Use of OSPF-MDR in
Single-Hop Broadcast Networks

draft-ogier-ospf-manet-single-hop-00

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Problem Statement and Background

- There is a need to support single-hop broadcast networks in which different costs are associated with different neighbors on the same interface.
  - One example is when the underlying radio system performs layer-2 routing, but has a different number of (layer-2) hops to (layer-3) neighbors.
- The point-to-multipoint interface uses a point-to-point (Type 1) link to describe each fully adjacent neighbor, but is not scalable since every neighbor must become fully adjacent.
- The OSPF-MANET extensions already solve this problem, since a single-hop broadcast network is a special case of a MANET.
- Another solution for solving this problem is proposed in draft-nsheth-ospf-hybrid-bcast-and-p2mp-01.

Summary of Presentation

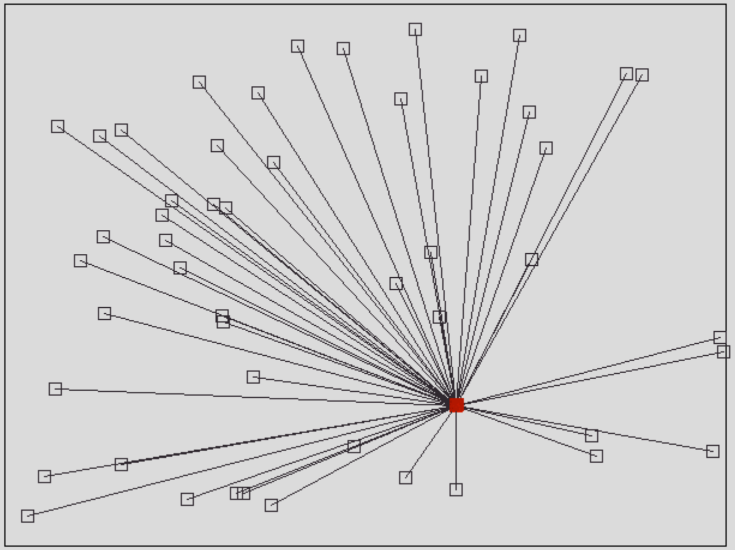
- OSPF-MDR (RFC 5614) extends OSPF to support MANET interfaces in a scalable manner, and therefore provides an efficient solution for single-hop broadcast networks without any modification.
- A few optional simplifications are possible in single-hop networks:
  - Simplified procedure for originating router-LSA that avoids checking whether a neighbor is routable.
  - Simplified MDR selection algorithm, which is similar to the DR election algorithm of OSPF.
- With the above simplifications and recommended configuration, OSPF-MDR provides a solution similar to draft-nsheth-ospf-hybrid-bcast-and-p2mp-01.

OSPF-MDR Approach

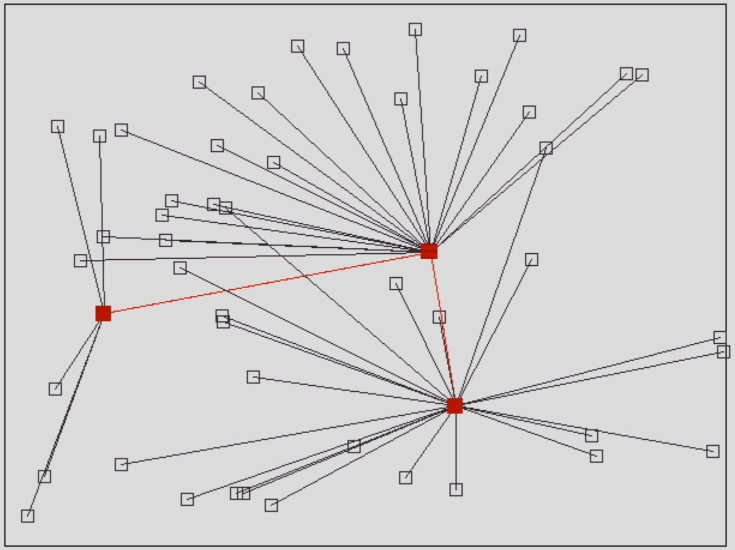
- OSPF uses the Designated Router (DR) and Backup DR to achieve scalability in broadcast networks, by requiring each non-DR/BDR router to form only two adjacencies (with the DR and BDR).
- OSPF-MDR generalizes the DR and BDR to multihop wireless networks:
  - The DR is generalized by selecting a small subset of routers, called ***MANET Designated Routers (MDRs)*** that form a connected dominating set (CDS).
  - ***Backup MDRs (BMDRs)*** are also selected so that the MDRs and BMDRs together form a biconnected dominating set.
- MDRs achieve scalability in MANETs similar to the way DRs achieve scalability in broadcast networks:
  - MDRs have primary responsibility for flooding LSAs. Backup MDRs provide backup flooding when MDRs fail.
  - ***Adjacency reduction*** may be used, in which adjacencies are formed only between MDR/BMDR routers and their neighbors.

Basic Idea – Generalize Designated Router to MANET Designated Routers (MDRs)

- In an OSPF broadcast network, a single DR (red) is elected.
- Each router becomes adjacent with the DR, forming a tree with n-1 edges.

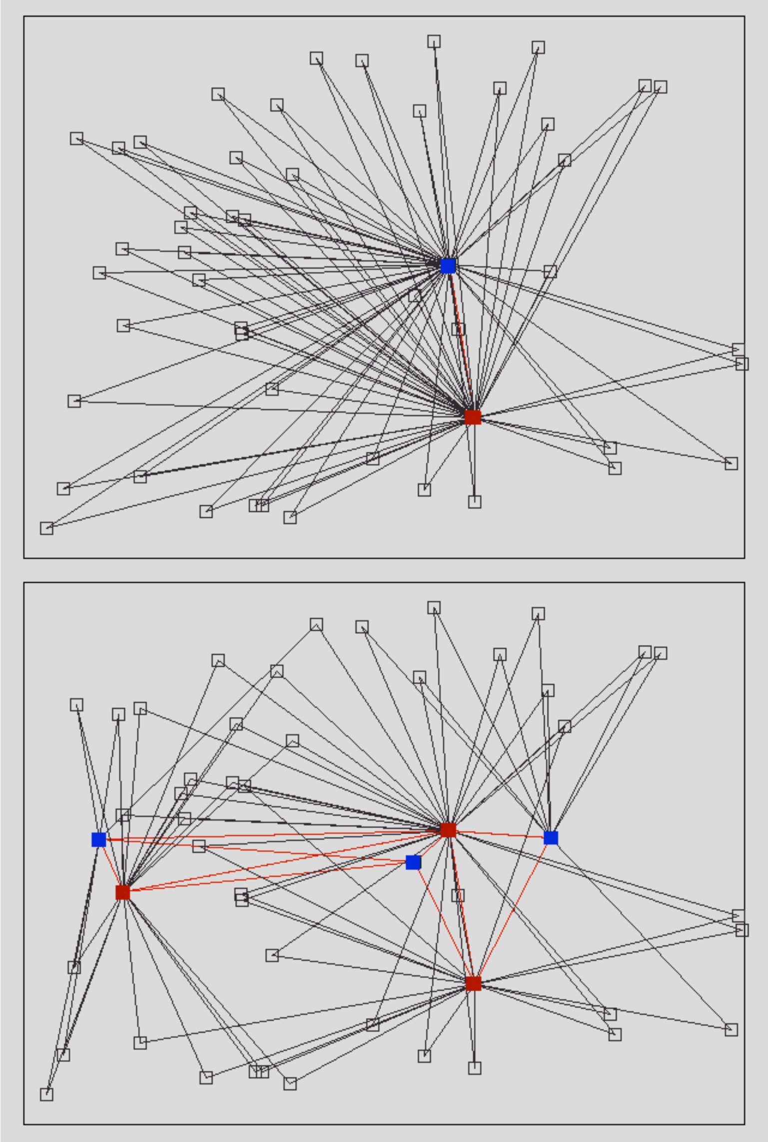


- In a multihop wireless network, the DR generalizes to multiple **MDRs** (red) which form a connected dominating set.
- MDRs select themselves based on 2-hop neighbor information obtained from modified hello packets.
- Adjacencies are formed between MDRs to form a ***connected backbone*.**
- Each non-MDR becomes adjacent with an MDR neighbor called its ***Parent***.



Also Generalize Backup Designated Router for Biconnected Redundancy

- In an OSPF broadcast network, a Backup DR (blue) is added for redundancy.
- Each DR Other becomes adjacent with the DR and the Backup DR.



- In a multihop wireless network, **Backup MDRs** (blue) are added to form a biconnected dominating set.
- Backup MDRs perform backup flooding for improved robustness.
- ***Optionally***, additional adjacencies may be added to form a ***biconnected backbone***, and each MDR Other may become adjacent with a second (Backup) MDR neighbor called its ***Backup Parent***.

Features of OSPF-MDR

- MDRs and BMDRs are elected based on 2-hop neighbor information obtained from modified Hello packets.
- If adjacency reduction is used (the default), adjacencies are formed between MDRs so as to form a ***connected backbone***. An option (AdjConnectivity = 2) allows for additional adjacencies to be formed between MDRs/BMDRs to form a ***biconnected backbone***.
- Each non-MDR router becomes adjacent with an MDR called its ***Parent***, and optionally (if AdjConnectivity = 2) becomes adjacent with another MDR or BMDR called its ***Backup Parent*.**
- *Each router advertises connections to its neighbor routers as point-to-point links in its router-LSA. Network-LSAs are not used.*
- In addition to full-topology LSAs, ***partial-topology LSAs*** may be used to reduce the size of router-LSAs. Such LSAs are formatted as standard LSAs, but advertise links to only a subset of neighbors.
- Optionally, ***differential Hellos*** can be used, which reduce overhead by reporting only changes in neighbor states.

Properties of OSPF-MDR in a Single-Hop Network

If adjacency reduction and full-topology LSAs are used, OSPF-MDR running on a single-hop broadcast network has the following properties:

- A single MDR is selected, which becomes adjacent with every other router (*similar to OSPF*).
- If AdjConnectivity = 2 (biconnected), every non-MDR/BMDR router becomes adjacent with a BMDR in addition to the MDR (*similar to OSPF*).
- Two BMDRs are selected. This occurs because the MDR selection algorithm ensures that the MDR/BMDR backbone is biconnected.
- When all adjacencies are in Full state, the router-LSA for each router includes point-to-point (type 1) links to all bidirectional neighbors (in state 2-Way or greater).

Configuration in a Single-Hop Broadcast Network

When OSPF-MDR is used in a single-hop broadcast network, the following parameter settings and options (defined in RFC 5614) should be used:

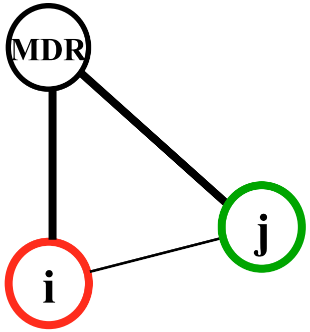
- *AdjConnectivity* SHOULD be equal to 2 (biconnected), MAY be equal to 1 (uniconnected), and SHOULD NOT be equal to 0 (full topology).
- An adjacency SHOULD be eliminated if neither the router nor the neighbor is an MDR or BMDR (see Section 7.3).
- *LSAFullness* SHOULD be equal to 4 or 5 so that full-topology LSAs are originated. (The value 5 is a new option for single-hop networks.)
- *LSAFullness* MAY be equal to 1 (min-cost LSAs) if full-topology LSAs are not required. This option reduces the number of advertised links while still providing shortest paths. (See Appendix C of RFC 5614.)

Simplified Procedure for Selecting Neighbors to Advertise in LSAs

- When using full LSAs, OSPF-MDR includes in its router-LSA point-to-point links for all fully adjacent neighbors, and all bidirectional neighbors that are ***routable***.
- A neighbor is routable if the SPT calculation has produced a route to the neighbor. (A flexible quality condition may also be required.)
- In single-hop networks, the following alternative procedure may be used, which avoids having to update the set of routable neighbors:
  1. The MDR includes in its router-LSA a point-to-point (type 1) link for each fully adjacent neighbor. (Note that the MDR becomes adjacent with all of its neighbors.)
  2. Each non-MDR router includes in its router-LSA a point-to-point link for each fully adjacent neighbor, and, if the router is fully adjacent with the MDR, for each bidirectional neighbor j such that the MDR's router-LSA includes a link to j.

Discussion of Alternative LSA Procedure

- The new procedure implies that router i advertises a link to neighbor j only if router i is fully adjacent with the MDR, and the MDR is fully adjacent with router j.
- Similarly, router j will advertise a link to router i only if it is fully adjacent with the MDR and the MDR is fully adjacent with router i.
- Therefore, since the SPT calculation allows routers i and j to use each other as next hops only if they both advertise links to each other, the new procedure ensures that routers i and j are fully synchronized before they use each other as next hops.
- The new procedure corresponds to LSAFullness = 5, and is interoperable with the other LSA options.
- A similar (but not equivalent) procedure was proposed in draft-nsheth-ospf-hybrid-bcast-and-p2mp-01.



Simplified MDR Selection Algorithm

- The MDR selection algorithm of OSPF-MDR becomes much simpler in a single-hop network.
- The resulting algorithm is similar to the DR election algorithm of OSPF, but not exactly the same.
  - A single MDR is selected, but two BMDRs are selected so that the MDR/ BMDR backbone is biconnected.
  - As in an OSPF broadcast network, the number of resulting adjacencies is O (n).
- In a single-hop network, the simplified algorithm described in the draft is equivalent to (and interoperable with) the full MDR selection algorithm.
- Note: The DR election algorithm of OSPF can instead be used in single-hop networks if agreed by all routers. This would require a separate interface type for single-hop networks.

Conclusions and Discussion

- OSPF-MDR is an extension of OSPF that provides scalable routing in MANETs. In particular, it can be applied to single-hop broadcast networks in which different costs are assigned to different neighbors.
- Recommended configuration settings are specified, and properties of OSPF-MDR are described when used in a single-hop network.
- Two simplified procedures are specified when OSPF-MDR is used in a single-hop network. These procedures are optional, and are interoperable with unmodified OSPF-MDR.
- If a network includes both (multihop) MANET interfaces and single-hop broadcast interfaces, then OSPF-MDR can be used for both interface types.
- However, if the network includes only single-hop broadcast interfaces, a simpler solution is possible, e.g. draft-nsheth-ospf-hybrid-bcast-and-p2mp-01.
- The partial-topology LSA option of OSPF-MDR may be useful in single-hop networks, to reduce LSA size and improve scalability.