Linux Optimized Link State Routing Protocol (OLSR) IPv6 HOWTO

Lars Strand

<lars (at) unik no>

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Revision History

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Final review complete. Document published to the LDP collection.		
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Thanks to Thomas Zimmerman <thomas (at) zimres net> for a language review! Updated to latest version number and added a section on plugin−support in OLSRd. Changed lisence back to GFDL		
Revision 0.5	2004−03−08	Revised by: LKS
An almost complete rewrite. Adding OLSRd (old uOLSR), updated to RFC3626. Removed NROLSR and CRCOLSR. Converted to XML Docbook. Changed the license from GFDL to OPL due to some GFDL problems.		
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Initial release.		

This document describes the software and procedures to set up and use Optimized Link State Routing Protocol (OLSR) with IPv6 for Linux. OLSR is used as a routing protocol for Mobile Ad−Hoc Networks (MANET) (also called "spontaneous network").

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1. Introduction

This document describes the software and procedures to set up and use Optimized Link State Routing Protocol (OLSR) with IPv6 for Linux.

1.1. Why Ad−Hoc network?

An English translation of *ad−hoc* is "For a particular purpose (improvised, made up in an instant)" (source: Wikipedia). An Ad−hoc network, or "spontaneous network", is especially useful when dealing with wireless devices in which some of the devices are part of the network only for the duration of a communications session and the need for a dynamic network topology is eminent. A "Mobile Ad hoc Network" is usually called a *MANET*.

1.2. What is a MANET?

" A MANET consists of mobile platforms (e.g., a router with multiple hosts and wireless communications devices)−−herein simply referred to as 'nodes'−−which are free to move about arbitrarily. The nodes may be located in or on airplanes, ships, trucks, cars, perhaps even on people or very small devices, and there may be multiple hosts per router. A MANET is an autonomous system of mobile nodes. The system may operate in isolation, or may have gateways to and interface with a fixed network." −−− RFC2501: Mobile Ad hoc Networking (MANET), section 3 (page 3).

1.3. What is Optimized Link State Routing (OLSR)?

"OLSR is a proactive routing protocol for mobile ad hoc networks. The protocol inherits the stability of a link state algorithm and has the advantage of having routes immediately available when needed due to its proactive nature. OLSR is an optimization over the classical link state protocol, tailored for mobile ad hoc networks."

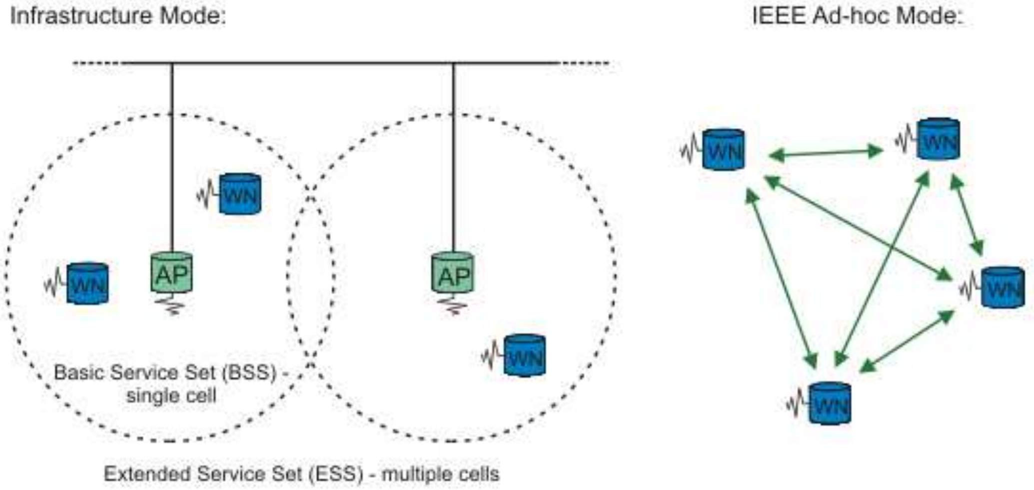
"OLSR is designed to work in a completely distributed manner and does not depend on any central entity. The protocol does NOT REQUIRE reliable transmission of control messages: each node sends control messages periodically, and can therefore sustain a reasonable loss of some such messages. Such losses occur frequently in radio networks due to collisions or other transmission problems." −−− RFC3626: OLSR, section 1.3 (page 8)

1.4. How does OLSR work?

"The Optimized Link State Routing Protocol (OLSR) is developed for mobile ad hoc networks. It operates as a table driven, proactive protocol, i.e., exchanges topology information with other nodes of the network regularly. Each node selects a set of its neighbor nodes as 'multi−point relays' (MPR). In OLSR, only nodes, selected as such MPRs, are responsible for forwarding control traffic, intended for diffusion into the entire network. MPRs provide an efficient mechanism for flooding control traffic by reducing the number of transmissions required." −−− RFC3626: OLSR, section 1 (page 4)

1.5. What about IBSS (IEEE ad−hoc mode)?

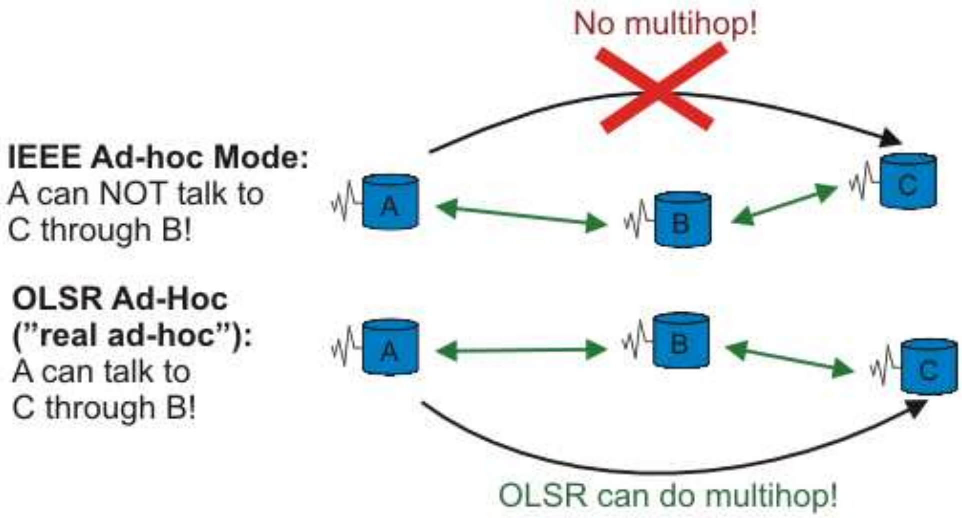
The IEEE 802.11 standard defines two modes:



IEEE 802.11 standard

1. *Infrastructure mode:* The wireless network consist of at least one access point (AP) connected to the wired network and a set of wireless nodes (WN). This configuration is called a *Basic Service Set (BSS)*. Extended Service Set (ESS) is a set of two or more BSSs (multiple cells).
2. *Ad hoc mode:* Also called "IEEE ad−hoc mode" or "peer−to−peer mode". This configuration is called *Independent Basic Service Set (IBSS)* and is useful for establishing a network where wireless infrastructure does not exist or where services are not required.

So why use OLSR when we can use "IEEE ad−hoc mode"? *IEEE ad−hoc mode does NOT support multi−hop.* See figure below



"IEEE 8102.11 Ad hoc" mode has *no* support for multihop, something OLSR does have.

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2. IPv6

IP version 6 (IPv6) is a new version of the Internet Protocol, designed as the successor to IP version 4 (IPv4) [RFC−791]. The changes from IPv4 to IPv6 fall primarily into the following categories:

- Expanded addressing capabilities
- Header format simplification
- Improved support for extensions and options
- Flow labeling capability
- Authentication and privacy capabilities

For more information on IPv6 in general, visit the IETF's IPv6 Working Group.

3. OLSR for Linux

There are several OLSR implementation for Linux, but not all of them support IPv6. You should know how to enable and use IPv6 on Linux. Peter Bieringer has written an excellent Linux IPv6 HOWTO.

There is one OLSR implementation that is becoming the "standard" and most widely used. It goes by the descriptive name "OLSRd" (old Unik−OLSR).

OLSRd is an implementation based on the INRA C code, but has been almost completely rewritten, so there is not much left of the original INRA code (that mean it almost GPL). OLSRd also is under very rapid development, and if you report in a bug, it is usually fixed in a matter of hours.

OLSRd fully comply to the OLSR RFC, support for plugins, and it has an optional GUI interface (to see what's going on). The implementation also has a informative "up−to−date" web−page with links to mailing lists and papers.

3.1. Installing OLSRd

There are up−to multiple new releases of OLSRd each month, so check the OLSRd web−site for the newest release.

1. The latest release as of this writing is 0.4.3, but by the time you read this there is almost certain a new release. Fetch the latest release from http://www.olsr.org/index.cgi?action=download.
2. Unpack, compile and install the source code:
   ```
   # tar jxvf uolsrd-x.y.z
         # cd unik-olsrd-x.y.z
         # make
         # make install
   ```
3. The **`olsrd`** gets installed to `/usr/bin/` and a default config file, `olsrd.conf` can be found under `/etc`

Check out the `/etc/olsrd.conf` config file, and change values to fit your system. All values in this file can be overridden with command line options to **`olsrd`**. The main options to change are:

```
    # Debug level(0-9)
    # If set to 0 the daemon runs in the background
    DEBUG           1
    # IP version to use (4 or 6)
    IPVERSION       6
    # A list of whitespace separated interface names
    INTERFACES      eth1
```

Later on, when you know OLSRd is configured correctly, you may set "DEBUG" to **`0`** to make it run in the background. You may then also add it to your init scripts. But to test that everything first, set this to at least **`1`** (setting this higher will produce a lot more info messages on APM, forwarding, parsing of the config file etc.)

3.2. Using OLSRd

3.2.1. On one host

When OLSRd is installed and configured, it can be started as root with:

```
# olsrd
```

All the settings in `/etc/olsrd.conf` can be overridden by command line options:

```
# olsrd -i eth1 -ipv6 -d 1
```

Would start **olsrd** listening on interface **eth1** using IPv6 and with debug messages.

We start olsrd:

```
# olsrd -i eth1 -d 1 -ipv6

       *** UniK olsrd-0.4.3 ***

    hello interval = 2.00       hello int nonwireless: = 4.00 (1)
    tc interval = 5.00          polling interval = 0.10
    neighbor_hold_time = 6.00   neighbor_hold_time_nw = 12.00
    topology_hold_time = 15.00  tos setting = 16
    hna_interval = 15.00         mid_interval = 5.00
    Willingness set to 3 - next update in 20.000000 secs
    Using IP version 6
    Using multicast address ff05::15

     ---- Interface configuration ----

     eth1:                                          (2)
            Address: fec0:106:2700::10
            Multicast: ff05::15
            Interface eth1 set up for use with index 0


     Main address: fec0:106:2700::10                (3)

     NEIGHBORS: l=linkstate, m=MPR, w=willingness

     Thread created - polling every 0.10 seconds    (4)
     neighbor list: 11:43:17.214807
     neighbor list: 11:43:19.194967
     neighbor list: 11:43:21.395046
     neighbor list: 11:43:23.604800
     neighbor list: 11:43:25.694875
```

(1)
: This shows all the settings OLSRd is using. You may override these by either specifying it in the config file (`/etc/olsrd.conf`) or specify it at the command line. Read the OLSR RFC for a description on what all these settings means.

(2)

OLSRd found our interface. If you are using OLSRd with multiple interfaces, "Multiple Interface Declaration" (MID) messages will be generated.

❸ If you are using OLSRd with multiple interfaces, it will pick the first interface specified as the "main" address.

❹ Since no other hosts are running OLSRd, this list is empty.

Another thing worth noticing, is that an entry is added to our routing table:

```
# route -A inet6
    Destination:   Next Hop   Flags  Metric  Ref  Use Iface
    ...
    ff05::15/128   ff05::15   UAC    0       1    1   eth1
    ...
```

This is the IPv6 multicast address OLSR is using to talk to other nodes running OLSR.

3.2.2. Adding other hosts

There is no point in using OLSRd on only one node, so we add some nodes. You will then see the "neighbor list" gets updated:

```
neighbor list: 12:55:14.733586
neighbor list: 12:55:18.803585
Willingness for fec0:106:2700::11 changed from 0 to 3 - UPDATING   ❶
neighbor list: 12:55:22.763585
fec0:106:2700::11:l=0:m=0:w=3[2hlist:]                            ❷
neighbor list: 12:55:26.833589
fec0:106:2700::11:l=1:m=0:w=3[2hlist:]
Willingness for fec0:106:2700::12 changed from 0 to 2 - UPDATING   ❸
neighbor list: 12:55:30.903585
fec0:106:2700::12:l=0:m=0:w=2[2hlist:]
fec0:106:2700::11:l=1:m=0:w=3[2hlist:]
neighbor list: 12:55:34.863585
fec0:106:2700::12:l=0:m=0:w=2[2hlist:]
fec0:106:2700::11:l=1:m=0:w=3[2hlist:]
neighbor list: 12:55:39.153586
fec0:106:2700::12:l=1:m=0:w=2[2hlist:fec0:106:2700::11:]          ❹
fec0:106:2700::11:l=1:m=0:w=3[2hlist:fec0:106:2700::12:]          ❺
neighbor list: 12:55:43.443605
fec0:106:2700::12:l=1:m=0:w=2[2hlist:fec0:106:2700::11:]
fec0:106:2700::11:l=1:m=0:w=3[2hlist:fec0:106:2700::12:]
```

❶ Another node detected (node B). This specifies the willingness of a node to carry and forward traffic for other nodes. Here the new node **`fec0:106:2700::11`** is willing to forward traffic. A host with low battery may not be willing to forward large amount of traffic, – so it will proclaim a lower willingness value (routing based on powerstatus is available as a plugin).

❷ The node has been added to our routing table. We can not (yet) reach any other node by way of this node, since the 2–hop neighbor list (**`[2hlist:]`**) is empty. A 2–hop neighbor is a node heard by a neighbor.

❸ Here is a third node (node C) running OLSRd.

❹ After a short time, when all nodes have been updated and routes calculated, we may also reach any of the other nodes via the other. The 2–hop neighbor list (`[2hlist:]`) is populated: We can reach node **B** via **C**.

❺ Here we can reach node **C** via **B**.

You will also see the routing table is updated with the new hosts:

```
# route -A inet6
    Destination:            Next Hop    Flags   Metric   Ref   Use  Iface
    ...
    fec0:106:2700::11/128   ::          UH      1        0     0    eth1
    fec0:106:2700::12/128   ::          UH      1        0     0    eth1
    ...
```

The real beauty of OLSR is when you add a bunch of nodes and move them around. You can still reach each one of them either directly (if they are close), or through other nodes.

3.2.3. Movement

When every node can reach every other node, it's no fun. Let's start moving the nodes, so that node "A" and "B" are out of (radio) range of each other. So when we move node "A" far enough away so that it can't hear node "C", all traffic must go through node "B":

We move our three nodes so that node **A** and **C** must speak through node **B** to reach each other.

Tip: Instead of physically moving the nodes around, you can use **`ip6tables`**. You can drop all packet using the MAC–address. You just need to block on one node:

```
# ip6tables -A INPUT -m mac --mac-source XX:XX:XX:XX:XX:XX -j DROP
```

The output from OLSRd on host A is then:

```
  neighbor list: 13:22:35.693587
  fec0:106:2700::11:l=1:m=1:w=3[2hlist:fec0:106:2700::12:]   ❶
  neighbor list: 13:22:40.093588
  fec0:106:2700::11:l=1:m=1:w=3[2hlist:fec0:106:2700::12:]
  neighbor list: 13:22:44.053594
  fec0:106:2700::11:l=1:m=1:w=3[2hlist:fec0:106:2700::12:]
  neighbor list: 13:22:48.233594
  fec0:106:2700::11:l=1:m=1:w=3[2hlist:fec0:106:2700::12:]
  neighbor list: 13:22:52.193605
  fec0:106:2700::11:l=1:m=1:w=3[2hlist:fec0:106:2700::12:]
```

❶ We can reach node **B** directly, and via node **B** we can reach node **C**.

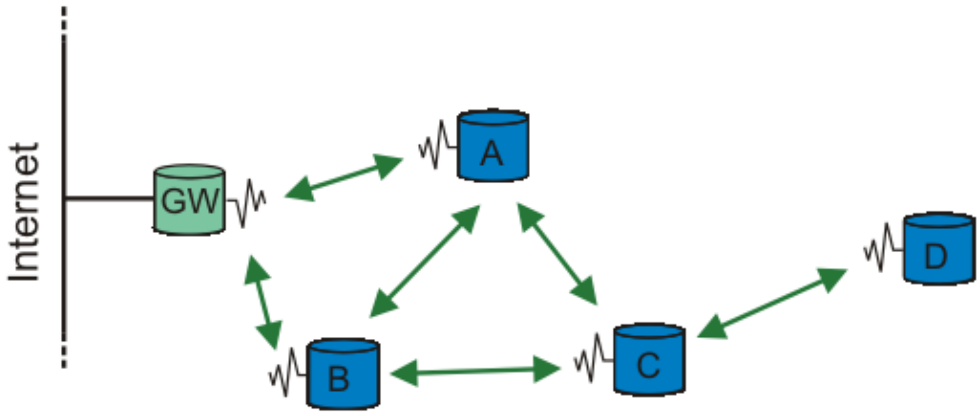
The routing table also gets updated. For node **A** to reach node **C** it must go through node **B**:

```
# route -A inet6
    Destination:              Next Hop             Flags  Metric   Ref   Use  Iface
    ...
    fec0:106:2700::11/128     ::                   UH       1      1     0    eth1
    fec0:106:2700::12/128     fec0:106:2700::11    UGH      2      0     0    eth1
    ...
```

3.3. What about HNA messages?

" In order to provide this capability of injecting external routing information into an OLSR MANET, a node with such non–MANET interfaces periodically issues a Host and Network Association (HNA) message, containing sufficient information for the recipients to construct an appropriate routing table."

" An example of such a situation could be where a node is equipped with a fixed network (e.g., an Ethernet) connecting to a larger network as well as a wireless network interface running OLSR." ––– RFC3626: OLSR, section 12 (page 51).



OLSR with a gateway (GW), that sends out HNA messages. All the other nodes may then be accessing the "Internet"

To have one node, act as a gateway and send out HNA messages, you must change the **HNA6** in `/etc/olsrd.conf`:

```
    # HNA IPv6 routes
    # syntax: netaddr prefix
    # Example Internet gateway
    HNA6 :: 0
```

When you start **OLSRd**, you will see the node is sending out HNA messages periodically:

```
...
Sending HNA (48 bytes)...
...
```

When the other nodes receives a HNA message, they update their routing table:

```
# route -A inet6
    Destination:            Next Hop          Flags  Metric  Ref  Use Iface
    ...
    ::/0                    fec0:106:2700::1  UG     1       0    0   eth1
    ...
```

You may also have multiple nodes in a MANET to act as gateways (sending out HNA messages). Each mobile node then use the nearest gateway.

3.4. Plugin support

As of version 0.4.3 OLSRd also support plugins. Plugins may be used to add extended functionality in a MANET. If only a subset of the nodes knows how to interpret the messagetype, it will be forwarded by all the nodes by the "default forwarding algorithm" (see section 3.4.1 in the OLSR RFC). This way certain nodes may add special functionlity into OLSR.

As of this writing, two example plugins is included in the OLSRd release. One of these plugins add routing based on powerstatus. If one node has low battery, it can set its willingness lower and traffic may be routed through other nodes.

3.5. Optional GUI

OLSRd also has an optional GUI, which can show a list of available nodes and grab packets. To compile the GUI front end, you must have GTK2. In `unik-olsrd-x.y.z` directory do:

```
# cd front-end
# make
# make install
```

Remember to start OLSRd with the **`-ipc`** switch or set **`IPC-CONNECT yes`** in **`/etc/olsrd.conf`** to enable the GUI to chat with OLSRd.

To see some examples of the use of GUI, check out http://www.olsr.org/index.cgi?action=gui

3.6. Other OLSR implementations

There is also other OLSR implementations, none have gained as much popularity as OLSRd, and none of them (except QOLSR?) are fully RFC compliant.

3.6.1. INRIA

INRIA was one of the first(?) implementation of OLSR http://hipercom.inria.fr/olsr/#code. Their web−site has not been updated for quite a while, and the OLSR code you can download only complies to draft−ietf−manet−olsr−03.txt (it's now an RFC). There is suppose to be another more up−to−date version of INRIA olsr, but I have not found it. INRIA OLSR does not support IPv6.

3.6.2. NROLSR

The "US Naval Research Laboratory" (NRL) also has an OLSR implementation. It is written in C++, and has IPv6 support. http://pf.itd.nrl.navy.mil/projects/olsr/

3.6.3. CRCOLSR

CRCOLSR is a implementation based on the French INRIA code. It is is supposed to be maintained by "Communication Research Center" (CRC) in Canada. But as of this writing, there have been no new releases since April 3, 2003. http://pf.itd.nrl.navy.mil/projects/olsr/

3.6.4. QOLSR

QOLSR is aiming to provide "Quality of Service" routing in wireless mobile ad hoc networks. There is no QoS support at the time of this writing, and support for ipv4/ipv6 is triggered at compile time. Written in C++.

4. FAQ

Some of these question/answers are from the OLSRd site.

4.1. If OLSRd fully RFC3626 compliant?

Yes. It even has implemented some of the extra functionality mentioned in the RFC. See the RFC Compliance section for complete list.

4.2. Can I mix site−local and global IPv6 addresses?

Yes. But keep in mind that they intentionally were not designed to be used at the same time. The network topology can be quite "messy" if you start using these two.

4.3. The GUI front−end failed to compile...why?

You probably don't have the GTK2.0 development libraries installed.

4.4. If there is multiply gateways present, how does the mobile node conclude to use the nearest one?

When a new gateway is detected, the Mobile Node checks the distance (number of hops) to this newly discovered gateway compared to the current gateway. If there is a shorter distance, this new gateway becomes the current (default) gateway. See section 12.6.2 in the OLSR RFC (RFC3626)

4.5. I get OLSRd up and running − but the nodes don't seem to "hear" each other!

Most of the time this is a configuration error: Check the following:

- If using WLAN interfaces make sure the ESSID/key match.
- Make sure the cards are set in "ad−hoc" mode and not "managed".
- Make sure you are not blocking UDP/698. If using netfilter run **`ip6tables -L`** as root to see what rules are set. **`ip6tables -F`** flushes all rules.

5. Useful Resources

1. OLSRd (old uOLSR) http://www.olsr.org
2. Optimized Link State Routing Protocol (OLSR) RFC3626 http://www.ietf.org/rfc/rfc3626.txt
3. Mobile Ad hoc Networking (MANET) RFC2501 http://www.ietf.org/rfc/rfc3626.txt
4. Mobile Ad−hoc Networks (manet) Working Group (IETF) http://www.ietf.org/html.charters/manet−charter.html
5. Open Shortest Path First IGP (ospf) http://www.ietf.org/html.charters/ospf−charter.html
6. Protean Forge − OLSR software (CRC and NRL) http://pf.itd.nrl.navy.mil/projects/olsr/
7. INRIA OLSR http://hipercom.inria.fr/olsr/
8. QOLSR http://qolsr.lri.fr/
9. IPv6 Working Group (IETF) http://www.ietf.org/html.charters/ipv6−charter.html
10. RFC2460 Internet Protocol, Version 6 (IPv6) Specification http://www.ietf.org/rfc/rfc2460.txt
11. Peter Bieringer's Linux IPv6 HOWTO (en) http://ldp.linux.no/HOWTO/Linux+IPv6−HOWTO/
12. Current Status of IPv6 Support for Networking Applications http://www.deepspace6.net/docs/ipv6_status_page_apps.html

6. Copyright, acknowledgments and miscellaneous

6.1. Copyright and License

6.2. How this document was produced

This document was originally written in LaTeX using Emacs. HTML version created with latex2html. Later it was converted to DocBook XML.

An up−to−date version of this document can be found at:

HTML: http://www.tldp.org/HOWTO/OLSR−IPv6−HOWTO/index.html

6.3. Feedback

Suggestions, corrections, additions wanted. Contributors wanted and acknowledged. Flames not wanted.

I can always be reached at <lars at unik no>

Homepage: http://www.gnist.org/~lars/

6.4. Acknowledgments

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Thanks also to the other HOWTO authors whose works I have referenced:

Linux IPv6 HOWTO (en) by Peter Bieringer

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