TLVs

One new Message TLV is defined in this specification, and one existing Message TLV is extended by this specification.

7.1.1. MPR_TYPES TLV

The MPR_TYPES TLV is used in both HELLO messages sent over OLSRv2 interfaces and TC messages. A message MUST NOT contain more than one MPR_TYPES TLV.

The presence of this TLV in a message is used to indicate that the router supports MT-OLSRv2, in the same way that the presence of the MPR_WILLING TLV is used to indicate that the router supports OLSRv2, as specified in [RFC7181]. For this reason, the MPR_TYPES TLV has been defined with the same Type as the MPR_WILLING TLV, but with Type Extension = 1.

This TLV may take a Value field of any size. Each octet in its Value field will contain a link metric type that is supported, either on any OLSRv2 interface, when included in a TC message, or on the OLSRv2 interface on which a HELLO message including this TLV is sent. These octets MAY be in any order, but if there might be routers in the MANET that do not implement MT-OLSRv2, then the first octet MUST be LINK_METRIC_TYPE.

7.1.2. MPR_WILLING TLV

The MPR_WILLING TLV, which is used in HELLO messages, is specified in [RFC7181], and extended in this specification as enabled by [RFC7188].

The interpretation of this TLV, which is specified by [RFC7181] and uses all of its single-octet Value field, is unchanged. That interpretation uses bits 0-3 of its Value field to specify its willingness to be a flooding TLV, and bits 4-7 of its Value field to be a routing TLV. Those latter bits are, when using this specification, interpreted as its willingness to be a routing TLV using the link metric type LINK_METRIC_TYPE.

The extended use of this message TLV, as defined by this specification, defines additional 4-bit sub-fields of the Value field, starting with bits 4-7 of the first octet and continuing with bits 0-3 of the second octet, to represent willingness to be a routing MPR using the link metric types specified in this OLSRv2 interface's IFACE_METRIC_TYPES parameter, ordered as reported in the included MPR_TYPES Message TLV. Note that this means that, if there might be any non-MT-OLSRv2 routers, then the link metric type LINK_METRIC_TYPE will continue to occupy bits 4-7 of the first octet. (If there is no such TLV included, then the router does not support MT-OLSRv2, and only the first octet of the Value field will be used.)

If the number of link metric types in this OLSRv2 interface's IFACE_METRIC_TYPES parameter is even, then there will be an unused 4-bit sub-field in bits 4-7 of the last octet of a full-sized Value field. These bits will not be used; they SHOULD all be cleared ('0') on transmission and MUST be ignored on receipt.

If the Value field in an MPR_WILLING TLV is shorter than its full length, then, as specified in [RFC7188], missing Value octets, i.e., missing willingness values, are considered as zero (WILL_NEVER). This is the correct behavior. (In particular, it means that an OLSRv2 router that is not implementing MT-OLSRv2 will not act as a routing MPR for any link metric that it does not recognize.)

7.2. Address Block TLVs

New Type Extensions are defined for the LINK_METRIC TLV defined in [RFC7181], and the Value fields of the MPR TLV and the GATEWAY TLV, both defined in [RFC7181], are extended, as enabled by [RFC7188].

7.2.1. LINK_METRIC TLV

The LINK_METRIC TLV is used in HELLO messages and TC messages. This TLV is unchanged from the definition in [RFC7181].

Only a single Type Extension was specified by [RFC7181] -- 0 for "Link metric meaning as assigned by administrative action". This specification extends it to the range 0-7. This specification will work with any combination of Type Extensions both within and outside that range (assuming that the latter are defined as specified in [RFC7181]).

7.2.2. MPR TLV

The MPR TLV is used in HELLO messages and indicates that an address with which it is associated is of a symmetric 1-hop neighbor that has been selected as an MPR.

The Value field of this address block TLV is, in [RFC7181], defined to be one octet long, with the values 1, 2, and 3 defined. [RFC7188] redefines this Value field to be a bitfield where bit 7 (the least significant bit) denotes flooding status, bit 6 denotes routing MPR status, and bits 5-0 are unallocated (respecting the semantics of the bits/values 1, 2, and 3 from [RFC7181]).

This specification, as enabled by [RFC7188], extends the MPR TLV to have a variable-length Value field. Bits are allocated in increasing significance within as many octets as are required. These bits specify, in order, that:

- The neighbor with that network address has been selected as flooding MPR (1 bit).
- The neighbor with that network address has been selected as routing MPR for each link metric type (1 bit each), in the same order as indicated in the Value field of an MPR_TYPES Message TLV.

For interoperability with a router not implementing MT-OLSRv2, the two least significant bits of the first octet in the Value field of this TLV is as the TLV Value of an MPR TLV generated according to [RFC7181], as updated by [RFC7188].

7.2.3. GATEWAY TLV

The GATEWAY TLV is used in TC messages to indicate that a network address is of an attached network.

The Value field of this address block TLV is defined by [RFC7181] to be one octet long, containing the number of hops to that attached network.

This specification, as enabled by [RFC7188], allows the extension of the GATEWAY TLV to have a variable-length Value field when the number of hops to each attached network is different for different link metric types. For interoperability with a router not implementing MT-OLSRv2, the first octet in the Value field of this TLV MUST be the TLV Value of the GATEWAY TLV generated according to [RFC7181].

Any subsequent octets in the TLV Value field indicate the number of hops to the attached network for each other link metric type. Link metric types (including the first) are ordered as indicated in the Value field of an MPR_TYPES Message TLV.

Type	Value
GATEWAY	Number of hops to attached network for each link metric type.

Table 1: GATEWAY TLV Definition

8. HELLO Messages

The following changes are made to the generation and processing of HELLO messages compared to the description in [RFC7181] for routers that implement MT-OLSRv2.

8.1. HELLO Message Generation

A generated HELLO message to be sent on an OLSRv2 interface (whose IFACE_METRIC_TYPES parameter will be that used) is extended by:

- Adding an MPR_TYPES Message TLV. The Value octets will be the link metric types in IFACE_METRIC_TYPES. This TLV MAY be omitted if the only link metric type included would be LINK_METRIC_TYPE.

- Extending the MPR_WILLING Message TLV Value field to report the willingness values from the WILL_ROUTING parameter list that correspond to the link metric types in IFACE_METRIC_LIST, in the same order as reported in the MPR_TYPES TLV, each value (also including one representing WILL_FLOODING) occupying 4 bits.

- Including LINK_METRIC Address Block TLVs that report all values in L_in_metric, L_out_metric, N_in_metric, and N_out_metric elements that are not equal to UNKNOWN_METRIC, with the TLV Type Extension being the link metric type, and otherwise following the rules for such inclusions specified in [RFC7181].

- Including MPR Address Block TLVs such that for each link metric type in IFACE_METRIC_TYPES, and for the choice of flooding MPRs, the indicated addresses MUST be of the MPRs in an MPR set as specified for a single link metric type in [RFC7181].

8.2. HELLO Message Processing

On receipt of a HELLO message on an OLSRv2 interface, a router implementing MT-OLSRv2 MUST do the following, in addition to the processing described in [RFC7181]:

1. If in this deployment there might be routers that do not implement MT-OLSRv2, the HELLO message contains an MPR_TYPES Message TLV, and the first link metric type that it reports is not LINK_METRIC_TYPE, then the HELLO message MUST be silently discarded.

2. Determine the list of link metric types supported by the sending router on its corresponding OLSRv2 interface, either from an MPR_TYPES Message TLV (if present) or from the single link metric type LINK_METRIC_TYPE.

3. For all link metric types reported and supported by the receiving router, set the appropriate L_out_metric, N_in_metric, N_out_metric, N_will_routing, N_mpr_selector, N_advertised, N2_in_metric, and N2_out_metric elements using the rules for setting the single elements of those types specified in [RFC7181].

4. For any other metric types supported by the receiving router only (i.e. in IFACE_METRIC for the receiving OLSRv2 interface), set the elements listed in the previous point to their default values, i.e., UNKNOWN_METRIC, WILL_NEVER (not WILL_DEFAULT), or false.

9. TC Messages

The following changes are made to the generation and processing of TC messages compared to that described in [RFC7181] by routers that implement MT-OLSRv2.

9.1. TC Message Generation

A generated TC message is extended by:

- Adding an MPR_TYPES TLV. The Value octets will be the link metric types in ROUTER_METRIC_TYPES. This TLV MAY be omitted if the only link metric type included would be LINK_METRIC_TYPE.

- Including LINK_METRIC TLVs that report all values of N_out_metric that are not equal to UNKNOWN_METRIC, with the TLV Type Extension being the link metric type, and otherwise following the rules for such inclusions specified in [RFC7181].

- o Including a number of hops per reported (in an MPR_TYPES Message TLV) link metric type in the Value field of each GATEWAY TLV included, in the same order as reported in the MPR_TYPES TLV.

9.2. TC Message Processing

On receipt of a TC message, a router implementing this extension MUST do the following, in addition to the processing specified in [RFC7181]:

- o If in this deployment there might be routers that do not implement MT-OLSRv2, the TC message contains an MPR_TYPES Message TLV, and the first link metric type that it reports is not LINK_METRIC_TYPE, then the TC message MUST be silently discarded.

- o For all link metric types reported and supported by the receiving router, set the appropriate TR_metric, TA_metric, AN_dist, and AN_metric elements using the rules for setting the single elements of those types specified in [RFC7181].

- o For any other metric types supported by the receiving router that do not have an advertised outgoing neighbor metric of that type, set the corresponding elements of TR_metric, TA_metric, and AN_metric to UNKNOWN_METRIC. (The corresponding element of AN_dist may be set to any value.)

10. MPR Calculation

Routing MPRs are calculated for each link metric type in ROUTER_METRIC_TYPES. Links to symmetric 1-hop neighbors via OLSRv2 interfaces that do not support that link metric type are not considered. The determined status (routing MPR or not routing MPR) for each link metric type is recorded in the relevant element of N_routing_mpr.

Each router may make its own decision as to whether or not to use a link metric, or link metrics, for flooding MPR calculation. If using link metric(s), each router decides which one(s) and how they are used. These decisions MUST be made in a manner that ensures that flooded messages will reach the same symmetric 2-hop neighbors as would be the case for a router not supporting MT-OLSRv2.

Note that it is possible that a 2-Hop Tuple in the Information Base for a given OLSRv2 interface does not support any of the link metric types that are in the router’s corresponding IFACE_METRIC_TYPES; nevertheless, that 2-Hop Tuple MUST be considered when determining flooding MPRs.

11. Routing Set Calculation

A Routing Set is calculated for each link metric type in ROUTER_METRIC_TYPES. The calculation may be as for [RFC7181], except that where an element is now represented by a map, the value from the map for the selected link metric type is used. Where this is a link metric of value UNKNOWN_METRIC, that protocol Tuple is ignored for the calculation.

12. Management Considerations

MT-OLSRv2 may require greater management than unextended OLSRv2. In particular, a MANET using MT-OLSRv2 requires the following management considerations:

- Deciding which link metric, and hence which Routing Set to use, for received packets, hence how to use the Routing Sets to configure the network layer (IP). All routers MUST make the same decision for the same packet. An obvious approach is to map each DSCP [RFC2474] to a single link metric. (This may be a many-to-one mapping.)

- Selecting which link metrics to support on each OLSRv2 interface and implementing that decision. (Different interfaces may have different physical and data link-layer properties, and this may inform the selection of link metrics to support, and their values.) If the MANET might contain non-MT-OLSRv2 routers, which are also subject to management, then the rules in this specification for link metric assignment to OLSRv2 interfaces for that case MUST be followed.

- Ensuring that the MANET is sufficiently connected, by ensuring that, for example, sufficiently many routers implement each metric type required. (This is easier in, for example, a denser network.) Note that if there is any possibility that there are routers not implementing MT-OLSRv2, then the MANET will be connected, to the maximum extent possible, using the link metric type LINK_METRIC_TYPE, but this will only serve to deliver packets that use that link metric type.

- Non-MT-OLSRv2 routers SHOULD be managed so as not produce packets that will be routed by a topology that they are not part of. However, if that were to happen, then such packets will be routed until either they reach their destination or they reach an MT-OLSRv2 router. In the latter case, the packet then either will be dropped (if that MT-OLSRv2 router is not part of that topology, or is not aware of the destination within that topology) or will be routed by that topology to the destination. Such a packet will not loop.

- If a packet is created for a destination that is not part of the corresponding topology, then it may or may not be delivered (if the originating router is a non-MT-OLSRv2 router) or will not be sent (if the originating router is an MT-OLSRv2 router). Routers SHOULD be managed so that topologies are as complete as possible and that packets are not sent if they may not be delivered. In particular, non-MT-OLSRv2 routers SHOULD only send packets that will be routed using the topology using the link metric type LINK_METRIC_TYPE.

13. IANA Considerations

This specification adds one new Message TLV, allocated as a new Type Extension to an existing Message TLV, using a new name. It also modifies the Value field of an existing Message TLV and that of an existing Address Block TLV. Finally, this specification makes additional allocations from the LINK_METRIC Address Block TLV Type registry.

13.1. Expert Review: Evaluation Guidelines

For the registry where an Expert Review is required, the designated expert SHOULD take the same general recommendations into consideration as are specified by [RFC5444] and [RFC7631].

13.2. Message TLV Types

This specification modifies the Message TLV Type 7, replacing Table 4 of [RFC7631] by Table 2, changing the description of the Type Extension MPR_WILLING, and adding the Type Extension TLV_TYPES. Each of these TLVs MUST NOT be included more than once in a Message TLV Block.

Type Extension	Name	Description	Reference
0	MPR_WILLING	First (most significant) half-octet of Value field specifies the originating router's willingness to act as a flooding MPR; subsequent half-octets specify the originating router's willingness to act as a routing MPR, either for the link metric types reported in an MPR_TYPES TLV (in the same order), or (if no MPR_TYPES TLV is present) for the single administratively agreed link metric type	[RFC7181] [RFC7631] RFC 7722
1	MPR_TYPES	The link metric types supported on this OLSRv2 interface of this router (one octet each).	RFC 7722
2-223		Unassigned	
224-255		Reserved for Experimental Use	[RFC7181]

Table 2: Type 7 Message TLV Type Extensions

13.3. Address Block TLV Types

Table 7 of [RFC7188] is replaced by Table 3.

Bit	Value	Name	Description
First octet bit 7	First octet 0x01	Flooding	If set, then the neighbor with that network address has been selected as flooding MPR
From first octet bit 6	From first octet 0x02	Routing	If set, then the neighbor with that network address has been selected as routing MPR, either for the link metric types reported in an MPR_TYPES TLV (in the same order), or (if no MPR_TYPES TLV is present) then (first octet bit 6, value 0x02) for the single administratively agreed link metric type

Table 3: MPR TLV Bit Values

Table 14 of [RFC7631] is replaced by Table 4. The only changes are to the Description and the References for the GATEWAY TLV.

Type Extension	Name	Description	References
0	GATEWAY	Specifies that a given network address is reached via a gateway on the originating router. The number of hops is indicated by the Value field, one octet per link metric type reported in an MPR_TYPES Message TLV (in the same order) or (if no MPR_TYPES Message TLV is present) using a single octet	[RFC7181] RFC 7722
1-223		Unassigned	
224-255		Reserved for Experimental Use	[RFC7631]

Table 4: Type 10 Address Block TLV Type Extensions

Table 13 of [RFC7181] is replaced by Table 5. The only change is that 8 Type Extensions are allocated as assigned by administrative action, in order to support administratively determined multi-topologies.

Name	Type	Type Extension	Description	Allocation Policy
LINK_METRIC	7	0-7	Link metric meaning assigned by administrative action.	
LINK_METRIC	7	8-223	Unassigned.	Expert Review
LINK_METRIC	7	224-255	Unassigned.	Experimental Use

Table 5: Address Block TLV Type assignment: LINK_METRIC

14. Security Considerations

This extension to OLSRv2 allows a router to support more than one link metric type for each link advertised in HELLO and TC messages, and for routers to support different sets of types. Link metric values of additional types are reported by the inclusion of additional TLVs in the messages sent by a router, which will report known values of all supported types.

HELLO and TC message processing is then extended simply to record, for each supported type, all of the received link metric values for each link. Protocol-internal processing (specifically, MPR set and shortest path calculations) then operates as specified in [RFC7181] for each link metric type that the router supports.

Consequently, the security considerations, including the security architecture and the mandatory security mechanisms, from [RFC7181] are directly applicable to MT-OLSRv2.

Furthermore, this extension does not introduce any additional vulnerabilities beyond those of [RFC7181], because each link metric type is used independently, and each one could have been the single link metric type supported by an implementation of [RFC7181] receiving the same information, as received information of an unsupported type is ignored by all routers.

15. References

15.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

[RFC5444] Clausen, T., Dearlove, C., Dean, J., and C. Adjih, "Generalized Mobile Ad Hoc Network (MANET) Packet/Message Format", RFC 5444, DOI 10.17487/RFC5444, February 2009, <http://www.rfc-editor.org/info/rfc5444>.

[RFC6130] Clausen, T., Dearlove, C., and J. Dean, "Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP)", RFC 6130, DOI 10.17487/RFC6130, April 2011, <http://www.rfc-editor.org/info/rfc6130>.

[RFC7181] Clausen, T., Dearlove, C., Jacquet, P., and U. Herberg, "The Optimized Link State Routing Protocol Version 2", RFC 7181, DOI 10.17487/RFC7181, April 2014, <http://www.rfc-editor.org/info/rfc7181>.

[RFC7188] Dearlove, C. and T. Clausen, "Optimized Link State Routing Protocol Version 2 (OLSRv2) and MANET Neighborhood Discovery Protocol (NHDP) Extension TLVs", RFC 7188, DOI 10.17487/RFC7188, April 2014, <http://www.rfc-editor.org/info/rfc7188>.

[RFC7631] Dearlove, C. and T. Clausen, "TLV Naming in the Mobile Ad Hoc Network (MANET) Generalized Packet/Message Format", RFC 7631, DOI 10.17487/RFC7631, September 2015, <http://www.rfc-editor.org/info/rfc7631>.

15.2. Informative References

[RFC2474] Nichols, K., Blake, S., Baker, F., and D. Black, "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers", RFC 2474, DOI 10.17487/RFC2474, December 1998, <http://www.rfc-editor.org/info/rfc2474>.

[RFC2501] Corson, S. and J. Macker, "Mobile Ad hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations", RFC 2501, DOI 10.17487/RFC2501, January 1999, <http://www.rfc-editor.org/info/rfc2501>.

[RFC3626] Clausen, T., Ed., and P. Jacquet, Ed., "Optimized Link State Routing Protocol (OLSR)", RFC 3626, DOI 10.17487/RFC3626, October 2003, <http://www.rfc-editor.org/info/rfc3626>.

[RFC4915] Psenak, P., Mirtorabi, S., Roy, A., Nguyen, L., and P. Pillay-Esnault, "Multi-Topology (MT) Routing in OSPF", RFC 4915, DOI 10.17487/RFC4915, June 2007, <http://www.rfc-editor.org/info/rfc4915>.

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