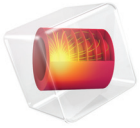


COMSOL Server

Manual

5.0

COMSOL

COMSOL Server Manual

© 1998–2014 COMSOL

Protected by U.S. Patents listed on www.comsol.com/patents, and U.S. Patents 7,519,518; 7,596,474; 7,623,991; and 8,457,932. Patents pending.

This Documentation and the Programs described herein are furnished under the COMSOL Software License Agreement (www.comsol.com/comsol-license-agreement) and may be used or copied only under the terms of the license agreement.

COMSOL, COMSOL Multiphysics, Capture the Concept, COMSOL Desktop, and LiveLink are either registered trademarks or trademarks of COMSOL AB. All other trademarks are the property of their respective owners, and COMSOL AB and its subsidiaries and products are not affiliated with, endorsed by, sponsored by, or supported by those trademark owners. For a list of such trademark owners, see www.comsol.com/trademarks.

Version: December 2014 COMSOL 5.0.1

Contact Information

Visit the Contact COMSOL page at www.comsol.com/contact to submit general inquiries, contact Technical Support, or search for an address and phone number. You can also visit the Worldwide Sales Offices page at www.comsol.com/contact/offices for address and contact information.

If you need to contact Support, an online request form is located at the COMSOL Access page at www.comsol.com/support/case.

Other useful links include:

- Support Center: www.comsol.com/support
- Product Download: www.comsol.com/product-download
- Product Updates: www.comsol.com/support/updates
- Discussion Forum: www.comsol.com/community
- Events: www.comsol.com/events
- COMSOL Video Gallery: www.comsol.com/video
- Support Knowledge Base: www.comsol.com/support/knowledgebase

Part number: CM010010

Contents

Introduction 5

Installing COMSOL Server. 8

Installing COMSOL Server in Windows 8

Installing COMSOL Server in Linux and OS X. 17

Firewalls 18

Starting COMSOL Server 19

Starting COMSOL Server as a Windows Service 19

Starting COMSOL Server Manually in Windows. 19

Starting COMSOL Server in Linux. 21

Starting COMSOL Server in OS X 22

Logging in to COMSOL Server 22

COMSOL Server Administration 24

Monitor 24

User Database 26

Preferences 27

Running Applications 32

Running Applications in a Web Browser. 32

Running Applications in the COMSOL Client 39

Running Applications that use LiveLink Products 42

Configuring COMSOL Server. 44

Configuring a Local User Database 44

Configuring Windows Authentication 48
Configuring Active Directory or LDAP 49
Advanced Login Configuration 51
Enabling Secure Communication with HTTPS 55

Introduction

With a COMSOL® Server license, a COMSOL application can be run in major web browsers on platforms such as Windows®, OS X, iOS, Linux®, and Android™. In the Windows® operating system, you can also run COMSOL applications by connecting to a COMSOL Server with an easy-to-install COMSOL® Client, available for download from www.comsol.com. COMSOL Server does not include the Application Builder, Physics Builder, and Model Builder tools that come with the COMSOL Desktop® environment.

A COMSOL application is a COMSOL Multiphysics® model with a user interface. To create such applications, use the Application Builder, which is included in the Windows® version of COMSOL Multiphysics. For more information on how to build applications, refer to the book *Introduction to Application Builder*.

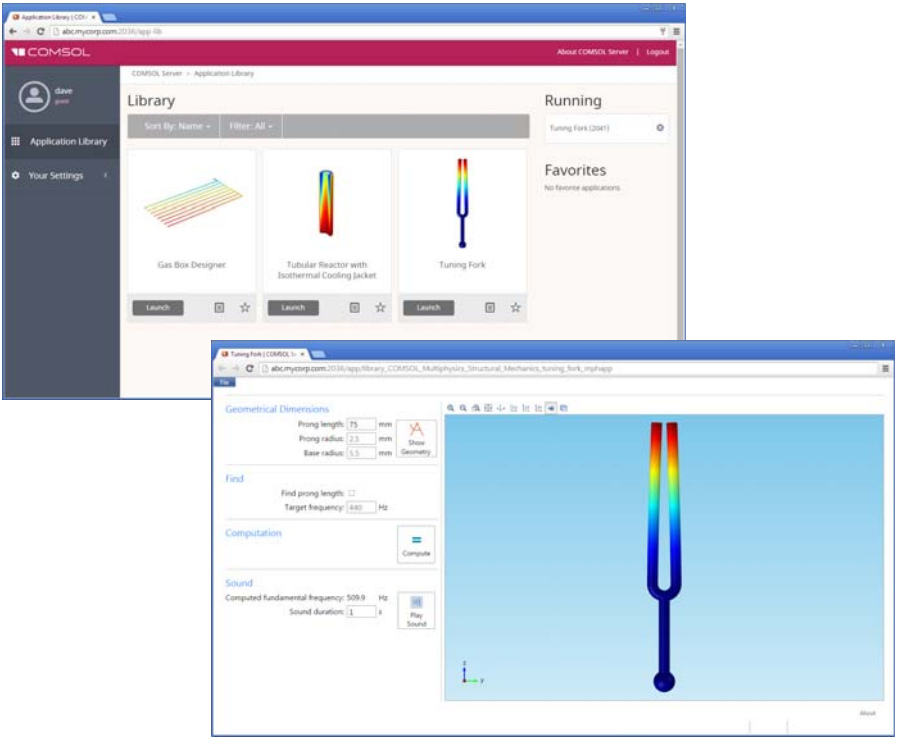
COMSOL Multiphysics and its add-on products are used to create an application. A license for the same add-on products is required to run the application from COMSOL Server. Users can run up to four applications per session through a single COMSOL Server license.

COMSOL Server is a multiuser service that can be run continuously on the host computer. It can be configured to start automatically upon booting.

COMSOL Server contains administrative tools that allow you to create user accounts and user groups. You can also create user accounts based on a preexisting database of users on your system.

Additional resources, including video tutorials, are available online at www.comsol.com.

The figure below shows the COMSOL Server web interface and an application running in a web browser.



Users and Roles in COMSOL Server

Use the COMSOL Server web interface to assign usernames and passwords and to grant privileges. The *administrator* role can add and remove users as well as stop jobs. The *user* role is for running and uploading applications. The *guest* role is only for running applications.

ROLE	ADD/REMOVE USERS	UPLOAD APPLICATIONS	RUN APPLICATIONS
Administrator	Yes	Yes	Yes
User	No	Yes	Yes
Guest	No	No	Yes

There is also a group concept in COMSOL Server that you can use to manage groups of users. Use groups to grant access to different categories of applications that are relevant to that particular group.

COMSOL Server can maintain its own database of users and groups. You can also configure COMSOL Server to use the login mechanism of your operating system, such as Windows® Authentication or Lightweight Directory Access Protocol (LDAP).

Installing COMSOL Server

A COMSOL Server installation is similar to a COMSOL Multiphysics installation, the only difference being an additional step called **Server**.

For detailed information on installation, license files, and license management, see the *COMSOL Multiphysics Installation Guide*.

The default COMSOL Server installation directory for each platform is as follows:

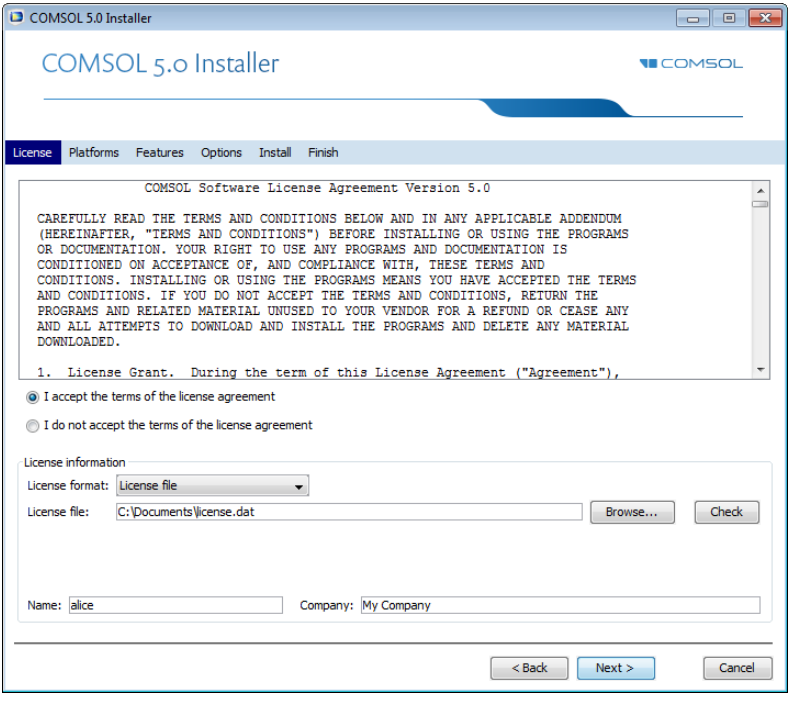
- Windows®: `C:\Program Files\COMSOL\COMSOL50\Server`
- Linux®: `/usr/local/comsol50/server`
- OS X: `/Applications/COMSOL50/Server`

Installing COMSOL Server in Windows

Start the installation by using the media that you have received or by using an Internet download. In the COMSOL installer, after selecting your preferred language, choose **New COMSOL 5.0 Installation**:

LICENSE

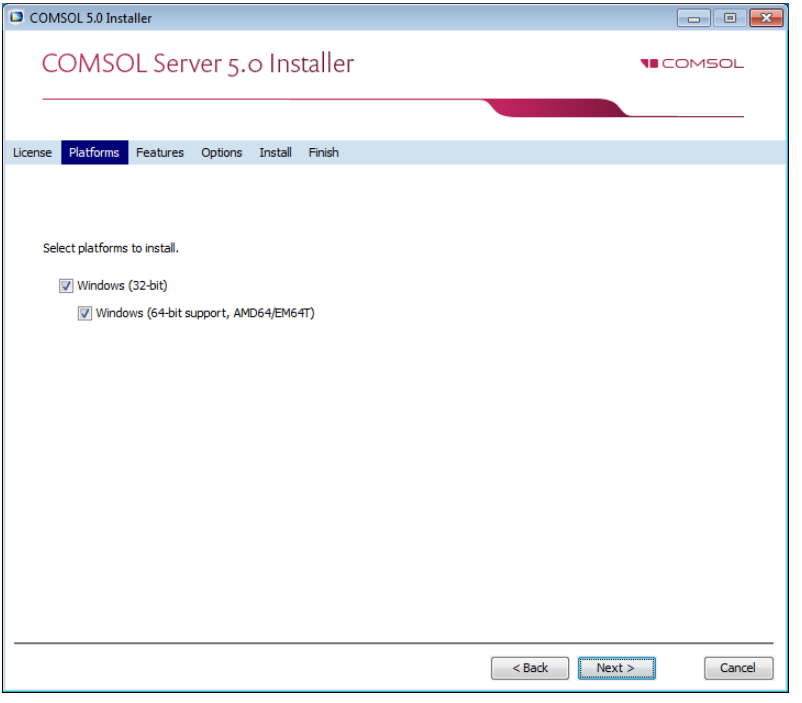
In the next step, **License**, you are prompted for a passcode or license file. COMSOL Server will only function with a license file (that you get from your COMSOL representative).



At this point, the COMSOL installer detects the type of license file used. The following instructions assume that the license file used during installation corresponds to a COMSOL Server license.

PLATFORMS

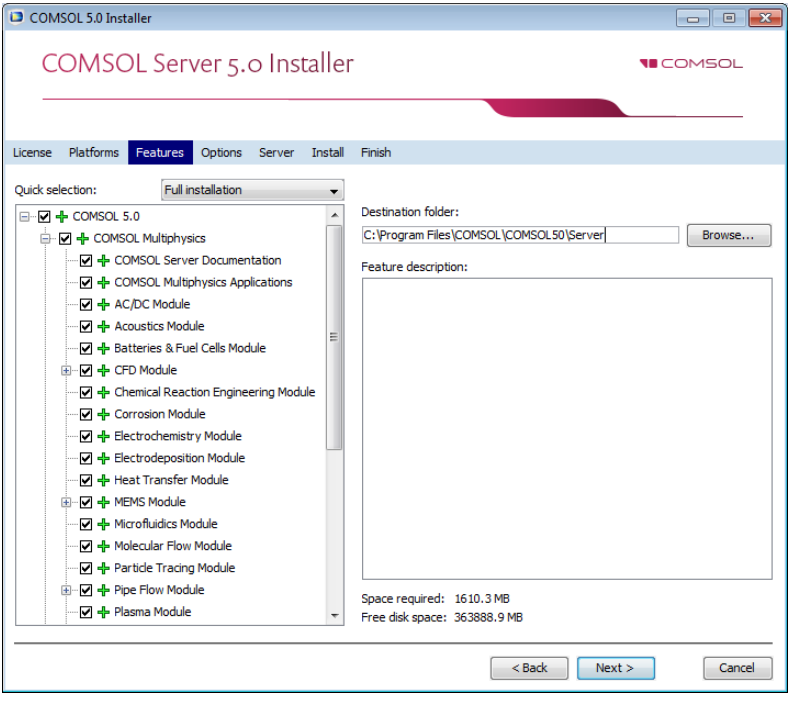
On the next screen—the **Platforms** step—you select the type of platform. The example below shows the **Platforms** screen for a Windows® installation with options for installing on a 32-bit or 64-bit operating system.



FEATURES

In the next step, **Features,** select the installation location and which software components you want to install. Licensed software components are selected by

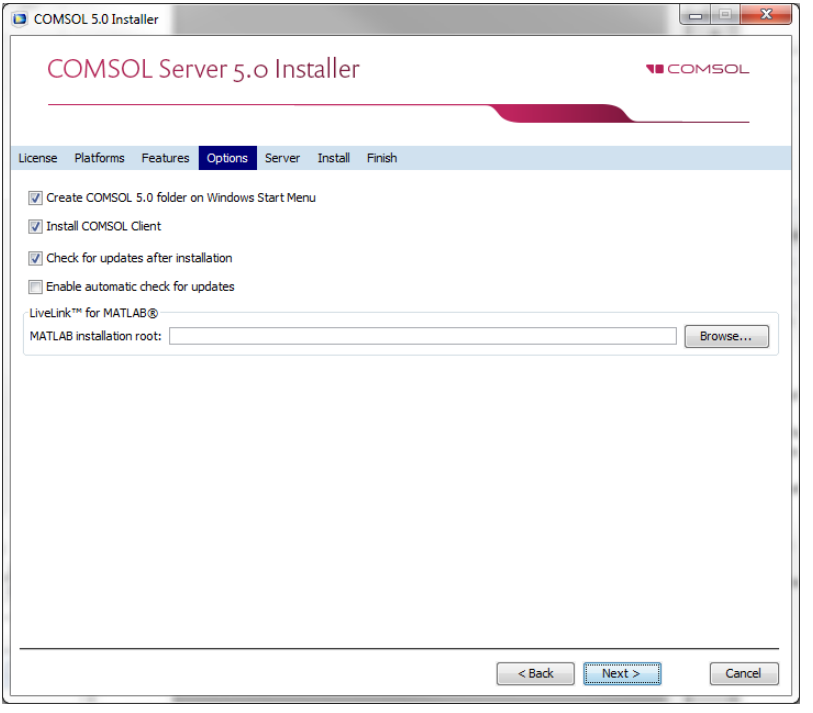
default. There are options to include documentation, applications, and software components for the add-on products.



OPTIONS

In the **Options** step, you can choose to install COMSOL Client, install Start menu shortcuts (Windows® operating system only), enable checking for updates, and

specify the location for a MATLAB® installation (only available if you have licensed LiveLink™ *for* MATLAB®).

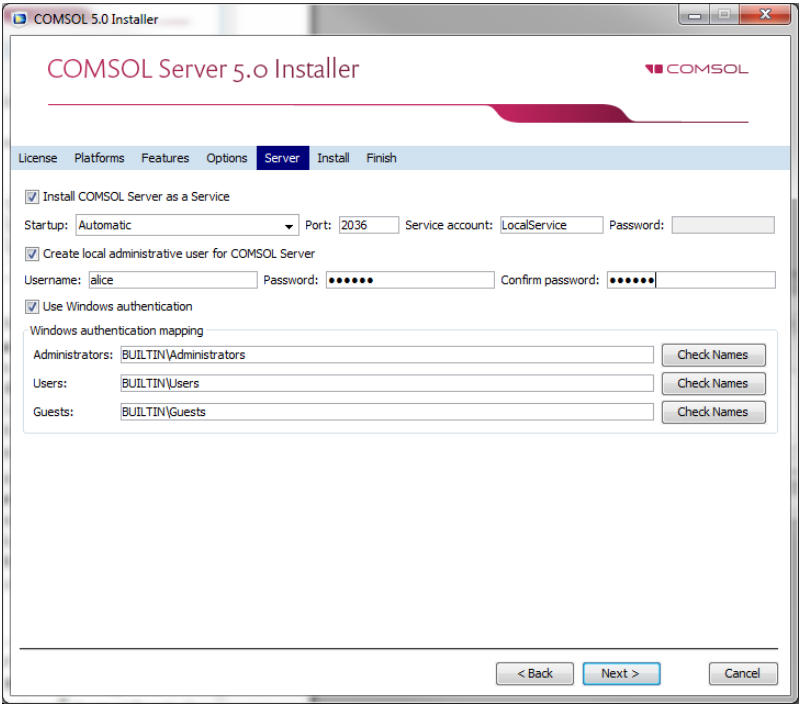


LiveLink™ *for* MATLAB® is the only LiveLink™ product with software components in the COMSOL Server installation. A number of additional LiveLink products are installed with the COMSOL Client for Windows®. For more information, see Running Applications in the COMSOL Client.

SERVER

The next **Server** step does not have any corresponding step in the COMSOL Multiphysics installer but is unique to a COMSOL Server installation. This step makes it possible to set up COMSOL Server as a Windows® service and enables

you to configure an initial user database. The **Server** page in the COMSOL Installer includes the following settings (see the following sections):



Settings for Launching COMSOL Server

There are two different ways to install COMSOL Server in Windows®. If you select the **Install COMSOL Server as a Service** check box (the default), then COMSOL Server is installed as a Windows® service. Otherwise COMSOL Server is installed as a regular executable. Use the **Startup** list to configure how to start COMSOL Server when installed as a Windows® service. Choose **Disabled**, **Manual**, **Automatic** (the default), or **Automatic (Delayed Start)**. With the default choice of **Automatic**, the installed COMSOL Server service is configured to start automatically when the host computer boots or restarts. This setting provides the highest availability to users of the installed server. With **Automatic (Delayed Start)** the service also starts automatically but delayed until all automatic-start threads have finished starting. If you select **Manual** or **Disabled**, the COMSOL Server service will not be started after the installation.

By default, the installer provides the default port number in the **Port** field and the predefined `LocalService` service account in the **Service account** field. It is recommended that you use the `LocalService` account to run COMSOL Server

service; it has sufficient but limited privileges intended for running local services. The predefined `LocalService`, `LocalSystem`, and `NetworkService` accounts in Windows® have no password. When using other accounts, you have to provide a password.

If you choose **Manual** or **Disabled** for the COMSOL Server service's **Startup** setting, you can enable or start the services from the command line or by using the **Manage local services** shortcut installed on the **Start** menu in Windows®. The same configuration options are also available in the snap-in **Services** in the **Microsoft Management Console** (search for services from the Windows® **Control Panel**).

Creating a Local Administrative User for COMSOL Server

Select **Create a local administrative user for COMSOL Server** to create a default username and password for an administrator account that is provided when COMSOL Server is installed as a Windows® service. You can use that account to log in to the web interface after installation to perform administrative tasks. In addition to this administrator, which is local to the COMSOL Server user database, you can add administrator accounts to that user database using Windows authentication (see below).

The user account entered here can only be used to log in to COMSOL Server running as a Windows®service. If COMSOL Server is not installed as a service, it will ask for a default username and password when it is first launched.

When selected it creates:

- A local user in the file `<COMSOL Server installation directory>\bin\tomcat\conf\login.properties`.
- A roles file `<COMSOL Server installation directory>\bin\tomcat\conf\roles.properties`. The roles file assigns administrative rights to the user you specify.

When COMSOL Server is started for the first time as a service, the command `<COMSOL Server Installation Directory>\bin\win64\comsolservice`

copies the password and roles files from the installation directory to the service user's home directory in:

- `<User's home directory>\.comsol\50server\login.properties`, and
- `<User's home directory>\.comsol\50server\server\roles.properties`

For the LocalService account, the home directory typically is `C:\Windows\ServiceProfiles\LocalService`

If you do not create a local administrator, you cannot log in using the COMSOL Server web interface unless at least one user is configured with Windows® Authentication or LDAP, for Linux® and OS X, holding the administrative role. You can also configure the administrator later by manually editing configuration files.

Using Windows Authentication

Select **Use Windows authentication** to use Windows® authentication in addition to the users from the local user database and the administrator you may have chosen to provide in the settings above. Windows® authentication is only available when you install COMSOL Server on a computer using the Windows® operating system.

The text fields under **Windows authentication mapping** for **Administrators**, **Users**, and **Guests** associate Windows® groups or built-in security principals, separated by semicolons, with COMSOL Server roles for administrators, users, and guests, respectively. The defaults are `BUILTIN\Administrators`, `BUILTIN\Users`, and `BUILTIN\Guests`, respectively, which refer to users in such Windows® groups on the computer where you install COMSOL Server. Click the corresponding **Check Names** button to verify that the group names are valid. If you type only a name (`Guests`, for example), the installer finds its location and prepends it in the text field when you click **Check Names**. You can only map a specific Windows® group to a single COMSOL Server role.

You must make sure the Windows® groups you associate with the roles exist in your Windows® installation, otherwise the mapping for the missing groups will not be in effect until they are created. If you leave one of the roles text fields empty, no user will be given this role.

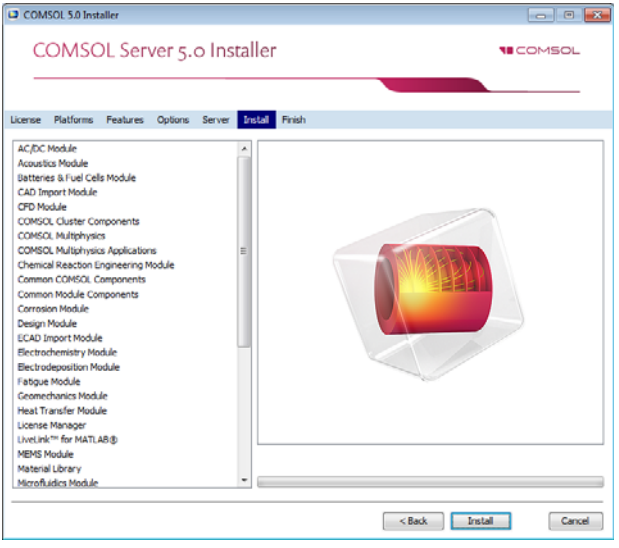
See Configuring COMSOL Server for more information about Windows® authentication.

Using LDAP Authentication

LDAP configuration is required after the installation. See Configuring COMSOL Server.

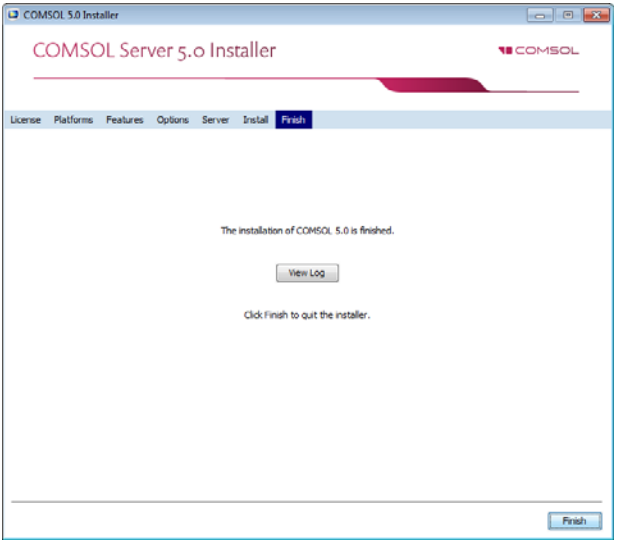
INSTALL

The **Install** step lets you monitor the installation progress.



FINISH

The last step **Finish** lets you view an installation log in the case there are warnings or errors.



Installing COMSOL Server in Linux and OS X

When installing in the Linux® and OS X operating systems the Server step only contains the setting for a default administrative user account. See Starting COMSOL Server for more information about how to automatically launch COMSOL Server after installation on Linux® and OS X.

CREATING A LOCAL ADMINISTRATIVE USER FOR COMSOL SERVER

Select **Create a local administrative user for COMSOL Server** and provide a username and password to create a default administrative account that is provided when COMSOL Server is started as a service.

When selected the installer creates:

- A local user in the file `<COMSOL Server installation directory>/bin/tomcat/conf/login.properties`.
- A roles file `<COMSOL Server installation directory>/bin/tomcat/conf/roles.properties`. The roles file assigns administrative rights to the user you specify.

When COMSOL Server is started for the first time as a service, the command `<COMSOL Server Installation Directory>/bin/comsol server -silent -login never`, copies the password and roles files from the installation directory to the service user's home directory in:

- `<User's home directory>/.comsol/50server/login.properties`
- `<User's home directory>/.comsol/50server/server/roles.properties`

If you do not create an administrator, you can start COMSOL Server as the user you intend COMSOL Server with and manually enter the password.

For security reasons, it is not recommended to use an account with administrative privileges to run COMSOL Server.

Firewalls

By default, COMSOL Server uses a range of ports from 2036 and above. You must open up firewalls that exist between the server and your users. Open up for incoming TCP connections to those ports. To improve security, you may reduce the IP address range to known potential IP addresses for your users.

Starting COMSOL Server as a Windows Service

By default, COMSOL Server is installed as a Windows® service that is set to start automatically. In this case, a link to the COMSOL Server web interface is installed on the **Start** menu as **COMSOL Server**. See Logging in to COMSOL Server for more information about accessing the web interface.

To manually start or stop the COMSOL Server service, or to configure if it is started automatically, use the **Manage local services** shortcut installed on the **Start** menu. The same configuration options are also available in the snap-in **Services**, in the **Microsoft Management Console** (search for services from the Windows **Control Panel**).

Starting COMSOL Server Manually in Windows

You can start COMSOL Server by using the shortcut installed on the **Start** menu as **COMSOL Server**, by double-clicking the Windows® executable in a file browser, or from the command window.

When COMSOL Server has been installed as a Windows service, the shortcut for starting manually is not available on the **Start** menu. It is not recommended to start COMSOL Server manually when the service is running. Since the service runs under a special system user account, it does not share its application and user database with COMSOL Server started manually.

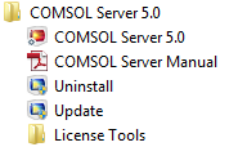
The COMSOL Server executable is located at:

```
<Installation directory>\bin\win64\comsolserver.exe
```

where `win64` corresponds to a 64-bit installation (`win32` for a 32-bit installation). An example of a typical `<Installation directory>` is:

```
C:\Program Files\COMSOL\COMSOL50\Server\bin\win64
```

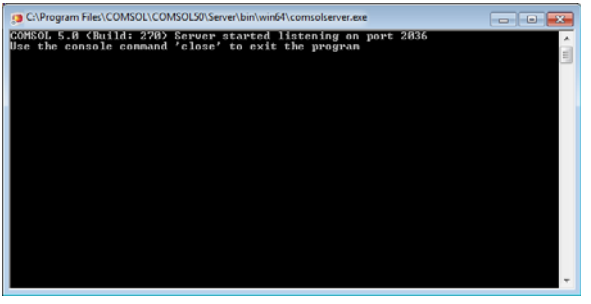
The figure below shows the **Start** menu items for COMSOL Server:



To start COMSOL Server from a command window, type

```
<Installation directory>\bin\win64\comsolserver.exe
```

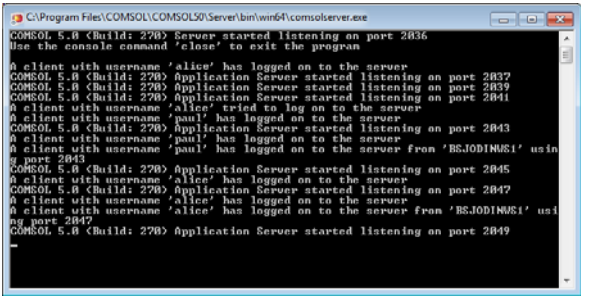
For both methods of starting COMSOL Server, the command window displays a short message that COMSOL Server has started and which port number is used.



In case the default port number 2036 is busy, subsequent port numbers are searched until a free port number has been found (or you can set the port number manually).

If you are starting COMSOL Server for the first time from your current account, you are prompted for an initial administrator. You can use this administrator account to add users with the COMSOL Server web interface at `http://localhost:2036` (assuming that port number 2036 is free).

When additional users log in to COMSOL Server, information on which port numbers are used is displayed in the command window.



Once started, see Logging in to COMSOL Server for how to access the COMSOL Server web interface.

Starting COMSOL Server in Linux

To start COMSOL Server manually, type

```
<Server installation>/bin/comsol server -silent -login never
```

If you are starting COMSOL Server for the first time from your current account, you are prompted for the initial administrator of COMSOL Server. You can use this administrator account to add users with the COMSOL Server web interface at `http://localhost:2036` (assuming that port number 2036 is free).

For COMSOL Server to start automatically at boot up, you need to add Bourne shell commands to the appropriate boot script. You must be a superuser (root) to edit boot scripts.

For security reasons, it is recommended that the daemons are not started as a user with administrative privileges. Instead, use a dedicated username to start the license manager.

Add the following text to the end of the file `rc.local` in the `/etc` directory of your Linux® system:

```
FP=<Server installation>
MYUSER=username
if [ -x $FP/bin/comsol ]; then
    su $MYUSER -c "umask 022; $FP/bin/comsol service -silent -login never"
fi
```

Replace the installation directory with your actual installation directory, and `username` with the username that you want to have to run the service.

You should not use the root user or another user with system access. Create a special user for COMSOL Server with limited system access.

Starting COMSOL Server in OS X

To start COMSOL Server manually, type

```
<Installation directory>/bin/comsol server
```

If you are starting COMSOL Server for the first time from your current account, you are prompted for an initial administrator of COMSOL Server. You can use this administrator account to add users with the COMSOL Server web interface on `http://localhost:2036`.

Logging in to COMSOL Server

In a web browser, go to `http://localhost:2036` (if you are accessing it remotely, use the computer name—computer name and domain, or the local IP address—of your server instead of localhost). If the port number 2036 is taken, then COMSOL Server will use the next available port number: 2037, 2038, and so on. Log in to COMSOL Server with your username and password.

Press return or click **Log in to COMSOL Server**. If you log in for the first time, you must also read the COMSOL Software License Agreement and click **Accept** to enter the COMSOL Server web interface. A user only needs to accept the license agreement once.

After five failed consecutive attempts to log in to COMSOL Server using the web interface, you will be locked out for five minutes before you can log in again.

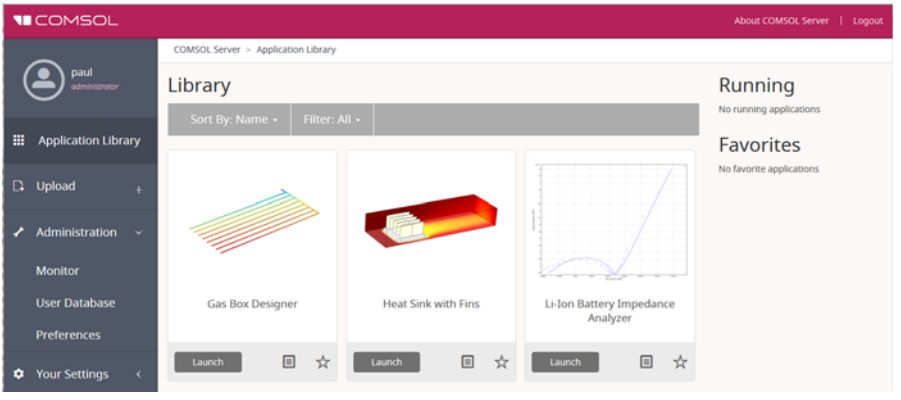
You can log out from COMSOL Server by clicking **Logout** in the upper-right corner of the COMSOL Server web interface.

As an alternative to logging in from a web browser, you can log in from the COMSOL Client for Windows®. For more information see Running Applications in the COMSOL Client.

COMSOL Server Administration

COMSOL Server can be managed through its web interface. Log in using an administrator username and password. Once logged in you have access to an **Administration** section in the web interface with windows for **Monitor**, **Sessions**, **User Database**, and **Preferences**.

The figure below shows the Administrator page in the COMSOL Server web interface.

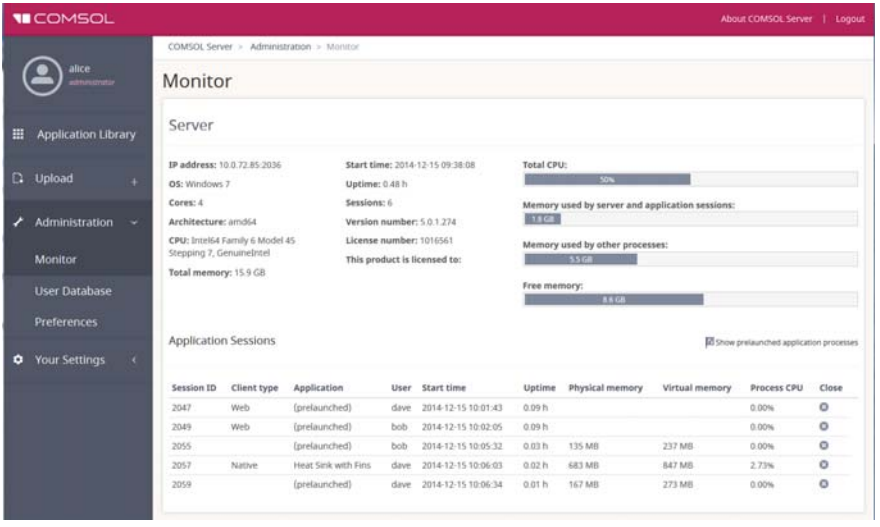


Users cannot access the Administration tools; guests cannot access the Administration tools and cannot upload applications.

Monitor

On the **Monitor** page you find information including: the local IP address, OS and architecture, start time and uptime, CPU and memory use, and also an overview of the running application sessions with the session ID, application, user, start time and uptime, and memory and CPU usage. Click the column header for a

session property to sort the application sessions alphabetically based on that property. Click **Close** to stop a session.

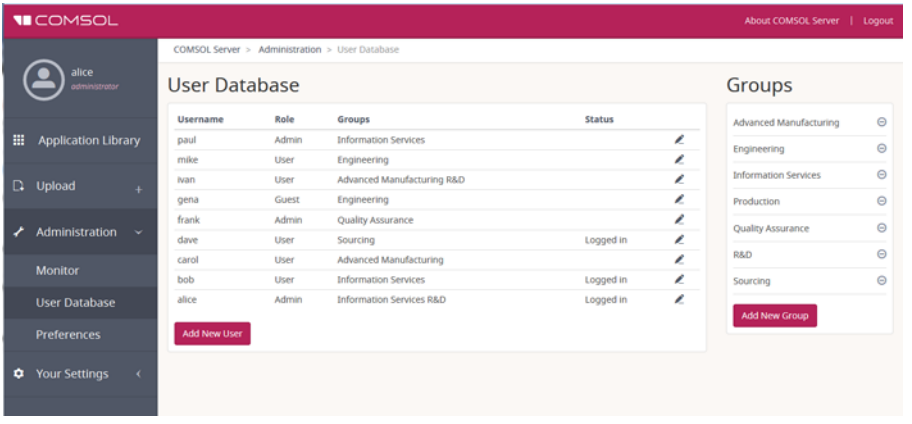


Selecting the **Show prelaunched application processes** check box enables the display of prelaunched application processes in the list of **Application Sessions**. A prelaunched application process is used to speed up the launch of new applications and does not check out any COMSOL Server license.

The **Client type** can be either **Web** or **Native**. **Web** means that the application is run in a web browser. **Native** means that the application is run as a native Windows® application using the COMSOL Client for Windows®.

User Database

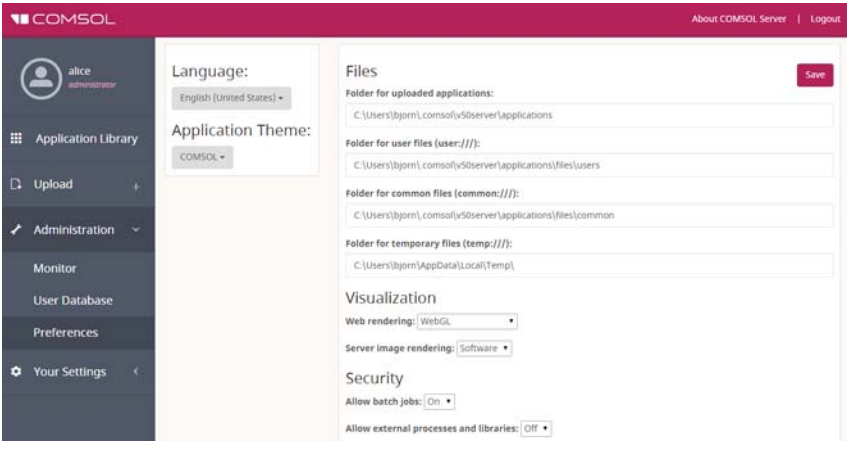
On the **User Database** page you can add users and groups to the server's user database. See Adding and Editing Users and Groups.



If, for example, a new user logs in, you need to click refresh in browser to update the **User Database** page.

Preferences

On the **Preferences** page you access server administrative preferences and settings.



Under **General**, you can control the following settings:

- Choose the language to use for COMSOL Server from the **Language** list. COMSOL Server supports the same languages as the COMSOL Desktop user interface.
- Choose a theme for the application's look and feel from the **Application Theme** list: Choose **COMSOL** for a look and feel that is similar to the COMSOL Desktop user interface, or choose **COMSOL Website** for a look and feel that is more adapted for display on the web.

In addition, the settings in the following tables are available under **Advanced**:

Files

The table below summarizes the settings in the **Files** section.

SETTING	DESCRIPTION
Folder for uploaded applications	Folders for MPHAPP-files.
Folder for user files	Folders for files referred to in MPHAPP-files.
Folder for common files	Common storage area for files created by applications.
Folder for temporary files	Storage area for temporary files created by applications.

VISUALIZATION

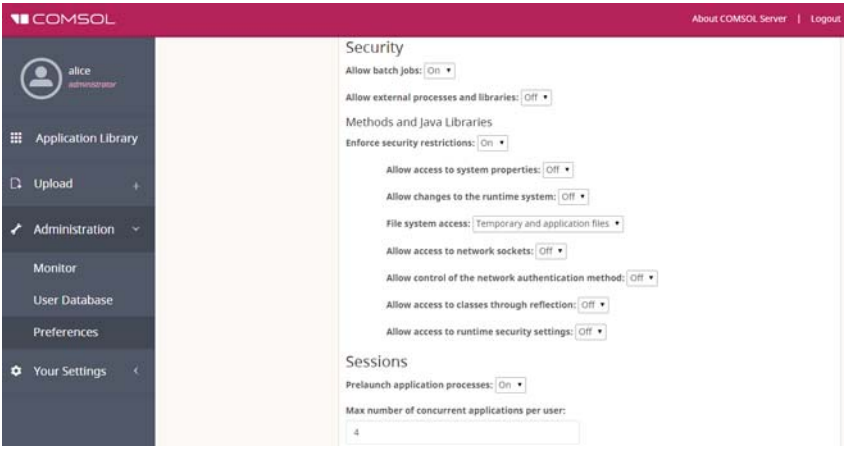
The table below summarizes the settings in the **Visualization** section.

SETTING	DEFAULT	DESCRIPTION
Web rendering	WebGL	Rendering method when running in a web browser: WebGL™ or Images from server.
Server image rendering	Software	Rendering method for images in COMSOL Server: Software or OpenGL.

WebGL is an emerging standard for interactive 3D and 2D graphics in web browsers. The option **Images from server** is used for browsers that do not support WebGL. It renders by generating images instead of offering interactive graphics. The **Software** and **OpenGL** options are the same as in the COMSOL Desktop environment but are here used for image rendering for the purpose of image export in an application. The COMSOL Client for the Windows® operating system provides the same interactive graphics rendering options as the COMSOL Desktop user interface: **OpenGL**, **DirectX**, and **Software**. These options are chosen from the COMSOL Desktop Startup menu icons.

SECURITY

The following security settings are available in the **Preferences** page in the COMSOL Server web interface when you are logged in as an administrator. (The corresponding settings in COMSOL Multiphysics can be found on the **Security** page in the **Preferences** dialog box, which you open from the COMSOL Desktop.)



- Select the **Allow batch jobs** check box to allow applications to run detachable batch jobs. These are separate COMSOL Server processes where the simulation

is stored on file when the computation is finished. This functionality is used in the Batch, Batch Sweep, Cluster Computing, and Cluster Sweep nodes in the COMSOL Desktop model tree.

- Select **Allow external processes and libraries** to allow applications to start external processes on the computer hosting COMSOL Server. This includes using the built-in `executeOS()` method. This setting also allows external C libraries to be called from methods in an application. The security settings do not extend to methods used to access the model object.

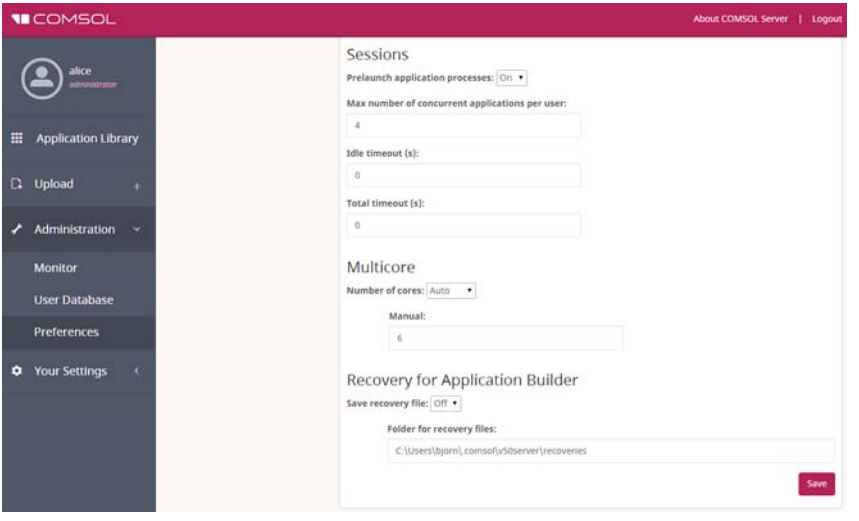
Under **Methods and Java libraries**:

- The **Enforce security restrictions** check box is selected by default. If selected, this check box enforces the following restrictions on methods and Java libraries:
  - Select the **Allow access to system properties** check box to read and write values to system properties such as `System.getProperty("cs.np")` which can be used to determine the number of cores that COMSOL Server currently uses.
  - Select the **Allow changes to the runtime system** check box to allow methods and Java libraries to change the runtime system—for instance, by modifying class loaders.
  - From the **File system access** list, select **Temporary and application files** (the default) to restrict methods and Java libraries to only have access to such files, or select **All files** to allow methods and Java libraries to access all files that the account used to start the COMSOL Server service (default: LocalService) has permissions to access on the file system.
  - Select the **Allow access to network sockets** check box to allow methods and Java libraries to open sockets for network access.
  - Select the **Allow control of the network authentication method** check box to allow methods and Java libraries to control the network authentication method used.
  - Select the **Allow access to classes through reflection** check box to allow access to all members in a class through reflection.
  - Select the **Allow access to runtime security settings** check box to allow methods and Java libraries to access security settings.

All check boxes above are cleared by default, enforcing those security restrictions.

SESSIONS

The table and associated figure below summarizes the settings in the **Sessions** section.



SETTING	DEFAULT	DESCRIPTION
Prelaunch application processes	On	Prelaunching allows fast launch of an application but requires more resources on the server computer.
Max number of concurrent applications per user	4	The maximum number of concurrently running applications per user is four. You can use a lower number to restrict the number of concurrent applications per user.
Idle timeout (s)	0	The maximum idle time in seconds before the user is thrown out and the applications started by that user are shut down. This option makes it possible to reduce resources and licenses required on the server. The default (0) is an infinite timeout time.
Total timeout (s)	0	The maximum total elapsed time in seconds before the user is thrown out and the applications started by that user are shut down. This option makes it possible to reduce resources and licenses required on the server. The default (0) is an infinite timeout time.

MULTICORE

The table below summarizes the settings in the **Multicore** section.

SETTING	DEFAULT	DESCRIPTION
Number of cores	Off	Determines if the number of cores assigned to each application is determined automatically or by manual input.
Manual	All cores	Number of cores assigned to each application in the manual case.

Each user may have up to four (4) applications running at the same time. Assuming that intense computations are performed only with one of these applications at a time, then the best performance is achieved with one core per user. Adjust the **Number of cores** setting accordingly with respect to expected number of concurrent users, concurrently running applications, and the number of cores on the computer hosting COMSOL Server.

RECOVERY

The table below summarizes the settings in the **Recovery** section.

SETTING	DEFAULT	DESCRIPTION
Save recovery file	Off	Determines if launched applications should be configured to automatically use recovery files. This means that failed applications can be recovered by accessing these files.
Folder for recovery files	HOME\.comsol\ v50server\recoveries	Common storage area for recovery files.

Click **Save** to store the updated preference settings.

Running Applications

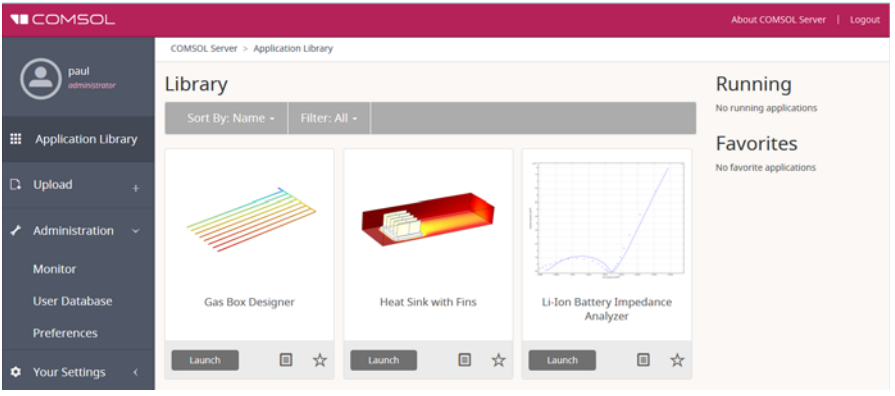
COMSOL applications can be run by connecting to COMSOL Server from a web browser, or from a COMSOL Client for Windows®. The COMSOL Client for Windows® allows a user to run applications that require a LiveLink™ product for CAD, as described in Running Applications in the COMSOL Client. In addition, the COMSOL Client for Windows® supports interactive graphics in 1D, 2D, and 3D.

Running applications in a web browser does not require any installation and no web browser plug-ins are needed. Running an application in a web browser supports interactive graphics in 3D using WebGL™ technology. However, selecting objects in graphics using mouse clicks in not supported when running in a web browser.

Running Applications in a Web Browser

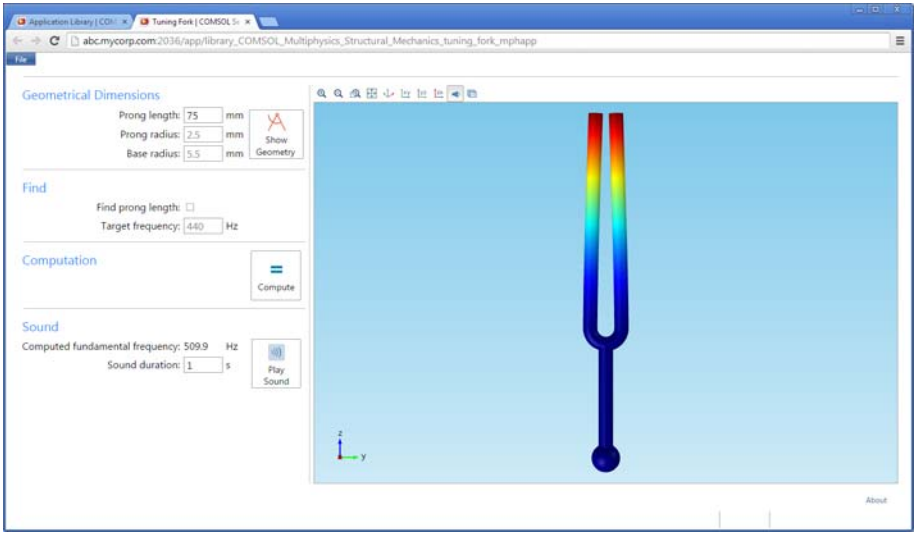
Using a web browser you can point directly to the computer name and port number of a COMSOL Server web interface—for example, `http://abc.mycorp.com:2036`. You need to provide a username and password to log in using the web interface.

When logged in, the **Application Library** page displays a list of applications to run.



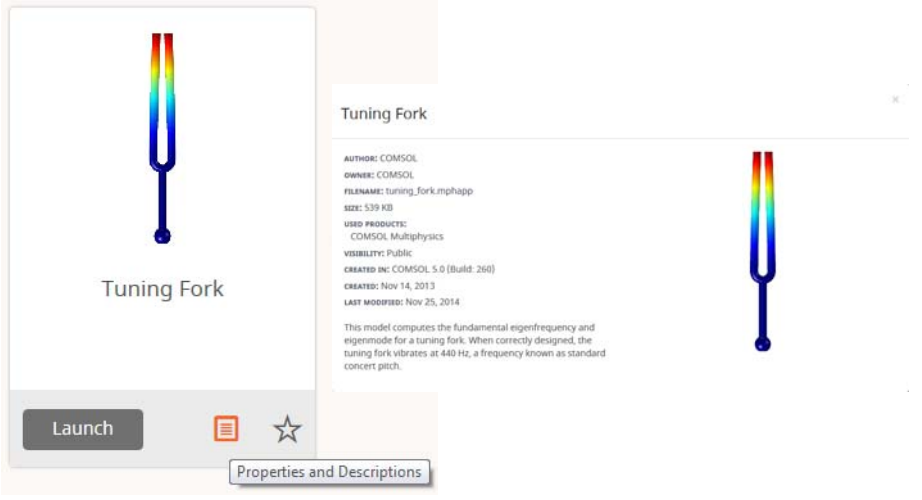
When logged in as user or guest, the Administration options, in the panel to the left, are not visible.

Click **Launch** to run an application. Applications are run in separate tabs in the browser.



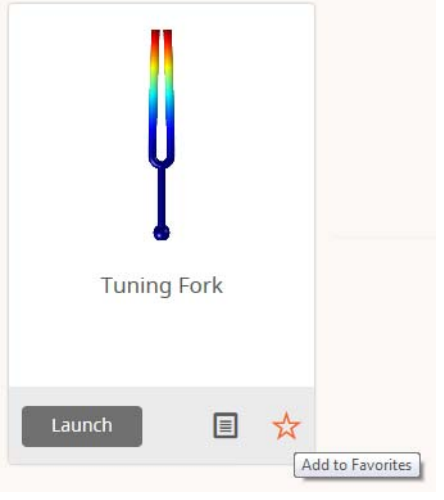
Users can upload applications and determine which groups have access. Guests can only run applications.

Click the **Properties and Descriptions** button to show a description and some general information about that application.

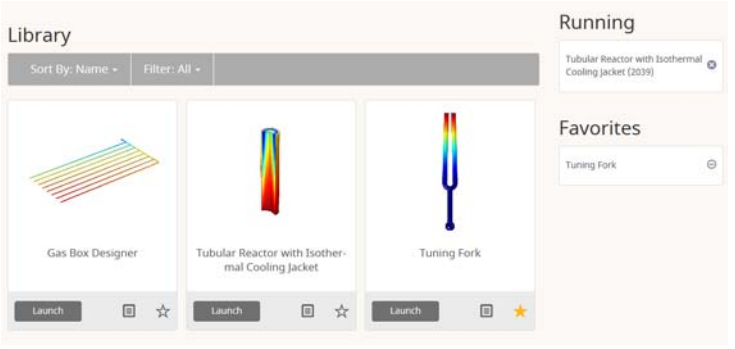


In the information display, under **Used Products**, you find the COMSOL products used to create and run the application.

Click the **Add to Favorites** button to add the application under **Favorites**.

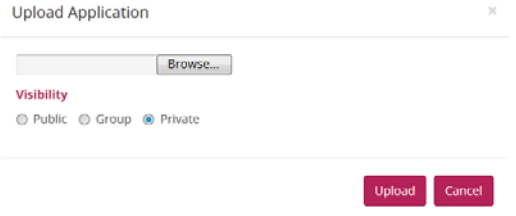


Click an application under **Favorites** to launch it. For an application already marked as a favorite, click the star or the **Remove from Favorites** button next to the application under **Favorites** to remove it from the **Favorites** section.

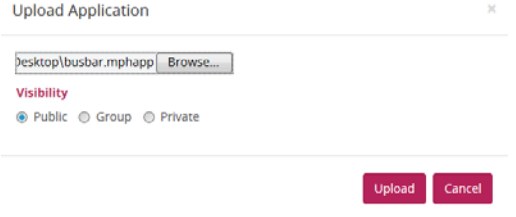


Uploading and Editing Applications

As a user or administrator, you can expand the Application Library by uploading applications (MPHAPP-files). Click **Upload**, in the panel to the left, to open the **Upload Application** dialog box.

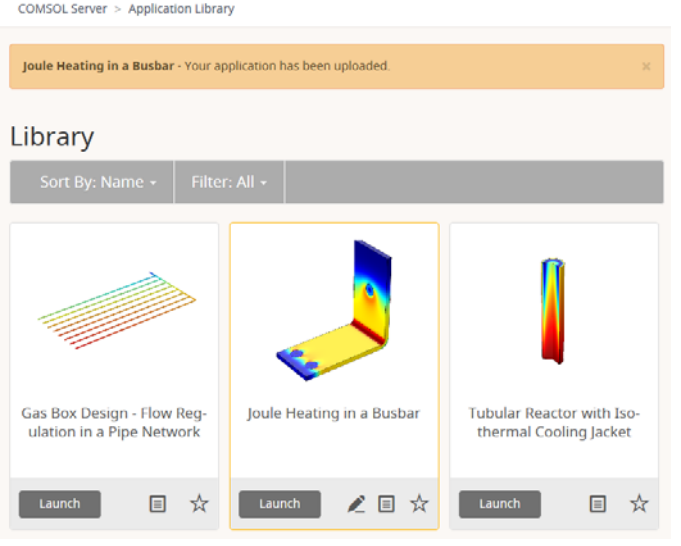


Click **Browse** to browse and select the application to upload. Then select an option under **Visibility**: **Public**, **Group**, or **Private** (the default). A public application is available to all users.

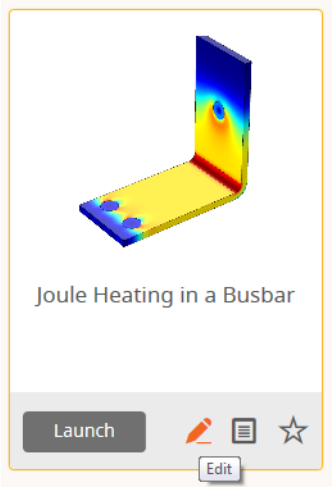


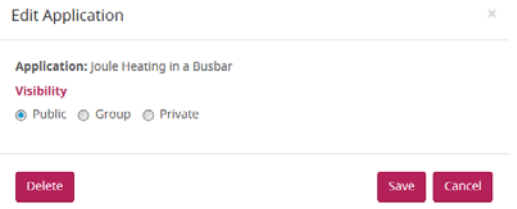
An application with a group visibility is available to members of the groups that you select under **Groups**. A private application is available only to the user who uploads it.

When you have uploaded an application, a message **Your application has been uploaded** appears at the top of the COMSOL Server window. The uploaded application gets an orange border to identify that it has recently been uploaded.



For applications that have been uploaded, click the **Edit** button to open the **Edit Application** dialog box.



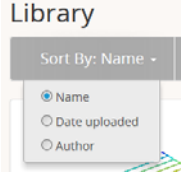


This dialog box contains a **Delete** button to delete the application from the Application Library and a **Save** button to save any new visibility settings.

Sorting and Showing Applications

The menu at the top of the Application Library window contains options for sorting and filtering the applications:

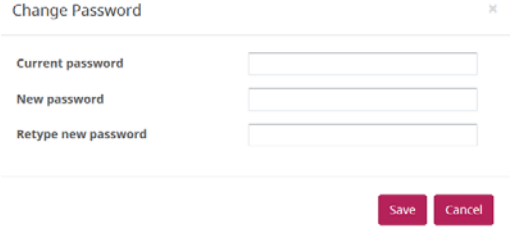
- From the **Sort By** list, choose to sort the applications by **Name** (alphabetically), which is the default, **Date uploaded** (showing the latest uploaded application first), or **Author**.



- From the **Filter** list, choose **All** (the default), **Public**, **All Groups**, **Private**, or any available group.

Changing Password

Under **Your Settings** in the menu to the left, click **Change Password** to open a **Change Password** dialog box where you can change the password used to log in to COMSOL Server.



Limitations When Running Applications in Web Browsers

When you create applications for running in a web browser, make sure you use the grid layout mode in the Application Builder. This will ensure that the user interface layout adapts to the size and aspect ratio of the browser window. For low-resolution displays, make sure to test the user interface layout in the target platform to check that all form objects are visible. Applications that contain resizable graphics forms may not fit in low-resolution displays. In such cases, use graphics with fixed width and height to make sure all form objects fit in the target browser window.

When running in a web browser, the interactive selection of domains, boundaries, edges, and points is not supported. The LiveLink™ products for CAD software packages are not supported when running in a web browser.

When running COMSOL applications in web browsers for smartphones and certain tablets, not all functionality is supported. Typical limitations include the ability to play sounds or open documents. In addition, file upload and download may not be supported.

Running Applications in the COMSOL Client

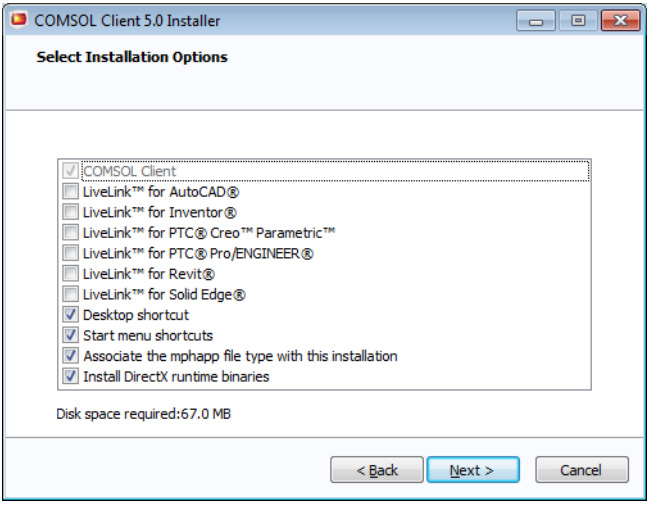
As an alternative to using a web browser for running applications, the COMSOL Client for Windows® can be used to connect to COMSOL Server and run applications natively in the Windows® operating system. This typically gives better graphics performance and supports interactive graphics in 1D, 2D, and 3D. In addition, the COMSOL Client for Windows® allows applications that require a LiveLink™ product for CAD, as listed below.

You can install the COMSOL Client together with COMSOL Server. You can also download the COMSOL Client from www.comsol.com/client-download. In the download page, you can choose between a 32-bit and a 64-bit version and the corresponding installation files are: `COMSOL50_client_win32.exe` and `COMSOL50_client_win64.exe`, respectively. The size of an installation file is about 40 MB and expands to about 70 MB in the installation.

Double-click the download file to start the COMSOL Client installer:

In the next few steps of the installer, accept the license agreement and choose the installation folder.

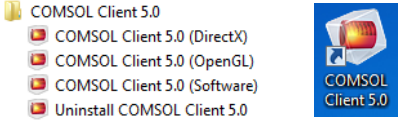
In the step **Select Installation Options** you get the options shown in the figure below.



The following LiveLink™ products are available in the COMSOL Client:

- LiveLink™ *for* AutoCAD®
- LiveLink™ *for* Inventor® (One Window interface not available)
- LiveLink™ *for* PTC® Creo® Parametric™
- LiveLink™ *for* PTC® Pro/ENGINEER®
- LiveLink™ *for* Revit®
- LiveLink™ *for* Solid Edge®

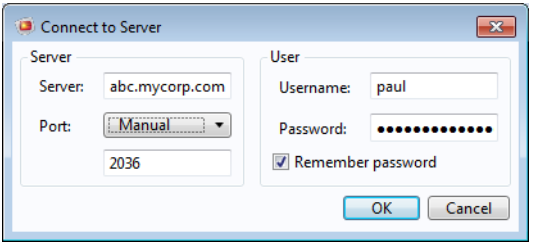
Once installed, double-click the Desktop or **Start** menu icon to start.



There are three **Start** menu options depending on the graphics renderer you want to use: **DirectX**, **OpenGL**, and **Software**. When clicking the Desktop icon, the default **OpenGL** renderer will be used. If the **OpenGL** renderer fails to function properly—for example, due to limitations in the graphics card—then the COMSOL Client shuts down. The next time you start the COMSOL Client, **Software** rendering will be used as a fallback renderer. The **OpenGL** and **DirectX** options use hardware graphics acceleration and give higher performance on supported graphics cards.

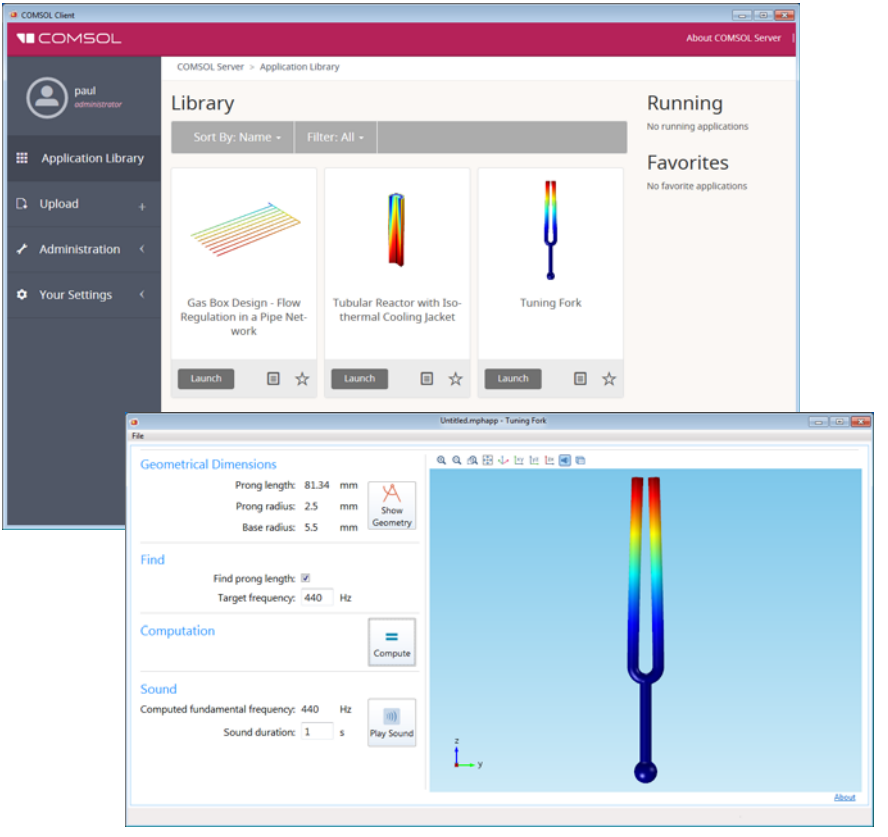
The installation options also let you associate the MPHAPP-file type with the COMSOL Client installation.

Before you can use the COMSOL Client to run applications, you must log in to the COMSOL Server web interface with a valid username and password.



Logging in from the COMSOL Client displays a COMSOL Server web interface identical to that seen when logging in from a web browser. Using the COMSOL Client, applications run as native Windows® applications in separate windows that have a Windows® look-and-feel. For example, applications run in the COMSOL

Client may have a Windows® specific ribbon with tabs. When run in a web browser, ribbons are represented by a toolbar.



For more information on running applications, see Running Applications in a Web Browser.

Running Applications that use LiveLink Products

Most of the LiveLink™ products can be used in applications run with COMSOL Server. However, in some cases the functionality is limited compared to running with a COMSOL Multiphysics license that includes the COMSOL Desktop. Depending on the LiveLink product, software components are installed with the

COMSOL Client or COMSOL Server. The table below summarizes where the software components are installed and which functionality is available.

LIVELINK PRODUCT	LOCATION OF SOFTWARE COMPONENTS	FUNCTIONALITY
LiveLink™ *for* MATLAB®	Server	Support is limited to function calls from the Global Definitions node in the model tree. Can be used only when accessing an application in a web browser.
LiveLink™ *for* Excel®	Client	No support in version 5.0.1. Loading and saving files will be supported in version 5.1.
LiveLink™ *for* SOLIDWORKS®	N/A	Not supported.
LiveLink™ *for* Inventor®	Client	Same as COMSOL Desktop, with the exception that the One Window interface is not supported. Not supported when running applications in a web browser.
LiveLink™ *for* AutoCAD®	Client	Same as COMSOL Desktop. Not supported when running applications in a web browser.
LiveLink™ *for* Revit®	Client	Same as COMSOL Desktop. Not supported when running applications in a web browser.
LiveLink™ *for* PTC® Creo® Parametric™	Client	Same as COMSOL Desktop. Not supported when running applications in a web browser.
LiveLink™ *for* PTC® Pro/ENGINEER®	Client	Same as COMSOL Desktop. Not supported when running applications in a web browser.
LiveLink™ *for* Solid Edge®	Client	Same as COMSOL Desktop. Not supported when running applications in a web browser.

Configuring COMSOL Server

To operate COMSOL Server, you must set up user authentication (password validation) and authorization (groups and roles) for your users.

One administrator account can be added during installation. You can also create an administrator after installation using `comsolserver.exe` in the Windows® operating system or `comsol server` in the OS X and Linux® operating systems.

COMSOL Server can maintain its own local user database. This is the easiest way to set up the server. In addition, you can use your operating system's user authentication method.

Using the authentication method of your operating system is only supported when accessing COMSOL Server from a web browser.

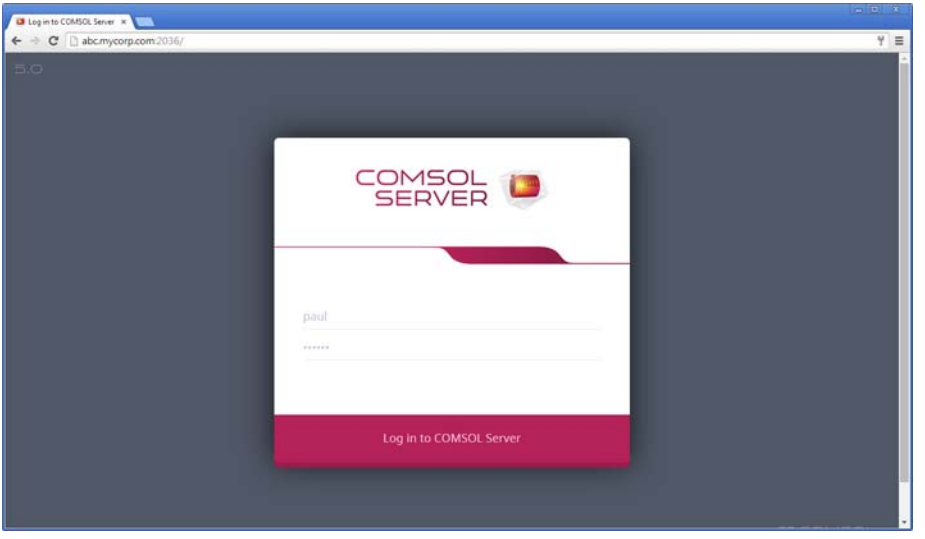
Configuring a Local User Database

Using the COMSOL Server installer, you can set up an initial administrator account that is available when COMSOL Server is started as a service. When COMSOL Server is not started as a service, the initial administrator account is created the first time it is started.

You can add more users to the local user database as soon as COMSOL Server is started. These users are automatically added to the local user database of your COMSOL Server installation.

In a web browser, go to `http://localhost:2036` (if you are accessing it remotely, use the computer name—computer name and domain, or the local IP address—of your server instead of localhost). If the port number 2036 is taken,

then COMSOL Server will use the next available port number: 2037, 2038, and so on. Log in to COMSOL Server with your username and password.

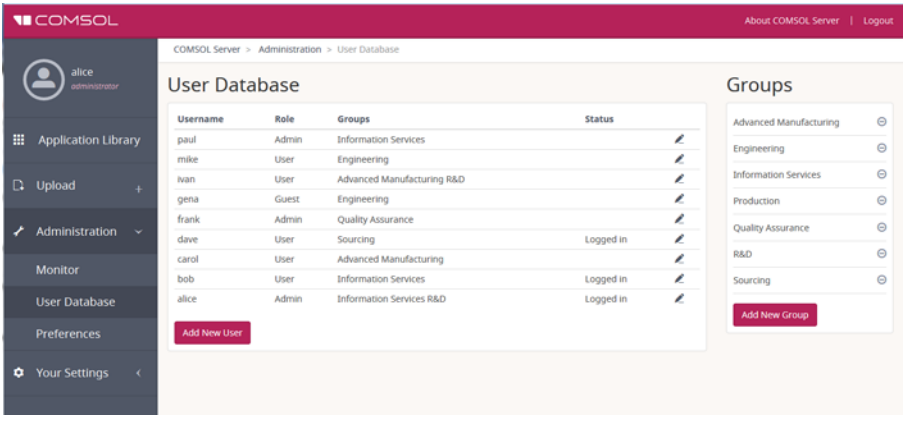


Press return or click **Log in to COMSOL Server**. If you log in for the first time, you must also read the COMSOL Software License Agreement and click **Accept** to enter the COMSOL Server web interface.

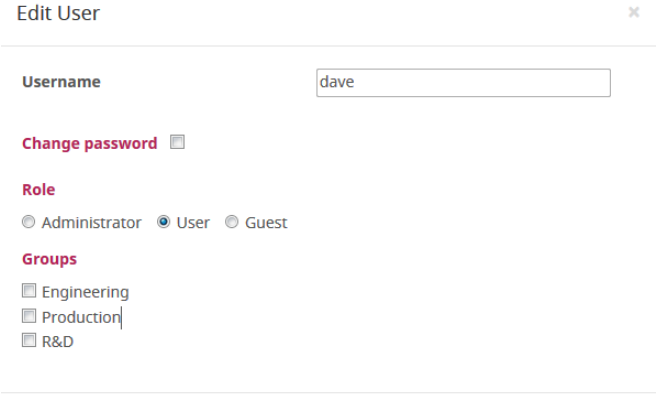
You can log out from COMSOL Server by clicking **Logout** in the upper-right corner of the COMSOL Server web interface.

Adding and Editing Users and Groups

When you run COMSOL Server as administrator, you have access to a **User Database** page under **Administration** in the menu on the left side of the COMSOL Server web interface.



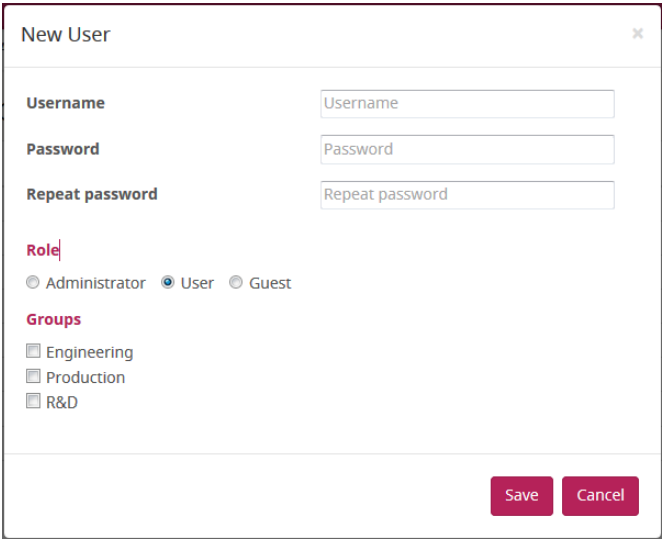
From this page you can manage users and groups for running and accessing applications. Under **Users**, you see all users with their username, role, groups they belong to, and status (if the user is logged in or not). Click a column header for a user property to sort the users in alphabetical order based on that property. Click the **Edit User** button to open an **Edit User** dialog box for a user, where you can change the password, role, and which groups the user belongs to.



Click **Save** to store the new user properties. You can also click **Log Out User** to log out a user that is currently logged in, or click **Delete** to remove a user from the list.

Adding a New User

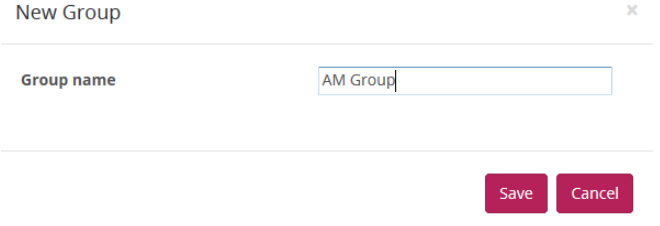
To add a new user, click the **Add New User** button.



In the **New User** dialog box, specify the **Username** and **Password** (you need to confirm the password in the **Repeat password** field). Under **Role**, click **Administrator**, **User** (the default), or **Guest**, depending on the role that you want the user to have (see Users and Roles in COMSOL Server). Under **Groups**, select the check boxes for the available groups that you want the new user to belong to. Finally, click **Save** to store the new user and its properties. The new user then appears in the list under **Users**.

Adding Groups

You can use groups to ensure that users assigned to the same group can view and run the same applications. Available groups appear on the **User Database** page under **Groups**. To add a new group, click the **Add New Group** button.



In the **New Group** dialog box, enter a **Group name** and then click **Save**. The added group then appears in the list under **Groups**.

You can control the visibility of the applications so that they are available only for users within a certain group (or groups). Click the **Delete Group** button next to a group to remove that group.

Configuring Windows Authentication

In addition to the local user database, the COMSOL Server installer for the Windows® operating system makes it possible to use Windows® authentication. To determine which Windows users are allowed to log in, and which COMSOL Server roles they should have, you set up a mapping between Windows® groups and COMSOL Server roles.

You will find the login configuration file created by the installer in *<Installation>\bin\tomcat\conf\login.config*. In addition, there is a sample file for Windows® authentication available in the file *<Installation>\bin\tomcat\conf\login.win.config*:

```
ComsolServerLogin {
waffle.jaas.WindowsLoginModule optional
                  principalFormat=both
                        roleFormat=fqn;
com.comsol.jaas.ComsolServiceLoginModule optional
  authenticate=true
  "BUILTIN\\Administrators"=ComsolServerAdministrator
           "BUILTIN\\Users"=ComsolServerUser
                 "Everyone"=ComsolServerGuest;

};

ComsolWebsocketLogin {
com.comsol.jaas.ComsolServiceLoginModule required;
};
```

By modifying this *login.win.config* file and copying it to the file *login.config* you can change the actual configuration used by the server and thus override any settings made by the installer.

The lines

```
"BUILTIN\\Administrators"=ComsolServerAdministrator
         "BUILTIN\\Users"=ComsolServerUser
               "Everyone"=ComsolServerGuest;
```

map the Windows® groups `Administrators`, `Users`, and `Everyone` to the roles identifiers `ComsolServerAdministrator`, `ComsolServerUser`, and

`ComsolServerGuest`, corresponding to the COMSOL Server roles, administrator, user, and guest, respectively.

For the details about settings in the configuration file, see the section Advanced Login Configuration in this chapter.

Finally, use administration tools in Windows® to set up users and groups. For example, use the Control Panel and the User Accounts settings in the control panel.

Using the authentication method of your Windows® operating system is only supported when accessing COMSOL Server from a web browser.

Configuring Active Directory or LDAP

In addition to the local user database and to the Windows Authentication available on the Windows® operating system, it is possible to use a Windows® Active Directory® or LDAP server to authenticate users. This means that you can use your Active Directory® or LDAP usernames and passwords to log in to COMSOL Server.

Configuring COMSOL Server to use an Active Directory or LDAP server for authentication requires editing the configuration file at: *<Installation>\bin\tomcat\conf\login.config*. There is a sample file for Active Directory® authentication available in the file *<Installation>\bin\tomcat\conf\login.ad.config*:

```
ComsolServerLogin {
    com.sun.security.auth.module.LdapLoginModule OPTIONAL
    userProvider="ldap://ldap.example.com:3268/DC=example,DC=com"
    authIdentity="{USERNAME}@example.com"
    userFilter="(&(sAMAccountName={USERNAME})(objectclass=user))"
    authzIdentity="{MEMBEROF}"
    useSSL=false;
    com.comsol.jaas.ComsolServiceLoginModule OPTIONAL
    authenticate=true;
};

ComsolWebsocketLogin {
     com.comsol.jaas.ComsolServiceLoginModule required;
};
```

In addition, a sample file for OpenLDAP is available in the file *<Installation>\bin\tomcat\conf\login.openldap.config*:

```
ComsolServerLogin {
} com.sun.security.auth.module.LdapLoginModule REQUIRED
    userProvider="ldap://ldap.example.com/ou=People,dc=example"
    userFilter="(&(uid={USERNAME})(objectClass=inetOrgPerson))"
    authzIdentity="{MAIL}"
    useSSL=false;
    com.comsol.jaas.ComsolServiceLoginModule required
    authenticate=false;
};

ComsolWebsocketLogin {
     com.comsol.jaas.ComsolServiceLoginModule required;
;
```

Modify the sample files and overwrite *login.config* with the changes to configure Active Directory® or LDAP authentication. You need to replace `ldap.example.com`, `example`, and `com` with the name of your Active Directory® or LDAP server and `DC=example`, `DC=com` with the settings of your Active Directory® or LDAP server, respectively.

You need to add each user and the user's associated role to the `roles.properties` file in *<Installation>*`\bin\tomcat\conf\`. COMSOL Server will user the username and password to authenticate. Use the syntax

```
alice=ComsolServerAdministrator;
dave=ComsolServerUser;
carol=ComsolServerGuest;
```

to add roles to the users `alice`, `dave`, and `carol`. `ComsolServerAdministrator`, `ComsolServerUser`, and `ComsolServerGuest` are valid as the right-hand side, representing the administrator, user, and guest roles in COMSOL Server, respectively.

Alternatively, if a user has attempted to log in using an Active Directory® or LDAP username, you can assign a role for that user from the COMSOL Server web interface by editing the automatically created user account under **Administration>User Database**.

The LDAP login module that COMSOL Server uses does not allow direct mappings from Active Directory groups to COMSOL Server roles.

For the details about settings in the configuration file, see the section Advanced Login Configuration in this chapter.

Active Directory® and LDAP authentication is only supported when accessing COMSOL Server from a web browser.

Advanced Login Configuration

COMSOL Server uses the pluggable authentication mechanisms of JAAS (Java® Authentication and Authorization Services). Using JAAS configuration files you can configure to use Windows® authentication and LDAP authentication. You can also combine local database users and operating system users by merging configurations.

Using the operating system authentication method is only supported when accessing COMSOL Server from a web browser

Login Module Configuration Files

The COMSOL Server installation includes prepared login configuration files. Use a suitable file, modify it, and replace the `login.config` file with an edited file to configure the required login module.

Configuration Files in <Installation>\bin\tomcat\conf

FILE NAME	FILE DESCRIPTION	ACTION
login.config	Login configuration file	Contains the login configuration that the running server uses.
login.openldap.config	LDAP configuration sample file	Modify and copy to login.config to use a OpenLDAP configuration.
login.ad.config	Active Directory sample file	Modify and copy to login.config to use a Active Directory configuration.
login.win.config	Windows authentication sample file	Modify and copy to login.config to use a Windows® authentication configuration.
login.local.config	Local configuration sample file	Modify and copy to login.config to use a local user database configuration.
login.properties	Initial user and password file	Created by installer. Automatically copied to the <user home>\.comsol\v50server\ login.properties of the user account that started COMSOL Server the first time the service is started.
roles.properties	Initial policy group file	Created by installer. Automatically copied to the <user home>\.comsol\v50server\ service\roles.properties of the user account that started COMSOL Server the first time the service is started.

The local user database is represented by two files:

- The `login.properties` file, which contains the local user database. Each row in this file represents a user. The username is followed by an equal sign and a hashed password. The file should only be readable to the account running COMSOL Server.
- The `roles.properties` file, which contains the roles of the users. Each row in this file contains a user. The username is followed by an equal sign and a semicolon-separated list of roles and groups that the user is associated with.

COMSOL Login Module

Configurable login modules are used to achieve the desired mechanism, and you can combine multiple modules in an authentication and authorization chain.

A local user database is used by the default JAAS configuration for both authentication (password validation) and authorization (groups and roles). A local user account with administrative privileges can be created during the installation process to allow subsequent login. It is also possible to configure COMSOL

Server to allow logins using nonlocal accounts optionally with a mapping from nonlocal to local groups and roles as a part of the installation process.

The `COMSOLServiceLoginModule` can be used to perform authentication and authorization of users based on the local user database or to perform mapping of nonlocal to local roles and groups. This login module always gives administrative privileges to the user owning the COMSOL Server process and all authenticated users belong to the group *Authenticated*, which gives access to the COMSOL Server web interface.

COMSOLServiceLoginModule Configuration Options

OPTION	VALUES	DESCRIPTION
debug	true/false	Debug information will be printed to the console.
authenticate	true/false	Determines if the module is used for authentication or only for mapping of roles and groups.
non-local-principal	<local-principal>	Any number of mappings from nonlocal role and group names to local; note that multiple nonlocal roles and groups can map to the same local roles or groups but there can be only one mapping per nonlocal role or group.

Other login modules: Any JAAS-compliant login modules can be used as a part of the authentication sequence, but configuration sometimes requires detailed knowledge about the authentication server setup and IT system administrator skills.

JAAS Configuration File Syntax

The configuration file is a text file with an arbitrary name and extension containing any number of entries of the form

```
RealmName{
LoginModuleClassName <behavior>
<option> = <value>;
}
```

`RealmName` is the name of the login realm this configuration represents, and for COMSOL Server the two required realms are as follows:

- The `ComsolServiceLogin` realm is used for authentication of users through the web interface.
- The `ComsolWebsocketLogin` realm is used for authentication of clients connecting via websockets.

`LoginModuleClassName` is the full name of a class implementing the `LoginModule` interface, and in addition to those provided in the Java distribution (like `com.sun.security.auth.module.LdapLoginModule`), COMSOL Server provides `com.comsol.jaas.ComsolServiceLoginModule`.

For integrated Windows® authentication the `waffle.jaas.WindowsLoginModule` is also included in the installation.

The `<behavior>` can be one of the following keywords:

- `required`—must authenticate the user
- `requisite`—no subsequent login modules will run if this fails
- `sufficient`—continues to run the other login modules in the list on failure
- `optional`—at least one optional module must succeed if all are optional

The `<option>` is one of the valid options for the login module, and `<value>` is a valid selection for this option. The configuration entry for one login module is terminated by a semicolon, after which any number of additional login module configuration entries can appear. However, there can be only one configuration entry per login module.

The COMSOL Server login configuration file

```
installation-path/bin/tomcat/conf/login.config
```

is created during installation according to the selected options.

A configuration example for integrated Windows® authentication:

```
ComsolServerLogin {
  waffle.jaas.WindowsLoginModule required
  principalFormat=both
  roleFormat=fqn;
  com.comsol.jaas.ComsolServiceLoginModule required
  authenticate=false
  "BUILTIN\\Administrators"=ComsolServerAdministrator
  "BUILTIN\\Users"=ComsolServerUser
  "Everyone"=ComsolServerGuest;
};
```

In this case the user must be authenticated by the `waffle.jaas.WindowsLoginModule`, and the `com.comsol.jaas.ComsolServiceLoginModule` performs a mapping of groups from the Windows® account to COMSOL Server roles without authenticating the user.

The following is a configuration example using either the LDAP interface of an Active Directory server for authentication or the COMSOL Server local user database:

```
ComsolServerLogin {
  com.sun.security.auth.module.LdapLoginModule optional
```

```
  userProvider="ldap://ldap.example.com:3268/DC=example,DC=com"
  authIdentity="{USERNAME}@example.com"
  userFilter="(&(sAMAccountName={USERNAME})(objectclass=user))"
  authzIdentity="{MEMBEROF}"
  useSSL=false;
  com.comsol.jaas.ComsolServiceLoginModule optional
  authenticate=true
  examplegroup=ComsolServerAdministrator
  ;
};
```

- If login is successful with the `LdapLoginModule`, the users belonging to the group `examplegroup` get the `ComsolServerAdministrator` role.
- If login is successful with the `ComsolServiceLoginModule` only the local user database is used to assign roles to the user.

Enabling Secure Communication with HTTPS

To be able to use HTTPS (HTTP Secure), you must have a key store that contains a certificate, possibly self-signed. To create a self-signed certificate on your computer, start a command window and run

```
keytool -genkey -alias COMSOLServer -keypass <password> -storepass <password>
-dname "cn=<User Name>, ou=<Org>, o=<Unit>, c=<Domain>" -keyalg RSA
keytool -selfcert -alias COMSOLServer -storepass <password>
```

after having replaced `<password>` with the passwords that you want to use. This will enable the HTTPS connector. To enforce using secure communication, the security constraint configuration in

```
service\WebContent\WEB-INF\web.xml
```

must be changed to use CONFIDENTIAL instead of NONE as transport guarantee.

Index

A
adding groups *47*
adding users *47*
add-on products *5*
administration in COMSOL Server *24*
administrator role *6*
Application Library *33*
applications
  adding as favorites *34*
  deleting *37*
  editing *35*
  filter *38*
  launching *33*
  properties and descriptions *34*
  sort by *37*
  sorting *37*
  upload *33*
  uploading *35*
authentication *44*
  in Windows *15*

B
batch jobs *28*
boot scripts *21*
Bourne shell commands *21*

C
changing password *38*
classes through reflection *29*
COMSOL Client *5, 23, 39*
  installation *11, 39*
  running applications in *39*
COMSOL Multiphysics *5*
COMSOL Server *5*
  administration *24*
  installing *8*
  logging in to *22*
  starting *19*
COMSOL Software License Agreement *22, 45*
configuring user database *44*

D
deleting applications *37*
Desktop shortcut *40*
DirectX rendering *40*

E
editing applications *35*
external processes and libraries *29*

F
favorite applications *34*
features, installation *10*
file download *39*
file system access *29*
file upload *39*
finishing installation *17*
firewalls *18*

G
graphics, interactive *32*
grid layout mode *38*
group *35*
groups, adding *47*
groups, of users *6*
guest role *6, 24, 33*

H
HTTPS *55*

I
install step, installation *16*
installation
  features *10*
  finish *17*
  install step *16*
  license *9*
  options *11*
  platforms *10*
  server *12*
installing COMSOL Server *8*
  in Linux *17*
  in OS X *17*
  in Windows *8*
interactive graphics *32*

J JAAS *51*

L language, to use *27*
launching applications *33*
LDAP *7, 15, 16, 49*
license, installation *9*
Lightweight Directory Access Protocol *7*
LiveLink™ products *39, 40, 42*
local administrative user *14*
local user database *44*
logging in to COMSOL Server *22*
login configuration files *51*
login realm *53*
low-resolution displays *38*

M Monitor page *24*
MPHAPP-file *41*
multicore settings *31*

N network authentication method *29*
network sockets *29*

O open documents *39*
OpenGL rendering *40*
options, installation *11*

P password, changing *38*
platforms, installation *10*
play sounds *39*
port number *20*
preferences *27*
  files *27*
  multicore *31*
  recovery *31*
  security *28*
  sessions *30*
  visualization *28*
Preferences page *27*
private *35*
products, used in application *34*
public *35*

R removing users *46*
resizable graphics *38*
roles, in COMSOL Server *6*
running applications
  in a web browser *32*
  in the COMSOL Client *39*
runtime security settings *29*

S security
  restrictions *29*
  settings *28*
server, installation *12*
smartphones *39*
sockets *29*
software license agreement *22, 45*
Software rendering *40*
sorting applications *37*
Start menu shortcut *40*
starting COMSOL Server *19*
  in Linux *21*
  in OS X *22*
  in Windows *19*
system properties *29*

T tablets *39*
TCP connections *18*
theme, for applications *27*

U uploading applications *33, 35*
used products, in application *34*
user authentication *44*
user database *44*
User Database page *26*
user role *6, 24, 33*
users
  adding *47*
  COMSOL Server *6*
  removing *46*

V visibility *35*

W web browser *5*
running applications in *32*
web implementation of an application *5*
WebGL *32*
Windows Active Directory *49*
Windows Authentication *7, 15*