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C. Dearlove
BAE Systems ATC
T. Clausen
LIX, Ecole Polytechnique
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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.

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Table of Contents

1. Introduction

The Optimized Link State Routing Protocol, version 2 [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 route over other than minimum hop routes, using a link metric.

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 use alternative metrics for different packet routing. 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.

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 [OLSRv2], which is to be interpreted as described in those specifications.

Additionally, this specification uses the following terminology:

Router - A MANET router that implements [OLSRv2].

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

This specification introduces the notation map[range -> type] to represent an associative map from elements of the range, which in this specification is always a set of link metric types that the router supports (either IFACE_METRIC_TYPES or ROUTER_METRIC_TYPES, as defined in Section 5), to a type, which may be a boolean, a willingness (a 4 bit unsigned integer from 0 to 15), a number of hops (an 8 bit unsigned integer value from 0 to 255), or a metric-value (either a representable link metric value, as described in [OLSRv2], or UNKNOWN_METRIC).

3. Applicability Statement

The protocol described in this specification is applicable to a MANET for which OLSRv2 is otherwise applicable (see [OLSRv2]), 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].

4. Protocol Overview and Functioning

The purpose of this specification is to extend [OLSRv2] 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.

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 on how these sets of link metrics are selected. However there may be deployments where routers, that do not implement MT-OLSRv2 (non-MT-OLSRv2 routers), are to participate in a MANET with MT-OLSRv2 routers. In this case, 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 thatEmay 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.

In addition to link and neighbor metric values for each link metric type, router MPR (multipoint relay) and MPR selector status, and advertised neighbor status, is maintained per supported neighbor metric type for each symmetric 1-hop neighbor. Each router may choose a different willingness to be a routing MPR for each link metric type that it supports.

More so than OLSRv2, the use of multiple metric types across the MANET must be managed, by administrative configuration or otherwise. Similarly to other decisions that may be made using OLSRv2, a bad collective choice will make the MANET anywhere from inefficient to non-functional, so care will be needed in selecting supported link metric types across the MANET.

5. Parameters

The parameters used in [OLSRv2], including from 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 [OLSRv2]. 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 [OLSRv2]).

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 may be any routers that do not implement MT-OLSRv2, then IFACE_METRIC_TYPES MUST include LINK_METRIC_TYPE if that OLSRv2 interface may be able to communicate with any routers that do not implement MT-OLSRv2. In that case, ROUTER_METRIC_TYPES MUST also include LINK_METRIC_TYPE.

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 [OLSRv2], which extend those specified in 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 [OLSRv2] with elements representing multiple values (associative maps from a set of metric types to their corresponding values). The following subsections detail these extensions.

Note that, as in [OLSRv2], 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 [OLSRv2] 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 [OLSRv2].

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 value from this map is used, Router Topology Tuples whose corresponding value of 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 value from this map is used, Routable Address Topology Tuples whose corresponding value of 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 value from this map is used, Attached Network Tuples whose corresponding value of 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 [OLSRv2].

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 HELLO messages, and may be used in TC messages. A message MUST NOT contain more than one MPR_TYPES TLV.

The presence of this TLV in a HELLO 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 [OLSRv2]. For this reason, the MPR_TYPES TLV has been defined with the same Type as the MPR_WILLING TLV, but with Type Extension == 1. (The different symbolic name is used for convenience, any reference to a MPR_TYPES TLV means to this TLV, with this Type and Type Extension.)

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 for the OLSRv2 interface over which the HELLO message containing this TLV is sent. These octets MAY be in any order, except that if there may be any routers in the MANET not implementing 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 [OLSRv2], and extended in this specification as enabled by [TLV-Extensions].

The interpretation of this TLV, specified by [OLSRv2], and which 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. (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’).

If the Value field in an MPR_WILLING TLV is shorter than its full length, then, as specified in [TLV-Extensions], missing Value octets, i.e., missing willingness values, are considered as zero, i.e., as WILL_NEVER. This is the correct behaviour. (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 recognise.)

7.2. Address Block TLVs

New Type Extensions are defined for the LINK_METRIC TLV defined in [OLSRv2], and the Value fields of the MPR TLV and the GATEWAY TLV, both defined in [OLSRv2], are extended, as enabled by [TLV-Extensions].

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 [OLSRv2].

Only a single Type Extension was specified by [OLSRv2] (link metric type) 0 as defined by administrative action. This specification extends this range, it is suggested either to 0-7 or to 0-15. This specification will work with any combination of Type Extensions both within and without that range (assuming that the latter are defined as specified in [OLSRv2]).

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 [OLSRv2], defined to be one octet long, with the values 1, 2 and 3 defined. [TLV-Extensions] redefines this Value field to be a bitfield where bit 7 (the lsb) 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 [OLSRv2]).

This specification, as enabled by [TLV-Extensions], extends the MPR TLV to have a variable-length Value field. 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 MUST be the TLV Value of the MPR TLV, generated according to [OLSRv2].

Subsequent bits (in increasing significance within an octet, then continuing with the least significant bit in the next octet, if required) in the TLV Value field indicate which link metric types, for which the corresponding address is selected as a routing MPR, link metric types (including the first) being indicated in the Value field of an MPR_TYPES Message TLV.

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, in [OLSRv2] defined to be one octet long, containing the number of hops to that attached network.

This specification, as enabled by [TLV-Extensions], allows the extension 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 [OLSRv2].

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) being 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 that described in [OLSRv2] by routers that implement MT-OLSRv2.

8.1. HELLO Message Generation

A generated HELLO message to be sent on an OLSRv2 interface is extended by:

- Adding an MPR_TYPES TLV. The value octets will be the link metric types in IFACE_METRIC_TYPES.
- Extending the MPR_WILLING 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 TLVs that report all values of L_in_metric, L_out_metric, N_in_metric and 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 [OLSRv2].
- Including MPR TLVs such that for each link metric type in IFACE_METRIC_TYPES, and for the choice of flooding MPRs, these MUST be an MPR set as specified for a single link metric type in [OLSRv2].

8.2. HELLO Message Processing

On receipt of a HELLO message, a router implementing MT-OLSRv2 MUST, in addition to the processing described in [OLSRv2]:

1. Determine the list of link metric types supported by the sending router on the relevant OLSRv2 interface, either from an MPR_TYPES TLV or, if not present, the type LINK_METRIC_TYPE supported by a router not implementing the extension described in this specification.
2. For those link metric types supported by both routers, 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 values as described for the single such elements in [OLSRv2].

3. For any other metric types supported by the receiving router only, set those elements to their default value: 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 [OLSRv2] by routers that implement MT-OLSRv2.

9.1. TC Message Generation

A generated TC message is extended by:

- If any GATEWAY TLVs are included requiring more than one number of hops value, then adding an MPR_TYPES TLV with Value octets being the link metric types in ROUTER_METRIC_TYPES.

- 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 [OLSRv2].

- When not all the same, including a number of hops per reported (in an MPR_TYPES Messsage TLV) link metric type in the Value field of each GATEWAY TLV included.

9.2. TC Message Processing

On receipt of a TC message, a router implementing this extension MUST, in addition to the processing specified in [OLSRv2]:

- 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 [OLSRv2].

- 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, and if so which and how. This decision 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, but 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 [OLSRv2], 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 MT-OLSRv2 requires the following management considerations:

- 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.)

- Ensuring that the MANET is sufficiently connected. Note that if there is any possibility that there are any routers not implementing MT-OLSRv2, then the MANET will be connected, to the maximum extent possible, using the link metric type LINK_METRIC_TYPE.

- 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). An obvious approach is to map each DiffServ Code Point (DSCP) [RFC2474] to a single link metric. (This may be a many to one mapping.)

- Note that there could be cases where a router that is not implementing MT-OLSRv2 is the source or destination of an IP packet that is mapped to a link metric that is not the link metric LINK_METRIC_TYPE used by that router.

- If such a router is the source, then routing may work if the first router implementing MT-OLSRv2 to receive the packet supports the appropriate link metric type. At worst the packet will be dropped, it will not loop.

- If such a router is the destination, then the packet will never reach its destination, as the source will not have a suitable routing table entry for the destination. Network management may be required to ensure that the MANET still functions in these cases.

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 of an existing Address Block TLV.

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].

13.2. Message TLV Types

This specification replaces Table 11 of [OLSRv2]. That specified a Message MPR Type described as MPR_WILLING, for which only Type Extension 0 was defined. This specification reserves that name MPR_WILLING for Type Extension 0, defines a new Type Extension 1, with a new name MPR_TYPES, and leaves the remaining Type Extensions of this TLV Type unnamed. It also changes the Value field specification of the MPR_WILLING TLV.

Note: The Type number TBD2 will be replaced by the value assigned by IANA when [OLSRv2] is published as an RFC, and this note will be removed.

Specifications of these TLVs are in Table 2. Each of these TLVs MUST NOT be included more than once in a Message TLV Block.

Name	Type	Type Extension	Description	Allocation Policy
MPR_WILLING	TBD2	0	Bits 0-3 specify the originating router’s willingness to act as a flooding MPR. Each following 4 bit subfield (using bits 0-3 of an octet before bits 4-7) specifies the originating router’s willingness to act as a routing MPR for a link metric, either a single such field (bits 4-7) when no MPR_TYPES Message TLV is present, or one subfield per type reported in an MPR_TYPES Message TLV Value field (in the same order).	
MPR_TYPES	TBD2	1	The link metric types supported on this OLSRv2 interface of this router (one octet each).	
Unnamed	TBD2	2-255	Unassigned.	Expert Review

Table 2: Message TLV Type assignment: MPR_WILLING and MPR_TYPES

13.3. Address Block TLV Types

Table 16 of [OLSRv2] is replaced by Table 3. Note that the only change is to the description of the Value field.

Note: The Type number TBD7 will be replaced by the value assigned by IANA when [OLSRv2] is published as an RFC, and this note will be removed.

Name	Type	Type extension	Description	Allocation Policy
GATEWAY	TBD7	0	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, either using a single octet (if no MPR_TYPES Message TLV is present) or one octet per type reported in an MPR_TYPES Message TLV (in the same order).	
GATEWAY	TBD7	1-255		Expert Review

Table 3: Address Block TLV Type assignment: GATEWAY

14. Security Considerations

TBD.

15. Acknowledgments

TBD.

16. References

16.1. Normative References

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16.2. Informative References

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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
URI: http://www.baesystems.com/

Thomas Heide Clausen
LIX, Ecole Polytechnique

Phone: +33 6 6058 9349
Email: T.Clausen@computer.org
URI: http://www.ThomasClausen.org/