Motorola Surfboard 4100 + 4200 Series USB Cable Modem mini−HOWTO

Howard Shane

<hshane[AT]austin.rr.com>

Revision History

Revision 1.0	2003−05−15	Revised by: tmm
Initial release, reviewed by LDP		
Revision 0.02	2003−04−10	Revised by: jhs
Completed draft.		

This document was written to assist the Linux user in setting up the Motorola Surfboard 4000 series of cable modems.

Table of Contents

1. Introduction

This document was written to assist the Linux user in setting up the Motorola Surfboard 4100 and 4200 series cable modems, and includes information on configuring a DHCP client, enabling the device with or without USB support and troubleshooting.

1.1. Copyright Information

1.2. Disclaimer

No liability for the contents of this document can be accepted. Use the concepts, examples and other content entirely at your own risk. As this is a new edition, there may be technical or other inaccuracies that may result in the loss of irreplaceable data. In any case, proceed with caution, and realize that although errors are highly unlikely, the author can accept no responsibility for them.

All copyrights are held by their by their respective owners, unless specifically noted otherwise. Use of a term in this document should not be regarded as affecting the validity of any trademark or service mark.

Naming of particular products or brands should not be seen as endorsements.

1.3. New Versions

This is the initial release.

The latest version number of this document can be found here.

1.4. Credits

I would like to thank Brad Hards, the primary author of the Linux CDCEther kernel driver for graciously volunteering several useful bits of information.

Also, I would like to thank Marla, who has cheerily tolerated the time I've spent sifting through documentation and endless typing while completing this and other projects. Without you I'm lost.

1.5. Feedback

Please send any additions or comments pertaining to this document to the following email address: `<hshane[AT]austin.rr.com>`. If you have an earlier (e.g., 3000 series) or later (e.g. 5000) series Surfboard and have it working in linux, please contact me with any model−specific setup information so we can update this document!

1.6. Conventions Used in this Document

The following conventions are used in this document and are outlined here for those who may not yet have a complete understanding of how to access and control the underlying operating system in Linux, which is almost always the bash shell.

First, filenames are referenced in a paragraph like so: `/path/file`

Commands in Linux are executed (or 'called') at the command prompt, otherwise known as the 'command line.' If you are in the non−graphical (text−based) environment you will usually be presented the bash shell prompt which is a dollar sign:

```
$
```

...or the hash mark:

```
#
```

...if you have logged in as root or have acquired root, or 'superuser' privileges. You can also access the bash shell in the X window system, otherwise known as X or X11, with an xterm or similar X−terminal−emulator. Commands to be performed at the bash prompt, but referenced in a paragraph of this document, usually look like this: **do this now**

Commands and/or the resulting output of commands may also be outlined with screen output in their own paragraph or heading:

```
$ date
Sun Jul 27 22:37:11 CDT 2003
```

When a command is written in front of the bash prompt (e.g. **$ date** above), it is assumed the [Return] or [Enter] key has been depressed after the command, possibly followed by the output on a new line (e.g., as in the date in the above example).

2. Prerequisites

2.1. Networking and Operating System Support

The Motorola Surfboard 4100 and 4200 Cable Modem series are common devices provided by cable Internet services. They are easily configurable for use under Linux. For more information about the device not related to Linux configuration, please see the manufacturer's website here.

There are two requirements for using a Motorola Surfboard 4100 and 4200 series USB cable modem (hereafter referred to as a 'Surfboard'). The first is the appropriate networking support for the device in your kernel; note that most base installs of Linux distributions come TCP/IP and ethernet enabled 'out of the box,' so there is probably very little most readers will need to do other than be sure their ethernet card is working. If you know that your ethernet card is supported and working you can move on to Section 2.2. For those who like to compile their own kernels (see the Kernel HOWTO for more information), the following options are required to get the cable modem to work:

Under 'Networking options':

- TCP/IP Networking

along with ONE of the following:

- Network Device Support: Ethernet (10 or 100Mbit) Support and your ethernet card driver
- USB Support + USB CDCEther driver support

PPP support is not required per se, as the modem is itself a PPP link.

Note that there are two possible interfaces on the modem to connect your computer. One is through ethernet and is probably the default a cable provider will attempt to use when setting up the Surfboard. The other is to use the USB interface. The former of these is arguably easiest; the only requirements other than the above is that you have an ethernet card installed which is open, i.e. that you can connect to the modem ethernet jack using ordinary 10BaseT/100BaseT ethernet cable. If you are uncertain about anything in the last sentence I recommend you read the Ethernet HOWTO for proper configuration of your ethernet card.

I have used my own 4100 model with each interface, and at least on my system there seems to be little difference in performance using an ethernet card or the USB port. The drawback of the ethernet method is that your network card will be tied up.

2.2. The Modem Device

First, plug in and turn on the Surfboard. Connect your ethernet card to the Surfboard with 10BaseT/100BaseT cable into the non−USB interface, if this was not already done for you. Be sure the modem isn't on standby mode by checking the LEDs; you should see some dancing green lights to confirm this. The standby button is on the top of the device on most models. Your cable internet provider should be able to tell remotely whether your modem is connected and functioning properly, which is helpful for differentiating between hardware and configuration problems on your end. They will also need the MAC (Media Access Control) hardware address of your modem to allow the device access to their network. If at any time you substitute one modem for another you will need to inform them so the MAC address can be updated and your access to the cable network restored.

Once you connect for the first time, your modem will be assigned an IP address, which may remain the same or change periodically depending on the IP address turnover of your ISP's DHCP server, and how long you remain offline if you disconnect. Should the IP address provided to the modem by your ISP ever have to be released, for whatever reason, you can do this by resetting the device. This involves inserting the tip of a sharp pencil or a pin into the small orifice on the input face. The only time this may be necessary is if you are having trouble with your connection and you are instructed to try this maneuver by your ISP's technical support staff. Only do this if you know what you're doing or are directed to do so by your ISP, as it's generally not a good idea to go around sticking metal objects into the various openings of electrical devices.

2.3. The DHCP Client

2.3.1. Installation on a Debian System

The Surfboard works fine out of the box under Debian once you have installed and started the DHCP client package. As of this writing there are two user−space programs for this. In Woody (stable), there is the dhcp−client package, automatically installed as a part of the base packages as `/sbin/dhclient`. For Sarge (testing) and up, this has been replaced by the dhcpcd package. The latter has its configuration files under `/etc/dhcpc`, but nothing really needs to be modified if you are setting up only one ethernet card for the cable internet service. The dhcpcd daemon is easily installed for those using testing branch as root, with **apt−get install dhcpcd** .

2.3.2. Installing on .rpm− or .tgz−Based Systems

For .rpm− or .tgz−based distributions, I offer the following link that walks you through the setup of a DHCP client, in the DHCP mini−HOWTO.

Just run **/sbin/dhclient** or whichever client you use to get a dynamic IP address.

2.3.3. Checking your Configuration

Once you are plugged into the system you are provided your own IP address, which doesn't change unless you drop the lease (i.e. go offline) for a while. To confirm that the DHCP client is working and you have a new IP address, execute (as root) **ifconfig** without any other arguments, and you should see the following:

```
eth0    Link encap:Ethernet  HWaddr 00:D0:09:DE:D4:6F
        inet addr:66.190.XXX.XXX  Bcast:255.255.255.255  Mask:255.255.255.0
        UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
        RX packets:2591777 errors:0 dropped:0 overruns:0 frame:0
        TX packets:5589 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:100
        RX bytes:168673636 (160.8 MiB)  TX bytes:1752872 (1.6 MiB)
        Interrupt:12 Base address:0xc400
```

```
lo      Link encap:Local Loopback
        inet addr:127.0.0.1  Mask:255.0.0.0
        UP LOOPBACK RUNNING  MTU:16436  Metric:1
        RX packets:5168 errors:0 dropped:0 overruns:0 frame:0
        TX packets:5168 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:0
        RX bytes:1695104 (1.6 MiB)  TX bytes:1695104 (1.6 MiB)
```

...which shows the system loopback device, `/dev/lo`, and also `/dev/eth0`, your ethernet card and the Surfboard, having successfully acquired an IP address (or 'inet addr') provided by the cable internet service provider.

---

3. Using the USB interface instead of an ethernet card

3.1. USB CDCEther

If you wish to use the USB interface to accept data you will need USB subsystem support in your kernel, whether USB−ohci, USB−ehci, or whichever USB host controller driver type your system prefers. For a more in−depth discussion of this, I direct you to the Linux−USB project site.

Assuming you have USB subsystem support, to find out if your kernel supports the CDCEther (Communications Device Class Ethernet) driver as a module, in a shell, issue the command **lsmod** as root.

You should see output similar to the following, though a number of entries have been edited, and you shouldn't worry too much if you don't see the exact entries displayed here:

```
CDCEther                11040   0  (unused)
usb−ohci                17888   0  (unused)
usbcore                 56768   1  [scanner CDCEther usb−ohci]
```

If you don't see CDCEther listed among the modules try loading the module directly:

```
 #  modprobe CDCEther
```

If all goes well you should see the following message in your system log files, or with **dmesg**:

```
Mar  2 11:00:52 K7 kernel: CDCEther.c: 0.98.6 7 Jan 2002 Brad Hards and another
Mar  2 11:00:52 K7 kernel: usb.c: registered new driver CDCEther
```

If you don't have it compiled as a module, check the output of **dmesg** (you may need to pipe it through 'less' or 'more' like so: **dmesg | less**); if the driver loads as a module you will see a message similar to the above at boo− up. If not, and you want to use the USB conduit of this device, you will need to recompile your kernel to support it. You will need the 2.4.3 kernel or later. For detailed instructions on recompiling your kernel, I direct you to the Kernel−HOWTO. The options shown next will need to be selected. As an aside, you should be aware that compiling things as modules, rather than statically within the kernel, gives you a greater degree of control and greatly simplifies troubleshooting.

3.1.1. Kernel Requirements

In addition to the 'TCP/IP networking' listed in Section 2, the following should be compiled in your kernel in the 'USB support' menu (assuming you are using **menuconfig**):

- USB support
- USB Communication Class Ethernet device support

3.1.2. Grabbing the Correct Interface

Now we have to select the correct ethernet interface (`/dev/ethX`) to be the receipient of the DHCP service. If you run **ifconfig** as root you get a list of open devices:

```
eth0 Link encap:Ethernet HWaddr 00:D0:09:DE:D4:6F
        inet addr:192.168.1.1
        Bcast:192.168.1.255 Mask:255.255.255.0
        BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
        RX packets:0 errors:0 dropped:0 overruns:0 frame:0
        TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:100
        RX bytes:0 (0.0 b) TX bytes:0 (0.0 b) Interrupt:12 Base address:0xc400
```

```
lo Link encap:Local Loopback
        inet addr:127.0.0.1 Mask:255.0.0.0
        UP LOOPBACK RUNNING MTU:16436 Metric:1
        RX packets:5168 errors:0 dropped:0 overruns:0 frame:0
        TX packets:5168 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:0
        RX bytes:1695104 (1.6 MiB)  TX bytes:1695104 (1.6 MiB)
```

...where eth0 is a standard NIC, pre−configured to the IP address 192.168.1.1.

Note the HWaddr field, or hardware address, on the first line. This is the same as the MAC, or Media Access Control address, and is how we will specify the interface for each action. If you are running a Debian system, you can alter the `/etc/network/interfaces` file to look like this:

```
        # /etc/network/interfaces -- configuration file for ifup(8), ifdown(8)
        # The loopback interface
        auto lo
        iface lo inet loopback
        auto eth0
        iface eth0 inet static
        address 192.168.1.1
        netmask 255.255.255.0
        network 192.168.1.0
        hwaddress ether 00:D0:09:DE:D4:6F

        auto eth1
        iface eth1 inet dhcp
        hwaddress ether 00:04:BD:DE:42:0B
```

The **auto eth0** and **auto eth1** are required to have the interfaces configured at bootup. Note that some versions of dhcp clients by default always grab eth0 for the dhcpc interface. So even after doing all the above, unless you specifically run **/sbin/dhcpcd−bin eth1** it won't work. The easy way to do this at boot−up is to make an init script to load the dhcp address to the correct interface. For most distributions, such a script is in `/etc/rc.d` or a similar location. If you have an `rc.local` script, as in Slackware, you can simply add **/sbin/dhclient** to the end of the file. If you have a model rc.d script (such as `/etc/init.d/skeleton` in Debian) you can convert that to such a purpose. Whatever the case (either at the command line manually or appended to an init script), the command to run is as follows:

```
# ifconfig ethX hw ether 00:D0:09:DE:D4:6F up
```

You can confirm it worked by calling **ifconfig** without options after your next reboot.

4. Troubleshooting

Q: I get kicked offline about once every 4 days, for no apparent reason, and get the following error, or something similar, in the kernel log:

```
Feb 20 10:05:12 K7 kernel: CDCEther.c: rx status −110
Feb 20 10:05:12 K7 kernel: CDCEther.c: no repsonse in BULK IN
Feb 20 10:05:12 K7 kernel: CDCEther.c: rx status −110
Feb 20 10:05:12 K7 kernel: CDCEther.c: no repsonse in BULK IN
Feb 20 10:05:12 K7 kernel: CDCEther.c: rx status −110
Feb 20 10:05:12 K7 kernel: CDCEther.c: no repsonse in BULK IN
Feb 20 10:05:12 K7 kernel: CDCEther.c: rx status −110
```

A: There are a number of reasons this may be happening, and future updates to the CDCEther driver may solve some of them. A user on the Linux−USB−user mailing list noticed that on at least one occasion data sent to the modem from upstream by the cable provider has triggered it. Also, the modem itself is very sensitive to power interruptions and can lose the connection if this occurs. The fix is to run **ifdown ethX**, where *ethX* is the ethernet interface (eth0, eth1 etc.) to clear out any remaining settings that are hung, then remove the module with **rmmod CDCEther**, reinsert the CDCEther module and then **ifup ethX** . A reboot may be necessary if this doesn't fix the problem. If none of these work you probably have a real service interruption.

Q: I get the following messages on boot−up; are they errors?

```
Can't use SetEthernetMulticastFilters request
Mar  2 11:00:52 K7 kernel: CDCEther.c: Ethernet information found at
device configuration.  Trying to use it anyway.
Mar  2 11:00:52 K7 kernel: CDCEther.c: Imperfect filtering support −
need sw hashing
```

A: No. The multicast message is pertaining to Multicast support in the kernel, which is optional and not necessary for the proper functioning of this modem. The message about 'Ethernet Information' is a design bug in the modem and can be ignored. As for the 'Imperfect filtering support,' to quote Brad Hards:

" This is a bit difficult to explain − I assume that you know what multicasting is − when you join a multicast group, this can be handled by the networking device so that other multicast traffic doesn't cause interrupts. That is called 'perfect filtering.' However sometimes the number of multicast addresses exceeds the number of filters that you have. This leads to 'imperfect filtering,' which can cut down the number of interrupts, but you still need to do some work in the networking stack. Then you get to the typical cable modem implementation, and there is not filtering at all. Every multicast packet goes to the host to be filtered. This doesn't normally matter though, because the cable modem is a point to point link. "

Q: I'm still having problems, or I'm unusually curious...is there a way that I can get more information about what the device is up to?

A: Yes, there is. The manufacturer hard−wired an http server for status and configuration purposes into the modem itself. It seems to have been designed for troubleshooting by cable tecnician staff, but you can access the 4100 and 4200 models by directing your web browser to http://192.168.100.1. You will need to kill your firewall if you have one running prior to doing this. You can see statistics, logs and some other miscellaneous info at this address.

A. Gnu Free Documentation License

Version 1.2, November 2002

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document "free" in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondarily, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft cense designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world−wide, royalty−free license, unlimited in duration, to use that work under the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front−matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document's overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front−Cover Texts or Back−Cover Texts, in the notice that says that the Document is released under this License. A Front−Cover Text may be at most 5 words, and a Back−Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine−readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called "Opaque".

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard−conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine−generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "Title Page" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work's title, preceding the beginning of the body of the text.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front−Cover Texts on the front cover, and Back−Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine−readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer−network location from which the general network−using public has access to download using public−standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.

B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.

C. State on the Title page the name of the publisher of the Modified Version, as the publisher.

D. Preserve all the copyright notices of the Document.

E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.

F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.

G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.

H. Include an unaltered copy of this License.

I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.

J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.

K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.

L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.

M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.

N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.

O. Preserve any Warranty Disclaimers. If the Modified Version includes new front−matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles. You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties−−for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front−Cover Text, and a passage of up to 25 words as a Back−Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front−Cover Text and one of Back−Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements".

6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation's users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document's Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See http://www.gnu.org/copyleft/.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

ADDENDUM: How to use this License for your documents

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page:

Copyright (c) YEAR YOUR NAME. Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front−Cover Texts, and no Back−Cover Texts. A copy of the license is included in the section entitled "GNU Free Documentation License".

If you have Invariant Sections, Front−Cover Texts and Back−Cover Texts, replace the "with...Texts." line with this: with the Invariant Sections being LIST THEIR TITLES, with the Front−Cover Texts being LIST, and with the Back−Cover Texts being LIST. If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.