

COMSOL INSTALLATION AND OPERATIONS GUIDE

VERSION 3.5 a



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COMSOL Installation and Operations Guide

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Installing the COMSOL Software

This chapter provides detailed instructions for installing the COMSOL software for all different platforms and license types. You also find complete system requirements and license manager information. For most installations, the *COMSOL Quick Installation Guide* that comes bundled with the DVD provides the basic instructions for installation on the Windows, Mac, and Linux/Sun platforms. Also see the COMSOL Support Knowledge Base on www.comsol.com for specific troubleshooting tips.

General Tips

Welcome to COMSOL® 3.5a! Use this *Installation and Operations 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 Compatibility Notes

Accessible from the COMSOL Help Desk, this electronic PDF document provides an overview of changes throughout the COMSOL product line since the previous release that require special attention with regards to backward compatibility.

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 and Quick Reference* manual. Also see the *COMSOL 3.5a New Feature Highlights* document, included with the DVD media, for an overview of the major new features in the 3.5a release. Further, the full COMSOL documentation set is available on your computer in the COMSOL help resources and as a set of PDF files.

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 code.
- 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 DVD drive for installation. If you need to install the software using CD-ROM media, please contact your local COMSOL representative
- TCP/IP on all platforms when using a license server
- Adobe Acrobat Reader 7.0 or later 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

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

GENERAL SYSTEM REQUIREMENTS—WINDOWS

Use Automatic Updates to keep your Windows system up-to-date. You can access it and turn it on from the Control Panel.

SYSTEM REQUIREMENTS—32-BIT WINDOWS VERSION

- The following 32-bit Windows operating systems are supported:
 - Windows 2000 with Service Pack 4 or later
 - Windows XP with Service Pack 2 or later
 - Windows 2003 Server with Service Pack 2 or later
 - Windows Vista
- Pentium III or later
- OpenGL 1.1 from Microsoft or an accelerator that supports OpenGL 1.1, or DirectX version 8.0 or later. The graphics card should have at least 32 MB of memory.

SYSTEM REQUIREMENTS—64-BIT WINDOWS VERSION

- The following 64-bit Windows operating systems are supported:
 - Windows XP Professional x64 Edition with Service Pack 2 or later
 - Windows 2003 Server x64 Edition with Service Pack 2 or later
 - Windows 2003 Server with Service Pack 2 or later
 - Windows 2003 Compute Cluster Server with Service Pack 1 or later
 - Windows HPC Server 2008
 - Windows Vista
- A PC with one of these processors: AMD with AMD64 or Intel with EM64T.
- A graphics card with at least 32 MB of memory

COMSOL Multiphysics System Requirements for Linux and Sun

SYSTEM REQUIREMENTS

Standalone COMSOL Multiphysics, the COMSOL Multiphysics client, and the COMSOL Multiphysics server are available in 32- and 64-bit versions as indicated in the table:

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

PLATFORM	OPERATING SYSTEM	PROCESSOR
32-bit Linux	Linux 2.4.x kernel, glibc-2.2.5 or later	Pentium III or later
64-bit Linux	Linux 2.4.x kernel, glibc-2.3.2 or later	AMD with AMD64 or Intel with EM64T

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

PLATFORM	OPERATING SYSTEM	PROCESSOR
Itanium	Linux 2.4.x kernel, glibc-2.3.2 or later	Itanium 2
Sun	Solaris 8, 9, 10	UltraSPARC II or later

Note: On the Itanium 2 only the 64-bit COMSOL Multiphysics server is available. Here 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 4/5, Fedora Core 8, SUSE 10.3
64-bit Linux	SUSE 9.0, 9.3, and 10.3, RedHat Enterprise 4/5, Fedora Core 8
Itanium	Debian 3.1 (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.

COMSOL Multiphysics System Requirements for Mac

SYSTEM REQUIREMENTS—INTEL PROCESSOR, 32 BIT

- Mac OS X 10.4.8, 10.5
- Java 1.5 or later (part of the Mac OS X installation)

SYSTEM REQUIREMENTS—INTEL PROCESSOR, 64 BIT

- Mac OS X 10.5
- Java 1.5 or later (part of the Mac OS X installation)

SYSTEM REQUIREMENTS—POWERPC PROCESSOR

- Mac OS X 10.3.1, 10.4, 10.5
- Java 1.4 or later (part of the Mac OS X installation)
- Java 3D and Java Advanced Imaging
- BSD Subsystem (part of the Mac OS X installation)

Optional MATLAB Add-On Requirements

The following chart indicates available MATLAB interfaces in COMSOL 3.5a.

TABLE 1-2: MATLAB COMPATIBILITY CHART

PLATFORM	7.0	7.0.1	7.0.4	7.1	2006A/B	2007A/B
Windows, 32 bit	√	√	√	√	√	√
Windows, 64 bit					√	√
Linux, 32 bit	√ ^a	√				
Linux, 64 bit		√ ^a	√ ^a	√ ^a	√ ^a	√
Linux, Itanium						
Sun, 32 bit	√	√	√	√	√	
Sun, 64 bit						√ ^b
Mac, Power PC	√	√	√	√	√	√
Mac, Intel, 32 bit						√ ^a
Mac, Intel, 64 bit						

a. Shared-memory parallelism is not supported for these interfaces.

b. The CAD Import Module is not compatible with use of the interface to MATLAB 2007a/b on Sun.

CAD Import Modules Platform Support

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

TABLE 1-3: CAD IMPORT MODULE SYSTEM REQUIREMENTS

PRODUCT	REQUIRED PRODUCTS	PLATFORM SUPPORT
CAD Import Module	COMSOL Multiphysics	Windows ^a , Linux ^b , Sun ^c , Mac ^d
CATIA V4 Import Module	CAD Import Module	Windows ^a , Linux ^b , Sun ^c , Mac ^d
CATIA V5 Import Module	CAD Import Module	Windows ^a
Inventor Import Module	CAD Import Module	Windows ^a
Pro/E Import Module	CAD Import Module	Windows ^a , Linux ^b , Sun ^c , Mac ^d
VDA-FS Import Module	CAD Import Module	Windows ^a , Linux ^b , Sun ^c , Mac ^d

a. Windows 2000 is not supported.

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

c. Only Solaris 10 is supported. On Sun, the CAD Import Module is not compatible with use of the interface to MATLAB 2007a/b (64 bit only).

d. Only 64 bit Macintosh is supported.

BIDIRECTIONAL INTERFACE TO SOLIDWORKS

The Bidirectional Interface to SolidWorks has been tested with SolidWorks 2006 SP5.1, SolidWorks 2007 SP5.0, and SolidWorks 2008 SP4.0. It is available on all platforms supported both by these versions and COMSOL Multiphysics. Supported on the Windows XP x64 platform are connections between SolidWorks 64 bit and COMSOL Multiphysics 64 bit, as well as between SolidWorks 32 bit and COMSOL Multiphysics 32 bit.

BIDIRECTIONAL INTERFACE TO AUTODESK INVENTOR

The Bidirectional Interface to Autodesk Inventor requires Autodesk Inventor 2009. It is available on all platforms supported by Autodesk Inventor 2009.

Parallel System Requirements

The table below shows the COMSOL 3.5a support for shared-memory parallelism and distributed-memory parallelism.

PLATFORM	SHARED MEMORY	DISTRIBUTED MEMORY
Windows, 32 bit	√	√ ^a
Windows, 64 bit	√	√ ^a
Linux, 32 bit	√ ^b	√ ^b
Linux, 64 bit	√ ^c	√ ^c
Linux, Itanium	√	√
Sun, 32 bit		
Sun, 64 bit	√	
Mac, Power PC		
Mac, Intel, 32 bit	√	
Mac, Intel, 64 bit	√	

a. Requires Windows Compute Cluster Server 2003 with Service Pack 1 or later.

b. Requires glibc version 2.3.2 or higher.

c. Requires glibc version 2.3.4 or higher.

ADDITIONAL LINUX DISTRIBUTED MEMORY SYSTEM REQUIREMENTS

Supported operating systems: Red Hat Enterprise Linux 4 or 5 and SUSE Linux 9.0 or 9.3. All computers in the cluster must use the same Linux version and should have similar hardware.

IPv6 Support

IPv4 is supported on all platforms. IPv6 is supported on all platforms except Itanium and Macintosh.

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 3.5a. 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 install COMSOL software with a passcode, no license manager is needed. If you install 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 26 for instructions. You can install your COMSOL software products and the license manager in any order.

Other COMSOL license types require a dongle (hardware lock). If you have received a dongle to use with the COMSOL software, please refer to `dongle/readme.txt` on the DVD for installation instructions.

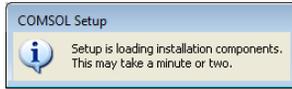
An installation of earlier COMSOL versions on your computer is not affected by the COMSOL 3.5a installation except that double-clicking a Model MPH-file created with an earlier version of COMSOL will open it in COMSOL 3.5a. You can continue to use earlier versions or uninstall them independently of the COMSOL 3.5a installation.

Note: In this manual, the term COMSOL 3.5a refers not only to COMSOL Multiphysics 3.5a but also to any other members of the COMSOL product line.

Installing COMSOL 3.5a

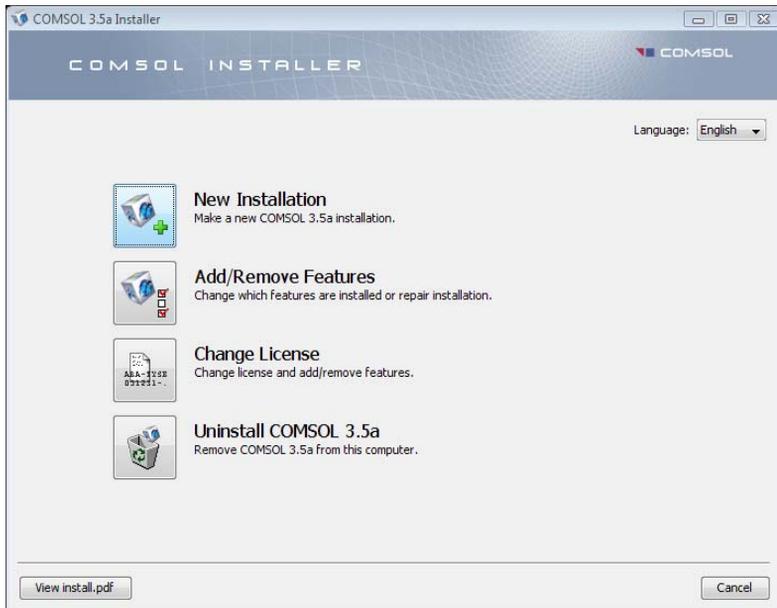
- 1 Insert the COMSOL 3.5a DVD into the DVD drive. The **COMSOL Setup** window should appear automatically; if not, run the file `setup.exe` on the installation DVD.

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 3.5a Installer** window. To continue:

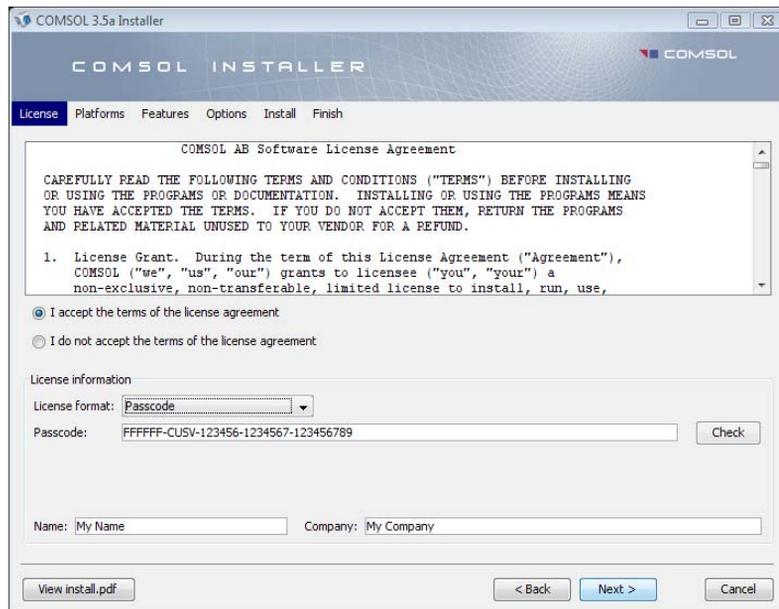
- Click **New Installation** and proceed to Step 2 to make a new installation.
- Click **Add/Remove Features** and proceed to Step 4 to change or repair an existing installation. For example, use **Add/Remove Features** when you add or remove documentation files for products installed or when you want 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 3.5a 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 3.5a** 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:

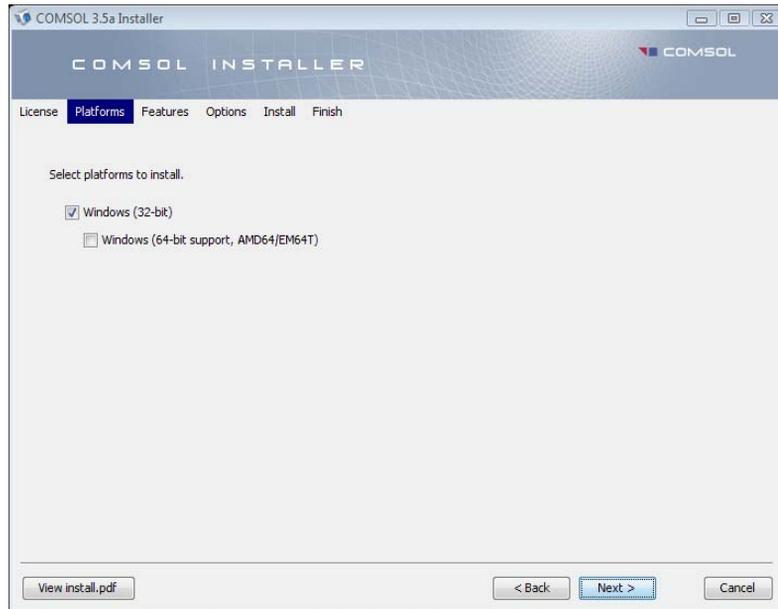
- **Passcode:** Enter your passcode, which is a series of characters and numbers that has a form similar to FFFFFFF-CUSV-123456-1234567-123456789. The passcode is case sensitive.
- **License file:** Enter the path to an existing license file or click **Browse** to select the file `license.dat`.
- **Port 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**.

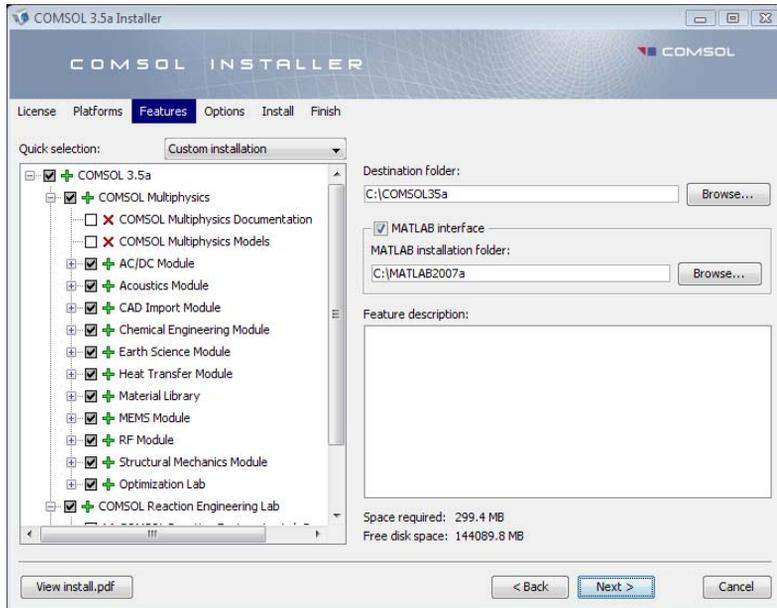
4 On the **Platforms** page, you can typically accept the default settings.



5 Click **Next**.

6 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 7.0, 7.0.1, 7.0.4, 7.1, 2006a/b, 2007a/b work with COMSOL 3.5a.



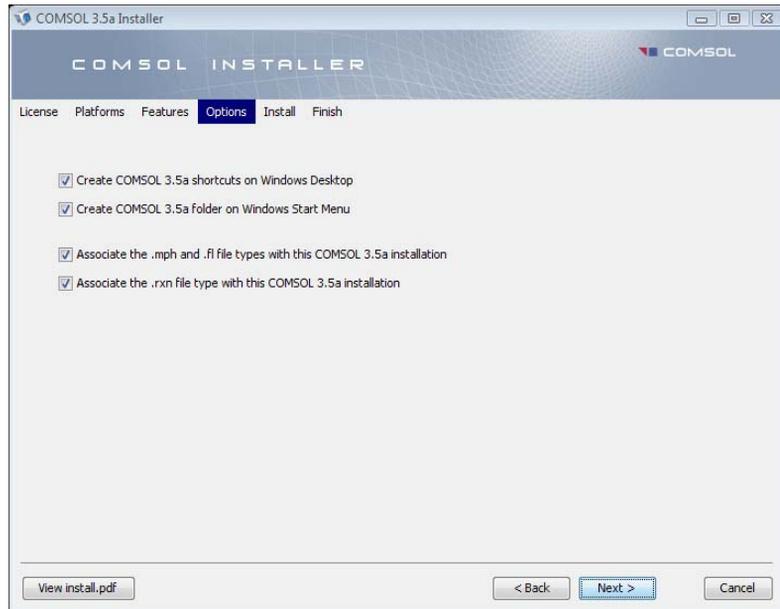
Feature symbols:

-  — 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.

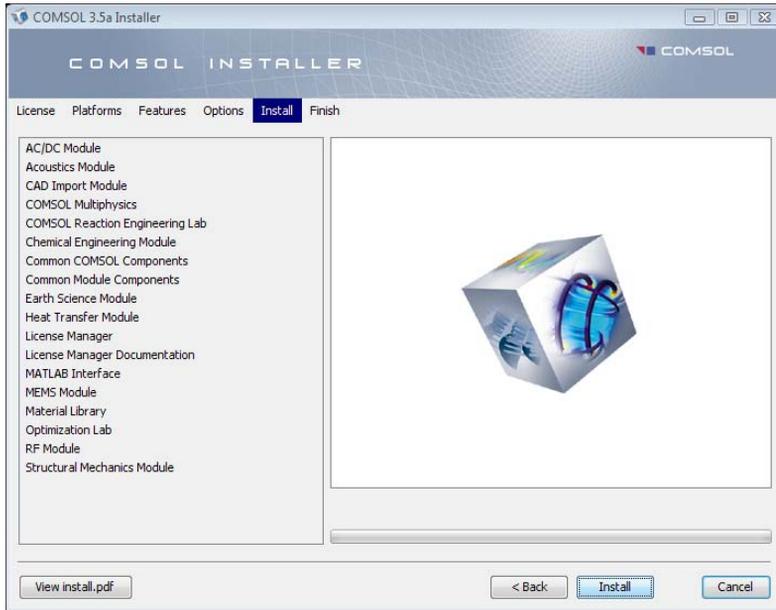
7 Click **Next**.

- 8 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 Multiphysics 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

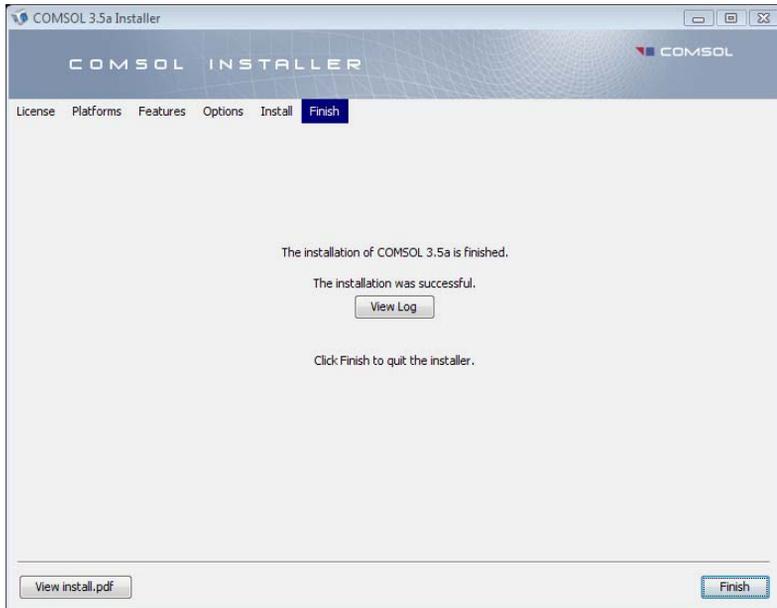


- 9 Click **Next**.

10 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.



- || 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

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 DVD>\setup.exe -s <answer file path>
```

where *<answer file path>* is the path to your answer file. A template answer file, `setup.ini`, with detailed usage information is available on the DVD.

Removing (Uninstalling) the COMSOL Installation

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

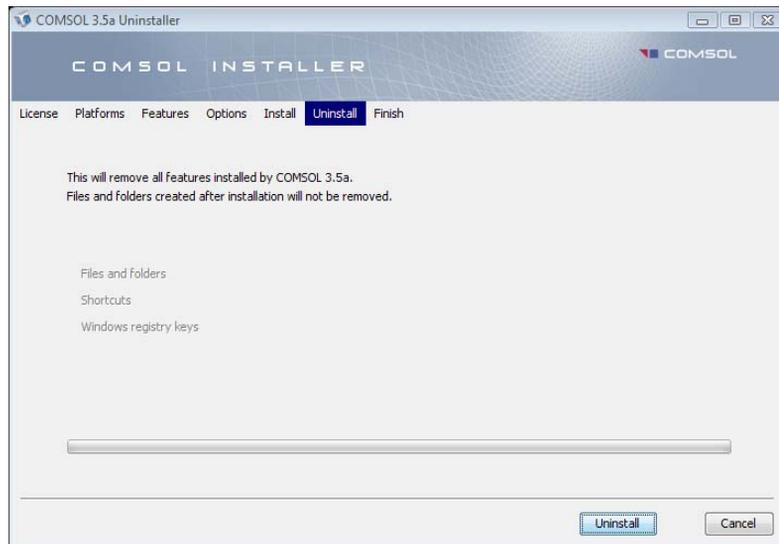
Note: The uninstaller deletes all COMSOL 3.5a files and directories on the system that were installed by the COMSOL installer. Files and folders created after installation are not removed.

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 3.5a**. Click **Uninstall COMSOL 3.5a**.
- On the Windows Start menu, point to **Settings**, then click **Control Panel**. Double-click **Add/Remove Programs**. Select **COMSOL 3.5a** 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.

Automated Removal (Uninstallation) of COMSOL 3.5a

Similar to how you can automate the installation, you can also uninstall COMSOL using an answer file. The documentation on how to create such an answer file is in the template answer file, `setup.ini`, which is available on the DVD. When you have created an answer file for uninstalling, you start the uninstallation by running

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

where *<answer file path>* is the path to your answer file.

Changing the Path to the MATLAB Installation

Edit the file `comsol.opts` in the `bin` directory under the COMSOL root directory (typically `C:\COMSOL35a`). In the file, change the line that starts with `m1root=` to point to the root directory of your MATLAB installation.

Adding the Bidirectional Interface to SolidWorks 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 on Windows XP, 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` (Windows XP) or `lib\win64` (Windows XP 64-bit) under the COMSOL 3.5a installation directory.

If your operative system is Windows Vista follow these steps instead:

- 1 Close SolidWorks if it is running on your computer.
- 2 Click the Start menu symbol in the lower-left corner of your Vista desktop.
- 3 Type `cmd` in the **Start Search** field.
- 4 `cmd.exe` appears in the list of programs. Right-click on it and select **Run as administrator**.

- 5 In the command window that appears type one of the following, depending on your operative system
 - on Vista 32-bit: `regsvr32 C:\comsol135a\lib\win32\flswinterface.dll`
 - on Vista 64-bit: `regsvr32 C:\comsol135a\lib\win64\flswinterface.dll`In the above `C:\comsol135a` is the local path to your COMSOL installation.
- 6 Open SolidWorks and on the **Tools** menu select **Add-Ins**.
- 7 In the **Add-Ins** dialog box that opens, make sure that the **COMSOL Multiphysics Interface** is active by checking the appropriate check boxes.

Adding the Bidirectional Interface to Autodesk Inventor to the CAD Import Module

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

In case the connection between COMSOL and Autodesk Inventor fails, run the batch script `RegisterInventorIface.bat` located in the `cad` directory found under the COMSOL installation directory. In Windows XP, you do this by double-clicking the batch file's icon in Windows Explorer; make sure that you have administrator privileges before running the script. On Windows Vista, instead right-click the icon and select **Run as administrator**.

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 26 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 3.5a

- 1 Insert the COMSOL 3.5a DVD into the DVD drive.
- 2 If the DVD is not mounted automatically by your operating system, use the `mount` command to mount it.
- 3 To start the installation, enter the command

```
sh drivepath/setup
```

where *drivepath* is the mount point of the DVD drive, for example, `/media/cdrom`.
- 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**.

Note: If you have a Named Single User License and you are installing the software on the license server a dialog box will open up at this point and you will be asked to enter the user to bind the license to.

- 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 7.0, 7.0.1, 7.0.4, 7.1, 2006a/b, 2007a/b work with COMSOL 3.5a.
- 8** Click **Next**.
- 9** Click **Install** to start the installation.
- 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. Use the `umount` and `eject` commands to unmount and eject the DVD. Some Linux and Sun configurations automatically unmount and eject the DVD when you press the DVD drive button.

The file `browser` in the `doc` directory attempts to start common web browsers. Edit the file in any text editor to adjust it for your preferred web browser. The variable `BROWSERS` in this file contains a list of web browsers in order of preference. The default list contains the following web browsers:

- 1** Mozilla
- 2** Firefox
- 3** Konqueror
- 4** Opera
- 5** Netscape

If you, for example, want to make Opera the preferred web browser, put it first in the list.

Note: To make sure all users can easily start COMSOL, include the `comsol35a/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 3.5a installation adds files only in the `comsol35a` directory. To remove the COMSOL installation, simply delete the `comsol35a` directory including all subdirectories.

Automated Installation

You can supply an answer file to the installer to run an unattended installation or to avoid the need of a display during the installation. The documentation on how to create an answer file is available in the template answer file, `setup.ini`, which you find on the DVD. When you have created an answer file, start the installation by running

```
<path to DVD>/setup -s <answer file path>
```

where `<answer file path>` is the path to your answer file.

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 `m1root=` 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 install COMSOL software with a passcode, no license manager is needed. If you install 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 26 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 3.5a 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 3.5a.

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/macosx_updates/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 COMSOL 3.5a

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 3.5a DVD into the DVD drive. Launch the **COMSOL Installer** application from the Finder. The **COMSOL 3.5a Installer** window appears.
- 2 To proceed, see the instructions for Windows in the section “Installing COMSOL 3.5a” on page 10. The procedure is the same for the Macintosh.

Removing (Uninstalling) the COMSOL Installation

The COMSOL 3.5a installation adds files only in the COMSOL35a folder. To remove the COMSOL installation, simply delete the COMSOL35a folder including all subfolders.

Automated Installation

You can install COMSOL using an automated installation process with minimal user interaction. The documentation on how to create an answer file is available in the template answer file, `setup.ini`, which you find on the DVD. When you have created an answer file, start the installation by running

```
<path to DVD>/setup -s <answer file path>
```

where *<answer file path>* is the path to your answer file.

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 `m1root=` 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 28

“License Manager Installation on Linux and Sun” on page 30

“License Manager Installation on the Macintosh” on page 35

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 11 from Acresso Software Inc. 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 3.5a permanent uncounted \
  VENDOR_STRING=T,7F3F3 HOSTID=DEMO SN=123456789 \
  SIGN=123456789ABC
INCREMENT COMSOL LMCOMSOL 3.5a permanent 10 DUP_GROUP=UH \
  SIGN=123456789ABC
INCREMENT COMSOLGUI LMCOMSOL 3.5a permanent 10 DUP_GROUP=UH \
  SIGN=123456789ABC
INCREMENT Chem LMCOMSOL 3.5a permanent 5 DUP_GROUP=UH \
  SIGN=123456789ABC
INCREMENT EM LMCOMSOL 3.5a permanent 5 DUP_GROUP=UH \
  SIGN=123456789ABC
INCREMENT SME LMCOMSOL 3.5a 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 3.5a license allowing ten concurrent users of

COMSOL Multiphysics and five concurrent users of the Chemical Engineering Module, the AC/DC 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 38 for instructions) and preferably your license server name. Please have them ready when contacting your local COMSOL representative.

License Manager Installation on Windows

You only need to install the license manager if you have obtained a license file that starts with a line that contains the word `SERVER`.

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 10 for installation instructions. When finished, skip the remainder of this section and continue with “Starting the License Manager” on page 29.

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

- 1 Insert the DVD into the DVD drive.
- 2 Follow the installation instructions starting on page 10 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.

Automated License Manager Installation

Alternatively, you can install the license manager using an automated installation process with minimal user interaction. See the section “Automated Installation” on page 17. Set `licmanager = 1` in the answer file to install the license manager.

STARTING THE LICENSE MANAGER

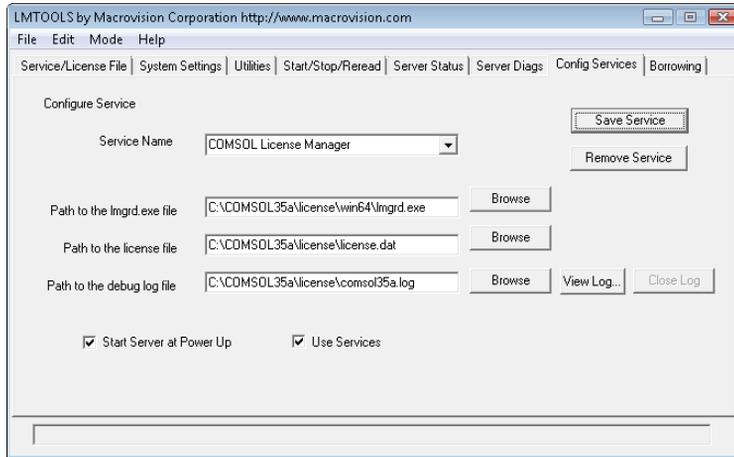
You can start the license manager manually, or it can run automatically as a service at boot.

Starting the Manager Automatically as a Service

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

- 1 Locate the `comsol35a\license\win32` (Windows) or `comsol35a\license\win64` (64-bit Windows) 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` (Windows) or `license\win64` (64-bit Windows) directory. Now, in a command window enter

```
lmgrd -c ..\license.dat -l ..\comsol35a.log
```

The license manager is now ready to distribute licenses over the network. It writes debug information to the log file `comsol35a\license\comsol35a.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 3.5a 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 21). When finished, skip the remainder of this section and continue at “Starting the License Manager” on page 33.

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

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

```
/media/cdrom/setup
```

depending on where `/media/cdrom` is the mount point of the DVD drive.
- 3 Continue according to the installation instructions on page 25 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.

Automated License Manager Installation

Alternatively, you can install the license manager using an automated installation process with minimal user interaction. See the section “Automated Installation” on page 23. Set `licmanager = 1` in the answer file to install the license manager.

LICENSE FILES FOR NAMED SINGLE USER LICENSE

If you have a *Named Single User License* the installer automatically creates an *options file* that binds the license to the named user. This section describes the format of the options file and how the `license.dat` file points to the options file.

Below is an example of an options file, `LMCOMSOL.opt`, for a user “philip” who has access to COMSOL Multiphysics, 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.

```
INCLUDE COMSOL USER philip
INCLUDE COMSOLGUI 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.

The following table contains the feature names for all products in the COMSOL 3.5a product family:

TABLE I-4: COMSOL 3.5A PRODUCTS AND THEIR FEATURE NAMES

PRODUCT/FEATURE	FEATURE NAME
COMSOL Multiphysics	COMSOL
COMSOL Multiphysics GUI	COMSOLGUI
COMSOL Multiphysics floating network license	CLIENTSERVER
COMSOL Reaction Engineering Lab	REACTION
AC/DC Module	EM
Acoustics Module	ACO
CAD Import Module	CADIMPORT
Chemical Engineering Module	ChEM
Earth Science Module	ES
Heat Transfer Module	HT
MEMS Module	MEMS

TABLE I-4: COMSOL 3.5A PRODUCTS AND THEIR FEATURE NAMES

PRODUCT/FEATURE	FEATURE NAME
RF Module	RF
Structural Mechanics Module	SME
Optimization Lab	OPTLAB

The license.dat file needs to point to the options file. The path to the options file is indicated by the “options” keyword. If your options file is placed here:

```
/usr/local/comsol35a/license/LMCOMSOL.opt
```

then the VENDOR row in license.dat should read

```
VENDOR LMCOMSOL options=/usr/local/comsol35a/license/LMCOMSOL.opt
```

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/comsol35a.log
```

The server is now ready to distribute licenses over the network. It writes any debug information to the log file /var/tmp/comsol35a.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 recommend 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 1-5: BOOT SCRIPT PROCEDURES

PLATFORM	PROCEDURE
Sun	<p>Copy the file <code>comsol35a/license/sol2/rc.lm</code> and paste it at the beginning of <code>/etc/init.d/lmgrd</code>. Create this file if it does not already exist.</p> <p>Edit <code>/etc/init.d/lmgrd</code>, replacing 'dir' in the code fragment with the full path to the sol2 platform directory, and replace 'username' with an actual username.</p> <p>If the file (link) <code>/etc/rc3.d/S171lmgrd</code> does not exist, create it with the commands</p> <pre>cd /etc/rc3.d ln -s /etc/init.d/lmgrd S171lmgrd</pre>
SuSE Linux	<p>The following instructions should work for SuSE Linux distributions, where <code>\$arch</code> is either <code>glnx86</code> (32-bit Linux), or <code>glnxa64</code> (64-bit Linux).</p> <p>In the <code>comsol35a/license/\$arch</code> directory, type the commands</p> <pre>cp rc.lm /etc/init.d/comsol35alm chmod 755 /etc/init.d/comsol35alm</pre> <p>Edit <code>/etc/init.d/comsol35alm</code>, replacing <code>dir</code> with the full path to the <code>\$arch</code> platform directory, and replace <code>username</code> with an actual username.</p> <p>Now create the following link</p> <pre>cd /etc/init.d/rc5.d ln -s ../comsol35alm S91comsol35alm</pre>
Debian Linux	<p>The following instructions should work for Debian Linux distributions, where <code>\$arch</code> is either <code>glnx86</code> (32-bit Linux), or <code>glnxa64</code> (64-bit Linux).</p> <p>Copy the file <code>comsol35a/license/\$arch/lm_comsol</code> to <code>/etc/init.d</code></p> <p>Edit <code>/etc/init.d/lm_comsol</code>. Update the <code>FP</code> and <code>MYUSER</code> variables as indicated in the file. Use the utility <code>update-rc.d</code> to automatically update the system's init script links:</p> <pre>update-rc.d lm_comsol start 99 2 3 4 5 . stop 1 0 1 6 .</pre> <p>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 <code>man update-rc.d</code> for more information on init scripts.</p>
Linux	<p>The following instructions should work for most Linux distributions, where <code>\$arch</code> is either <code>glnx86</code> (32-bit Linux), <code>glnxa64</code> (64-bit Linux), or <code>glnxi64</code> (Itanium).</p> <p>Copy the file <code>comsol35a/license/\$arch/rc.lm</code> and paste it at the end of <code>/etc/rc.d/rc.local</code>.</p> <p>Replace 'dir' in the code fragment with the full path to the <code>\$arch</code> platform directory, and replace 'username' with an actual username.</p>

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 Macintosh

You only need to install the license manager if you have obtained a license file that starts with a line that contains the word `SERVER`.

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 24). When finished, skip the remainder of this section and continue at “Starting the License Manager” on page 36.

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

- 1 Insert the COMSOL 3.5a DVD into the DVD drive.
- 2 Follow the installation instructions starting on page 25 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 10) to complete the license manager file installation.

Automated License Manager Installation

Alternatively, you can install the license manager using an automated installation process with minimal user interaction. See the section “Automated Installation” on page 25. Set `licmanager = 1` in the answer file to install the license manager.

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/COMSOL35a/license/macosx`
- 3 Then enter
`./lmgrd -c ../license.dat -l /var/tmp/comsol35a.log`

The server is now ready to distribute licenses over the network. It writes any debug information to the log file `/var/tmp/comsol35a.log`.

Starting the License Manager Automatically at Startup

A folder `COMSOL_Lmgr` located in the folder `COMSOL35a/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/COMSOL35a

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.

Changing the License

If you have received a new license file—for example, when adding COMSOL products to an existing license—replace your current license file with the new one.

Double-check the contents of this file to make sure it lists the products that your license includes.

When you have changed the license file you must restart the license manager; otherwise, it will continue to use the old license file still in memory.

RESTARTING THE LICENSE MANAGER ON WINDOWS

To restart the license manager on Windows, follow these steps:

- 1** In the Windows Start menu, choose **COMSOL3.5a>License Tools>LMTTOOLS**.
- 2** In the FLEXnet Control Panel, click, in turn, **Stop Server**, **ReRead License File**, and **Start Server**.

RESTARTING THE LICENSE MANAGER ON LINUX AND SUN

To restart the license manager on Linux and Sun, make the license/\$arch directory under the COMSOL installation directory the current directory, then enter the following commands

```
./lmdown -c ../license.dat  
./lmgrd -c ../license.dat -l /var/tmp/comsol35a.log
```

RESTARTING THE LICENSE MANAGER ON THE MACINTOSH

To restart the license manager on the Mac, do as follows:

- 1 Launch the **Terminal** application.
- 2 Change directory to the `license/macosx` directory

```
cd /Applications/COMSOL35a/license/macosx
```
- 3 Enter the commands

```
./lmdown -c ../license.dat
./lmgrd -c ../license.dat -l /var/tmp/comsol35a.log
```

Obtaining a Hostid

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

```
COMSOL35a/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 I-6: HOSTIDS FOR THE SUPPORTED PLATFORMS

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

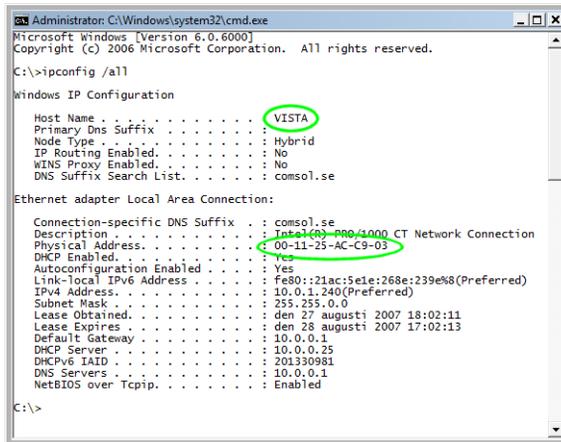
called a MAC address) as the hostid. An Ethernet address has six bytes, each with two hexadecimal digits. Be sure to specify all twelve hex digits when using an Ethernet address as a hostid. For example, if the Ethernet address is 8:0:20:0:5:ac specify 0800200005ac as the hostid.

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
```

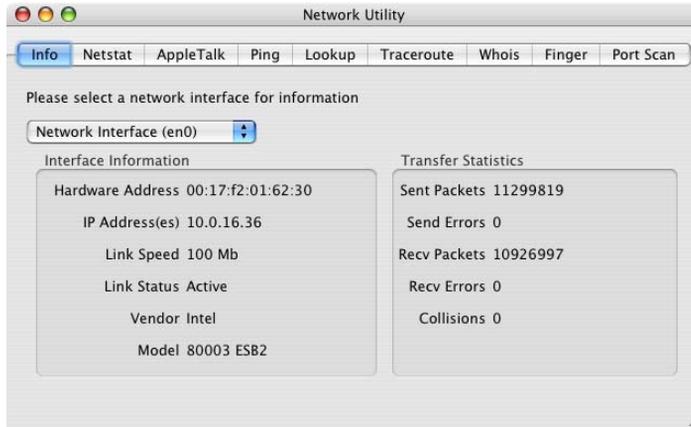
and press Enter.
- 4 The FLEXnet hostid is equal to the **Physical Address**, which is displayed in the next image, with the hyphens removed.



OBTAINING THE HOSTID ON A MACINTOSH

- 1 Launch the application **Network Utility** found in the **Applications/Utilities** folder.
- 2 Click the **Info** tab to the left.
- 3 Select **Network Interface (en0)**. This corresponds to your Ethernet card.
- 4 The hostid is the **Hardware Address**, which is displayed in the following image, with the colons removed. If you plan to install on a Macintosh laptop with a wireless

network card, please report the hardware address for both **Network Interface (en0)** and **Network Interface (en1)**.



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. Also check the COMSOL Support Knowledge Base at www.comsol.com/support/knowledgebase for up-to-date information about installation and license issues

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:\COMSOL35a\license\comsol35a.log Linux/Sun/Mac: /var/tmp/comsol35a.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” on page 26 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:\COMSOL35a\license\comsol35a.log Linux/Sun/Mac: /var/tmp/comsol35a.log

TABLE I-7: GENERAL ERROR MESSAGES

ERROR MESSAGE	EXPLANATION
License error: -15. Cannot connect to license server system.	<p>The COMSOL license manager has not been installed or started yet. If the first line of your license.dat file looks like this:</p> <pre>SERVER mylicserver 000123456789 1716</pre> <p>a license manager is required. Please refer to the section “License Manager Installation” on page 26 for instructions how to install and start the COMSOL license manager.</p> <p>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.</p> <p>Check that no firewall on the license server is preventing the connection from the COMSOL client computer to the license manager.</p> <p>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:</p> <pre>Windows: C:\COMSOL35a\license\license.dat Linux/Sun: /usr/local/comsol35a/license/license.dat Mac: /Applications/comsol35a/license/license.dat</pre> <p>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:</p> <pre>SERVER mylicserver 000123456789 1716</pre> <p>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.</p> <p>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:</p> <pre>Windows: C:\COMSOL35a\license\comsol35a.log Linux/Sun/Mac: /var/tmp/comsol35a.log</pre> <p>NOTE: The log file is created by the license manager after it has been started.</p> <p>Please send the log file to support@comsol.com if you want help in interpreting the information.</p>

TABLE I-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:\COMSOL35a\license\license.dat Linux/Sun: /usr/local/comsol35a/license/license.dat Mac: /Applications/comsol35a/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:\COMSOL35a\license\comsol35a.log Linux/Sun/Mac: /var/tmp/comsol35a.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.

Updating COMSOL

To make sure your COMSOL installation is up to date, you can check for product updates by choosing **Check For Updates** from the **Help** menu. If any update is available, the application will direct you to a website where you can download the update. Download the update and place it in the `updates/` folder of your COMSOL installation. To install the update on a Windows machine, select **Programs>COMSOL 3.5a>Tools>Install COMSOL Update** from the Windows Start menu. To install the update on other platforms, run `comsol update`.

Running COMSOL

This chapter describes the various options for running the COMSOL software products on the supported platforms.

Running COMSOL on Windows

The installer adds the folder **COMSOL 3.5a** 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 with MATLAB:** Starts MATLAB 7.0, 7.0.1, 7.0.4, 7.1, 2006a/b, or 2007a/b 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 62).
- **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 62).
- **Uninstall COMSOL 3.5a.**
- **Documentation:** A folder that contains COMSOL documentation shortcuts.

Running COMSOL Multiphysics

You can run COMSOL Multiphysics by double-clicking the **COMSOL Multiphysics 3.5a** icon on the desktop.



Alternatively, to activate COMSOL Multiphysics from the **Start** menu, point to **Programs**, then to **COMSOL 3.5a**, and then click **COMSOL Multiphysics**.

Running COMSOL Multiphysics with MATLAB

To run COMSOL Multiphysics with MATLAB, double-click the **COMSOL 3.5a with MATLAB** icon on the desktop.



Alternatively, start COMSOL Multiphysics with MATLAB from the **Start** menu by pointing to **Programs**, then to **COMSOL 3.5a**, 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. COMSOL also creates a `java.opts` file in your current directory. 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 in the **Start in** edit field.
- 3 Click **OK**.

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 Multiphysics with MATLAB

Run the command

```
comsol matlab
```

to launch MATLAB with paths setup to run COMSOL Multiphysics functions.

Run the command

```
comsol matlab multiphysics
```

to launch the COMSOL Multiphysics user interface from within the MATLAB environment.

The script `comsol` creates the files `classpath.txt` and `java.opts` that MATLAB requires, and it puts those files 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. COMSOL 32-bit with MATLAB on 64-bit Linux is not supported.

Considerations on Linux

COMSOL has been compiled to run on certain older versions of Linux. COMSOL does not automatically detect these older Linux versions, so you need to tell COMSOL about this. These versions do not have full parallel support.

32-BIT LINUX

To run COMSOL on a Linux version with glibc version lower than 2.3.2, you need to run the `comsol` command with the `-gcc323` option. Type `comsol -gcc323` to start COMSOL.

64-BIT LINUX

To run COMSOL on a Linux version with glibc version lower than 2.3.4, you need to run the `comsol` command with the `-gcc332` option. Type `comsol -gcc332` to start COMSOL.

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 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 62).

- **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 62).

Running COMSOL Multiphysics from a Terminal Window

You can also launch COMSOL Multiphysics from a terminal window using the shell script `COMSOL35a/bin/comsol`. See the section “Running COMSOL on Linux/Sun” on page 48 for options available in the `comsol` command.

To run the `comsol` command more easily, include the `COMSOL35a/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/COMSOL35a/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 `COMSOL35a/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>] [<target>] [<target arguments>] [<expression>]
```

where square brackets indicate optional arguments. Table 2-1 lists available options.

TABLE 2-1: COMSOL OPTIONS (CURLY BRACKETS INDICATE DEFAULT VALUES)

COMSOL OPTION	DESCRIPTION	AVAILABILITY
-32	Use a 32-bit data model if available	In Windows, use <code>comsol.exe</code>
-64	Use a 64-bit data model if available	In Windows, use <code>comsol64.exe</code> . Not available on PowerPC Mac
-blas {auto} mk1 atlas sunperf path acml veclib	BLAS library to use	See section “COMSOL and BLAS” on page 70
-h	Print general help	
-h <target>	Print target-specific help	
-ipv6	Activate IPv6 support	
-mesa	Use mesa software rendering libraries	Only available on Linux
-mpmode <throughput> <turnaround> <owner>	Multiprocessor mode	See “Optimizing Processor Usage” on page 68
-nn <no. of nodes>	Number of nodes	Available on Linux and Windows CCS 2003
-nopin	Disable process pinning on cluster	Available on Linux
-np <no. of processors>	Number of processors	Not available on PowerPC Mac

TABLE 2-1: COMSOL OPTIONS (CURLY BRACKETS INDICATE DEFAULT VALUES)

COMSOL OPTION	DESCRIPTION	AVAILABILITY
-prefdir <path>	Preference directory	
-tmpdir <path>	Temporary file directory	
-version	Print COMSOL version	
-version <target>	Print target version	

We support the 64-bit option on Linux, Itanium, Intel Mac, 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 `-prefdir` option specifies the directory where COMSOL should store the preference file.

The available `comsol` command targets are:

TABLE 2-2: COMSOL COMMAND TARGETS

TARGET	DESCRIPTION	AVAILABILITY
<code>multiphysics</code>	Run standalone COMSOL Multiphysics	
<code>batch</code>	Run COMSOL Multiphysics in batch mode	In Windows, use <code>comsolbatch.exe</code> or <code>comsolbatch64.exe</code>
<code>client</code>	Run COMSOL Multiphysics client	
<code>matlab</code>	Run COMSOL Multiphysics with MATLAB	
<code>mpd</code>	Run a COMSOL MPD (multiprocessor daemon) command	Only available on Linux
<code>reaction</code>	Run COMSOL Reaction Engineering Lab	In Windows, optionally use <code>comsolreaction.exe</code> or <code>comsolreaction64.exe</code>
<code>server</code>	Run COMSOL Multiphysics server	This is the only target available on the Itanium platform. In Windows use <code>comsolserver.exe</code> or <code>comsolserver64.exe</code>
<code>update</code>	Install COMSOL update	

From within COMSOL Multiphysics and COMSOL Reaction Engineering Lab, you can start the 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 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 62.

GENERAL COMSOL TARGET COMMAND-LINE ARGUMENTS

TABLE 2-3: COMSOL TARGET COMMAND-LINE ARGUMENTS

TARGET	OPTION	DESCRIPTION
multiphysics reaction	-open	Open model file
server client	-port	Server port number
server client	-timeout	Time before disconnecting in seconds
server	-multi on {off}	Accept repeated client connections
server	-login {info} force never	Show login dialog box

Example

Start COMSOL Server and COMSOL Client, explicitly choosing a port number, enabling repeated client connections, 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 BATCH ARGUMENTS

The general syntax for the command for starting COMSOL Batch is

```
comsol [<options>] batch [<target arguments>]
```

The COMSOL Batch mode can be used to run parametric sweeps (see “Setting Up Parametric Sweeps” on page 383 of the *COMSOL Multiphysics User’s Guide* for a description of this feature). Its detailed command arguments are:

TABLE 2-4: COMSOL BATCH-SPECIFIC ARGUMENTS

COMSOL BATCH ARGUMENTS	DESCRIPTION
-input <file name>	Load the Model MPH-file with the given file name and solve using current solver settings. Note that the model must be meshed.
-output <file name>	Save the Model MPH-file using the given file name. If output is not given, the input file will be overwritten with the output.
-paramfile <file name>	File with parameter values.
-logfile <file name>	File to stored evaluated expressions in.
-pname <comma-separated list>	Parameter names.
-globals <comma-separated list>	Global expressions to evaluate.
-psave on {off}	Store intermediate solutions on file.

Example

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

```
comsol batch -input <file name>
```

On Windows, run the following command:

```
comsolbatch.exe -input <file name>
```

This command starts COMSOL Batch, solves the model in the Model MPH-file with the given file name using the active solver settings in the model, and stores the solution in the same file.

MATLAB ARGUMENTS

The command `comsol matlab [<options>]` starts MATLAB with the COMSOL paths set up. Run the command `comsol matlab multiphysics` to also launch the COMSOL Multiphysics user interface.

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 command `comsol matlab reaction [<options>]` starts MATLAB and the COMSOL Reaction Engineering Lab graphical user interface.

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
-mlroot <directory>	Specify root directory for MATLAB installation
-D<debugger>	Run MATLAB in debugger, no COMSOL paths set

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
```

Note: On Windows MATLAB uses DOS-type input arguments, so the equivalent line is

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

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

```
comsol matlab multiphysics -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,

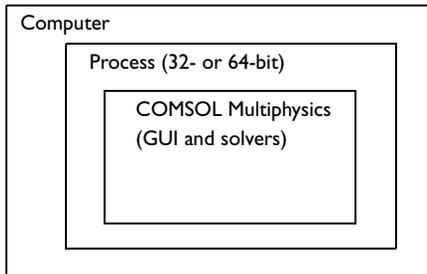
```
mlargs=-nodesktop -nosplash
```

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 3.5a can run as a 32-bit application on Windows, Linux, Sun, and Mac.

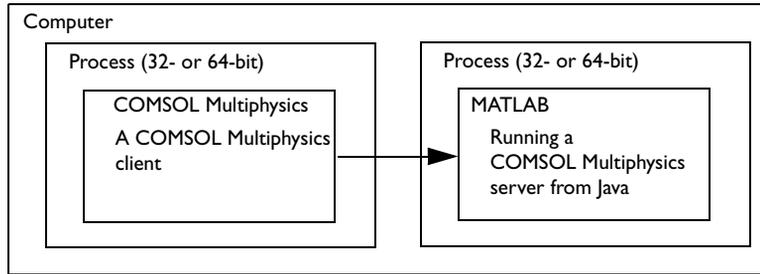


In addition, COMSOL Multiphysics can run in 64-bit mode as a standalone application on 64-bit Windows plus 64-bit Linux, Intel Mac and Sun.

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/b and 2007a/b; on 64-bit Linux with MATLAB 7.0.1, 7.0.4, 7.1, 2006a/b, and 2007a/b; and on Sun with MATLAB 2007a/b.

Running COMSOL Multiphysics as a Client/Server Application

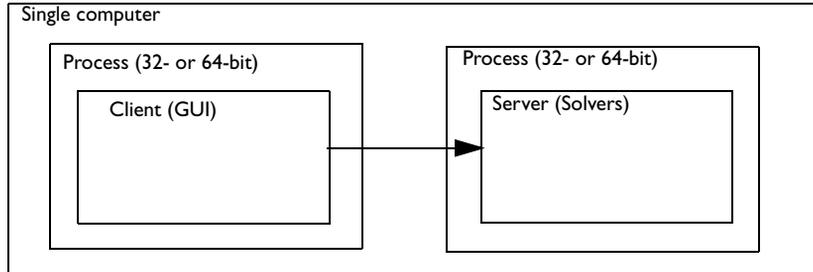
The COMSOL Multiphysics client runs as a 32-bit application on all platforms for which we distribute the software: Windows, Linux, Sun, and the Mac. In addition, the COMSOL Multiphysics client can run as a 64-bit application on 64-bit Windows plus 64-bit Linux, Intel Mac, and Sun.

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, Intel Mac and Sun.

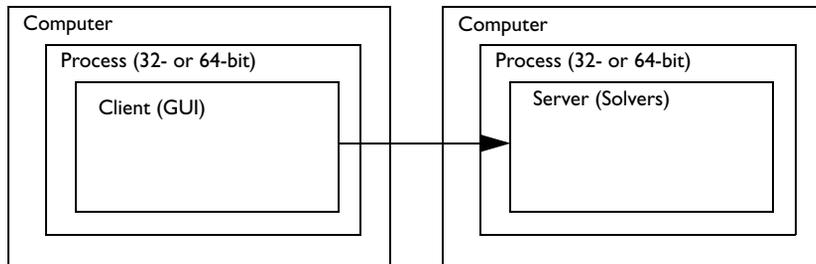
RUNNING COMSOL MULTIPHYSICS CLIENT/SERVER ON THE SAME COMPUTER

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).

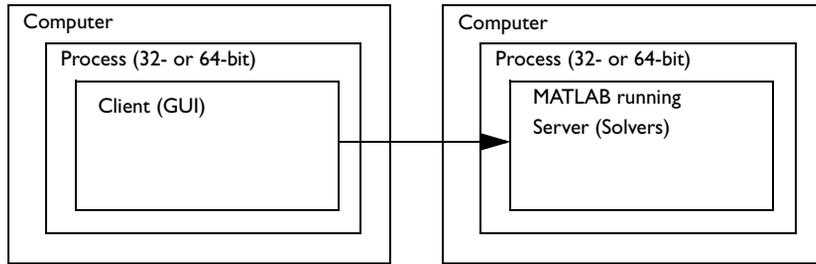


This is the only way to run the COMSOL Multiphysics server on the Itanium platform because neither the COMSOL Multiphysics client nor standalone COMSOL Multiphysics are available for this platform.

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 3.5a**, and then **Client/Server**. If starting the COMSOL Multiphysics server from a terminal window in Windows, use the command `C:\COMSOL35a\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 3.5a**, 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.

DISCONNECT/RECONNECT

The COMSOL Multiphysics server is only connected to the client for a short period of time. If no updates have been issued during this period the server shuts down the port and starts waiting for the client to reconnect. Once a new operation is issued on the client side the connection is reestablished. You can control the time before the server disconnects with the `-timeout` option. By default the server waits 10 minutes before it disconnects.

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`.

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.

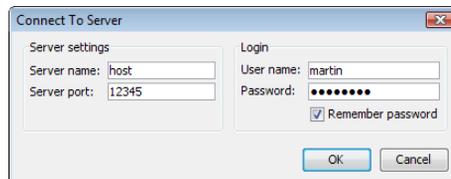
CONNECTING TO MATLAB

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 a COMSOL Multiphysics server 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 client 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 the COMSOL Multiphysics client. The software writes this login information in the subdirectory `.comsol/ver35a/login` in your home directory. On Mac OS X this login information is located in `Library/Preferences/COMSOL/ver35a/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/ver35a/login` in your home directory. This is 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.

Running COMSOL in Parallel

COMSOL supports two mutual modes of parallel operation. One mode is based on the distributed memory model and runs on several nodes on a Linux or Windows cluster; see “Distributed-Memory Parallel COMSOL” on page 72. The other mode, described below, is based on the parallel shared memory model.

Shared-Memory Parallel COMSOL

Most multiple-processor machines and dual-core/multicore machines support the shared memory model, however, it is not supported by several nodes on a cluster. The solvers, assembly, and meshing in COMSOL Multiphysics benefit from shared memory parallelism.

NUMBER OF PROCESSORS USED BY SHARED MEMORY COMSOL

On Linux and Sun, the COMSOL software runs on one processor by default. On Windows, COMSOL uses the environment variable `NUMBER_OF_PROCESSORS`. On Intel Mac, the number of processors is detected through the `sysctl` command. If you have a parallel machine that COMSOL supports, you can override the default with the option `-np <number of processors>`.

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

Note: MATLAB 2007a supports multiple processors. The support is activated on the **General** page of the **Preferences** dialog box, which you reach from the **Options** menu. When disabled, this setting overrides the processor settings in COMSOL.

OPTIMIZING PROCESSOR USAGE

Depending on how loaded your machine is, you can control how COMSOL uses the available processors. Apart from the default mode there are three modes of operation that you control with the option `-mpmode <multiprocessor mode>`. The *throughput mode* (`-mpmode throughput`) is expected to give the best performance when several

different processes are running actively at the same time as COMSOL. The *turnaround mode* (-mpmode turnaround) and *owner mode* (-mpmode owner) typically provide the best performance when no other processes than COMSOL are active. The owner mode provides the highest performance in most cases, but the only way to find out is to experiment with the different modes.

Note: You can set the environment variable COMSOL_MP_MODE instead. It is overridden by the option -mpmode.

BENEFITS OF RUNNING COMSOL SHARED MEMORY PARALLEL

All iterative solvers and smoothers except Incomplete LU are parallelized. Some smoothers have blocked versions. The blocked versions are usually more parallel than the nonblocked versions. The finite element assembly also runs in parallel. Usually the speedup depends on the problem size; problems using a lot of memory usually have better speedup.

The PARDISO sparse direct linear solver runs in parallel. It is available on Windows, Linux, and Intel Mac. The SPOOLES sparse direct linear solver also runs in parallel on Windows, Linux, Sun, and Intel Mac. The direct solvers UMFPACK and TAUCS both benefit from shared memory parallelism; however, to a lesser extent than PARDISO and SPOOLES.

The free mesher in 3D runs in parallel over the faces and subdomains of the geometry object being meshed. For this reason, the speedup when running on several processors depends strongly on the domain partitioning of the corresponding geometry. Meshing a geometry with only one subdomain, such as an imported CAD part, gives almost no speedup at all. On the other hand, meshing a geometry with several subdomains, such as an imported CAD assembly with many parts, can give significant speedup, especially if the number of elements in the mesh is large.

The following postprocessing plots run in parallel in 3D: slice plots, isosurface plots, subdomain plots, boundary plots, edge plots, deformed-shape plots, and streamline plots. In 2D, surface plots, contour plots, and boundary plots, and deformed-shape plots run in parallel.

A significant part of the parallel speedup in computations comes from functions of the type BLAS (basic linear algebra subprogram; see the next section). If you want to run

the software in parallel, it is important that the BLAS library you use supports parallelism. The ACML, MKL, and Sun performance libraries run in parallel.

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

Running in parallel usually requires extra memory. If you run out of memory, try to set the `-np` option to a lower number. The speedup depends on the processor load. For instance, if your system has m processors and n of them are used by other active programs, do not set the `-np` option to a number that is greater than $m - n$. The reason is that the programs compete for the same resources, which slows all of them considerably.

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 ACML (AMD Core Math Library) optimized for AMD processors with SSE2 support, MKL (Math Kernel Library) optimized for Intel processors, and ATLAS (Automatically Tuned Linear Algebra Software). On PowerPC Mac, COMSOL relies on vecLib, which is installed on the system. Sun provides the Sun Performance Library with Sun Studio. Use the Sun Studio 11 version on 64-bit Solaris and the Sun Studio 8 version on 32-bit Solaris. 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, Intel Mac and Windows).
- ACML on AMD processors that support SSE2 instructions; otherwise ATLAS is used (Linux and Windows).
- ATLAS on Sun.
- vecLib on PowerPC Mac.

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

- `auto`—same as not using the option (Linux, Windows, Sun)
- `mk1`—selects the MKL library (Linux, Intel Mac, Windows)

- `atlas`—selects the ATLAS library (Linux, Windows, Sun)
- `acml`—selects the ACML library (Linux, Windows)
- `sunperf`—selects the Sun Performance Library (Sun)
- `vecLib`—selects the vecLib Library (Intel Mac and PowerPC Mac)
- `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, Mac)

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` option, you can set the environment variable `COMSOL_BLAS_LIBRARY`. The option `-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 `COMSOL35a/lib/ARCH` where ARCH is the architecture (`glnx86`, `glnxa64`, `glnxi64`, `win32`, `win64`, `maci32`, `maci64`, `macosx`, `sol2`, or `sol64`) or somewhere in the standard search path.

Note: You must also provide the path to any sublibraries needed by the library.

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 (`LD_LIBRARY_PATH_64` on 64-bit 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.

Distributed-Memory Parallel COMSOL

The Linux and Windows versions of COMSOL support a distributed memory mode. The distributed mode starts a number of computational nodes determined by the `-nn <number of nodes>` option to the COMSOL command. Each computational node is a separate process running a COMSOL instance. A computational node is not the same as a physical node (computer), but they can coincide. When running in distributed mode, COMSOL uses MPI for communicating between the processes in the distributed environment.

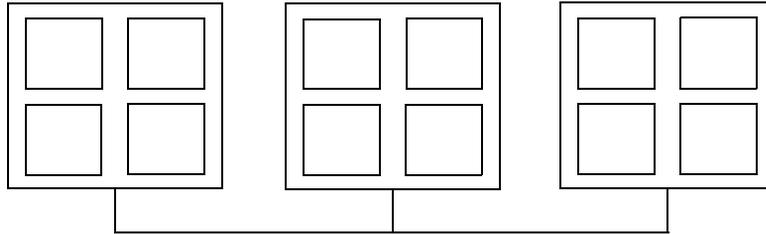


Figure 2-1: Schematic of a cluster with 3 physical nodes (computers) with 4 processors each.

The distributed-memory mode can be combined with COMSOL's ability to benefit from the shared-memory model. Use the `-nn` option in combination with the `-np` option. The `-nn` option directs COMSOL to start up a number of computational nodes that communicate using the distributed-memory model. The `-np` option directs each computational node to use a certain number of processors. See the section "Number of Processors Used by Shared Memory COMSOL" on page 68 for details about the `-np` option.

For the schematic in Figure 2-1, you can choose any number of computational nodes between 1 and 12 by specifying the `-nn` option. Each node, in turn, can use between 4 and 1 processors, as specified by the `-np` option. By default, COMSOL uses as many processors as are available on each physical node for shared-memory parallelism on Windows. This is suboptimal if the number of computational nodes is not the same as the number of physical nodes. Therefore we recommend that you explicitly set the number of processors. For the schematic example, if you run 6 computational nodes (`-nn`), the optimal value for number of processors (`-np`) is 2. The number of processors used is $nn * np$.

For the same example, assuming you are the sole user of the system for the duration of the computation and that your problem requires a lot of memory, set `-nn 3 -np 4`.

If, on the other hand, your problem is small, set `-nn 12 -np 1`. This way you make the best use of shared-memory and distributed-memory parallelism for each problem.

You do not need a cluster to benefit from COMSOL's ability to utilize the distributed-memory model. On a multiprocessor computer you can use the `-nn` option to start multiple computational nodes. This can be useful for small-sized parameter sweeps, for example. Make sure that the number of computational nodes times the number of processors does not exceed the number of available processors; otherwise performance deteriorates significantly. See the section “Benefits of Running COMSOL Shared Memory Parallel” on page 69.

Note: In client/server mode, the computer or cluster acting as server must be accessible from the client through a TCP/IP connection. If you are not able to connect to the server, you can use the `comsol batch` command to solve models on the cluster or do parametric sweeps.

RUNNING DISTRIBUTED-MEMORY PARALLEL COMSOL

Windows Compute Cluster Server 2003

Make sure that you have installed Windows Compute Cluster Server 2003. Running distributed COMSOL on other noncluster Windows versions is not supported.

On Windows we recommend that you start a COMSOL server (see “Running COMSOL Multiphysics Client/Server” on page 62) or run a COMSOL batch command from the Compute Cluster Job Manager. By default COMSOL uses as many processors as are available on each physical node for shared-memory parallelism on Windows. Therefore it is best to explicitly set the number of processors. Make sure that you set the Windows Compute Cluster Server 2003 working directory to point to the `comsol` command directory (*<path to COMSOL install directory>\bin*). The install directory must be shared between the nodes on your cluster.

COMSOL server When you create a COMSOL server cluster job, you must set a preference directory reachable from all nodes to avoid problems with the server login; see “The COMSOL Command” on page 52 and “Login Information and Security” on page 67. You can generate the preferences by starting COMSOL server once on the head node using the command

```
comsolserver.exe -prefmdir <path to common directory with preferences>
```

and then selecting the **Remember password** check box in the login dialog box.

When you start the COMSOL server on the cluster, the port number will be written to standard output, so you must set a standard output file and a standard error file for the cluster job. To start a COMSOL server, schedule a job with one of the following commands:

```
mpiexec comsolserver.exe -nn -1 -np 1 -prefsdir <path to common
  directory with preferences>
mpiexec comsolserver64.exe -nn -1 -np 1 -prefsdir <path to common
  directory with preferences>
```

The argument `-1` indicates that the number of computational nodes is decided at the `mpiexec` launch. You must be able to access the IP address of the COMSOL server from your COMSOL client computer.

COMSOL batch Schedule a job with one of the commands

```
mpiexec comsolbatch.exe -nn -1 -np 1 <filename>
mpiexec comsolbatch64.exe -nn -1 -np 1 <filename>
```

to run a COMSOL batch on a number of computational nodes given by `mpiexec`. For further information about the `mpiexec` command and the Windows Compute Cluster Server 2003, consult the documentation that was shipped with the product and the online manuals.

Windows HPC Server 2008

Make sure that you have installed Windows HPC Server 2008, then follow the instructions for Windows Compute Cluster Server 2003 on page 73.

Running on Linux

There are several implementations of MPI. COMSOL is shipped with the Intel MPI library but should also support most MPI implementations based on MPICH2. We recommend that you use the default Intel MPI library. For running COMSOL on a computer that has MPICH2 installed, COMSOL also has a compatibility mode that you can activate by adding the option `-mpi mpich2`. When using this option both the variables `PATH` and `LD_LIBRARY_PATH` must include your MPI implementation. It is also possible to use other MPI libraries based on MPICH2 using the option `-mpipath <path to shared library>`.

In order to start Intel MPI, have a file named `.mpd.conf` in your home directory to which you alone have access. This file should contain the single line

```
secretword = <your secret word here>
```

Before you start COMSOL, you must initialize the MPI environment. A so called multiprocessing daemon (MPD) must run on each computer node that you intend to use. To start MPD on several computer nodes, type

```
comsol -nn <number of computer nodes> mpd boot -f <filename>
```

The file *<filename>* should contain the names of the computer nodes that you intend to use. The file may contain more computer nodes than you actually intend to use. As an alternative to using the `-f <filename>` option, you can put the list of computer nodes in a file named `mpd.hosts` in your home directory. Start distributed COMSOL with the `-nn` option. For example, type

```
comsol -nn <number of computational nodes> server
```

to start a COMSOL server running on a specific number of computational nodes. The number of computational nodes can exceed the number of computer nodes. Avoid starting more computational nodes than the total number of processors that you have available. When you have finished using distributed COMSOL, you should take down the all MPDs. Type the command

```
comsol mpd allexit
```

stop all MPDs. To obtain more information about the `comsol mpd` commands, add the `-h` option to the commands, for example, `comsol mpd boot -h`.

Start MPD on a single computer with the command

```
comsol mpd mpd &
```

This is useful when running all computational nodes on a single multiprocessor computer or when you have difficulties attaching computational nodes because of firewalls. In the second case you can start an MPD on each node and attach them by specifying the main port and host. Use

```
comsol mpd trace -l
```

and

```
comsol mpd mpd --port <the port number reported> --host <the  
hostname reported>
```

You can also start COMSOL with the `-clustersimple` option. This option automatically starts and terminates the MPD daemon. It uses the `mpd.hosts` file in your home directory to determine what computational nodes to use.

Usually COMSOL only uses a display for one of the processes. However, if possible, the `-clusterdisplay` option starts a display for every process.

Starting Distributed COMSOL—Linux Examples

Start an MPD on a single computer. Then start distributed COMSOL on two computational nodes each using three processors, and finally stop the MPD:

```
comsol mpd mpd &  
comsol -nn 2 -np 3  
comsol mpd allexit
```

Start three MPDs on computer nodes with names defined in the file `myhosts`. Then start a distributed COMSOL server on three computational nodes, and finally stop the MPDs. First make sure that you can connect to all the computers with `ssh` without having to use your password (see the man pages for `ssh`). Also make sure that all computers have access to the same COMSOL installation and that they are using the same Linux version.

```
comsol -nn 3 mpd boot -f myhosts  
comsol -nn 3 server  
comsol mpd allexit
```

Start four computational nodes on hosts listed in the file `mpd.hosts` using distributed COMSOL and simplified start:

```
comsol -nn 4 -clustersimple
```

USING THE DISTRIBUTED VERSION INSIDE MATLAB

Running the distributed version in MATLAB is equivalent to running in client/server mode.

BENEFITS OF RUNNING COMSOL IN A DISTRIBUTED MODE

COMSOL runs parameter sweeps using the distributed mode. There are two ways of running distributed parameter sweeps. First, the parametric solver available from the **Solver Parameters** dialog box runs in distributed mode. Second, the **Parametric Sweep** dialog box on the **Solve** menu lets you run distributed parameter sweeps using any solver. These two features are also available in the COMSOL Batch mode; see “COMSOL Batch arguments” on page 54. In addition, the **Geometric Parametric Sweep** dialog boxes on the **File** menu lets you perform geometric parameter sweeps using the bidirectional interfaces to SolidWorks® and Autodesk Inventor® using the CAD Import Module. The parametric solver can run parametric sweeps from the command line in MATLAB. The parametric sweep feature is only available from the graphical user interface.

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