COMSOL
INSTALLATION GUIDE

VERSION 3.3

COMSOL

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Company home page
www.comsol.com

COMSOL user forums
www.comsol.com/support/forums

COMSOL Installation Guide

Version: August 2006 COMSOL 3.3

CONTENTS

Chapter 1: Installation Guide

Chapter 2: Running COMSOL

Chapter 3: COMSOL Engine API

Chapter 4: License Agreement

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Installation Guide

General Tips

Welcome to COMSOL® 3.3! Use this *Installation Guide* to install your COMSOL software products and start working with the packages. In addition to this manual, we supply many other resources to help you get the most out of COMSOL products. Among them are:

COMSOL Multiphysics Quick Start and Online Help

The easiest way for new users to get an overview of COMSOL Multiphysics' capabilities and how to use them is to read the *COMSOL Multiphysics Quick Start* manual. Further, the full COMSOL documentation set is available on your computer in the COMSOL help resources and as a set of PDF files. To get started with COMSOL Script, have a look at the *COMSOL Script User's Guide*.

Technical Support

If any questions arise regarding COMSOL software products—whether concerning installation, licensing, modeling, applications, or other technical questions—do not hesitate to contact your local COMSOL representative or send your questions to support@comsol.com.

Further, at www.comsol.com/support you can find a broad range of technical support resources including the searchable COMSOL Knowledge Base.

Typographical Conventions

All COMSOL manuals use a set of consistent typographical conventions that should make it easy for you to follow the discussion, realize what you can expect to see on the screen, and know which data you must enter into various data-entry fields. In particular, you should be aware of these conventions:

- A **boldface** font of the shown size and style indicates that the given word(s) appear exactly that way on the COMSOL graphical user interface (for toolbar buttons in the corresponding tooltip). For instance, we often refer to the **Model Navigator**, which is the window that appears when you start a new modeling session in COMSOL; the corresponding window on the screen has the title **Model Navigator**. As another example, the instructions might say to click the **Multiphysics** button, and

the boldface font indicates that you can expect to see a button with that exact label on the COMSOL user interface.

- The names of other items on the graphical user interface that do not have direct labels contain a leading uppercase letter. For instance, we often refer to the Draw toolbar; this vertical bar containing many icons appears on the left side of the user interface during geometry modeling. However, nowhere on the screen will you see the term "Draw" referring to this toolbar (if it were on the screen, we would print it in this manual as the **Draw** menu).
- The symbol **>** indicates a menu item or an item in a folder in the **Model Navigator**. For example, **Physics>Equation System>Subdomain Settings** is equivalent to: On the **Physics** menu, point to **Equation System** and then click **Subdomain Settings**. **COMSOL Multiphysics>Heat Transfer>Conduction** means: Open the **COMSOL Multiphysics** folder, open the **Heat Transfer** folder, and select **Conduction**.
- A `Code` (monospace) font indicates keyboard entries in the user interface. You might see an instruction such as "Type `1.25` in the **Current density** edit field." The monospace font also indicates COMSOL Script codes.
- An *italic* font indicates the introduction of important terminology. Expect to find an explanation in the same paragraph or in the Glossary. The names of books in the COMSOL documentation set also appear using an italic font.

System Requirements

General Requirements

These requirements are common to all platforms:

- A CD-ROM drive for installation
- TCP/IP on all platforms when using a license server
- Adobe Acrobat Reader 5.0 or greater to view and print the COMSOL documentation in PDF format

The actual disk space needed varies with the size of the partition and the optional installation of online help files. The COMSOL installer informs you of hard-disk space requirements for a particular installation.

GENERAL SYSTEM RECOMMENDATIONS

For 3D modeling we recommend at least 1 GB of memory. The solutions of a few examples in the Model Library require substantially more than 1 GB of memory and some even a 64-bit platform.

FLOATING NETWORK LICENSES

Floating network licenses are supported on heterogeneous networks of Windows, Linux, Sun, and Mac computers. Both the license manager and the COMSOL application can run on either Windows, Linux, Sun, or Mac, and a single computer can run both of them.

COMSOL Multiphysics System Requirements for Microsoft Windows

SYSTEM REQUIREMENTS—32-BIT WINDOWS VERSION

- Windows 2000 or Windows XP
- Pentium III or later
- OpenGL 1.1 from Microsoft or an accelerator that supports OpenGL 1.1, or DirectX version 8.0 or later (see the section "Windows Graphics Rendering Solutions" on page 39). The graphics card should have at least 32 MB of memory.
- At least 1024 MB of system memory

OPTIONAL MATLAB ADD-ON REQUIREMENTS

The 32-bit COMSOL interface to MATLAB requires MATLAB 6.5, 6.5.1, 7.0, 7.0.1, 7.0.4, 7.1, or 32-bit MATLAB 2006a.

SYSTEM REQUIREMENTS—64-BIT WINDOWS VERSION

- Windows XP Professional x64 Edition
- A PC with one of these processors: AMD Opteron, AMD Athlon 64, Pentium 4 with EM64T, or Xeon with EM64T
- A graphics card with at least 32 MB of memory
- At least 1024 MB of system memory

OPTIONAL MATLAB ADD-ON REQUIREMENTS

The 64-bit COMSOL interface to MATLAB requires 64-bit MATLAB 2006a.

COMSOL Multiphysics System Requirements for Linux and Sun

SYSTEM REQUIREMENTS

The system should have at least 1024 MB of memory. See the following table for additional system requirements on the supported Linux and Sun platforms:

TABLE 1-1: SYSTEM REQUIREMENTS FOR LINUX AND SUN PLATFORMS

PLATFORM	OPERATING SYSTEM	PROCESSOR	32-BIT	64-BIT	64-BIT COMSOL SERVER
32-bit Linux	Linux 2.4.x kernel, glibc-2.2.5 or later	Pentium III or later	x		
64-bit Linux	Linux 2.4.x kernel, glibc-2.3.2 or later	AMD Opteron or AMD Athlon 64 or Pentium 4 with EM64T or Xeon with EM64T	x	x	x
Itanium	Linux 2.4.x kernel, glibc-2.2.5 or later	Itanium 2			x
Sun	Solaris 8, 9, 10	UltraSPARC II or later	x	x	x

Standalone COMSOL Multiphysics and the COMSOL Multiphysics client are available in 32- and 64-bit versions as indicated in the table. The COMSOL Multiphysics server is available for 64-bit platforms where indicated in the table.

Note: For the 64-bit COMSOL Multiphysics server on the Itanium 2, you must run the COMSOL Multiphysics client on a COMSOL Multiphysics platform other than Itanium using a floating network license to access the COMSOL Multiphysics server.

The following Linux distributions are officially supported by COMSOL:

PLATFORM	DISTRIBUTION
32-bit Linux	Debian 3.0, 3.1, RedHat Enterprise 4, Fedora Core 5, SUSE 10.1
64-bit Linux	SUSE 9.0, 9.3, and 10.1, RedHat Enterprise 4 (AMD64/Intel EM64T), Fedora Core 5
Itanium	Debian 3.0 (IA-64), RedHat Enterprise 4 (Itanium)

In addition, see the graphics requirements in the following sections.

Linux Graphics Requirements

You can use any of the following XFree86 and graphics-driver configurations:

- XFree86 4.1 or later with XFree86's Mesa library and DRI (Direct Rendering Infrastructure)
- XFree86 4.1 with NVIDIA driver 1.0-2880 or later
- XFree86 4.1 with ATI Fire GL2/3/4 drivers X4.1.0-1.9.16 or later. In order to get hardware acceleration with the Fire GL2/3/4 driver, set the environment variable `LD_PRELOAD=/usr/lib/libGL.so` before starting COMSOL (for example, `LD_PRELOAD=/usr/lib/libGL.so comsol`). According to ATI, this step is not necessary starting with the 1.9.19 driver.
- XFree86 4.1 with an official Mesa library (not XFree86's library). You can obtain it at `http://www.mesa3d.org/`. Use this configuration if you cannot or do not want to use DRI.
- XFree86 3.3.6 with Mesa 3.1 or later

Sun Graphics Requirements

Frame Buffer with OpenGL support (XVR-500, XVR-1000, XVR1200, XVR-4000, Expert3D, Elite3D, Creator3D, or PGX).

OpenGL 1.2.2 for Solaris or later. Depending on the type of frame buffer, a higher OpenGL version might be needed; for instance, XVR-1000 requires OpenGL 1.2.3.

OPTIONAL MATLAB ADD-ON REQUIREMENTS

The 32-bit COMSOL interface to MATLAB requires 32-bit MATLAB 6.5, 6.5.1, 7.0, 7.0.1, 7.0.4, 7.1, or 2006a. The 64-bit COMSOL interface to MATLAB requires 64-bit MATLAB 7.0.1, 7.0.4, 7.1, or 2006a.

COMSOL Multiphysics System Requirements for Mac

SYSTEM REQUIREMENTS

- A Macintosh computer with a PowerPC G4 or PowerPC G5 processor
- Mac OS X 10.3.1
- Java 1.4.1 or later (part of the Mac OS X installation)
- Java 3D and Java Advanced Imaging
- BSD Subsystem (part of the Mac OS X installation)
- At least 1024 MB of system memory

SYSTEM REQUIREMENTS FOR COMSOL DESKTOP

- Mac OS X 10.4.5
- Java 2 Standard Edition (J2SE) 5.0 Release 4.

OPTIONAL MATLAB ADD-ON REQUIREMENTS

The COMSOL interface to MATLAB requires X11 and MATLAB 6.5.1, 7.0, 7.0.1, 7.0.4, 7.1, or 2006a.

CAD Import Modules Platform Support

Find the platform support for products in the CAD Import Module family in the following table:

TABLE 1-2: CAD IMPORT MODULE SYSTEM REQUIREMENTS

PRODUCT	REQUIRED PRODUCTS	PLATFORM SUPPORT
CAD Import Module	COMSOL Multiphysics	Windows, Linux*, Sun
CATIA V4 Import Module	CAD Import Module	Windows, Linux, Sun
CATIA V5 Import Module	CAD Import Module	Windows
Inventor Import Module	CAD Import Module	Windows
Pro/E Import Module	CAD Import Module	Windows, Linux, Sun
VDA-FS Import Module	CAD Import Module	Windows, Linux, Sun

Only 32-bit Linux and 64-bit Linux are supported. The Itanium is not supported.

COMSOL Script System Requirements

The system requirements of COMSOL Script are similar to those for COMSOL Multiphysics except that COMSOL Script is not available on an Itanium platform.

Installing COMSOL on Windows

Before You Begin

- Check that your system meets all applicable requirements (see "COMSOL Multiphysics System Requirements for Microsoft Windows" on page 4).
- Have your passcode or license file ready. A passcode has a form similar to:

  `FFFFFF-CUSV-123456-1234567-123456789`

You need a passcode or a license file to install COMSOL 3.3. You should have received it in an email or letter from your sales representative. If you have not received a passcode or a license file, contact your local COMSOL representative.

Some COMSOL license types require that you also install a license manager before running a COMSOL software product. If you are installing it with a passcode, no license manager is needed. If you are installing it with a license file, you must install the license manager if the license file contains a line starting with the word `SERVER`. See "License Manager Installation" on page 24 for instructions. You can install your COMSOL software products and the license manager in any order.

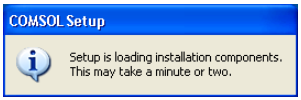
An installation of earlier COMSOL versions on your computer is not affected by the COMSOL 3.3 installation except that double-clicking a Model MPH-file created with an earlier version of COMSOL will open it in COMSOL 3.3. You can continue to use earlier versions or uninstall them independently of the COMSOL 3.3 installation.

Note: In this manual, the term COMSOL 3.3 refers not only to COMSOL Multiphysics 3.3 but also to any other members of the COMSOL product line including COMSOL Script, the COMSOL Reaction Engineering Lab, and all add-on modules and labs.

Installing COMSOL 3.3

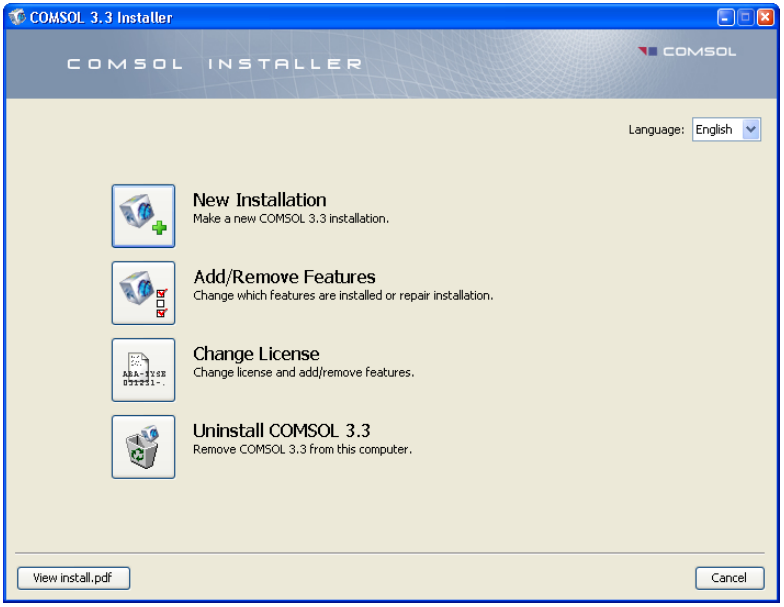
1 Insert the COMSOL 3.3 CD 1 into the CD-ROM drive. The **COMSOL Setup** window should appear automatically; if not, run the file `setup.exe` on the installation CD.

Note that you might need to run `setup_<language code>.exe` for some languages that require special fonts.



When the installation components have been loaded, the **COMSOL Setup** window is replaced by the **COMSOL 3.3 Installer** window. To continue:

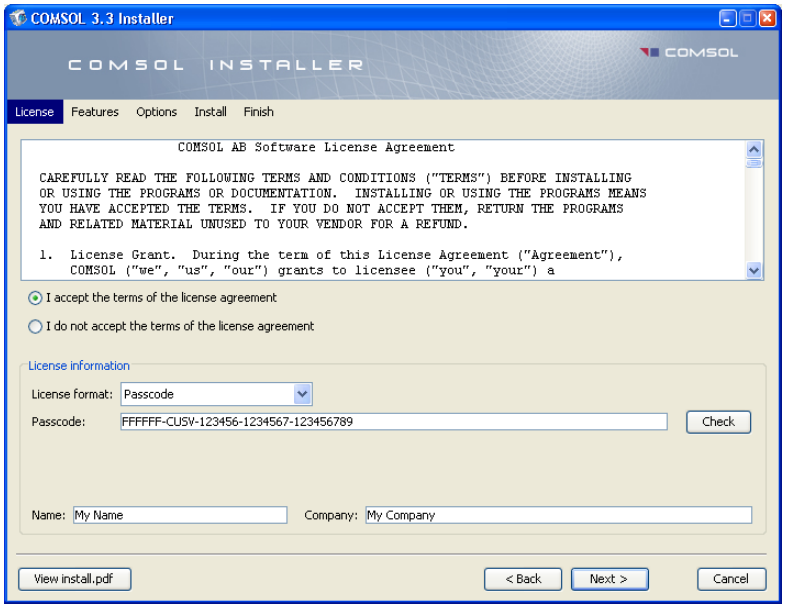
- Click **New Installation** and proceed to Step 2 to make a new installation.
- Click **Add/Remove Features** and proceed to Step 4 to change or repair an existing installation. For example, use **Add/Remove Features** when you add or remove documentation files for products installed or when you want to add or remove a product that your license includes.
- Click **Change License** and proceed to Step 2 to update license of an existing installation. Use this option when you have COMSOL 3.3 installed and get a new license file. The installer then removes features/products not licensed any more and lets you go through the **Add/Remove Features** procedure to add or remove features for the new license. If your trial license has expired you can use the **Change License** option to re-enable the old (paid) license.
- Click **Uninstall COMSOL 3.3** to remove an existing installation.



Note: You can change the path to the existing installation by pressing the F1 key.

2 Once you have read the license agreement, click the **I accept the terms of the license agreement** button and specify the license. You can use one of the following license formats:

- **Passcode**: Enter your passcode, which is a series of characters and numbers that has a form similar to `FFFFFF-CUSV-123456-1234567-123456789`.The passcode is case sensitive.
- **License file**: Enter the path to an existing license file or click **Browse** to select the file `license.dat`.
- **Port number** and **Host name**: Enter the host name of an existing license server and its license server port number.
- **Three-server redundancy**: Enter the host names and license server port numbers of an existing three-server redundant configuration.

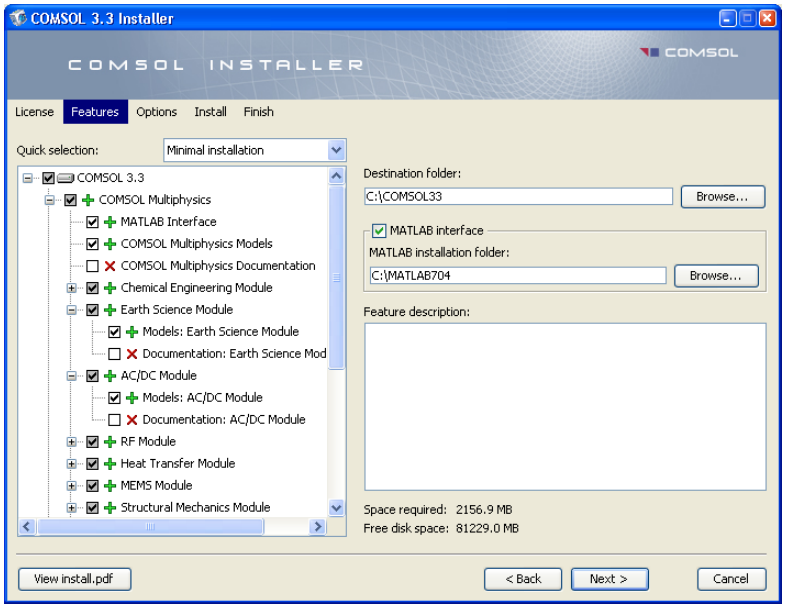


Note: If you clicked **Change License** in Step 1, you can choose to use an existing paid license or trial license, or you can choose to specify a new license. Click **Next** and proceed to Step 4 if you change the license to a license with different products. Otherwise, proceed to Step 9.

3 Click **Next**.

4 Select the features to install and specify the path to the COMSOL installation directory. Select **MATLAB Interface** and specify the MATLAB root folder if you want

the ability to run COMSOL using the MATLAB interface. MATLAB versions 6.5, 6.5.1, 7.0, 7.0.1, 7.0.4, 7.1, 2006a work with COMSOL 3.3.



Feature symbols:

— not currently installed, will be installed

— not currently installed, will not be installed

— currently installed, will not be updated

— currently installed, will be updated

— currently installed, will be removed

Note: If you clicked **Add/Remove Features** or **Change License** in Step 1, the **Features** page includes a **Repair all selected features** check box.

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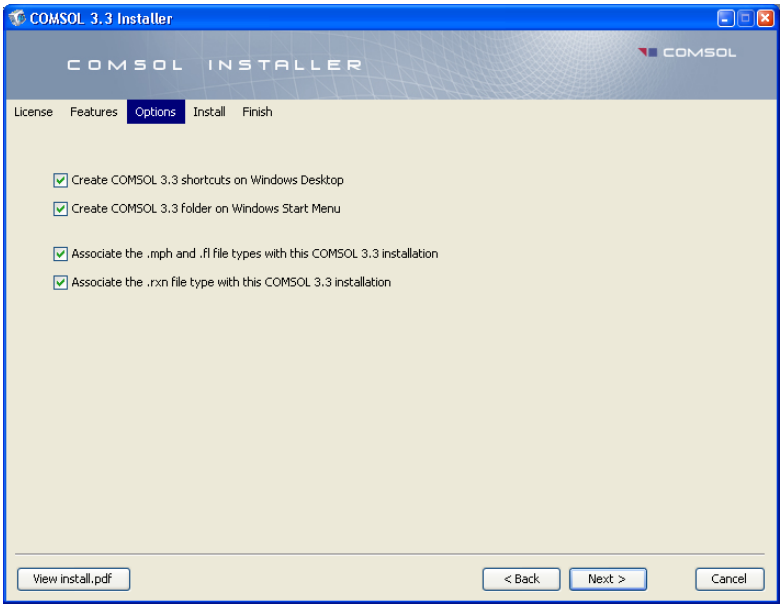
5 Click **Next**.

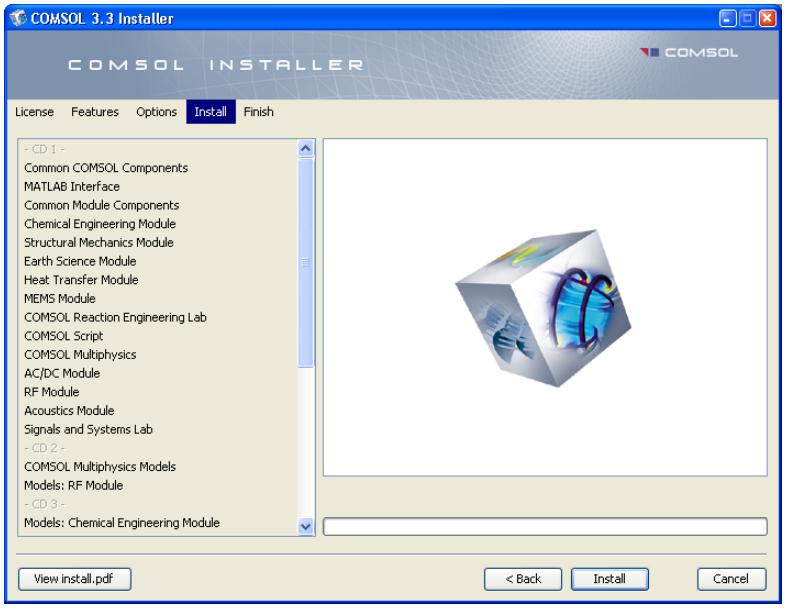
6 Set the installation options. Here you can choose whether or not you want:

- COMSOL shortcuts on the Windows desktop
- COMSOL shortcuts on the Windows Start menu
- to associate the COMSOL model file type (`.mph` files) with the COMSOL installation. If you choose this option you can open COMSOL models by double-clicking them.
- to associate the COMSOL Reaction Engineering Lab model file type (`.rxn` files) with the COMSOL installation. If you choose this option you can open COMSOL Reaction Engineering Lab models by double-clicking them.

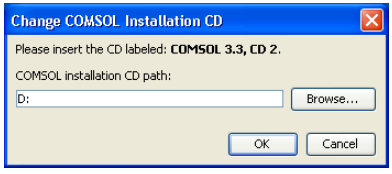


7 Click **Next**.

8 When you click **Install** the utility now installs or updates COMSOL. The installation process might take several minutes. The **Finish** page in Step 9 appears automatically when the installation process is finished.



Be prepared to eject CD 1 from the CD-ROM drive if the following dialog box appears. Follow the instructions in the dialog box and insert CD 2, CD 3, or CD 4 and click **OK**.



Note: Whether or not you will be asked for CD 2, CD 3, or CD 4 depends on your license and on the features selected in Step 4.

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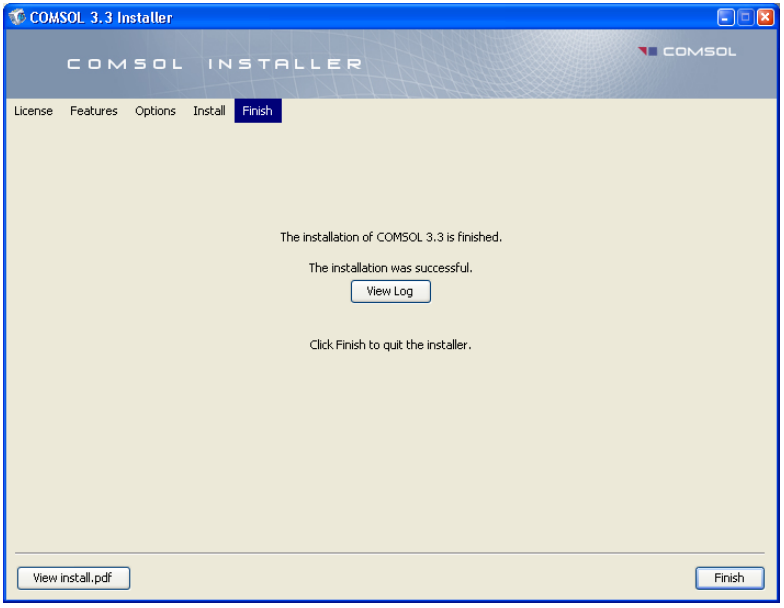
9 This window appears when the installation is finished. Click **View Log** to open a window that shows the installation log. Click **Finish** to quit the installer.



Automated Installation of COMSOL 3.3

You can install COMSOL using an automated installation process with minimal user interaction. An answer file then responds to questions while the installer is running. The answer file is a text file with a specific format that contains predefined settings that the COMSOL installer uses. Start the installation by running

```
<path to CD 1>\setup.exe -s <answer file path>
```

A template answer file, `setup.ini`, with detailed usage information is available on CD 1.

Removing (Uninstalling) the COMSOL Installation

To remove a COMSOL installation from your system, use the COMSOL uninstaller.

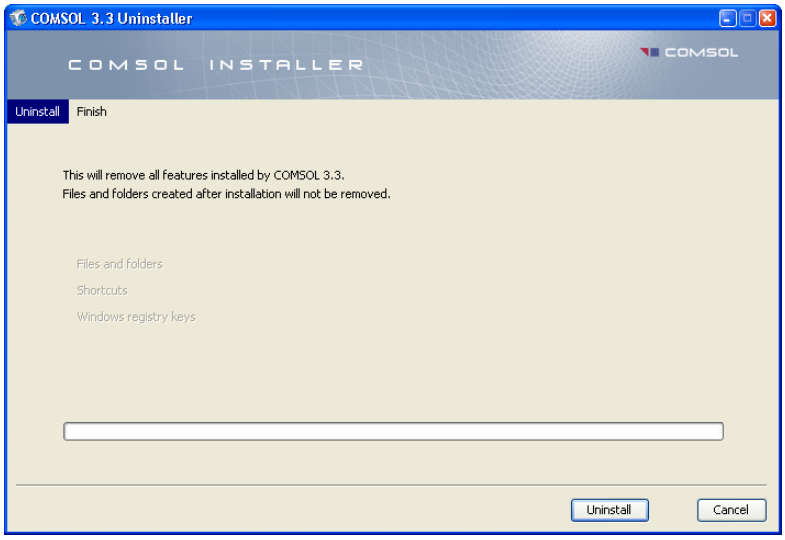
Note: The uninstaller deletes all COMSOL 3.3 files and directories on the system that were installed by the COMSOL installer. Files and folders created after installation are not removed.

STARTING THE UNINSTALLER

To start the COMSOL uninstaller, use either of these methods:

- On the Windows Start menu point to **Programs** and then to **COMSOL 3.3**. Click **Uninstall COMSOL 3.3**.
- On the Windows Start menu, point to **Settings**, then click **Control Panel**. Double-click **Add/Remove Programs**. Select **COMSOL 3.3** from the list.

RUNNING THE UNINSTALLER



Click **Uninstall** to start removing the installation. Click **Finish** to quit the installer when the deinstallation is complete.

Note: If you run COMSOL Multiphysics with MATLAB, close MATLAB before starting the uninstaller. If MATLAB is active, the utility cannot remove certain files.

Changing the Path to the MATLAB Installation

Edit the file `comsol.opts` in the `bin` directory under the COMSOL root directory (typically `C:\COMSOL33`). In the file, change the line that starts with `mlroot=` to point to the root directory of your MATLAB installation.

Adding the SolidWorks Connection to the CAD Import Module

If you have bought the CAD Import Module, the COMSOL Installer adds an add-in to SolidWorks called the **COMSOL Multiphysics Interface**. This add-in should appear on the SolidWorks user interface in the **Add-Ins** list that appears under the **Tools** menu.

The connection between COMSOL and SolidWorks can fail if SolidWorks is installed after COMSOL or if you make manual changes to the Windows registry. In the case of such a failure, it is possible to set up the connection as follows:

1. In SolidWorks, go to the **File** menu and choose **Open**.
2. In the **Files of type** list select **Add-Ins (*.dll)**.
3. Load the file `flswinterface.dll` from the directory `lib\win32` under the COMSOL 3.3 installation directory.

Installing COMSOL on Linux and Sun

Before You Begin

Check that you have a license file `license.dat`, which you should have received by email. If you have not received a license file, contact your local COMSOL representative.

The license manager must be installed and started before running a COMSOL software product with the exception of trial licenses, which do not require a license manager. See "License Manager Installation" on page 24 for instructions. You can install your COMSOL software products and the license manager in any order.

The installation program is an X-Windows application and thus needs access to an X-Windows display to run. Make sure that your DISPLAY variable is set up correctly and that you have access to an X-Windows display. Try the command `xclock` to test that the X-Windows display is working properly. To install your COMSOL software products in a system directory such as `/usr/local`, you might need to run the installation program as the root user. The COMSOL installer for Linux and Sun does not modify any files on your system outside the COMSOL installation directory.

Installing COMSOL 3.3

1. Insert the COMSOL 3.3 CD 1 into the CD-ROM drive.
2. If the CD is not mounted automatically, use the `mount` command to mount the CD.

Note: Make sure not to connect to a directory on CD 1 or open files on it. If you do so while installing the software, you will be unable to unmount and eject CD 1 and continue the installation with CD 2, CD 3, or CD 4.

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3. To start the installation, enter the following command.

   ```
   sh /mnt/cdrom/setup
   ```

   The path `/mnt/cdrom` is the mount point of the CD-ROM drive.
4. When the installer window appears, click **New Installation**.
5. Read the license agreement, select **I accept the terms of the license agreement**, specify **License information,** and then click **Next**.

6 Select the platforms that you want to install and click **Next**.

7 Select the features to install and specify the path to the COMSOL installation directory. If you want the ability to run COMSOL using the MATLAB interface, select **MATLAB Interface** and specify the MATLAB root folder. MATLAB versions 6.5, 6.5.1, 7.0, 7.0.1, 7.0.4, 7.1, and 2006a work with COMSOL 3.3.

8 Click **Next**.

9 Click **Install** to start the installation. The installation process might take several minutes. Be prepared to unmount and eject CD 1 from the CD-ROM drive when the corresponding dialog box appears. Insert CD 2, CD 3, or CD 4, make sure it is mounted, and click **OK**. You might be asked to insert both CD 2, CD 3, and CD 4 in some cases.

10 When the installation process is finished the **Finish** window appears. If errors arose during installation, this window issues a notification. The installer also writes a log entry into the text file `comsolsetup.log`, which resides in the specified installation directory. Click **Finish** to quit the installer.

The file `browser` in the `doc` directory attempts to start common web browsers. Edit the file to adjust it for your preferred browser.

Note: To make sure all users can easily start COMSOL, include the `comsol33/bin` directory in all users' paths or make a symbolic link from `/usr/local/bin/comsol` to the `comsol` command (see the `ln` command).

Removing (Uninstalling) the COMSOL Installation

The COMSOL 3.3 installation adds files only in the `comsol33` directory. To remove the COMSOL installation, simply delete the `comsol33` directory including all subdirectories.

Using the Text-based Installer

If the graphical installer does not work on Linux or Sun, you can use a script-based installer. Enter

```
/mnt/cdrom/setup -h
```

for help and examples of how to use the `nogui` option of the `setup` command.

Changing the Path to the MATLAB Installation

Open the file `comsol` in the `bin` directory under the COMSOL installation directory. In the file, change the line that starts with `mlroot=` to point to the root directory of your MATLAB installation.

Installing COMSOL on Macintosh

Before You Begin

- Check that your system meets all applicable requirements (see "COMSOL Multiphysics System Requirements for Mac" on page 7).
- Have your passcode or license file ready. A passcode has a form similar to:

  `FFFFFF-CUSV-123456-1234567-123456789`

New users can find the passcode or the license file in an email or letter from your sales representative. If you have not received a passcode or a license file, contact your local COMSOL representative.

Some COMSOL license types require that you also install a license manager before running a COMSOL software product. If you are installing it with a passcode, no license manager is needed. If you are installing it with a license file, you need to install the license manager if the license file contains a line starting with the word `SERVER`. See "License Manager Installation" on page 24 for instructions. You can install your COMSOL software products and the license manager in any order.

If your Macintosh contains an old COMSOL (FEMLAB) installation, the COMSOL 3.3 installer does not remove it; it merely removes the MATLAB path to the old COMSOL version. You can keep the old version if desired as well as uninstall it before or after installing COMSOL 3.3.

Installing Java 3D and Java Advanced Imaging

COMSOL requires Java 3D and Java Advanced Imaging from Apple. It is included in Mac OS X 10.4, but for Mac OS X 10.3 it must be installed separately. You can download this software update from

http://www.apple.com/downloads/macosx/apple/java3dandjavaadvancedimagingupdate.html

To install this software after the download:

1. If the disk image was not mounted automatically following the download, mount it by double-clicking the disk image file **Java3D_and_JAI.dmg**.
2. Double-click the file **Java3D_and_JAI.mpkg** to launch the installer. Follow the instructions to install the software update.

Installing the BSD Subsystem

COMSOL requires the BSD Subsystem of Mac OS X 10.3. This is part of the default OS installation, but you can install it separately if it is not already on your computer.

1 Insert Install Disc 1 of the Mac OS X 10.3 installer in the CD drive.

2 Open the folder **Optional Installs**.

3 Double-click the file **BSD Subsystem** and follow the instructions.

In Mac OS X 10.4 the BSD Subsystem is always installed when installing the system software.

Installing COMSOL 3.3

Note: COMSOL does not work if the path to the COMSOL folder, or the name of the COMSOL folder itself, contain spaces.

1 Insert the COMSOL 3.3 CD 1 into the CD-ROM drive. Launch the **COMSOL Installer** application. The **Introduction** window should appear.

2 To proceed, see the instructions for Windows in the section "Installing COMSOL 3.3" on page 9. The procedure is the same for the Mac.

Removing (Uninstalling) the COMSOL Installation

The COMSOL 3.3 installation adds files only in the `COMSOL33` folder. To remove the COMSOL installation, simply delete the `COMSOL33` folder including all subfolders.

Changing the Path to the MATLAB Installation

Edit the file `comsol` in the `bin` directory under the COMSOL installation directory. In the file, change the line that starts with `mlroot=` to point to the root directory of your MATLAB installation.

License Manager Installation

The license manager supports a heterogeneous network of Windows, Linux, Sun, and Mac computers. Both the license manager and a COMSOL application can run on either Windows, Linux, Sun, or Mac platforms. We refer to the computer where the license manager is installed as the *license server* and any computers where the COMSOL applications are installed as *clients*. You can install COMSOL anywhere, typically on a local PC or on a file server where users access the program over a network. A single computer can function as a license server *and* a client, holding both the license manager and COMSOL. The COMSOL license manager does *not* require a MATLAB license manager.

To install a license manager, start by following the instructions in the section "Before You Begin" that follows immediately. Then, depending on the platform, go to the following sections:

LICENSE MANAGER INSTALLATION SECTIONS
"License Manager Installation on Windows" on page 26
"License Manager Installation on Linux and Sun" on page 28
"License Manager Installation on the Mac" on page 33

You can install the license manager and COMSOL in any order. You cannot perform a full test of the installation until you have installed both.

COMSOL uses the FLEXnet™ license manager version 10.8.0 from Macrovision Corporation for license management. (Note that FLEXnet was formerly called FLEXlm.)

Before You Begin

SYSTEM REQUIREMENTS

Before starting the installation process, check that your system meets all necessary requirements (see page 4). They are crucial for the COMSOL application, whereas the license manager only needs the correct hardware and operating system—for the license manager you need not consider memory and graphics requirements. The COMSOL license manager is completely independent of the MATLAB license manager.

OBTAINING A FLEXNET LICENSE FILE

To install a COMSOL license manager you need a FLEXnet license file, `license.dat`. It looks something like this:

```
SERVER my_server 00b0d05d1635 1718
USE_SERVER
VENDOR LMCOMSOL
FEATURE SERIAL LMCOMSOL 3.3 permanent uncounted \
     VENDOR_STRING=T,7F3F3 HOSTID=DEMO SN=123456789 \
     SIGN=123456789ABC
INCREMENT COMSOL LMCOMSOL 3.3 permanent 10 DUP_GROUP=UH \
     SIGN=123456789ABC
INCREMENT COMSOLGUI LMCOMSOL 3.3 permanent 10 DUP_GROUP=UH \
     SIGN=123456789ABC
INCREMENT ChEM LMCOMSOL 3.3 permanent 5 DUP_GROUP=UH \
     SIGN=123456789ABC
INCREMENT EM LMCOMSOL 3.3 permanent 5 DUP_GROUP=UH \
     SIGN=123456789ABC
INCREMENT SME LMCOMSOL 3.3 permanent 5 DUP_GROUP=UH \
     SIGN=123456789ABC
```

As noted earlier, you should have received a COMSOL `license.dat` file with the COMSOL package. If you have not received it, contact your local COMSOL representative or send a request to `support@comsol.com`.

In the `license.dat` file, the text on the `SERVER` line should contain the license server name `my_server`, the hostid of the license server, and an optional port number.

Make sure that the license server name is the actual name of your license server; otherwise, change it by editing the file. You can also change the default port number (1718). This is necessary in the unlikely case that another program is already using that port number. If it becomes necessary to change the port number, any unused number between 1025 and 64,000 is valid.

Note: Only the license server name and the port number should change. Do not modify anything else in the `license.dat` file or your license will not work.

The `VENDOR` line defines the name of the vendor daemon binary, `LMCOMSOL`.

The `SERIAL` line contains license information.

The `INCREMENT` (can also be `FEATURE`) lines contain a product name, version, expiration date, and the number of available licenses. The example file just given shows that the user has a permanent COMSOL 3.3 license allowing ten concurrent users of

COMSOL Multiphysics and five concurrent users of the Chemical Engineering Module, the Electromagnetics Module, and the Structural Mechanics Module. The number after "SIGN=" at the end of each INCREMENT line contains a license key. To break up long lines use the continuation character (\).

In the event you have not received the license.dat file, you must provide us with the hostid of your license server (see "Obtaining a Hostid" on page 35 for instructions) and preferably your license server name. Please have them ready when contacting your local COMSOL representative.

License Manager Installation on Windows

You do not need to install the license manager unless you have obtained a floating network license or a Class Kit Option license.

The license server requires these components:

- COMSOL license manager files (FLEXnet)
- License file (license.dat)

COMSOL LICENSE MANAGER FILES (FLEXNET)

The license manager consists of four components:

- License manager daemon (lmgrd.exe)
- Vendor daemon (LMCOMSOL.exe)
- FLEXnet utility program (lmutil.exe)
- FLEXnet Control Panel (lmtools.exe)

The two daemons (lmgrd.exe and LMCOMSOL.exe) run on the license server. When a user starts COMSOL on a client computer, communication is established through the network from the client to the license server and the lmgrd.exe daemon. That daemon in turn makes a request to the vendor daemon (LMCOMSOL.exe), which releases licenses according to information in license.dat. The utility program and Control Panel handle license-server management. For more information on FLEXnet management, see Chapter 7 in the *FLEXnet Licensing End Users Guide* available from the COMSOL Help Desk.

INSTALLING THE LICENSE MANAGER FILES

Install the license manager only on the host(s) listed in license.dat.

If you want to install COMSOL on the same host as the license manager, first perform a complete COMSOL installation because that procedure installs the license manager files along with COMSOL. See the section "Installing COMSOL on Windows" on page 9 for installation instructions. When finished, skip the remainder of this section and continue with "Starting the License Manager" on page 27.

To install only the COMSOL license manager files, follow these instructions:

1. Insert the distribution disk CD 1 into the CD-ROM drive.
2. Follow the installation instructions starting on page 9 until you reach the **Features** screen in Step 4.
3. In the list of products to install, select only the **License Manager** check box.
4. Continue from the **Features** screen in the installation instructions to complete the license manager file installation.

STARTING THE LICENSE MANAGER

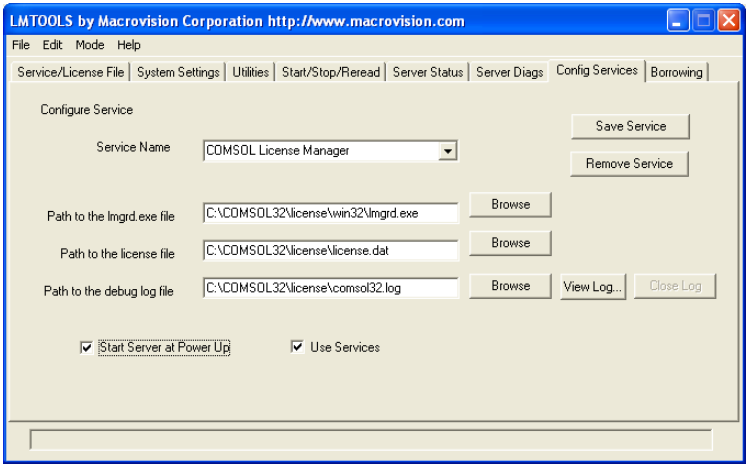
You can start the license manager manually, or it can run automatically as a service at boot.

Starting the Manager Automatically as a Service

To set up the license manager as a service from the FLEXnet Control Panel:

1. Locate the `comsol33\license\win32` directory and run `lmtools.exe`.
2. On the **Service/License File** page choose **Configuration using Services**. Note that you must perform this step every time you start the FLEXnet Control Panel.
3. Click the **Configure Services** tab.
4. Make an entry in the **Service Name** edit field, for example, `COMSOL License Manager`.
5. Specify the full path to `lmgrd.exe`, `license.dat`, and the debug log file of your choice.

6 Select the **Use Services** check box (this might not be possible on all platforms, but it is recommended) and then the **Start Server at Power Up** check box.



7 Click **Save Service**. The license manager now starts at boot. If you prefer, start the license manager directly by choosing **Start Server** on the **Start/Stop/Reread** page.

Starting the Manager Manually

To start the license manager manually, change to the `license\win32` directory. Now, in a command window enter

```
lmgrd -c ..\license.dat -l ..\comsol33.log
```

The license manager is now ready to distribute licenses over the network. It writes debug information to the log file `comsol33\license\comsol33.log`.

STARTING COMSOL

After the installation is complete and the license manager daemons are running on the license server(s), you can start using COMSOL.

License Manager Installation on Linux and Sun

You do not need to install the license manager if you are installing a trial version. The full version, however, always requires a running license manager on Linux and Sun.

You need the following components on the license server:

- COMSOL License Manager files (FLEXnet)
- License file (`license.dat`).

COMSOL LICENSE MANAGER FILES (FLEXNET)

The license manager consists of three components:

- License manager daemon (`lmgrd`)
- Vendor daemon (`LMCOMSOL`)
- FLEXnet utility programs (`lmutil` and others)

The two daemons (`lmgrd` and `LMCOMSOL`) run on the license server. When a user starts COMSOL on a client computer, communication is established through the network from the client to the license server and the `lmgrd` daemon. The `lmgrd` daemon in turn makes a request to the vendor daemon (`LMCOMSOL`) to release a license. The vendor daemon releases licenses according to information contained in `license.dat`. The utility programs are used for license-server management. For more information on FLEXnet management, see Chapter 7 in the *FLEXnet Licensing End Users Guide*, which is available on the COMSOL 3.3 Help Desk.

INSTALLING THE LICENSE MANAGER FILES

The license manager should be installed only on the host(s) listed in `license.dat`.

If you want to install COMSOL on the same host as the license manager, first perform a complete COMSOL installation because that procedure automatically installs the license manager files along with COMSOL (see the section "Installing COMSOL on Linux and Sun" on page 19). When finished, skip the remainder of this section and continue at "Starting the License Manager" on page 31.

If you want to install only the COMSOL license manager files, follow these instructions:

1. Insert CD 1 into the CD-ROM drive.
2. To start the installation, enter the following command:

   ```
   /mnt/cdrom/setup
   ```

   depending on where `/mnt/cdrom` is the mount point of the CD-ROM drive.
3. Continue according to the installation instructions on page 23 until the step where you see the **Features** screen.
4. In the list of products to install, select only the **License Manager** check box.
5. Resume the installation instructions with the **Features** screen to complete the license manager file installation.

NAMED SINGLE USER LICENSE

If you are installing a Named Single User License, you must perform the two steps listed below. If you are installing any other license type, skip this section and go directly to "Starting the License Manager" on page 31.

1 Create an options file, which should include the username of the person who will run COMSOL. We recommend that you name that file `LMCOMSOL.opt` and place it in the `license` directory. Below is an example of an options file for a user "philip" who has access to COMSOL Multiphysics with COMSOL Script, the Structural Mechanics Module, and the CAD Import Module. Notice that to access COMSOL Multiphysics, the options file must include both the COMSOL and the COMSOLGUI features; for COMSOL Script, the options file must include the SCRIPT and SCRIPTPROMPT features.

```
INCLUDE COMSOL USER philip
INCLUDE COMSOLGUI USER philip
INCLUDE SCRIPT USER philip
INCLUDE SCRIPTPROMPT USER philip
INCLUDE CADIMPORT USER philip
INCLUDE SME USER philip
```

Each `INCLUDE` row in the `LMCOMSOL.opt` file has a corresponding `FEATURE` row in the `license.dat` file (with the `USER_BASED` keyword). The second item on each `FEATURE` row is the name of the feature for which you have a license. You only need to add the items listed in `license.dat` to your options file. On Linux and Sun, the options file can be created like this:

```
cd /usr/local/comsol33/license
grep USER_BASED license.dat > temp.opt
awk '{print "INCLUDE "$2" USER philip"}' temp.opt > LMCOMSOL.opt
```

The following table contains the feature names for all products in the COMSOL 3.3 product family:

TABLE 1-3: COMSOL 3.3 PRODUCTS AND THEIR FEATURE NAMES

PRODUCT/FEATURE	FEATURE NAME
COMSOL Multiphysics	COMSOL
COMSOL Multiphysics GUI	COMSOLGUI
COMSOL Multiphysics floating network license	CLIENTSERVER
COMSOL Script	SCRIPT
COMSOL Script command prompt	SCRIPTPROMPT
COMSOL Reaction Engineering Lab	REACTION
AC/DC Module	EM

TABLE 1-3: COMSOL 3.3 PRODUCTS AND THEIR FEATURE NAMES

PRODUCT/FEATURE	FEATURE NAME
Acoustics Module	ACO
CAD Import Module	CADIMPORT
Chemical Engineering Module	ChEM
Earth Science Module	ES
Heat Transfer Module	HT
MEMS Module	MEMS
RF Module	RF
Structural Mechanics Module	SME
Signals and Systems Lab	SIGNAL
Optimization Lab	OPTLAB

2 Edit the `VENDOR` row in the `license.dat` file located in the `license` directory. The path to the options file is indicated by the "options" keyword. Change the path so it points to the location of the `LMCOMSOL.opt` file you generated. If your options file is placed here:

```
/usr/local/comsol33/license/LMCOMSOL.opt
```

then the `VENDOR` row in `license.dat` should read

```
VENDOR LMCOMSOL options=/usr/local/comsol33/license/LMCOMSOL.opt
```

You are now ready to start the license manager.

STARTING THE LICENSE MANAGER

You can start the license manager manually or it can run automatically at boot.

Starting the License Manager Manually

To start the license manager manually, make the `license/$arch` directory the current directory and enter

```
./lmgrd -c ../license.dat -l /var/tmp/comsol33.log
```

The server is now ready to distribute licenses over the network. It writes any debug information to the log file `/var/tmp/comsol33.log`.

Starting the License Manager Automatically at Boot

Add Bourne shell commands to the appropriate boot script. You must be a superuser (root) to edit boot scripts.

Note: We do not recommended that you start the daemons as root for security reasons. Instead, use a dedicated username to start the license manager.

The procedure for editing boot scripts on each platform appears in the following table:

TABLE 1-4: BOOT SCRIPT PROCEDURES

PLATFORM	PROCEDURE

Sun	Copy the file `comsol33/license/sol2/rc.lm` and paste it at the beginning of `/etc/init.d/lmgrd`. Create this file if it does not already exist.
	Edit `/etc/init.d/lmgrd`, replacing '`dir`' in the code fragment with the full path to the `sol2` platform directory, and replace '`username`' with an actual username.
	If the file (link) `/etc/rc3.d/S171lmgrd` does not exist, create it with the commands
	`cd /etc/rc3.d`
	`ln -s /etc/init.d/lmgrd S171lmgrd`

SuSE Linux	The following instructions should work for SuSE Linux distributions, where `$arch` is either `glnx86` (32-bit Linux), or `glnxa64` (64-bit Linux).
	In the `comsol33/license/$arch` directory, type the commands
	`cp rc.lm /etc/init.d/comsol33lm`
	`chmod 755 /etc/init.d/comsol33lm`
	Edit `/etc/init.d/comsol33lm`, replacing `dir` with the full path to the `$arch` platform directory, and replace `username` with an actual username.
	Now create the following link
	`cd /etc/init.d/rc5.d`
	`ln -s ../comsol33lm S91comsol33lm`

TABLE 1-4: BOOT SCRIPT PROCEDURES

PLATFORM	PROCEDURE
Debian Linux	Copy the file `comsol33/license/$arch/lm_comsol` to `/etc/init.d` Edit `/etc/init.d/lm_comsol`. Update the FP and MYUSER variables as indicated in the file. Use the utility `update-rc.d` to automatically update the system's init script links: `update-rc.d lm_comsol start 99 2 3 4 5 . stop 1 0 1 6` This means that the COMSOL license manager is started by runlevels 2, 3, 4, and 5, and stopped by runlevels 0, 1, and 6. Type `man update-rc.d` for more information on init scripts.
Linux	The following instructions should work for most Linux distributions, where `$arch` is either `glnx86` (32-bit Linux), `glnxa64` (64-bit Linux), or `glnxi64` (Itanium). Copy the file `comsol33/license/$arch/rc.lm` and paste it at the end of `/etc/rc.d/rc.local`. Replace '`dir`' in the code fragment with the full path to the `$arch` platform directory, and replace '`username`' with an actual username.

STARTING COMSOL

After the installation is complete and the license manager daemons are running on the license server(s) you can start using COMSOL.

License Manager Installation on the Mac

You do not need to install the license manager unless you have obtained a floating network license or a Class Kit Option license.

You need the following components on the license server:

- COMSOL License Manager files (FLEXnet)
- License file (`license.dat`)

COMSOL LICENSE MANAGER FILES (FLEXNET)

The license manager consists of three components:

- License manager daemon (`lmgrd`)
- Vendor daemon (`LMCOMSOL`)
- FLEXnet utility programs (`lmutil` and others)

The two daemons (`lmgrd` and `LMCOMSOL`) run on the license server. When a user starts COMSOL on a client computer, communication is established through the network from the client to the license server and the `lmgrd` daemon. The `lmgrd` daemon in turn makes a request to the daemon (`LMCOMSOL`) to release a license. The vendor daemon releases licenses according to the information contained in `license.dat`. The utility programs are used for license-server management. For more information on FLEXnet management, see Chapter 7 in the *FLEXnet Licensing End Users Guide*, available as a part of the FLEXnet documentation and from the COMSOL Help Desk.

INSTALLING THE LICENSE MANAGER FILES

You should install the license manager only on the host(s) listed in `license.dat`.

If you want to install COMSOL on the same host as the license manager, first perform a complete COMSOL installation because that procedure automatically installs the license manager files along with COMSOL (see the section "Installing COMSOL on Macintosh" on page 22). When finished, skip the remainder of this section and continue at "Starting the License Manager" on page 34.

If you want to install only the COMSOL license manager files, follow these instructions:

1. Insert the COMSOL 3.3 CD 1 into the CD-ROM drive.
2. Follow the installation instructions starting on page 23 until you reach the **Features** screen.
3. In the list of products to install, select only the **License Manager** check box.
4. Continue from the **Features** screen in the installation instructions (page 9) to complete the license manager file installation.

STARTING THE LICENSE MANAGER

You can either start the license manager manually or let it run automatically at startup.

Starting the License Manager Manually

To start the license manager manually, perform these steps:

1. Launch the **Terminal** application.
2. Change directory to the `license/macosx` directory
   ```
   cd /Applications/COMSOL33/license/macosx
   ```
3. Then enter
   ```
   ./lmgrd -c ../license.dat -l /var/tmp/comsol33.log
   ```

The server is now ready to distribute licenses over the network. It writes any debug information to the log file `/var/tmp/comsol33.log`.

Starting the License Manager Automatically at Startup

A folder `COMSOL_Lmgr` located in the folder `COMSOL33/license/macosx` holds a script that can automatically start the license manager when you start the computer. By installing and configuring this folder, there is no need to start the license manager manually.

1. Go to the top level `/Library` folder on your startup disk.
2. In the `Library` folder, create a folder `StartupItems` if it does not already exist.
3. Move or copy the folder `COMSOL_Lmgr` to the `StartupItems` folder.
4. Open the file `COMSOL_Lmgr` in a text editor, for example, TextEdit.
5. Edit the line
   `FP=<COMSOLPATH>`
   by replacing `<COMSOLPATH>` with the path to the COMSOL folder. If COMSOL is installed in the `Applications` folder this path is
   `FP=/Applications/COMSOL33`
6. Edit the line
   `USERNAME=<username>`
   by replacing <username> with your username.

To test the license manager installation restart the computer. During startup a message **Starting COMSOL License Manager** should appear.

STARTING COMSOL

After the installation is complete and the license manager daemons are running on the license server(s) you can start using COMSOL.

Obtaining a Hostid

If COMSOL is already installed on your license server, you can determine the hostid by executing the `lmhostid` command

```
COMSOL33/license/$arch/lmhostid
```

where `$arch` is either `win32` (Windows), `win64` (64-bit Windows), `glnx86` (32-bit Linux), `glnxa64` (64-bit Linux), `glnxi64` (Itanium), `sol2` (Sun), or `macosx` (Mac).

If COMSOL is not installed, you must obtain a hostid using OS commands as described in the following table:

TABLE 1-5: HOSTIDS FOR THE SUPPORTED PLATFORMS

PLATFORM	HOSTID	TYPE THIS COMMAND ON THE LICENSE SERVER:	EXAMPLE
Linux	Ethernet address	`/sbin/ifconfig eth0` and remove colons from HWaddr `00:40:05:16:E5:25` (do not use the `hostid` command)	`00400516E525`
Sun	32-bit hostid	`hostid`	`170a3472`
Windows	Ethernet address	`ipconfig /all` (remove hyphens from the physical address `00-50-02-84-A3-28`)	`00500284A328`
Mac	Ethernet address	see below	`00039377F4AC`

FLEXnet uses different machine identifications for different architectures. For example, all Sun Microsystems machines have a unique hostid whereas other machines do not. For this reason, some machine architectures use an Ethernet address (also called a MAC address) as the hostid. An Ethernet address has six bytes, each with two hexadecimal digits. Be sure to specify all twelve hex digits when using an Ethernet address as a hostid. For example, if the Ethernet address is `8:0:20:0:5:ac` specify `0800200005ac` as the hostid.

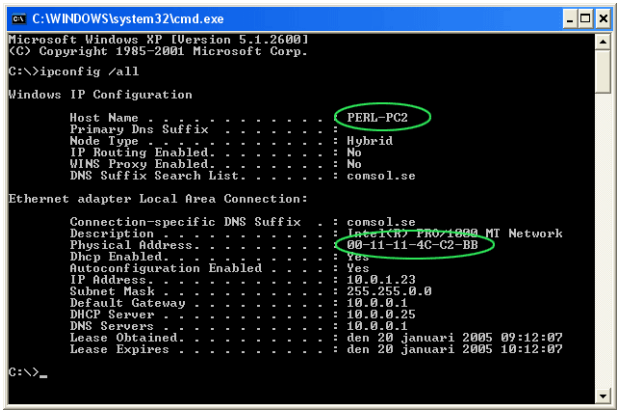
OBTAINING THE HOSTID ON WINDOWS

1. Open the Start menu and click **Run**.
2. Type `cmd` and click **OK** and the command window opens.
3. Type

   ```
   ipconfig /all
   ```

   and press Enter.

4 The FLEXnet hostid is equal to the **Physical Address**, which is displayed in the next image, with the hyphens removed.



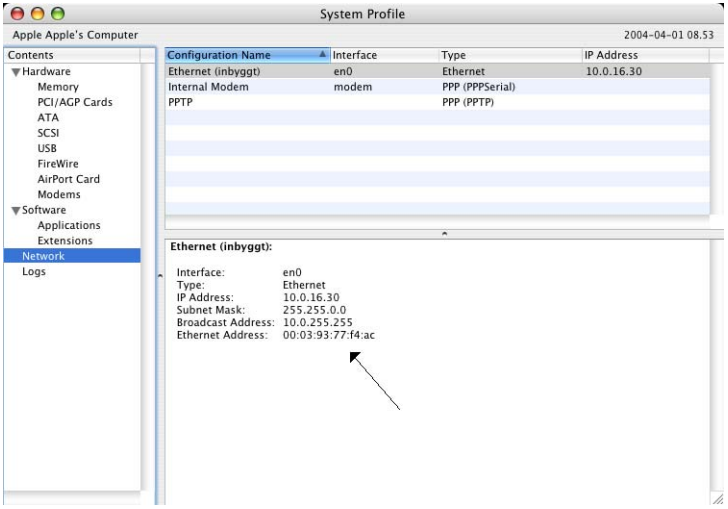
OBTAINING THE HOSTID ON A MACINTOSH

1 Launch the application **System Profiler** found in the **Applications/Utilities** folder.

2 Select **Network** in the **Contents** pane to the left.

3 Select **Ethernet** in the list to the upper right.

4 The hostid is the **Ethernet Address**, which is displayed in the next image, with the colons removed.



Troubleshooting Graphics

COMSOL relies on hardware acceleration for 3D graphics rendering. This section describes symptoms and solutions related to graphics rendering and the graphics drivers that COMSOL uses.

Symptoms for Graphics Rendering Problems

COMSOL uses hardware acceleration for graphics rendering throughout all 3D application modes as well as for mesh plots and postprocessing in the 1D and 2D application modes. COMSOL might thus appear to work properly for a while when you draw the geometry and set physical properties in 1D or 2D and then fail later on when displaying the mesh or the solution. This problem arises when drivers for hardware acceleration are loaded.

The following three occurrences indicate that you should expect problems with 3D rendering:

- COMSOL displays the message **Failed to Initialize 3D Graphics**.
- COMSOL crashes when you open a model.
- You can create a geometry and set physical properties in 1D or 2D, but COMSOL crashes when you initialize the mesh or solve the problem.

The next two items indicate general problems with the graphics driver:

- Gray shadows are left behind after using menus.
- Dialog boxes appear completely gray without any content.

The following item indicates that a graphics card has too little memory for the selected screen resolution and color depth:

- COMSOL crashes when you resize or maximize its graphical user interface.

The following problem indicates that a graphics card is configured with too small a color depth:

- The graphical user interface in COMSOL appears in strange colors all the time or only when the graphical user interface is not in focus.

WINDOWS GRAPHICS RENDERING SOLUTIONS

When you experience one or several of the symptoms just described, we suggest you try the following steps to alleviate the problem. The first two items are simple fixes to try for a start.

- Reduce the hardware acceleration on the graphics card. This action often resolves the problems for newer cards. To try this fix:

  Click the **Advanced** button on the **Settings** page in the **Display Properties** dialog box, for example, by double-clicking **Display** in the **Control Panel**. This opens a dialog box specific to your graphics card. This dialog box often has a **Troubleshooting** page where you can reduce the hardware acceleration.
- Reduce the graphics card's color depth or the screen area. This action often works for older cards with less than 16 MB of on-board graphics memory.

  Click the **Settings** page in the **Display Properties** dialog box to find the settings for screen resolution and color quality.

The following two items involve downloading and installing software. Running the latest graphics drivers is important for best stability and performance, so it could be worth performing these tasks even if you do not experience any graphics-rendering problems.

- Update to the latest version of DirectX. COMSOL requires at least version 8.0, but a later DirectX version can bring greater performance and stability. To determine the DirectX version on your computer, run the command `dxdiag.exe`. Download the latest driver from `www.microsoft.com/directx` or use `windowsupdate.microsoft.com`.
- Update the drivers for your graphics card. Most graphics card and graphics chipset vendors have web sites where you can download up-to-date stable drivers. Microsoft also provides graphics-card driver updates at `windowsupdate.microsoft.com`.

By default COMSOL uses DirectX for 2D software rendering and OpenGL for 3D hardware rendering. If you cannot find stable OpenGL drivers for your graphics card, an alternative is to use DirectX for 3D hardware rendering. This solution, however, might result in a slight degradation in COMSOL's graphics quality.

To switch to DirectX, follow these steps:

1. Start COMSOL and create a new 2D model.
2. Go to the **Options** menu and open the **Preferences** dialog box.
3. Click the **Visualization** tab and then select **DirectX** in the **Renderer** list. Click **OK**.

4 A warning dialog box, which states that you must restart COMSOL, appears. Click **OK** and restart COMSOL.

If you want to return to using OpenGL, follow the steps above but instead change **Renderer** to **OpenGL**.

LINUX SOLUTIONS

To run COMSOL on Linux you must have OpenGL drivers installed. Use the vendor's graphics drivers when they are available. Both NVIDIA and ATI provide drivers for their recent graphics cards on their web sites (see `www.nvidia.com` and `www.ati.com`). Other graphics-card vendors might provide similar services.

If you cannot find hardware-accelerated OpenGL drivers for your graphics card, an alternative is to use software OpenGL rendering. Linux distributions often include software OpenGL drivers, or you can try those provided with COMSOL. Untar the file `mesa.tar` in the `comsol33` installation directory, find the file `comsol33/bin/comsol`, and modify the line

```
LIBGLPATH=
```

to include the path to the Mesa drivers, for example,

```
LIBGLPATH=/usr/local/comsol33/mesa
```

(assuming that you have installed COMSOL in the `/usr/local` directory).

SUN SOLUTIONS

Verify that the computer has one of the supported graphics cards listed in the section "Sun Graphics Requirements" on page 6.

Also make sure that the system has at least OpenGL 1.2.2 for Solaris or later installed. To find your current version, use the command `pkginfo -l SUNWglrt`. OpenGL for Solaris is available at `http://www.sun.com/solaris/opengl`.

Sometimes X-Windows is configured with too small a color depth. Use the command `m64config -propt` to determine the display settings. Use `m64config -depth 24` to set a 24-bit color depth.

Problems During Startup on Windows

If COMSOL fails during startup (meaning that the **Model Navigator** screen does not appear), there might be a problem with the DirectX drivers. Either update these drivers or disable COMSOL from using DirectX entirely. If you cannot or do not want to

update the DirectX drivers, an alternative is to disable DirectX. To do so, edit the file `bin\comsol.opts` in the installation directory and remove the first (comment) character on the line following the line:

```
# Uncomment line below to disable DirectX graphics acceleration
```

Adjusting the Polygon Offset

Some OpenGL graphics card do not render touching edges and faces correctly in COMSOL. This makes the edges in mesh plots appear dashed or dotted. To improve their appearance, follow these steps:

1. Click the **Draw Mode** button on the Main toolbar.
2. Go to the **Options** menu and choose **Preferences**.
3. In the **Preferences** dialog box click the **Visualization** tab.
4. Adjust the value in the **Polygon offset** edit field to a larger integer.
5. Click **Apply**.

Polygon offset settings affect only 3D rendering when using OpenGL and are not applicable when using COMSOL with DirectX.

License Borrowing in COMSOL 3.3

License borrowing means that you can use COMSOL (for a limited time) without a network connection to the license server. This can be convenient when working from home or when being on a business trip.

Note: This *COMSOL Installation Guide* covers the basics of license borrowing. For more information, please refer to the *FLEXnet Licensing End Users Guide* (Chapter 8, the section "License Borrowing with BORROW"). The *FLEXnet Licensing End Users Guide* is available from the COMSOL Help Desk, which you open by pressing F1 or from the **Help** menu in the COMSOL Multiphysics user interface.

To be able to borrow license keys, you need:

- A COMSOL 3.3 Floating Network License (FNL).
- A `license.dat` file with the `BORROW` keyword included. The license file below shows what a borrow-enabled file looks like:

```
SERVER myserver 000102030405 1718
USE_SERVER
VENDOR LMCOMSOL
FEATURE SERIAL LMCOMSOL 3.3 permanent uncounted \
        VENDOR_STRING=C,3F3F0 HOSTID=ANY BORROW SN=1921634 \
        SIGN=123456789ABC
FEATURE COMSOL LMCOMSOL 3.3 permanent 1 BORROW DUP_GROUP=UH \
        SIGN=123456789ABC
FEATURE COMSOLGUI LMCOMSOL 3.3 permanent 1 BORROW DUP_GROUP=UH \
        SIGN=123456789ABC
FEATURE SCRIPT LMCOMSOL 3.3 permanent 1 BORROW DUP_GROUP=UH \
        SIGN=123456789ABC
FEATURE SCRIPTPROMPT LMCOMSOL 3.3 permanent 1 BORROW DUP_GROUP=UH \
        SIGN=123456789ABC
```

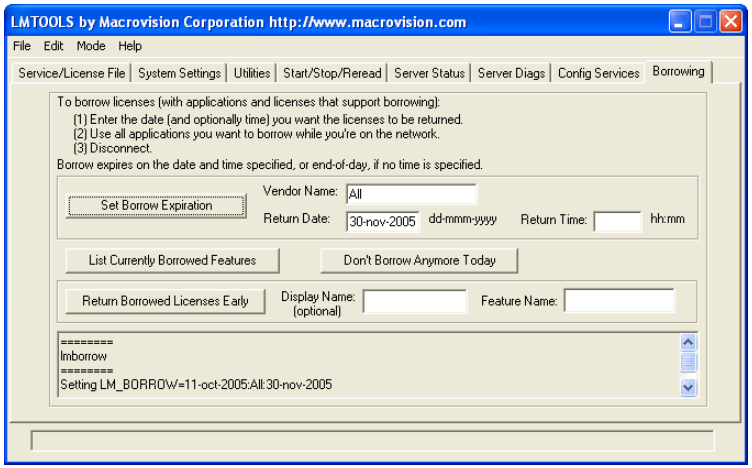
  If you have a Floating Network License and want to borrow license keys but do not have a `license.dat` file with the `BORROW` keyword, please contact your local COMSOL office.

1 Go to the computer on which you want to borrow license keys. Start the LMTOOLS utility by double-clicking the file

`COMSOL33\license\win32\lmtools.exe`

2 Click the **Borrowing** tab.

3 Now decide how long you need to borrow the license keys. Please note that the maximum borrow period is one week. When the borrow period expires, LMTOOLS automatically returns all borrowed license keys to the license manager.



Specify values in the **Return Date** and **Return Time** edit fields, then click the **Set Borrow Expiration** button.

4 Start COMSOL Multiphysics and use all the modules/features that you need. For example, if you are borrowing COMSOL Script, make sure to start a COMSOL Script window. COMSOL Script checks out the `SCRIPT` and `SCRIPTPROMPT` license features from the license server. If you need the Chemical Engineering Module, select a Chemical Engineering Module application mode from the Model Navigator, or open a model file that uses a Chemical Engineering Module application mode. In these cases COMSOL Multiphysics checks out a `CHEM` license feature from the license manager. If you want to use COMSOL Reaction Engineering Lab, start the application and load one of the models available in its Model Library. If you want to import CAD files, import CAD files on the formats

you need. Each COMSOL product has corresponding license features (see the following table).

TABLE 1-6: COMSOL LICENSE FEATURES

PRODUCT	FEATURES
COMSOL Multiphysics	COMSOL, COMSOLGUI
COMSOL Script	SCRIPT, SCRIPTPROMPT
COMSOL Reaction Engineering Lab	REACTION
Optimization Lab	OPTLAB
Signals and Systems Lab	SIGNAL
AC/DC Module	ACDC
Acoustics Module	ACO
Chemical Engineering Module	CHEM
Earth Science Module	ES
Heat Transfer Module	HT
MEMS Module	MEMS
RF Module	RF
Structural Mechanics Module	SME
CAD Import Module	CADIMPORT
Pro/ENGINEER	PROE
CATIA V4	CATIA4
CATIA V5	CATIA5
Inventor	INVENTOR
VDA	VDA

5 To view your currently borrowed license features, click the **List Currently Borrowed Features** button. The output looks something like this:

```
List All Currently Borrowed Features
========
Vendor     Feature                              Expiration
______     ________                             __________
LMCOMSOL   SERIAL                               30-Nov-06 23:59
LMCOMSOL   COMSOL                               30-Nov-06 23:59
LMCOMSOL   COMSOLGUI                            30-Nov-06 23:59
LMCOMSOL   SCRIPT                               30-Nov-06 23:59
LMCOMSOL   SCRIPTPROMPT                         30-Nov-06 23:59
LMCOMSOL   REACTION                             30-Nov-06 23:59
LMCOMSOL   OPTLAB                               30-Nov-06 23:59
LMCOMSOL   SIGNAL                               30-Nov-06 23:59
```

```
LMCOMSOL   ACDC                          30-Nov-06 23:59
LMCOMSOL   ACO                           30-Nov-06 23:59
LMCOMSOL   CHEM                          30-Nov-06 23:59
LMCOMSOL   SME                           30-Nov-06 23:59
LMCOMSOL   ES                            30-Nov-06 23:59
LMCOMSOL   HT                            30-Nov-06 23:59
LMCOMSOL   MEMS                          30-Nov-06 23:59
LMCOMSOL   RF                            30-Nov-06 23:59
LMCOMSOL   CADIMPORT                     30-Nov-06 23:59
LMCOMSOL   PROE                          30-Nov-06 23:59
LMCOMSOL   CATIA4                        30-Nov-06 23:59
LMCOMSOL   CATIA5                        30-Nov-06 23:59
LMCOMSOL   INVENTOR                      30-Nov-06 23:59
LMCOMSOL   VDA                           30-Nov-06 23:59
```

Make sure you have borrowed all the license features you need. The borrowed license features always include the `SERIAL` license feature.

6. When you have borrowed licenses for all the products that you need, disconnect from the network. If you want to stay connected for a while longer but do not want to borrow more licenses, click the **Don't Borrow Anymore Today** button.

License Borrowing on Linux/Sun/Macintosh

1. Go to the computer on which you want to borrow license keys, then `cd` to the folder containing the License Manager Files. In a shell window, type

   ```
   cd COMSOL33/license/$arch
   ```

   where `$arch` is either `glnx86` (32-bit Linux), `glnxa64` (64-bit Linux), `glnxi64` (Itanium), `sol2` (Sun), or `macosx` (Macintosh).

2. Use the `lmborrow` command to borrow licenses. Enter the line

   ```
   ./lmborrow -help
   ```

   to view the options.

3. Decide how long you need to borrow the license key. Please note that the maximum borrow period is one week. The `lmborrow` command automatically returns all borrowed license keys to the license manager when the borrow period expires. For example, if you want to borrow the licenses until November 29, 2006, at midnight, type:

   ```
   ./lmborrow LMCOMSOL 29-nov-2006
   ```

4. Start COMSOL Multiphysics and use all the modules/features that you need. For example, if you are borrowing COMSOL Script, make sure to start a COMSOL Script window. COMSOL Script then checks out the `SCRIPT` and `SCRIPTPROMPT`

license features from the license server. If you need the Chemical Engineering Module, select a Chemical Engineering Module application mode from the Model Navigator, or open a model file that uses a Chemical Engineering Module application mode. In these cases, COMSOL Multiphysics checks out a `CHEM` license feature from the license manager. If you want to use COMSOL Reaction Engineering Lab, start the application and load one of the models available in its Model Library. If you want to import CAD files, import a CAD file of the format(s) you need. Each COMSOL product has corresponding license features (see Table 1-6, COMSOL License Features, on page 1-44).

5 To view your currently borrowed license features, issue the command

```
./lmborrow -status
```

6 The output looks something like this:

```
List All Currently Borrowed Features
========
Vendor     Feature                                Expiration
______     ________                               __________
LMCOMSOL   SERIAL                                 30-Nov-06 23:59
LMCOMSOL   COMSOL                                 30-Nov-06 23:59
LMCOMSOL   COMSOLGUI                              30-Nov-06 23:59
LMCOMSOL   SCRIPT                                 30-Nov-06 23:59
LMCOMSOL   SCRIPTPROMPT                           30-Nov-06 23:59
LMCOMSOL   REACTION                               30-Nov-06 23:59
LMCOMSOL   OPTLAB                                 30-Nov-06 23:59
LMCOMSOL   SIGNAL                                 30-Nov-06 23:59
LMCOMSOL   ACDC                                   30-Nov-06 23:59
LMCOMSOL   ACO                                    30-Nov-06 23:59
LMCOMSOL   CHEM                                   30-Nov-06 23:59
LMCOMSOL   SME                                    30-Nov-06 23:59
LMCOMSOL   ES                                     30-Nov-06 23:59
LMCOMSOL   HT                                     30-Nov-06 23:59
LMCOMSOL   MEMS                                   30-Nov-06 23:59
LMCOMSOL   RF                                     30-Nov-06 23:59
LMCOMSOL   CADIMPORT                              30-Nov-06 23:59
LMCOMSOL   PROE                                   30-Nov-06 23:59
LMCOMSOL   CATIA4                                 30-Nov-06 23:59
LMCOMSOL   CATIA5                                 30-Nov-06 23:59
LMCOMSOL   INVENTOR                               30-Nov-06 23:59
LMCOMSOL   VDA                                    30-Nov-06 23:59
```

Make sure you have borrowed all the license features you need. The borrowed license keys always include the `SERIAL` license feature.

7 When you have borrowed all the license keys you want, disconnect from the network. If you want to stay connected for a while longer but do not want to borrow more licenses, type the command

```
./lmborrow -clear
```

This does not mean that the borrowed license keys are returned. The license keys remain on your computer until the borrow period expires.

Troubleshooting License Errors

This section summarizes the most common post-installation error messages generated by COMSOL, and it gives some advice how to troubleshoot them.

TABLE 1-7: GENERAL ERROR MESSAGES

ERROR MESSAGE	EXPLANATION
License error	A general license error has occurred. Check the error message for details that might help solve the problem. If you need help in interpreting the information, send the complete error message to `support@comsol.com`.
License error: -5. No such feature exists.	The license manager has encountered a problem during startup. Check the license manager log file for error messages. The log file is usually placed here: Windows: `C:\COMSOL33\license\comsol33.log` Linux/Sun/Mac: `/var/tmp/comsol33.log` Please send the log file to `support@comsol.com` if you want help in interpreting the information. NOTE: The license manager creates the log file. If there is no log file, make sure to first start the license manager. Please refer to the section "License Manager Installation" in the COMSOL Installation Guide for instructions how to install and start the COMSOL license manager.
License error: -12. Invalid returned data from license server system.	Check that no firewall on the COMSOL client is preventing the connection from the COMSOL client to the license server. Temporarily disable any firewall on the COMSOL client to see if that helps. Check that no firewall on the license server is preventing the connection from the COMSOL client computer to the license manager, or the connection from the lmgrd daemon and the LMCOMSOL daemon. If the problems remain, send the license manager log file to `support@comsol.com`. The log file is usually placed here: Windows: `C:\COMSOL33\license\comsol33.log` Linux/Sun/Mac: `/var/tmp/comsol33.log`

TABLE 1-7: GENERAL ERROR MESSAGES

ERROR MESSAGE	EXPLANATION
License error: -15. Cannot connect to license server system.	The COMSOL license manager has not been installed or started yet. If the first line of your license.dat file looks like this: `SERVER mylicserver 000123456789 1716` a license manager is required. Please refer to the section "License Manager Installation" in the COMSOL Installation Guide for instructions how to install and start the COMSOL license manager. Check that no firewall on the COMSOL client is preventing the connection from the COMSOL client to the license server. Temporarily disable any firewall on the COMSOL client to see if that helps. Check that no firewall on the license server is preventing the connection from the COMSOL client computer to the license manager. Check that the `license.dat` file on the COMSOL client computer points to the correct license server hostname. First, find the `license.dat` file in the COMSOL application folder: Windows: `C:\COMSOL33\license\license.dat` Linux/Sun: `/usr/local/comsol33/license/license.dat` Mac: `/Applications/comsol33/license/license.dat` Check that the first line has the correct license-server hostname. For example, if your license server hostname is `mylicserver`, the first row in the license.dat file should look like this: `SERVER mylicserver 000123456789 1716` If the COMSOL client computer does not recognize `mylicserver` as a proper hostname, it might help to instead use the fully qualified domain name (`mylicserver.mydomain.org`) or the IP address. If neither of these work, there might be a problem with DNS or the HOSTS file on the client. Please ask your system administrator for advice on how to connect with TCP/IP to the license server. Finally, the license manager might have encountered a problem during startup. Check the license manager log file for error messages. The log file is usually placed here: Windows: `C:\COMSOL33\license\comsol33.log` Linux/Sun/Mac: `/var/tmp/comsol33.log` NOTE: The log file is created by the license manager after it has been started. Please send the log file to `support@comsol.com` if you want help in interpreting the information.

TABLE 1-7: GENERAL ERROR MESSAGES

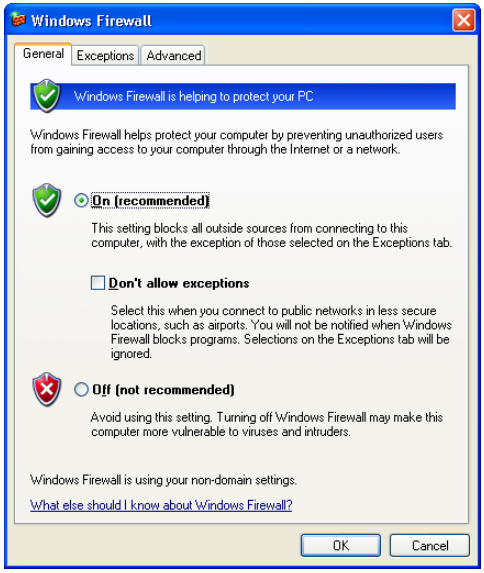
ERROR MESSAGE	EXPLANATION
License error: -39. User/host not on INCLUDE list for feature.	This error can only occur for the Named Single User License (NSL) license type. The error means that your username does not match the one listed in the license-manager options file, `LMCOMSOL.opt`. To get access to COMSOL, ask your license/system administrator for help. When the username in the options file is changed, the license manager must be shut down and restarted to give the new user immediate access to COMSOL.
License error: -88. System clock has been set back.	The software has detected that a system clock has been set back. Please make sure that your computer's clock is set to the current local time and date. If the problem remains check that there are no files on your hard drive that are dated in the future.
License error: -96. License server machine is down or not responding.	Please make sure that the SERVER hostname in the `license.dat` file is valid and that the TCP/IP network connection between the application computer and the license server is working properly. The `license.dat` file is located in the COMSOL application folder: Windows: `C:\COMSOL33\license\license.dat` Linux/Sun: `/usr/local/comsol33/license/license.dat` Mac: `/Applications/comsol33/license/license.dat`
License error: -97. The desired vendor daemon is down.	The license manager has encountered a problem during startup. Check the license manager log file for error messages. The log file is usually placed here: Windows: `C:\COMSOL33\license\comsol33.log` Linux/Sun/Mac: `/var/tmp/comsol33.log` NOTE: The log file is created by the license manager after it has been started. Please send the log file to `support@comsol.com` if you want help in interpreting the information.

The Windows XP Service Pack 2 Firewall

Windows XP Service Pack 2 turns on the Windows Firewall. This means that Windows security alert dialog boxes appear when running COMSOL with MATLAB or COMSOL Server. Make sure you have applied the official version of XP Service Pack 2.

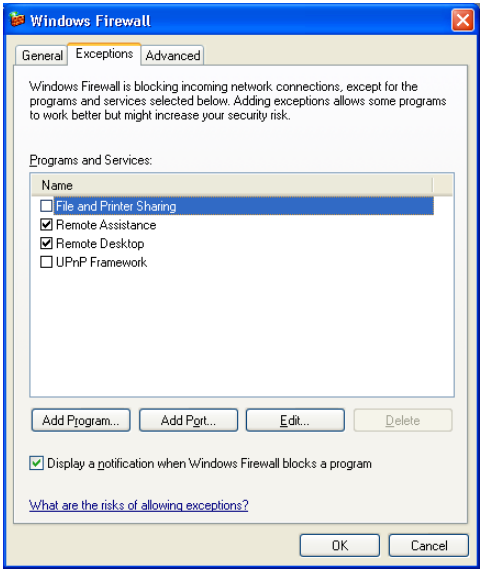
Firewall Configuration

Open the **Windows Firewall** dialog box in the Control Panel. The service pack installer turns on the firewall. We recommend you keep it on, adjusting its settings to allow connections to or from COMSOL when necessary. Keep in mind that we recommend you use the client/server features of COMSOL only in a trusted environment (see the section "Login Information and Security" on page 76). To allow exceptions to the firewall rules, make sure that the **Don't allow exceptions** check box is *not* selected.



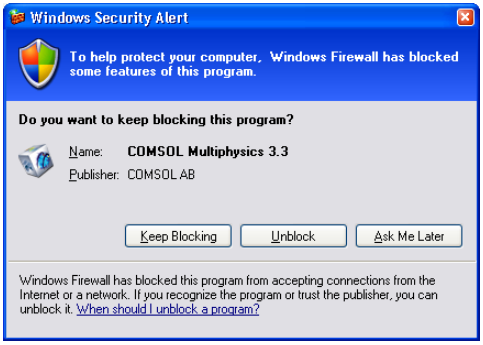
The **Exceptions** page should not contain any references to Java or MATLAB. If they do and COMSOL does not appear to work, delete the COMSOL and MATLAB related

exceptions (`MATLAB`, `COMSOL Multiphysics 3.3`) and start over following the guidelines in the next sections.



Running the COMSOL Server

When running the command `comsolserver.exe` from a command prompt, a Windows Security Alert appears for COMSOL 3.3.



Click **Unblock** to allow connections to the COMSOL Server.

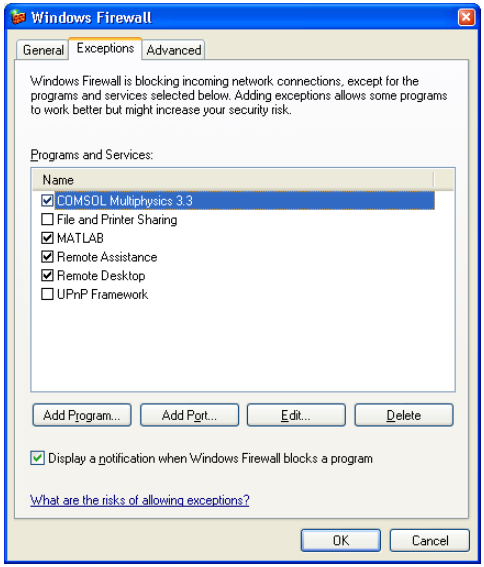
Running COMSOL with MATLAB

When you start COMSOL with MATLAB, a Windows Security Alert appears for MATLAB.

Click **Unblock** to allow connections to MATLAB.

Firewall Configuration

The previous steps add exceptions to the Windows Firewall. From the Control Panel, open the **Windows Firewall** dialog box. Check that exceptions have been added to the firewall for MATLAB and COMSOL Multiphysics 3.3.



2

Running COMSOL

Running COMSOL on Windows

The installer adds the folder **COMSOL 3.3** to the **Start** menu under the **Programs** item. That folder contains a selection of the items in the following list depending on the licensed COMSOL software products you have:

- **COMSOL Multiphysics**: Opens COMSOL Multiphysics. A corresponding shortcut is added to the desktop.
- **COMSOL Script**: Starts a COMSOL Script prompt. To start the COMSOL Multiphysics GUI from within COMSOL Script, run `comsol` at the command prompt. A corresponding shortcut is added to the desktop.
- **COMSOL with MATLAB**: Starts MATLAB 6.5, 6.5.1, 7.0, 7.0.1, 7.0.4, 7.1, or 2006a and sets up all necessary paths, and then it opens the COMSOL Multiphysics graphical user interface. If you quit COMSOL Multiphysics you can launch it again by typing `comsol` at the MATLAB command prompt. A corresponding shortcut is added to the desktop.
- **COMSOL Multiphysics Client**: Starts a COMSOL Multiphysics client for connecting to a COMSOL Multiphysics server (see the section "Running COMSOL Multiphysics Client/Server" on page 71).
- **COMSOL Multiphysics Server**: Starts a COMSOL Multiphysics server that a COMSOL Multiphysics client can connect to (see the section "Running COMSOL Multiphysics Client/Server" on page 71).
- **Uninstall COMSOL 3.3**.
- **Documentation**: A folder that contains COMSOL documentation shortcuts.
- **Movies**: A folder that contains COMSOL movies (if you selected this option during installation).

Running COMSOL Multiphysics

You can run COMSOL Multiphysics by double-clicking the **COMSOL Multiphysics 3.3** icon on the desktop.

Alternatively, to activate COMSOL Multiphysics from the **Start** menu, point to **Programs**, then to **COMSOL 3.3**, and then click **COMSOL Multiphysics**.

Running COMSOL Script

You can run COMSOL Script by double-clicking the **COMSOL Script 1.0** icon on the desktop.

Alternatively, to activate COMSOL Script from the **Start** menu, point to **Programs**, then to **COMSOL 3.3**, and then click **COMSOL Script**.

Use the command `comsolbatch.exe` in the directory `bin` under the COMSOL 3.3 installation directory to run COMSOL Script in batch mode. For example, use `comsolbatch "inv([1 2; 3 5])"` to compute the inverse of the matrix [1 2; 3 5].

Running COMSOL Multiphysics with MATLAB

To run COMSOL Multiphysics with MATLAB, double-click the **COMSOL 3.3 with MATLAB** icon on the desktop.

Alternatively, start COMSOL Multiphysics with MATLAB from the **Start** menu by pointing to **Programs**, then to **COMSOL 3.3**, and then select **COMSOL with MATLAB**.

THE CLASSPATH FILE AND ITS LOCATION

The `classpath.txt` file specifies which Java class path to use inside MATLAB. When starting COMSOL Multiphysics with MATLAB, COMSOL Multiphysics copies `classpath.txt` from the `toolbox\local` directory under the MATLAB installation to the directory specified as the **Start in** directory for the **COMSOL with MATLAB** shortcut. It then writes some extra lines to this file to include the Java class paths that COMSOL Multiphysics needs. Therefore you must have write access to the **Start in** directory when starting MATLAB using the `comsol` command. To change the **Start in** directory:

1 Right-click the **COMSOL with MATLAB** shortcut and choose **Properties**.

2 On the **Shortcut** page, type the path to the starting directory into the **Start in** edit field.

3 Click **OK**.

Enabling 3GB of Virtual Address Space

In both Windows XP Professional and Windows 2003 Server, each process can access as much as 3 GB of virtual memory instead of the standard 2 GB. We have updated COMSOL 3.3 to use this additional memory, but to access it you must boot the system using an additional boot parameter. The following example shows how to enable application memory tuning by adding the `/3GB` parameter in the `boot.ini` file:

```
[boot loader]
timeout=30
default=multi(0)disk(0)rdisk(0)partition(2)\WINNT
[operating systems]
multi(0)disk(0)rdisk(0)partition(2)\WINNT="????" /3GB
```

The `"????"` in the `boot.ini` file is the name of your operating system, for example, `"Windows XP Professional x64 Edition"`. Please note that the file `boot.ini` is critical to booting your system.

Running COMSOL on Linux/Sun

Running COMSOL Multiphysics

Run the `comsol` command. If it is not available, ask your system manager to make it available to you.

Running COMSOL Script

Run the command

```
comsol script
```

If it is not available, ask your system manager to make it available to you.

Running COMSOL Multiphysics with MATLAB

Run the command

```
comsol matlab
```

to launch COMSOL Multiphysics from within the MATLAB environment.

The script `comsol` creates a file `classpath.txt` that MATLAB requires, and it places that file in the current directory. Therefore you must have write access to this directory when starting MATLAB using the `comsol` command.

Note: To be able to run 64-bit COMSOL on Linux/Sun, make sure that you have installed the 64-bit support for your platform.

Running COMSOL on Mac OS X

The COMSOL Applications

The following five applications allow you to run COMSOL as described in the following sections.

Note: None of the COMSOL applications work if you move them outside the COMSOL folder. Create an alias if, for example, you want a desktop icon.

- **COMSOL Multiphysics** application

  This is the primary application to run the software. It launches COMSOL Multiphysics as a standalone application.

- **COMSOL Script** application

  This is the primary application to run the software. It launches COMSOL Script as a standalone application.

- **COMSOL with MATLAB** application

  Use this application when you want to use the interface between COMSOL Multiphysics and MATLAB. This application first launches MATLAB and then the COMSOL Multiphysics graphical user interface. If you quit COMSOL Multiphysics you can launch it again by typing `comsol` at the MATLAB command prompt.

Note: The **COMSOL with MATLAB** application requires that you use Apple's X11 application together with MATLAB. The X-Windows application OroborOSX is not supported.

- **COMSOL Multiphysics Client** application

  This application launches a COMSOL Multiphysics client that connects to a COMSOL Multiphysics server (see the section "Running COMSOL Multiphysics Client/Server" on page 71).

- **COMSOL Multiphysics Server** application

  This application launches the **Terminal** application and starts a COMSOL Multiphysics server in a terminal window (see "Running COMSOL Multiphysics Client/Server" on page 71).

Running COMSOL Multiphysics from a Terminal Window

You can also launch COMSOL Multiphysics from a terminal window using the shell script `COMSOL33/bin/comsol`. See the section "Running COMSOL on Linux/Sun" on page 59 for options available in the `comsol` command.

To run the `comsol` command more easily, include the `COMSOL33/bin` directory in the path or make a symbolic link from `/usr/bin/comsol` to the `comsol` script. Those with administrator privileges can create a symbolic link with the command

```
sudo ln -s /Applications/COMSOL33/bin/comsol /usr/bin/comsol
```

(assuming COMSOL is installed in the Applications folder). This command asks for a password before creating the link.

Note: The `comsol` command must not be moved from the `COMSOL33/bin` folder. The COMSOL applications also use this script.

The COMSOL Command

Use the `comsol` command to start COMSOL products with detailed start-up options. This command works similarly on all platforms, but there are differences in availability and options. On non-Windows platforms, you can start all COMSOL products with the `comsol` command. On Windows there are some differences: you must use different commands to start 32- and 64-bit applications, and you need special commands to start terminal-based products (see availability in the following chart).

The general syntax of the `comsol` command is:

```
comsol [options] [product] [product arguments] [expression]
```

where `[...]` indicates something optional:

TABLE 2-1: COMSOL OPTIONS

COMSOL OPTION	DESCRIPTION	AVAILABILITY
`-32`	Use a 32-bit data model if available	In Windows, use `comsol.exe`
`-64`	Use a 64-bit data model if available	In Windows, use `comsol64.exe`. Not available on Mac
`-blas <{auto}/mkl/ atlas/sunperf/path/ acml>`	BLAS library to use	See section "COMSOL and BLAS" on page 80
`-h`	Print general help	
`-h <product>`	Print product-specific help	
`-np <no. of processors>`	Number of processors	Not available on Mac
`-tmpdir <path>`	Temporary file directory	
`-version`	Print COMSOL version	
`-version <product>`	Print product version	

We support the 64-bit option on Linux, Itanium, and Sun platforms. On Windows, use the `comsol.exe` and `comsol64.exe` commands to start 32- and 64-bit products, respectively. For the `-tmpdir` option, COMSOL software uses the specified directory to store temporary files.

The available COMSOL products are:

TABLE 2-2: COMSOL PRODUCTS

PRODUCT	DESCRIPTION	AVAILABILITY
`multiphysics`	Run standalone COMSOL Multiphysics	
`server`	Run COMSOL Multiphysics server	This is the only product available on the Itanium platform. In Windows use `comsolserver.exe` or `comsolserver64.exe`
`client`	Run COMSOL Multiphysics client	
`script`	Run COMSOL Script	In Windows, optionally use `comsolscript.exe` or `comsolscript64.exe`
`batch`	Evaluate expression	In Windows, use `comsolbatch.exe` or `comsolbatch64.exe`
`reaction`	Run COMSOL Reaction Engineering Lab	In Windows, optionally use `comsolreaction.exe` or `comsolreaction64.exe`
`matlab`	Run COMSOL in MATLAB	
`ffi`	Compile foreign function	In Windows, use `comsolffi.exe` or `comsolffi64.exe`

From within COMSOL Multiphysics, COMSOL Script, and COMSOL Reaction Engineering Lab, you can start any other product by clicking its name in the **File** menu. This means the products run within the same process and that they can intercommunicate. Never start products separately if you want to make them communicate later on. From within COMSOL Script and MATLAB you can start the COMSOL Multiphysics graphical user interface and the COMSOL Multiphysics server by using the M-file `comsol.m`. For more information about the COMSOL Multiphysics client/server architecture, see the section "Running COMSOL Multiphysics Client/Server" on page 71.

GENERAL COMSOL PRODUCT COMMAND-LINE ARGUMENTS

TABLE 2-3: COMSOL PRODUCT COMMAND-LINE ARGUMENTS

PRODUCT	PRODUCT OPTION	DESCRIPTION
`multiphysics, reaction, script`	`-open`	Open model file
`server,client`	`-port`	Server port number.
`server`	`-multi <on|{off}>`	Accept multiple clients
`server`	`-login <{info}/force/never>`	Show login dialog box

Example:
Start COMSOL Server and COMSOL Client, explicitly choosing a port number, enabling multiple ports, and indicating that you want to provide a new passcode to the COMSOL Server.

```
comsol server -login force -port 4711 -multi on
comsol client -port 4711
```

COMSOL SCRIPT OPTIONS

The general syntax for the command to start COMSOL Script is

```
comsol [options] script [product arguments]
```

Its detailed product arguments are:

TABLE 2-4: COMSOL SCRIPT-SPECIFIC ARGUMENTS

COMSOL SCRIPT ARGUMENTS	DESCRIPTION	AVAILABILITY
`multiphysics`	Run COMSOL Multiphysics within COMSOL Script	
`server`	Run COMSOL server within COMSOL Script	
`-desktop`	Use COMSOL desktop interface	
`-gui`	Use graphical user interface	
`-term`	Use terminal interface	In Windows, use `comsolterm.exe` or `comsolterm64.exe`

TABLE 2-4: COMSOL SCRIPT-SPECIFIC ARGUMENTS

COMSOL SCRIPT ARGUMENTS	DESCRIPTION	AVAILABILITY
`-ws <motif/gtk>`	Determine window system to use	Available only on Linux
`<expression>`	Evaluate expression within COMSOL Script	

Example

An example of using the `comsol script` command on Linux is

```
comsol script -desktop -ws motif <expression>
```

It starts COMSOL Script within the COMSOL desktop environment, selects the Motif window system, and evaluates the expression before starting.

MATLAB ARGUMENTS

The command `comsol matlab [options]` starts MATLAB with the COMSOL paths set up, and it starts COMSOL Multiphysics within MATLAB.

Similarly, `comsol matlab path [options]` starts MATLAB with the COMSOL path set up.

The command `comsol matlab server [options]` starts MATLAB with the COMSOL path set up and starts a COMSOL Multiphysics server.

The full list of options for `comsol matlab` are:

TABLE 2-5: COMSOL MATLAB-SPECIFIC ARGUMENTS

MATLAB ARGUMENTS	DESCRIPTION
`{path}`	Set up COMSOL path within MATLAB
`multiphysics`	Run COMSOL Multiphysics within MATLAB
`server`	Run COMSOL server within MATLAB
`-ml <option>`	Start MATLAB using the specified option
`-mlr <expression>`	Evaluate expression in MATLAB after COMSOL within MATLAB has started

TABLE 2-5: COMSOL MATLAB-SPECIFIC ARGUMENTS

MATLAB ARGUMENTS	DESCRIPTION
`-mlroot <directory>`	Specify root directory for MATLAB installation
`-D<debugger>`	Run MATLAB in debugger, no COMSOL paths set
`<expression>`	Evaluate expression within COMSOL Script

Examples:

Start MATLAB without the MATLAB desktop and without the MATLAB splash screen and run `mycomsolscript`.

```
comsol matlab path -ml -nodesktop -ml -nosplash -mlr mycomsolscript
```

Run COMSOL Multiphysics with MATLAB using MATLAB installed in `/usr/local/MyMatlab`.

```
comsol matlab -mlroot /usr/local/MyMatlab
```

PERMANENTLY CHANGING THE MATLAB OPTIONS

You can add the MATLAB startup options to the file `comsol.opts` (on Windows) or `comsol` (on the Linux, Sun, and Macintosh platforms). On the line that starts with the string `mlargs=`, add the MATLAB startup options that you want to use. For example,

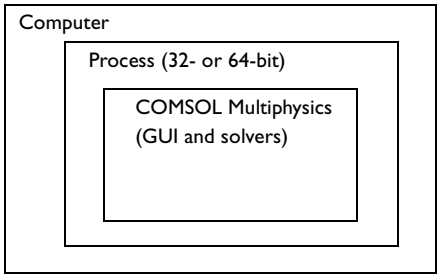
```
mlargs=-nodesktop -nosplash
```

starts COMSOL Multiphysics with MATLAB without showing the MATLAB splash screen and providing MATLAB without the desktop environment.

The COMSOL Multiphysics Client/Server Architecture

Standalone COMSOL Multiphysics

The most straightforward way of running COMSOL Multiphysics is as a standalone application. Standalone COMSOL Multiphysics 3.3 can run as a 32-bit application on Windows, Linux, Sun, and Mac.



In addition, COMSOL Multiphysics can run in 64-bit mode as a standalone application on 64-bit Windows plus 64-bit Linux and Sun.

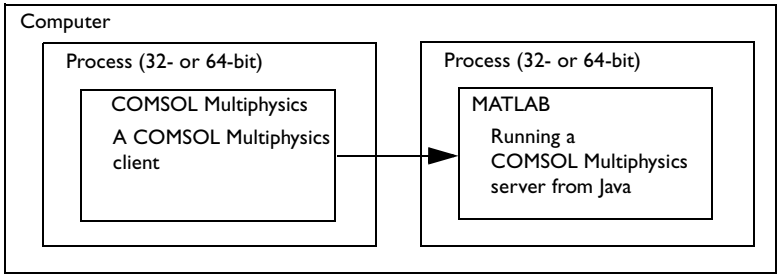
Running COMSOL Script

COMSOL Script runs in 32-bit mode on all platforms on Windows, Linux, Sun, and Mac. In addition it can run in 64-bit mode on 64-bit Windows plus 64-bit Linux and Sun. COMSOL Script typically runs in the same process as COMSOL Multiphysics.

Running COMSOL Multiphysics with MATLAB

COMSOL Multiphysics can run together with MATLAB on the same machine using COMSOL Multiphysics' client/server architecture. The COMSOL Multiphysics server runs on the Java engine within MATLAB, while the COMSOL Multiphysics graphical user interface runs as a separate application. COMSOL Multiphysics starts

automatically in this configuration when you run COMSOL Multiphysics with MATLAB.



MATLAB can currently run in 32-bit mode on Windows, Linux, Sun, and Mac, which means that COMSOL Multiphysics with MATLAB also runs in 32-bit mode within MATLAB on those platforms. In addition, COMSOL Multiphysics with MATLAB can run in 64-bit mode on 64-bit Windows with MATLAB 2006a and on 64-bit Linux with MATLAB 7.0.1, 7.0.4, 7.1, or 2006a.

Running COMSOL Multiphysics as a Client/Server Application

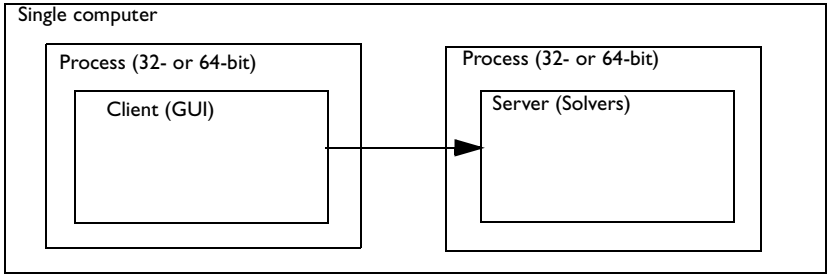
The COMSOL Multiphysics client runs as a 32-bit application on all platforms for which we distribute the software: Windows, Linux, Sun, and the Mac. In addition, the COMSOL Multiphysics client can run as a 64-bit application on 64-bit Windows plus 64-bit Linux and Sun.

THE COMSOL MULTIPHYSICS SERVER

The COMSOL Multiphysics server can run as a 32-bit application on Windows, Linux, Sun, and Mac. The COMSOL server is available as a 64-bit application on 64-bit Windows, 64-bit Linux, Itanium, and Sun.

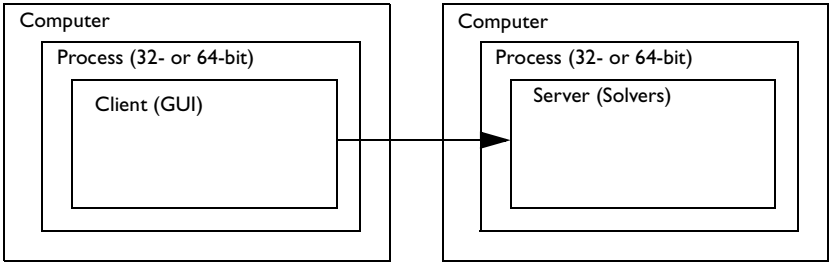
RUNNING COMSOL MULTIPHYSICS CLIENT/SERVER ON THE SAME COMPUTER

Both the COMSOL Multiphysics client and the COMSOL Multiphysics server can run on the same computer and with all available license types: named user license (NSL), CPU locked license (CPU), and floating network license (FNL).



RUNNING COMSOL MULTIPHYSICS CLIENT/SERVER ON DIFFERENT COMPUTERS

The COMSOL Multiphysics client and COMSOL Multiphysics server can also run on different computers, but this configuration requires a floating network license (FNL).

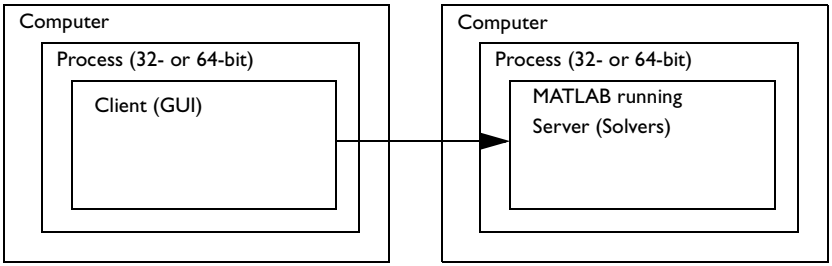


This is the only way to run the COMSOL Multiphysics server on the Itanium platform because neither the COMSOL Multiphysics client nor standalone COMSOL Multiphysics are available for this platform.

RUNNING COMSOL MULTIPHYSICS CLIENT AND COMSOL MULTIPHYSICS SERVER IN MATLAB

It is also possible to run the COMSOL Multiphysics server in MATLAB without starting the COMSOL Multiphysics graphical user interface. In this configuration you can access a COMSOL Multiphysics server running within MATLAB on a remote

computer. This configuration also requires a floating network license (FNL) for COMSOL Multiphysics.



Running COMSOL Multiphysics Client/Server

The COMSOL Multiphysics graphical user interface can run in a separate process as a client to a COMSOL Multiphysics server. The COMSOL Multiphysics client uses a TCP/IP connection to connect to the COMSOL Multiphysics server. The client and server need not run on the same platform. You must have a floating network license (FNL) to run the COMSOL Multiphysics server and the COMSOL Multiphysics client on separate computers.

You can also use the COMSOL Multiphysics client/server when running COMSOL Multiphysics with MATLAB. To do so, start a COMSOL Multiphysics client on a separate computer and connect to a COMSOL Multiphysics server started from within a MATLAB process.

Advantages of Using COMSOL Multiphysics Client/Server

The COMSOL Multiphysics client/server configuration frees your desktop computer of lengthy computations, dispatching your jobs to a dedicated computer. The computer that runs the COMSOL Multiphysics server could have more memory and a faster CPU than your desktop computer.

Note, too, that running the COMSOL Multiphysics server and the COMSOL Multiphysics client separately on the same computer increases the total memory available to solve problems. This is particularly interesting because the 32-bit limit on addressable memory can be the limiting factor for complex models. The COMSOL Multiphysics server components do not use the memory required for the graphical user interface, freeing that memory for the actual computations on the server.

Running COMSOL Multiphysics Client/Server

STARTING COMSOL MULTIPHYSICS SERVER

When you have access to the Windows desktop, start the COMSOL Multiphysics server from the **Start** menu. Go to **Programs**, select **COMSOL 3.3**, and then **Client/Server**. If starting the COMSOL Multiphysics server from a terminal window in Windows, use the command `C:\COMSOL33\bin\comsolserver.exe`.

On Linux and Sun, use the `comsol server` command to start a COMSOL Multiphysics server.

On the Mac, use the **COMSOL Multiphysics Server** application, or if you are logging on to the Mac from another computer, use the `comsol server` command in the terminal window.

STARTING A COMSOL MULTIPHYSICS CLIENT

To start a COMSOL Multiphysics client under Windows, use the **Start** menu. Go to **Programs**, select **COMSOL 3.3**, and then **Client/Server**. To start a client on Linux and Sun use the `comsol client` command. On Mac OS X use the **COMSOL Multiphysics Client** application.

ACCESSING THE COMSOL MULTIPHYSICS SERVER COMPUTER

To access the COMSOL Multiphysics server computer under Linux, Sun, or Mac OS X, simply log in on the server computer by using `ssh`, `rlogin`, or `telnet`, then enter the `comsol server` command. When running the COMSOL Multiphysics server within MATLAB on Linux and Sun, you need access to the X-Windows display pointed to by the DISPLAY variable. On Mac OS X, you need access to the Mac desktop, that is, you must be logged on from the Mac OS X computer console in order to run the COMSOL Multiphysics server within MATLAB.

On Windows you can access the server computer in several ways. If it is dedicated to a single person, you can sit down at that machine and log in on it. You can also connect to the server computer by using NetMeeting or Remote Desktop (Windows XP). Start the COMSOL Multiphysics server from the **Start** menu. If several people want to access a single Windows computer to run the COMSOL Multiphysics server, you must use Windows Terminal Server or another tool that allows multiple users to log in on the same Windows server. In some Windows versions, Microsoft provides a Telnet Server with which you can log in through a terminal window. When using a terminal window to log in on Windows, use the `comsolserver` command to start the COMSOL Multiphysics server.

INITIALIZING THE COMSOL MULTIPHYSICS SERVER

The first time you start a COMSOL Multiphysics server on a computer, a dialog box asks for a user name and password. A terminal window without access to a display does not allow you to open this dialog box, so you cannot use a terminal window when initially logging on to the server computer. The easiest method is to sit down at the computer and log in on it the first time you start the COMSOL Multiphysics server. Enter a user name and password, and then select the **Remember password** check box.

You can now connect through a terminal window the next time you want to run the COMSOL Multiphysics server.

PORT NUMBER

The COMSOL Multiphysics server requires that each user log in and start the COMSOL Multiphysics server manually. The COMSOL Multiphysics server prints a port number in the terminal window. In the COMSOL Multiphysics client, go to the **Model Navigator**, click the **Settings** tab, and provide the computer name and a port number. If you have identical home directories on the server and client and you start the COMSOL Multiphysics client after the COMSOL Multiphysics server has been started, the COMSOL Multiphysics client can obtain the computer name and port number from the `.comsol` directory in your home directory. If the COMSOL Multiphysics client has not determined the computer name and port number, you must enter them manually.

SAVING AND LOADING MODELS ON THE SERVER

For large models run on the 64-bit COMSOL Multiphysics server, memory available on the client might not be sufficient to save the model. Therefore we have implemented the ability to load and save a model directly on the computer where the COMSOL Multiphysics server is running. Please note that the file systems accessible on the COMSOL Multiphysics server might be different than the ones where your COMSOL Multiphysics client is running. These options are available when you are running COMSOL Multiphysics client/server on different computers by going to the **File** menu and choosing **Open** and **Save As**.

RUNNING THE COMSOL MULTIPHYSICS SERVER WITHIN MATLAB REMOTELY

On Windows and the Macintosh you must have access to a display to run MATLAB. Thus to run the COMSOL Multiphysics server within MATLAB on a remote Windows or Macintosh computer, you must sit down at the computer and log in, or you need a remote login tool with display capabilities such as NetMeeting or Remote Desktop.

On Linux and Sun you can start MATLAB remotely as long as you have access to a display pointed to by the DISPLAY variable. Start the COMSOL Multiphysics server within MATLAB by typing `comsol server`. You must start MATLAB in Windows by using **COMSOL with MATLAB** on the **Start** menu, on a Mac by running the **COMSOL with MATLAB** application, or on Linux and Sun platforms by typing the command `comsol matlab`.

USING A WINDOWS XP PROFESSIONAL TELNET SERVER

The Telnet Server capabilities vary somewhat in various versions of Windows, but the Telnet Server is available in Windows XP Professional. Note, though, that you cannot use a terminal window such as Telnet to run a COMSOL Multiphysics server within MATLAB on Windows. You must first enable a Telnet Server daemon on the computer where you intend to run the COMSOL Multiphysics server.

1. Start the Telnet service. Open the **Services** dialog box. Right-click on the **Telnet service** and select **Start**.
2. Add the user group **TelnetClients** if it does not already exist. Open **Groups** and select **New Group**. Type **TelnetClients** in the edit field.
3. Create/modify user accounts. The Telnet user and COMSOL Multiphysics server user must be a member of **TelnetClients** group.

Remember that you must initialize the COMSOL Multiphysics server by entering a user name and password from a Windows session with access to the Windows desktop. Do not forget to select the **Remember password** check box when doing so. After initializing the COMSOL Multiphysics server, you can log in with a Telnet session from the remote computer and start the COMSOL Multiphysics server by typing the command `C:\COMSOL33\bin\comsolserver.exe`. You might need the port number displayed by the COMSOL Multiphysics server.

Connecting Standalone COMSOL Multiphysics to a Server

It is not necessary to set up a client-server connection from the start when you run COMSOL Multiphysics. You can connect COMSOL Multiphysics running in standalone mode to a COMSOL Multiphysics server or to MATLAB at any time. To do this use the **Client/Server/MATLAB** menu in the **File** menu.

When a standalone version of COMSOL Multiphysics is connected to a server, data the solvers need is transferred to the server, and the previously standalone COMSOL Multiphysics becomes a COMSOL Multiphysics client.

CONNECTING TO MATLAB

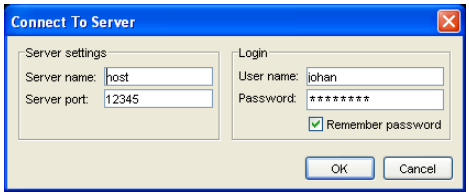
To connect to MATLAB, use the menu item **Connect to MATLAB**. This launches MATLAB and starts a server in MATLAB. Then the standalone COMSOL Multiphysics is connected to this server.

The **Connect to MATLAB** menu item always launches a new MATLAB session. To connect to an already running session of MATLAB, first go to MATLAB and issue the

command `comsol server`. This starts a COMSOL Multiphysics server in MATLAB. Then use the **Connect to Server** menu item to connect to this server.

CONNECTING TO A SERVER

To connect to a COMSOL Multiphysics server, use the menu item **Connect to Server**. This opens a dialog box where you can enter the server and login information.



The user name and password are the ones you used when starting the server, and the port number is printed by the server when it is started.

DISCONNECTING FROM A SERVER

You can close the connection to the server or MATLAB using the menu item **Disconnect from Server/MATLAB**. Doing so transfers all data from the server to the client and makes it a standalone version of COMSOL Multiphysics.

Keep in mind that if you close the connection from a server running on another computer and the client computer has less memory, there might not be enough memory on the client computer for all data. This can in particular happen if you have a large model open at the time you close the connection. The solution data resides on the server. This data is transferred to the client, and there must be enough memory on the client computer to complete this transfer.

Login Information and Security

Login Information

When you start COMSOL Multiphysics for the first time, the **Set Login Information** window appears. Select a user name and a password, which COMSOL Multiphysics then uses in communications between the COMSOL Multiphysics user interface and the server. You must also specify a matching user name and password on the **Settings** page in the **Model Navigator**, which opens when you start COMSOL Multiphysics. The software writes this login information in the subdirectory `.comsol/ver32/login` in your home directory. On Mac OS X this login information is located in `Library/Preferences/COMSOL/ver32/login` in your home directory.

Client/Server Security Issues

COMSOL Multiphysics can operate in a client/server mode where COMSOL Multiphysics runs as a separate client and a server. COMSOL Multiphysics uses a TCP/IP connection to send data between the server and the client.

Always make sure that untrusted users cannot access the COMSOL login information. Thus you must protect the file `.comsol/ver32/login` in your home directory. This is particularly important when using COMSOL Multiphysics' client/server feature.

Once you start a COMSOL Multiphysics server, a person with access to your login information could potentially connect to your COMSOL Multiphysics server. By default, only a single COMSOL Multiphysics client can connect to a server. If you disconnect from the server, you must once again run the `comsol server` command to make further connections. When a COMSOL Multiphysics client connects or disconnects from a remote computer, the COMSOL Multiphysics server displays a message. The connection from the client to the server is made with the TCP protocol.

The server and client are mutually authenticated using a challenge handshake authentication protocol, which means that login information cannot be easily obtained by someone eavesdropping on the network communication. The TCP connection between the client and the server is otherwise not encrypted. If you require encryption of the TCP connection, you can use third-party software based on protocols such as SSH or IPSEC.

Optimizing Memory Use

The Java engine in the graphical user interface and in the COMSOL Multiphysics server component reserves a fixed amount of memory for its heap. You might have to increase or decrease the size of the Java heap depending on the situation.

For example, to make more memory available for the solvers, you could try and decrease the Java heap size in standalone COMSOL Multiphysics or the 32-bit COMSOL Multiphysics server. In addition, always try to select a solver that minimizes memory usage (see the chapter "Solving the Model" in the *COMSOL Multiphysics User's Guide*).

For large models, you might get problems during postprocessing or when loading or saving them. In those cases you must increase the size of the Java heap. This issue is particularly true when running the 64-bit COMSOL Multiphysics server from the COMSOL Multiphysics client.

Follow this procedure to modify the Java heap size for standalone COMSOL Multiphysics: On Windows modify the file `COMSOL33/bin/comsol.opts`, and on Linux/Sun/Mac modify the file `COMSOL33/bin/comsol`. Change the value of the parameter `MAXHEAP=256m` from 256 MB to, say 128, by changing it to `MAXHEAP=128m`.

You can also modify the Java heap size on a the 32-bit COMSOL Multiphysics server in this fashion: On Windows modify the file `COMSOL33/bin/comsol.opts`, and on Linux/Sun/Mac modify the file `COMSOL33/bin/comsol`. Change the value of the parameter `MAXHEAPSERVER=256m` from 256 MB to, say 128, by changing it to `MAXHEAPSERVER=128m`.

The COMSOL Multiphysics client uses the variable `MAXHEAPCLIENT` to determine the Java heap size. The default value is 512MB. The 64-bit COMSOL Multiphysics server uses `MAXHEAPSERVER64`, which is 1024 MB by default. The `MAXHEAPCLIENT` and `MAXHEAPSERVER64` settings are tuned for running large models on 64-bit servers from a COMSOL Multiphysics client.

To run a COMSOL Multiphysics server and a COMSOL Multiphysics client on different computers you need a floating network license. All COMSOL Multiphysics licenses allow you to run a COMSOL Multiphysics server and a COMSOL Multiphysics client on the same computer.

If you run out of memory when saving an MPH-file from the COMSOL Multiphysics user interface when running COMSOL Multiphysics with MATLAB, you might need to increase the Java heap size within MATLAB. When running COMSOL Multiphysics with MATLAB, the Java heap within MATLAB functions similar to the Java heap within the COMSOL Multiphysics server. To set the Java heap size in MATLAB to a maximum of, for example, 256 MB, create a `java.opts` file with the contents

```
-Xmx256m
```

COMSOL Multiphysics with MATLAB automatically creates a `java.opts` file with heap size settings (`MAXHEAPSERVER` or `MAXHEAPSERVER64` value) in the current directory if the `JAVAOPTS` variable equals `on` in `COMSOL33/bin/comsol` (Linux/Sun/Mac) or `COMSOL33/bin/comsol.opts` (Windows). Set `JAVAOPTS` to `off` if you do not want COMSOL Multiphysics to create a `java.opts` file.

If you want to create a `java.opts` file manually, do so either in the current directory or in the directory `MATLAB/bin/ARCH`, where `MATLAB` is the `MATLAB` installation directory (typically `C:\MATLABR7)`, and `ARCH` is the architecture (`win32`, `glnx86`, `sol2`, or `macosx`).

STACK SIZE AND THE DIRECT CHOLESKY (TAUCS) SOLVER

To analyze large problems with the Direct Cholesky (TAUCS) solver you might need to increase the size of the Java stack. On Windows modify the file `COMSOL33/bin/comsol.opts`, and on Linux/Sun/Mac modify the file `COMSOL33/bin/comsol`. Change the parameter `STACKSIZE=2m` from 2 MB to a higher value, say 4 MB, by changing it to `STACKSIZE=4m`.

Running COMSOL in Parallel

The parallel sections of COMSOL are based on the parallel shared memory model. Most multiple-processor machines and dual/multi-core machines support the shared memory model; however, it is not supported by clusters. The solvers and the linear algebra functions in COMSOL Script are the functions that benefit the most from parallelism.

Parallel COMSOL

NUMBER OF PROCESSORS THAT COMSOL USES

On Linux and Sun, the COMSOL software runs on one processor by default. On Windows, COMSOL uses the maximum of the environment variable `NUMBER_OF_PROCESSORS`–1 or 1 processors.

Note: By default, COMSOL leaves one processor free to other processes on Windows.

If you have a parallel machine that COMSOL supports, you can override the default with the switch `-np <number of processors>`.

Note: You can set the environment variable `OMP_NUM_THREADS` instead. It is overridden by the switch `-np`.

BENEFITS OF RUNNING COMSOL IN PARALLEL

The main parallel speedup in computations comes from functions of the type BLAS (basic linear algebra subprogram, see next section). If you want to run the software in parallel, it is important that the BLAS library you use supports parallelism. The MKL and Sun performance libraries run in parallel.

Note: These libraries run in parallel but they might not be the best choice for your processor type.

The direct solvers UMFPACK and Taucs benefit from BLAS. All linear algebra operations in COMSOL Script benefit from BLAS. You can also use the parallel sparse direct linear solver PARDISO on Linux and Windows. It does not depend on the BLAS library you use. The parallel solver provided by the Sun Performance Library can be used on Sun, but it requires that the Sun Performance Library be installed.

COMSOL and BLAS

BLAS is a set of functions for basic linear algebra operations. Vendors often supply BLAS libraries optimized for their hardware. A large portion of the computational engine in COMSOL relies on BLAS. Included with COMSOL are the BLAS libraries MKL (Math Kernel Library) optimized for Intel processors and ATLAS (Automatically Tuned Linear Algebra Software). On Mac OS X, COMSOL relies on vecLib, which is installed on the system. AMD also supplies a BLAS library called ACML (AMD Core Math Library), which you can download from http://developer.amd.com/acml.aspx. Sun provides the Sun Performance Library with Sun Studio. On Linux, Windows, and Sun, you can also supply your own BLAS library optimized for your hardware. By default COMSOL automatically tries to detect an appropriate BLAS library. The defaults in COMSOL are:

- MKL on Intel processors (Linux and Windows)
- ATLAS on AMD processors (Linux and Windows except Windows 64-bit where MKL is used). If ACML is installed and appropriately set up COMSOL uses it instead
- ATLAS on Sun
- vecLib on Mac OS X

You can override the default with the switch `-blas`. Valid options to the `-blas` switch are:

- `auto`—same as not using the switch (Linux, Windows, Sun)
- `mkl`—selects the MKL library (Linux, Windows)
- `atlas`—selects the ATLAS library (Linux, Windows, Sun)
- `acml`—selects the ACML library (Linux, Windows)

- `sunperf`—selects the Sun Performance Library (Sun)
- `path`—tries to load the library specified by the environment variable `COMSOL_BLAS_PATH`. The library must support the standard FORTRAN BLAS interface (Linux, Windows, Sun)

If the library you want to use is unavailable or incorrectly installed, COMSOL switches back to the default library.

Note: Instead of starting COMSOL with the `-blas` switch, you can set the environment variable `COMSOL_BLAS_LIBRARY`. The switch `-blas` overrides the environment variable.

USING A DIFFERENT BLAS LIBRARY THAN THE DEFAULT

If you want to use a different BLAS library than the default, make sure that COMSOL can find the library. The simplest way for COMSOL to find a library is to put it in `COMSOL33/lib/ARCH` where `ARCH` is the architecture (`glnx86`, `glnxa64`, `glnxi64`, `win32`, `win64`, `sol2`, or `sol64`) or somewhere in the standard search path.

Note: You must also provide the path to any sublibraries needed by the library. ACML requires `libg2c.so` on Linux, for instance.

You can also set the search path to point to the directory where the library is installed. To do so, use the environment variable `LD_LIBRARY_PATH` on Linux and Sun, or the environment variable `PATH` on Windows.

If you use the Sun Performance Library on Sun, that vendor recommends you change the default stack size to 4 MB for 32-bit Solaris and 8 MB for 64-bit Solaris. COMSOL assumes that Sun Performance Library is installed in `/opt/SUNwspro/`. Otherwise you must provide the search path.

3

COMSOL Engine API

Introduction

The COMSOL Engine API (Application Programming Interface) makes it possible to set up, solve, and postprocess a PDE problem using COMSOL as a "black box." The API uses a Java VM to communicate with the COMSOL shared library. To create an application with the API requires the Java SDK 1.4.2, which you must download and install separately.

We recommend you run the COMSOL Engine API from the Java VM (Java Virtual Machine) that ships with COMSOL. The Java VM needs access to the COMSOL class library and the COMSOL shared libraries. The COMSOL API lets you control COMSOL through commands similar to those in COMSOL Script. In fact, to run a COMSOL model through the API, you can use the exact same command sequence that you get by saving a Model M-file from the COMSOL user interface. COMSOL commands sent to the Java VM describe the geometry, mesh, PDE, and boundary conditions; you send additional commands to solve the model and perform postprocessing. Finally, other COMSOL Engine API methods fetch the data into Java.

To get started using the API you should refer to the section "COMSOL Engine API" on page 85. Additionally, the *COMSOL Multiphysics Scripting Guide* is useful reading for working with the API, and the *COMSOL Multiphysics Command Reference* describes COMSOL Multiphysics commands in detail.

Note that it is possible to start the COMSOL API from a C program, as well. You must use the JNI (Java Native Interface) to start a Java VM from the C program, and then send commands to the Java VM using the JNI. You also use the JNI to fetch numerical results from COMSOL. It is clearly easier to use the COMSOL API from a program that is already integrated with Java.

COMSOL Engine API

An external program can communicate with COMSOL through a Java API that is based on executing COMSOL Script commands. The interface classes are declared in the Java package `com.comsol.script.api`.

When it receives commands through the API, COMSOL evaluates them sequentially. The subset of MATLAB from which these commands come consists of those that can appear in Model M-files; for additional details in this regard as well as a description of which COMSOL functions that you can call and in what order, see "The Structure of a Model M-file" on page 67 in the *COMSOL Multiphysics Scripting Guide* that is part of the COMSOL Multiphysics documentation set.

Classes

THE APIWORKSPACE CLASS

`ApiWorkspace` is the main class for communicating with COMSOL. It corresponds to the root workspace in MATLAB. It provides the following interface:

- `ApiWorkspace()` creates a new COMSOL workspace.
- `void destroy()` deactivates the workspace and frees all memory it has allocated.
- `void eval(String command)` executes a COMSOL command written in the MATLAB language. The command can contain several MATLAB statements separated by semicolons, commas, or newline characters.
- `boolean isNumeric(String var)` returns True if a variable called `var` exists and its value is or can be converted to a real or complex matrix.
- `boolean isComplex(String var)` returns True if a variable called `var` exists and its value has a non-zero imaginary part.
- `double[][] getMatrixReal(String var)` returns a matrix containing the real parts of the matrix `var`. If no such variable exists an exception is thrown.
- `double[][] getMatrixImag(String var)` returns a matrix containing the imaginary parts of the matrix `var`. If no such variable exists, an exception is thrown.
- `String getVar(String var)` returns the value of a the variable `var` as a string.
- `void setVar(String var, String value)` assigns the variable `var` the value of the expression `value`.

THE APIEXCEPTION CLASS

`ApiException` is an exception thrown by all member functions of `ApiWorkspace`. It provides the following interface:

- `String getMessage()` returns a descriptive error message.

Some common situations where this exception is thrown include:

- The command sent to `ApiWorkspace.eval()` could not be parsed.
- The command sent to `ApiWorkspace.eval()` contains MATLAB commands, expressions, or functions not supported by COMSOL.
- The command sent to `ApiWorkspace.eval()` contains invalid calls to COMSOL functions.
- The variable name passed to `ApiWorkspace.getMatrixReal()` or `ApiWorkspace.getVar()` does not correspond to an existing matrix variable.

Example

The following code snippet illustrates how it is possible to use the API.

```
import com.comsol.script.api.*;
import java.io.*;

public class Example {

  public static void main(String[] args) {

    try {

      ApiWorkspace ws = new ApiWorkspace();

      // Create geometry: A square
      ws.eval("g1 = rect2(1, 1, 'base', 'corner', 'pos',[0, 0]);");
      ws.eval("s.objs = {g1};");
      ws.eval("s.name = {'R1'};");
      ws.eval("s.tags = {'g1'};");
      ws.eval("fem.draw = struct('s', s);");
      ws.eval("fem.geom = g1;");

      // Create mesh
      ws.eval("fem.mesh = meshinit(fem);");

      // Use the Electrostatics application mode
      ws.eval("appl.mode.class = 'Electrostatics';");
      ws.eval("appl.assignsuffix = '_es';");
```

```
        // Set boundary constraints: Potentials 0 and 10V on
        // the left and right sides, respectively.
        ws.eval("bnd.V0 = {0, 0, 10};");
        ws.eval("bnd.type = {'V0', 'nD0', 'V'};");
        ws.eval("bnd.ind = [2, 3, 2, 1];");
        ws.eval("appl.bnd = bnd;");
        ws.eval("fem.appl{1} = appl;");

        // Solve the problem using the linear solver
        ws.eval("fem = multiphysics(fem);");
        ws.eval("fem.xmesh = meshextend(fem);");
        ws.eval("fem.sol = femlin(fem);");

        // Retrieve the potential in the midpoint of the square
        ws.setVar("coord", "[0.5 ; 0.5]");
        ws.eval("sol = postinterp(fem, 'V', coord);");
        double[][] sol = ws.getMatrixReal("sol");
        ws.destroy();

        // Print the results
        for (int i=0; i<sol.length; i++) {
          for (int j=0; j<sol[i].length; j++)
            System.out.print(sol[i][j]);
          System.out.println();
        }

      } catch (ApiException e) {
        System.out.println(e.getMessage());
      }
    }
  }
```

Running the Example

WINDOWS

To run this example under Windows, you must first have COMSOL 3.3 installed. Next download and install Java SDK 1.4.2 for Windows. You also need the batch files `comsolapic.bat` and `comsolapi.bat` (available in the COMSOL `bin` directory) and the example file `Example.java` (available in the COMSOL `api/engine` directory). Put all three of these files in a new directory. Edit the variable `SDKROOT` in the batch files to reflect the installation directories of COMSOL 3.3 and Java SDK 1.4.2.

To compile the function enter

```
comsolapic.bat Example.java
```

and to run the model enter

```
comsolapi.bat Example
```

You can determine exactly which parameters Java needs in order to run a model using the COMSOL API by looking at the file `comsolapi.bat`. You must also perform these tasks: provide the correct class path to Java, update the `PATH` variable, and set the variable `COMSOL_LICENSE_FILE`.

LINUX/SUN/MAC

To run the example just presented under Linux, Sun, or the Mac, you must first have COMSOL 3.3 installed. Next download and install Java SDK 1.4.2 for your platform. You also need the shell scripts `comsolapic` and `comsolapi` plus the example file `Example.java`. Edit the variables `FLROOT`, `SDKROOT`, and `ARCH` in the shell scripts to reflect the installation directories of COMSOL 3.3, Java SDK 1.4.2, as well as the computer architecture.

To compile the function enter

```
comsolapic Example.java
```

and to run the model enter

```
comsolapi Example
```

You can determine exactly which parameters Java needs in order to run a model using the COMSOL API by looking at the file `comsolapi`. You must also perform these tasks: provide the correct class path to Java, update the `LD_LIBRARY_PATH` variable (`DYLD_LIBRARY_PATH` on Mac), and set the variable `COMSOL_LICENSE_FILE`.

4

License Agreement

COMSOL AB Software License Agreement

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(i) the information necessary to achieve the Permitted Objective has not already been made available or has not been provided by us within a reasonable time after a written request to provide such information;

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(iii) the information gained is not used or anything other than the Permitted Objective and is not disclosed to any other person except as may be necessary to achieve the Permitted Objective; and

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(i) We may deliver the Programs and Documentation to you in archival form on CD-ROM or over the Internet with a passcode which specifies the licensed Programs. You shall be responsible for all use of your passcode, authorized or not, and you shall not disclose the archive passcode or allow it to be used except for installation of the Programs.

(ii) If you have licensed the NSL version of the Programs, they may be installed and operated on one or more individual computers, provided the Programs are only accessible to, and operated by, a single licensed user designated by us as the "Named User" for that license. You may replace the named user for the license, on a temporary or permanent basis but no more than four (4) times a year, provided that only one licensed user is designated as the named user at any given time. The NSL version of the Programs may not be accessed or used over a network.

(iii) If you have licensed the CPU version of the Programs, a single individual may use one concurrent session of a Program on a single designated computer at any given time. The CPU version of the Programs may not be accessed or used over a network.

(iv) If you have licensed the FNL version of the Programs, they may be installed in a central location on a single dedicated network server. You may have as many sessions of a Program in use at any given time as you have licensed concurrent users. If the Programs have the ability to run as client and server on separate computers, only the FNL version gives you the right to use the Programs as client and server on separate computers. Portions of the Programs may be installed on individual computers, as long as the individual installations are controlled by the license manager on the network server. You may not provide access to the FNL version of the Programs to users located outside the country in which the license manager server is installed unless you have contracted for global use. For the purposes of this Agreement, all servers located in a member country of the North American Free

Trade Agreement ("NAFTA") shall be considered located in the same country as those of the other NAFTA members, and all servers located in Iceland, Norway, Switzerland, or any member country of the European Union shall be considered located in the same country.

(v) You may make a backup copy of the Programs and Documentation as reasonably necessary to support the use of the Programs in accordance with this Agreement.

(vi) Regardless of which license you have, you may use the Programs only for your internal operations. For the purposes of this Agreement, "internal operations" means use of the Programs by your employees or those of your subsidiaries or parent company and for the performance of consulting or research for third parties who engage you as an employee or independent contractor.

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10 Third Parties. You shall notify us of third parties (and give their respective names, addresses, and contact information) that have access to or use the licensed Programs on your behalf. This provision shall not limit your other obligations hereunder.

11 Prevailing Party. If any legal action or other proceeding is brought for any breach of this Agreement, the prevailing party shall be entitled to recover its reasonable attorneys' fees and other costs incurred in bringing such action or proceeding, in addition to any other relief to which such party may be entitled.

12 Taxes. You shall be liable for any taxes (except those on our net income) due in connection with this Agreement.

13 Termination. We may terminate this Agreement by written notice to you if you breach any Term and have not cured such breach within sixty (60) days (within fifteen (15) days if the breach is for non-payment) thereafter. You may terminate this Agreement at any time for any reason, but you shall not be entitled to any refund except for license fees paid for any Programs for which the Acceptance Period has not expired at the time we receive your notice of termination.

14 Effect Of Termination. Immediately upon termination of this Agreement for any reason, (a) your rights shall cease and all rights granted herein shall automatically revert to us; (b) you shall stop using the Programs and Documentation; (c) you shall erase all copies of licensed Programs from your computers and deliver to us all tangible copies of the Programs and Documentation; (d) you shall pay all amounts due us; and (e) you shall take such acts and execute all documents we reasonably request to register or effect the termination. Within five (5) business days of the termination, you shall provide us with a written declaration signed under penalty of perjury by you attesting to compliance with the provisions of subsections (b), (c) and (d) above. Expiration or termination of this Agreement shall not relieve a party

of obligations accrued before such event. In addition, Sections 1(c), 1(l), 5, 8, 9, 11, 12, 14, and 17 shall survive termination or expiration of this Agreement.

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16 Revised Terms of Use. We may revise the terms of use of the Programs from time to time. Revisions are effective upon receipt of notice from us.

17 Miscellaneous. You shall not grant any ownership right or security interest in the Programs to any person. You shall comply with all laws applicable to you in the jurisdiction in which you use the Programs. A breach of any provision of this Agreement may only be waived in writing and the waiver of such breach shall not operate or be construed as a waiver of any subsequent breach. If any Term should, for any reason, be held invalid or unenforceable in any respect, the remainder of this Agreement shall be enforced to the full extent permitted by law. A court of competent jurisdiction is hereby empowered to modify the invalid or unenforceable provision to make it valid and enforceable. This Agreement and the applicable Addenda hereto (if relevant) contain the entire understanding of the parties, and, except as provided herein, may not be changed except in a writing signed by your and us. This Agreement shall be governed by the laws of Massachusetts, without regard to its conflict of laws, the U.N. Convention on Contracts for the International Sale of Goods, and any version of the Uniform Computer Information Transactions Act ("UCITA") adopted by any state, and to the extent UCITA is applicable, the parties agree to opt out of its applicability pursuant to the opt-out provisions contained therein. The parties consent to the exclusive personal jurisdiction of the state and federal courts in the Commonwealth of Massachusetts if there is any dispute between them. You may not bring any action against us or our licensors more than two (2) years after the cause of action accrued.

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3 Definitions.

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4.2 Class Kit Limited Rights. Specific rights, obligations, and restrictions apply to the Class Kit Option. By selecting the Class Kit Option, the Institution and any users of the Class Kit Option agree to the terms of the Agreement and this Academic Addendum for use of the Class Kit Option for Academic Internal Operations.

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4.4 Support. Support requests shall be made by the teaching assistants or the central administrator of the Class Kit Option.

INDEX