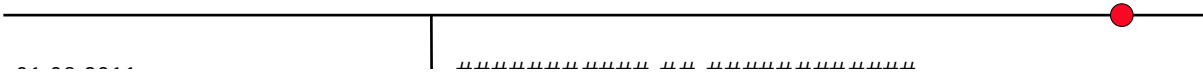
# openSUSE

11.4



# Руководство по безопасности

# Содержание

# О этом руководстве

Это руководство представляет основные концепции безопасности системы в openSUSE. Оно охватывает обширную часть документации, об аутетификационных механизмах, доступных в GNU/Linux, такие как NIS или LDAP. В руководстве также освещаются такие вопросы безопасности как: списки контроля доступа, шифрование и обнаружение вторжения. В третьей части "Сетевая безопасность" Вы узнаете как обезопасить свой компьютер с помощью брандмауера, а так же настроить виртуальную частную сеть (VPN). Это руководство также рассказывает как использовать доступное в системе ПО для обеспечения безопасности, такое как: Novell AppArmor (с помощью него Вы можете настраивать доступ для ПО к файлам).

Многие главы в этом руководстве содержат ссылки на ресурсы с дополнительной документацией. Все эти ресурсы и оригинальная документация, доступны как в системе, так и в сети.

Документацию, доступную для Вашего продукта, можно найти на этой странице: `http://www.novell.com/documentation` , а так же в следующих разделах.

# 1 Доступная документация

Мы предоставляем HTML и PDF-версии наших книг на разных языках. Для данного дистрибутива доступны следующие руководства для пользователей и администраторов:

Вступление (↑Вступление)
: Руководство шаг за шагом провведет Вас через установку openSUSE с DVD или из ISO-образа, даст краткое введение в окружения рабочего стола GNOME и KDE, включая некоторые ключевые приложения. Также познакомит с LibreOffice и его модулями для создания текста со сложным форматированием, работы с электронными таблицами или создания графики и презентаций.

Reference (↑Reference)
: Даст Вам общее понимание работы openSUSE, затрагивая задачи продвинутого системного администрирования. Его материал предназначен в

первую очередь для системных администраторов и домашних пользователей, обладающих базовыми навыками администрирования. Содержит детальную информацию о продвинутых вариантах развертывания, администрирования, взаимодействия ключевых компонентов и настройке различных сетевых и файловых служб openSUSE.

Руководство по безопасности (стр. 1)
: Описываются основные понятия системы безопасности, охватывающей как локальные, так и сетевые аспекты. Показывается, как использовать такие утилиты для обеспечения сетевой безопасности, как Novell AppArmor (которая позволяет определить к каким файлам заданная программа будет иметь доступ на запись, чтение или выполнение) или система аудита, которая тщательно собирает информацию о событиях, так или иначе связанных с обеспечением надлежащего уровня безопасности системы.

System Analysis and Tuning Guide (↑System Analysis and Tuning Guide)
: Руководство администратора по обнаружению проблем, их разрешение и оптимизация работы. В нем найдется информация о том, как проверить и оптимизировать работу системы с помощью специальных инструментов, эффективно управлять ее ресурсами. Также в нем содержится обзор общих проблем и их решений, а также дополнительные справочные материалы и обзор доступных ресурсов.

Виртуализация с KVM (↑Виртуализация с KVM)
: Данное руководство предлагает краткое описание настройки и управления системой виртуализации на базе KVM (Kernel-based Virtual Machine) в openSUSE. Также показывается, как управлять VM Guest с помощью `libvirt` и QEMU.

Большинство HTML-версий руководств в установленной системе можно найти по адресу `/usr/share/doc/manual` или в справочном центре Вашего окружения рабочего стола. Последние обновления документации доступны по адресу `http://www.novell.com/documentation`, где можно загрузить в PDF или HTML-версии руководств для Вашего продукта.

# 2 Обратная связь

Некоторые из доступных каналов обратной связи:

Bugs and Enhancement Requests
: Чтобы сообщить об ошибке или отправить запрос об улучшении, пожалуйста, используйте https://bugzilla.novell.com/ . Для ошибок в документации отправьте Ваш отчет для компонента *Documentation* для соответствующего продукта.

  Если Вы плохо знакомы с Bugzilla, то Вам могут быть полезные этим статьи:

  - http://ru.opensuse.org/openSUSE:Сообщить_об_ошибке
  - http://ru.opensuse.org/openSUSE:Bug_reporting_FAQ

Комментарии пользователей
: Мы хотим услышать Ваши комментарии и предложения об этом руководстве и другой документации, поставляемой с данным продуктом. Используйте функцию комментариев пользователей в нижней части каждой страницы в онлайн-документации или перейдите по ссылке http://www.novell.com/documentation/feedback.html и оставьте Ваш комментарий.

# 3 Условные обозначения

В данном руководстве используются следующие типографские соглашения:

- `/etc/passwd` : имена каталогов и файлов
- *`заполнитель`*: замена *`заполнитель`* на фактическое значение
- `PATH`: переменная окружения PATH
- `ls`, `--help`: команды, опции и параметры
- `user`: пользователи или группы
- Alt, Alt + F1: клавиша или клавиатурная комбинация; названия клавиш показаны в верхнем регистре, как на клавиатуре
- *Файл*, *Файл* > *Сохранить как*: пункты меню, кнопки

- *Танцующие пингвины* (Глава *Пингвины*, ↑Другое руководство): это ссылка на главу в другом руководстве.

# 4 О создании этого руководства

Эта книга была создана в Novdoc, основан на DocBook (смотрите http://www.docbook.org ). Исходные XML-файлы проверяются программой `xmllint`, обработанные `xsltproc` и преобразованный в XSL-FO с использованием специализированной версии таблиц стилей Нормана Уолша (Norman Walsh). Конечный PDF-файл отформатирован через XEP от RenderX. Инструменты с открытым исходным кодом и среда, используемая для создания этого руководства, доступны в пакете `susedoc`, поставляемым в составе openSUSE.

# 5 Исходный код

Исходный код openSUSE находится в открытом доступе. Чтобы его загрузить, выполните следующее: http://ru.opensuse.org/Portal:Дистрибутив/Возможности . Если потребуется – мы можем отправить исходные коды на DVD. Мы берем $15 или €15 за запись, упаковку и доставку дисков. Чтобы запросить DVD с исходным кодом, отправьте e-mail на электронный адрес sourcedvd@suse.de [mailto:sourcedvd@suse.de ] или обычное письмо:

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# 6 Благодарности

Разработчики Linux сотрудничают с огромным числом добровольцев по всему миру, чтобы способствовать развитию Linux. Мы благоданы им за приложенные усилия — этот дистрибутив не существовал бы без них. Кроме того, мы

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Have a lot of fun!

Ваша команда SUSE

# 1

# Безопасность и конфиденциальность

Одной из главных характеристик UNIX/Linux систем является возможность обслуживать несколько пользователей (многопользовательские системы), а так же предоставлять им возможность выполнять несколько задач одновременно (многозадачность). Более того, опреационная система прозрачна для сети. Пользователи часто даже не знают находятся ли данные или программы, которые они используют, локально или доступны через сеть.

Так как системы многопользовательские, данные разных пользователей должны храниться раздельно, а так же должна быть обеспечена их безопасность и приватность. Безопасность данных всегда была важной проблемой, и даже до того, как появилась возможность объединять компьютеры через сеть. На много большее беспокойство вызывает несанкционированный доступ к информации, нежели ее потеря или даже поломка носителя информации (например жесткого диска).

Этот раздел фокусируется на проблемах конфиденциальности и на способах защиты личных пользовательских данных. Концепция безопасности включает в себя регулярно обновляемую, рабочую и проверяемую резервную копию, хранящуюся в безопасном месте. Без этих мер Вам придется потратить много времени, возвращая информацию— притом не только в случае поломки или дефекта носителя, но и в случае несанкционированного доступа.

# 1.1 Локальная и сетевая безопасность

There are several ways of accessing data:

- personal communication with people who have the desired information or access to the data on a computer
- directly through physical access from the console of a computer
- over a serial line
- using a network link

In all these cases, a user should be authenticated before accessing the resources or data in question. A Web server might be less restrictive in this respect, but you still would not want it to disclose your personal data to an anonymous user.

In the list above, the first case is the one where the highest amount of human interaction is involved (such as when you are contacting a bank employee and are required to prove that you are the person owning that bank account). Then, you are asked to provide a signature, a PIN, or a password to prove that you are the person you claim to be. In some cases, it might be possible to elicit some intelligence from an informed person just by mentioning known bits and pieces to win the confidence of that person. The victim could be led to reveal gradually more information, maybe without even being aware of it. Among hackers, this is called *social engineering*. You can only guard against this by educating people and by dealing with language and information in a conscious way. Before breaking into computer systems, attackers often try to target receptionists, service people working with the company, or even family members. In many cases, such an attack based on social engineering is only discovered at a much later time.

A person wanting to obtain unauthorized access to your data could also use the traditional way and try to get at your hardware directly. Therefore, the machine should be protected against any tampering so that no one can remove, replace, or cripple its components. This also applies to backups and even any network cables or power cords. Also secure the boot procedure, because there are some well-known key combinations that might provoke unusual behavior. Protect yourself against this by setting passwords for the BIOS and the boot loader.

Serial terminals connected to serial ports are still used in many places. Unlike network interfaces, they do not rely on network protocols to communicate with the host. A simple cable or an infrared port is used to send plain characters back and forth between the devices. The cable itself is the weakest point of such a system: with an older printer connected to it, it is easy to record any data being transferred thusly. What can be achieved with a printer can also be accomplished in other ways, depending on the effort that goes into the attack.

Reading a file locally on a host requires additional access rules than opening a network connection with a server on a different host. There is a distinction between local security and network security. The line is drawn where data must be put into packets to be sent somewhere else.

# 1.1.1 Local Security

Local security starts with the physical environment at the location in which computer is running. Set up your machine in a place where security is in line with your expectations and needs. The main goal of local security is to keep users separate from each other, so no user can assume the permissions or the identity of another. This is a general rule to be observed, but it is especially true for the user `root`, who holds system administration privileges. `root` can take on the identity of any other local user and read any locally-stored file without being prompted for the password.

## Passwords

On a Linux system, passwords are not stored as plain text and the entered text string is not simply matched with the saved pattern. If this were the case, all accounts on your system would be compromised as soon as someone got access to the corresponding file. Instead, the stored password is encrypted and, each time it is entered, is encrypted again and the two encrypted strings are compared. This only provides more security if the encrypted password cannot be reverse-computed into the original text string.

This is actually achieved by a special kind of algorithm, also called *trapdoor algorithm*, because it only works in one direction. An attacker who has obtained the encrypted string is not able to get your password by simply applying the same algorithm again. Instead, it would be necessary to test all the possible character combinations until a combination is found that looks like your password when encrypted. With passwords eight characters long, there are quite a number of possible combinations to calculate.

In the seventies, it was argued that this method would be more secure than others due to the relative slowness of the algorithm used, which took a few seconds to encrypt just one password. In the meantime, however, PCs have become powerful enough to do several hundred thousand or even millions of encryptions per second. Because of this, encrypted passwords should not be visible to regular users (`/etc/shadow` cannot be read by normal users). It is even more important that passwords are not easy to guess, in case the password file becomes visible due to some error. Consequently, it is not really useful to «translate» a password like «tantalize» into «t@nt@1lz3».

Replacing some letters of a word with similar looking numbers (like writing the password «tantalize» as «t@nt@1lz3» ) is not sufficient. Password cracking programs that use dictionaries to guess words also play with substitutions like that. A better way is to make up a word with no common meaning, something that only makes sense to you personally, like the first letters of the words of a sentence or the title of a book, such as «The Name of the Rose» by Umberto Eco. This would give the following safe password: «TNotRbUE9». In contrast, passwords like «beerbuddy» or «jasmine76» are easily guessed even by someone who has only some casual knowledge about you.

## The Boot Procedure

Configure your system so it cannot be booted from a floppy or from a CD, either by removing the drives entirely or by setting a BIOS password and configuring the BIOS to allow booting from a hard disk only. Normally, a Linux system is started by a boot loader, allowing you to pass additional options to the booted kernel. Prevent others from using such parameters during boot by setting an additional password in `/boot/grub/menu.lst` (see Глава 18, *The Boot Loader GRUB* (↑Reference)). This is crucial to your system's security. Not only does the kernel itself run with `root` permissions, but it is also the first authority to grant `root` permissions at system start-up.

## File Permissions

As a general rule, always work with the most restrictive privileges possible for a given task. For example, it is definitely not necessary to be `root` to read or write e-mail. If the mail program has a bug, this bug could be exploited for an attack that acts with exactly the permissions of the program when it was started. By following the above rule, minimize the possible damage.

The permissions of all files included in the openSUSE distribution are carefully chosen. A system administrator who installs additional software or other files should take great care when doing so, especially when setting the permission bits. Experienced and security-conscious system administrators always use the `-l` option with the command `ls` to get an extensive file list, which allows them to detect any incorrect file permissions immediately. An incorrect file attribute does not only mean that files could be changed or deleted. These modified files could be executed by `root` or, in the case of configuration files, programs could use such files with the permissions of `root`. This significantly increases the possibilities of an attack. Attacks like these are called cuckoo eggs, because the program (the egg) is executed (hatched) by a different user (bird), just like a cuckoo tricks other birds into hatching its eggs.

An openSUSE® system includes the files `permissions`, `permissions.easy` , `permissions.secure` , and `permissions.paranoid` , all in the directory `/etc`. The purpose of these files is to define special permissions, such as world-writable directories or, for files, the setuser ID bit (programs with the setuser ID bit set do not run with the permissions of the user that has launched it, but with the permissions of the file owner, in most cases `root`). An administrator can use the file `/etc/permissions.local` to add his own settings.

To define which of the above files is used by openSUSE's configuration programs to set permissions, select *Local Security* in the *Security and Users* section of YaST. To learn more about the topic, read the comments in `/etc/permissions` or consult the manual page of `chmod` (`man chmod`).

## Buffer Overflows and Format String Bugs

Special care must be taken whenever a program needs to process data that could be changed by a user, but this is more of an issue for the programmer of an application than for regular users. The programmer must make sure that his application interprets data in the correct way, without writing it into memory areas that are too small to hold it. Also, the program should hand over data in a consistent manner, using interfaces defined for that purpose.

A *buffer overflow* can happen if the actual size of a memory buffer is not taken into account when writing to that buffer. There are cases where this data (as generated by the user) uses up more space than what is available in the buffer. As a result, data is written beyond the end of that buffer area, which, under certain circumstances, makes it possible for a program to execute program sequences influenced by the user

(and not by the programmer), rather than just processing user data. A bug of this kind may have serious consequences, especially if the program is being executed with special privileges (see «File Permissions» (стр. 4)).

*Format string bugs* work in a slightly different way, but again it is the user input that could lead the program astray. In most cases, these programming errors are exploited with programs executed with special permissions—setuid and setgid programs—which also means that you can protect your data and your system from such bugs by removing the corresponding execution privileges from programs. Again, the best way is to apply a policy of using the lowest possible privileges (see «File Permissions» (стр. 4)).

Given that buffer overflows and format string bugs are bugs related to the handling of user data, they are not only exploitable if access has been given to a local account. Many of the bugs that have been reported can also be exploited over a network link. Accordingly, buffer overflows and format string bugs should be classified as being relevant for both local and network security.

## Viruses

Contrary to popular opinion, there are viruses that run on Linux. However, the viruses that are known were released by their authors as a *proof of concept* that the technique works as intended. None of these viruses have been spotted *in the wild* so far.

Viruses cannot survive and spread without a host on which to live. In this case, the host would be a program or an important storage area of the system, such as the master boot record, which needs to be writable for the program code of the virus. Owing to its multiuser capability, Linux can restrict write access to certain files (this is especially important with system files). Therefore, if you did your normal work with `root` permissions, you would increase the chance of the system being infected by a virus. In contrast, if you follow the principle of using the lowest possible privileges as mentioned above, chances of getting a virus are slim.

Apart from that, you should never rush into executing a program from some Internet site that you do not really know. openSUSE's RPM packages carry a cryptographic signature, as a digital label that the necessary care was taken to build them. Viruses are a typical sign that the administrator or the user lacks the required security awareness, putting at risk even a system that should be highly secure by its very design.

Viruses should not be confused with worms, which belong entirely to the world of networks. Worms do not need a host to spread.

# 1.1.2 Network Security

Network security is important for protecting from an attack that is started outside the network. The typical login procedure requiring a username and a password for user authentication is still a local security issue. In the particular case of logging in over a network, differentiate between the two security aspects. What happens until the actual authentication is network security and anything that happens afterwards is local security.

## X Window System and X Authentication

As mentioned at the beginning, network transparency is one of the central characteristics of a UNIX system. X, the windowing system of UNIX operating systems, can make use of this feature in an impressive way. With X, it is basically no problem to log in at a remote host and start a graphical program that is then sent over the network to be displayed on your computer.

When an X client needs to be displayed remotely using an X server, the latter should protect the resource managed by it (the display) from unauthorized access. In more concrete terms, certain permissions must be given to the client program. With the X Window System, there are two ways to do this, called host-based access control and cookie-based access control. The former relies on the IP address of the host where the client should run. The program to control this is xhost. xhost enters the IP address of a legitimate client into a database belonging to the X server. However, relying on IP addresses for authentication is not very secure. For example, if there were a second user working on the host sending the client program, that user would have access to the X server as well—just like someone stealing the IP address. Because of these shortcomings, this authentication method is not described in more detail here, but you can learn about it with `man xhost`.

In the case of cookie-based access control, a character string is generated that is only known to the X server and to the legitimate user, just like an ID card of some kind. This cookie is stored on login in the file `.Xauthority` in the user's home directory and is available to any X client wanting to use the X server to display a window. The file `.Xauthority` can be examined by the user with the tool

`xauth`. If you rename `.Xauthority` , or if you delete the file from your home directory by accident, you would not be able to open any new windows or X clients.

SSH (secure shell) can be used to encrypt a network connection completely and forward it to an X server transparently, without the encryption mechanism being perceived by the user. This is also called X forwarding. X forwarding is achieved by simulating an X server on the server side and setting a DISPLAY variable for the shell on the remote host. Further details about SSH can be found in Глава 13, *SSH: Безопасная работа в сети* (стр. 167).

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**ВНИМАНИЕ**

If you do not consider the host where you log in to be a secure host, do not use X forwarding. With X forwarding enabled, an attacker could authenticate via your SSH connection to intrude on your X server and perpetrate various actions (reading, or sniffing, your keyboard input, for instance).

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## Buffer Overflows and Format String Bugs

As discussed in «Buffer Overflows and Format String Bugs» (стр. 5), buffer overflows and format string bugs should be classified as issues applying to both local and network security. As with the local variants of such bugs, buffer overflows in network programs, when successfully exploited, are mostly used to obtain `root` permissions. Even if that is not the case, an attacker could use the bug to gain access to an unprivileged local account to exploit other vulnerabilities that might exist on the system.

Buffer overflows and format string bugs exploitable over a network link are certainly the most frequent form of remote attacks, in general. Exploits for these—programs to exploit these newly-found security holes—are often posted on security mailing lists. They can be used to target the vulnerability without knowing the details of the code. Over the years, experience has shown that the availability of exploit codes has contributed to more secure operating systems, obviously due to the fact that operating system makers were forced to fix the problems in their software. With free software, anyone has access to the source code (openSUSE comes with all available source codes) and anyone who finds a vulnerability and its exploit code can submit a patch to fix the corresponding bug.

## Denial of Service

The purpose of a denial of service (DoS) attack is to block a server program or even an entire system, something that could be achieved by various means: overloading the server, keeping it busy with garbage packets, or exploiting a remote buffer overflow. Often, a DoS attack is made with the sole purpose of making the service disappear. However, once a given service has become unavailable, communications could become vulnerable to *man-in-the-middle attacks* (sniffing, TCP connection hijacking, spoofing) and DNS poisoning.

## Man in the Middle: Sniffing, Hijacking, Spoofing

In general, any remote attack performed by an attacker who puts himself between the communicating hosts is called a *man-in-the-middle attack*. What almost all types of man-in-the-middle attacks have in common is that the victim is usually not aware that there is something happening. There are many possible variants. For example, the attacker could pick up a connection request and forward that to the target machine. Now the victim has unwittingly established a connection with the wrong host, because the other end is posing as the legitimate destination machine.

The simplest form of a man-in-the-middle attack is called *sniffer* (the attacker is «just» listening to the network traffic passing by). As a more complex attack, the «man in the middle» could try to take over an already established connection (hijacking). To do so, the attacker would need to analyze the packets for some time to be able to predict the TCP sequence numbers belonging to the connection. When the attacker finally seizes the role of the target host, the victims notice this, because they get an error message saying the connection was terminated due to a failure. The fact that there are protocols not secured against hijacking through encryption (which only perform a simple authentication procedure upon establishing the connection) makes it easier for attackers.

*Spoofing* is an attack where packets are modified to contain counterfeit source data, usually the IP address. Most active forms of attack rely on sending out such fake packets (something that, on a Linux machine, can only be done by the superuser (`root`)).

Many of the attacks mentioned are carried out in combination with a DoS. If an attacker sees an opportunity to bring down a certain host abruptly, even if only for a short time, it makes it easier for him to push the active attack, because the host will not be able to interfere with the attack for some time.

## DNS Poisoning

DNS poisoning means that the attacker corrupts the cache of a DNS server by replying to it with spoofed DNS reply packets, trying to get the server to send certain data to a victim who is requesting information from that server. Many servers maintain a trust relationship with other hosts, based on IP addresses or hostnames. The attacker needs a good understanding of the actual structure of the trust relationships among hosts to disguise itself as one of the trusted hosts. Usually, the attacker analyzes some packets received from the server to get the necessary information. The attacker often needs to target a well-timed DoS attack at the name server as well. Protect yourself by using encrypted connections that are able to verify the identity of the hosts to which to connect.

### Worms

Worms are often confused with viruses, but there is a clear difference between the two. Unlike viruses, worms do not need to infect a host program to live. Instead, they are specialized to spread as quickly as possible on network structures. The worms that appeared in the past, such as Ramen, Lion, or Adore, make use of well-known security holes in server programs like bind8 or lprNG. Protection against worms is relatively easy. Given that some time elapses between the discovery of a security hole and the moment the worm hits your server, there is a good chance that an updated version of the affected program is available on time. That is only useful if the administrator actually installs the security updates on the systems in question.

## 1.2 Some General Security Tips and Tricks

To handle security competently, it is important to observe some recommendations. You may find the following list of rules useful in dealing with basic security concerns:

- Get and install the updated packages recommended by security announcements as quickly as possible.
- Stay informed about the latest security issues:
  - `opensuse-security-announce@opensuse.org` is the SUSE mailinglist for security announcements. It is a first-hand source of

information regarding updated packages and includes members of SUSE's security team among its active contributors. You can subscribe to this list on page http://en.opensuse.org/Communicate/Mailinglists .

- Find SUSE security advisories as a news feed at http://www.novell.com/linux/security/suse_security.xml .

- bugtraq@securityfocus.com is one of the best-known security mailing lists worldwide. Reading this list, which receives between 15 and 20 postings per day, is recommended. More information can be found at http://www.securityfocus.com .

- Discuss any security issues of interest on our mailinglist opensuse-security@opensuse.org .

- According to the rule of using the most restrictive set of permissions possible for every job, avoid doing your regular jobs as `root`. This reduces the risk of getting a cuckoo egg or a virus and protects you from your own mistakes.

- If possible, always try to use encrypted connections to work on a remote machine. Using `ssh` (secure shell) to replace `telnet`, `ftp`, `rsh`, and `rlogin` should be standard practice.

- Avoid using authentication methods based solely on IP addresses.

- Try to keep the most important network-related packages up-to-date and subscribe to the corresponding mailing lists to receive announcements on new versions of such programs (bind, postfix, ssh, etc.). The same should apply to software relevant to local security.

- Change the `/etc/permissions` file to optimize the permissions of files crucial to your system's security. If you remove the setuid bit from a program, it might well be that it cannot do its job anymore in the intended way. On the other hand, consider that, in most cases, the program will also have ceased to be a potential security risk. You might take a similar approach with world-writable directories and files.

- Disable any network services you do not absolutely require for your server to work properly. This makes your system safer. Open ports, with the socket state LISTEN,

can be found with the program `netstat`. As for the options, it is recommended to use `netstat -ap` or `netstat -anp`. The `-p` option allows you to see which process is occupying a port under which name.

Compare the `netstat` results with those of a thorough port scan done from outside your host. An excellent program for this job is `nmap`, which not only checks out the ports of your machine, but also draws some conclusions as to which services are waiting behind them. However, port scanning may be interpreted as an aggressive act, so do not do this on a host without the explicit approval of the administrator. Finally, remember that it is important not only to scan TCP ports, but also UDP ports (options `-sS` and `-sU`).

- To monitor the integrity of the files of your system in a reliable way, use the program `AIDE` (Advanced Intrusion Detection Environment), available on openSUSE. Encrypt the database created by AIDE to prevent someone from tampering with it. Furthermore, keep a backup of this database available outside your machine, stored on an external data medium not connected to it by a network link.

- Take proper care when installing any third-party software. There have been cases where a hacker had built a trojan horse into the tar archive of a security software package, which was fortunately discovered very quickly. If you install a binary package, have no doubts about the site from which you downloaded it.

  SUSE's RPM packages are gpg-signed. The key used by SUSE for signing is:

  ```
  ID:9C800ACA 2000-10-19 SUSE Package Signing Key <build@suse.de>
       Key fingerprint = 79C1 79B2 E1C8 20C1 890F 9994 A84E DAE8 9C80 0ACA
  ```

  The command `rpm --checksig package.rpm` shows whether the checksum and the signature of an uninstalled package are correct. Find the key on the first CD of the distribution and on most key servers worldwide.

- Check backups of user and system files regularly. Consider that if you do not test whether the backup works, it might actually be worthless.

- Check your log files. Whenever possible, write a small script to search for suspicious entries. Admittedly, this is not exactly a trivial task. In the end, only you can know which entries are unusual and which are not.

- Use `tcp_wrapper` to restrict access to the individual services running on your machine, so you have explicit control over which IP addresses can connect to a

service. For further information regarding `tcp_wrapper`, consult the manual pages of tcpd and hosts_access (`man 8 tcpd`, `man hosts_access`).

- Use SuSEfirewall to enhance the security provided by `tcpd` (`tcp_wrapper`).
- Design your security measures to be redundant: a message seen twice is much better than no message at all.
- If you use suspend to disk, consider configuring the suspend image encryption using the `configure-suspend-encryption.sh` script. The program creates the key, copies it to `/etc/suspend.key`, and modifies `/etc/suspend.conf` to use encryption for suspend images.

# 1.3 Using the Central Security Reporting Address

If you discover a security-related problem (please check the available update packages first), write an e-mail to `security@suse.de`. Please include a detailed description of the problem and the version number of the package concerned. SUSE will try to send a reply as soon as possible. You are encouraged to pgp-encrypt your e-mail messages. SUSE's pgp key is:

```
ID:3D25D3D9 1999-03-06 SUSE Security Team <security@suse.de>
Key fingerprint = 73 5F 2E 99 DF DB 94 C4 8F 5A A3 AE AF 22 F2 D5
```

This key is also available for download from `http://www.novell.com/linux/security/securitysupport.html`.

# Часть I. Аутентификация

# 2

# Authentication with PAM

Linux uses PAM (pluggable authentication modules) in the authentication process as a layer that mediates between user and application. PAM modules are available on a systemwide basis, so they can be requested by any application. This chapter describes how the modular authentication mechanism works and how it is configured.

## 2.1 What is PAM?

System administrators and programmers often want to restrict access to certain parts of the system or to limit the use of certain functions of an application. Without PAM, applications must be adapted every time a new authentication mechanism, such as LDAP, Samba, or Kerberos, is introduced. This process, however, is rather time-consuming and error-prone. One way to avoid these drawbacks is to separate applications from the authentication mechanism and delegate authentication to centrally managed modules. Whenever a newly required authentication scheme is needed, it is sufficient to adapt or write a suitable *PAM module* for use by the program in question.

The PAM concept consists of:

- *PAM modules* which are a set of shared libraries for a specific authentication mechanism.
- A *module stack* with of one or more PAM modules.

- A PAM-aware *service* which needs authentication by using a module stack or PAM modules. Usually a service is a familiar name of the corresponding application, like `login` or `su`. The service name `other` is a reserved word for default rules.

- *module arguments* with which the execution of a single PAM module can be influenced.

- a mechanism evaluating each *result* of a single PAM module execution. A positive value executes the next PAM module. The way a negative value is dealt with, depends on the configuration— «no influence, proceed» up to «terminate immediately» and anything in between are valid options.

# 2.2 Structure of a PAM Configuration File

PAM can be configured in two ways:

File based configuration (`/etc/pam.conf` )
: The configuration of each service is stored in `/etc/pam.conf` . However, for maintenance and usability reasons, this configuration scheme is not used in openSUSE.

Directory based configuration (`/etc/pam.d/` )
: Every service (or program) that relies on the PAM mechanism has its own configuration file in the `/etc/pam.d/` directory. For example, the service for `sshd` can be found in the `/etc/pam.d/sshd` file.

The files under `/etc/pam.d/` define the PAM modules used for authentication. Each file consists of lines, which define a service, and each line consists of a maximum of four components:

```
TYPE CONTROL MODULE_PATH MODULE_ARGS
```

The components have the following meaning:

*TYPE*
: Declares the type of the service. PAM modules are processed as stacks. Different types of modules have different purposes. For example, one module checks the

password, another verifies the location from which the system is accessed, and yet another reads user-specific settings. PAM knows about four different types of modules:

`auth`
: Check the user's authenticity, traditionally by querying a password. However, this can also be achieved with the help of a chip card or through biometrics (for example, fingerprints or iris scan).

`account`
: Modules of this type check if the user has general permission to use the requested service. As an example, such a check should be performed to ensure that no one can log in with the username of an expired account.

`password`
: The purpose of this type of module is to enable the change of an authentication token. In most cases, this is a password.

`session`
: Modules of this type are responsible for managing and configuring user sessions. They are started before and after authentication to log login attempts and configure the user's specific environment (mail accounts, home directory, system limits, etc.).

*`CONTROL`*
: Indicates the behavior of a PAM module. Each module can have the following control flags:

`required`
: A module with this flag must be successfully processed before the authentication may proceed. After the failure of a module with the `required` flag, all other modules with the same flag are processed before the user receives a message about the failure of the authentication attempt.

`requisite`
: Modules having this flag must also be processed successfully, in much the same way as a module with the `required` flag. However, in case of failure a module with this flag gives immediate feedback to the user and no further modules are processed. In case of success, other modules are subsequently processed, just like any modules with the `required` flag. The

`requisite` flag can be used as a basic filter checking for the existence of certain conditions that are essential for a correct authentication.

`sufficient`
: After a module with this flag has been successfully processed, the requesting application receives an immediate message about the success and no further modules are processed, provided there was no preceding failure of a module with the `required` flag. The failure of a module with the `sufficient` flag has no direct consequences, in the sense that any subsequent modules are processed in their respective order.

`optional`
: The failure or success of a module with this flag does not have any direct consequences. This can be useful for modules that are only intended to display a message (for example, to tell the user that mail has arrived) without taking any further action.

`include`
: If this flag is given, the file specified as argument is inserted at this place.

*MODULE_PATH*
: Contains a full filename of a PAM module. It does not need to be specified explicitly, as long as the module is located in the default directory `/lib/security` (for all 64-bit platforms supported by openSUSE®, the directory is `/lib64/security`).

*MODULE_ARGS*
: Contains a space-separated list of options to influence the behavior of a PAM module, such as `debug` (enables debugging) or `nullok` (allows the use of empty passwords).

In addition, there are global configuration files for PAM modules under `/etc/security`, which define the exact behavior of these modules (examples include `pam_env.conf` and `time.conf`). Every application that uses a PAM module actually calls a set of PAM functions, which then process the information in the various configuration files and return the result to the requesting application.

To facilitate the creation and maintenance of PAM modules, common default configuration files for the types `auth`, `account`, `password`, and `session` modules have been introduced. These are retrieved from every application's PAM

configuration. Updates to the global PAM configuration modules in `common-*` are thus propagated across all PAM configuration files without requiring the administrator to update every single PAM configuration file.

The global PAM configuration files are maintained using the `pam-config` tool. This tool automatically adds new modules to the configuration, changes the configuration of existing ones or deletes modules (or options) from the configurations. Manual intervention in maintaining PAM configurations is minimized or no longer required.

---

**ЗАМЕЧАНИЕ: 64-Bit and 32-Bit Mixed Installations**

When using a 64-bit operating system, it is possible to also include a runtime environment for 32-bit applications. In this case, make sure that you install both versions of the pam modules.

---

# 2.3 The PAM Configuration of sshd

Consider the PAM configuration of sshd as an example:

***Пример 2.1*** *PAM Configuration for sshd (/etc/pam.d/sshd)*

```
#%PAM-1.0                    ❶
auth     required       pam_nologin.so  ❷
auth     include        common-auth     ❸
account  include        common-account  ❸
password include        common-password ❸
session  required       pam_loginuid.so ❹
session  include        common-session  ❸
```

❶ Declares the version of this configuration file for PAM 1.0. This is merely a convention, but could be used in the future to check the version.

❷ Checks, if `/etc/nologin` exists. If it does, no user other than `root` may log in.

❸ Refers to the configuration files of four module types: `common-auth` , `common-account` , `common-password` , and `common-session` . These four files hold the default configuration for each module type.

❹ Sets the login uid process attribute for the process that was authenticated.

By including them instead of adding each module separately to the respective PAM configuration, you automatically get an updated PAM configuration when an administrator changes the defaults. Formerly, you had to adjust all configuration files manually for all applications when changes to PAM occurred or a new application was installed. Now the PAM configuration is made with central configuration files and all changes are automatically inherited by the PAM configuration of each service.

The first include file (`common-auth` ) calls three modules of the `auth` type: `pam_env.so`, `pam_gnome_keyring.so` and `pam_unix2.so`. See Пример 2.2, «Default Configuration for the `auth` Section» (стр. 22).

***Пример 2.2*** *Default Configuration for the auth Section*

```
auth    required        pam_env.so
auth    optional        pam_gnome_keyring.so
auth    required        pam_unix2.so
```

The first one, `pam_env.so`, loads `/etc/security/pam_env.conf` to set the environment variables as specified in this file. It can be used to set the `DISPLAY` variable to the correct value, because the `pam_env` module knows about the location from which the login is taking place. The second one automatically unlocks the GNOME keyring when necessary. The last one, `pam_unix2`, checks the user's login and password against `/etc/passwd` and `/etc/shadow` .

The whole stack of `auth` modules is processed before sshd gets any feedback about whether the login has succeeded. Given that all modules of the stack have the `required` control flag, they must all be processed successfully before sshd receives a message about the positive result. If one of the modules is not successful, the entire module stack is still processed and only then is sshd notified about the negative result.

As soon as all modules of the `auth` type have been successfully processed, another include statement is processed, in this case, that in Пример 2.3, «Default Configuration for the `account` Section» (стр. 22). `common-account` contains just one module, `pam_unix2`. If `pam_unix2` returns the result that the user exists, sshd receives a message announcing this success and the next stack of modules (`password`) is processed, shown in Пример 2.4, «Default Configuration for the `password` Section» (стр. 23).

***Пример 2.3*** *Default Configuration for the account Section*

```
account required        pam_unix2.so
```

***Пример 2.4*** *Default Configuration for the password Section*

```
password        requisite       pam_pwcheck.so  nullok cracklib
password        optional        pam_gnome_keyring.so    use_authtok
password        required        pam_unix2.so    use_authtok nullok
```

Again, the PAM configuration of sshd involves just an include statement referring to the default configuration for `password` modules located in `common-password` . These modules must successfully be completed (control flags `requisite` and `required`) whenever the application requests the change of an authentication token.

Changing a password or another authentication token requires a security check. This is achieved with the `pam_pwcheck` module. The `pam_unix2` module used afterwards carries over any old and new passwords from `pam_pwcheck` , so the user does not need to authenticate again after changing the password. This procedure makes it impossible to circumvent the checks carried out by `pam_pwcheck` . Whenever the `account` or the `auth` type are configured to complain about expired passwords, the `password` modules should also be used.

***Пример 2.5*** *Default Configuration for the session Section*

```
session required        pam_limits.so
session required        pam_unix2.so
session optional        pam_apparmor.so
session optional        pam_umask.so
session optional        pam_gnome_keyring.so    auto_start only_if=gdm,lxdm
```

As the final step, the modules of the `session` type (bundled in the `common-session` file) are called to configure the session according to the settings for the user in question. The `pam_limits` module loads the file `/etc/security/limits.conf` , which may define limits on the use of certain system resources. The `pam_unix2` module is processed again. The `pam_umask` module can be used to set the file mode creation mask. Since this module carries the `optional` flag, a failure of this module would not affect the successful completion of the entire session module stack. The `session` modules are called a second time when the user logs out.

# 2.4 Configuration of PAM Modules

Some of the PAM modules are configurable. The configuration files are located in `/etc/security` . This section briefly describes the configuration files relevant to the sshd example—`pam_env.conf` and `limits.conf` .

## 2.4.1 pam_env.conf

`pam_env.conf` can be used to define a standardized environment for users that is set whenever the `pam_env` module is called. With it, preset environment variables using the following syntax:

```
VARIABLE [DEFAULT=value] [OVERRIDE=value]
```

*VARIABLE*
Name of the environment variable to set.

[DEFAULT=<value>]
Default *value* the administrator wants to set.

[OVERRIDE=<value>]
Values that may be queried and set by `pam_env`, overriding the default value.

A typical example of how `pam_env` can be used is the adaptation of the `DISPLAY` variable, which is changed whenever a remote login takes place. This is shown in Пример 2.6, «pam_env.conf» (стр. 24).

***Пример 2.6*** *pam_env.conf*

```
REMOTEHOST     DEFAULT=localhost OVERRIDE=@{PAM_RHOST}
DISPLAY        DEFAULT=${REMOTEHOST}:0.0 OVERRIDE=${DISPLAY}
```

The first line sets the value of the `REMOTEHOST` variable to `localhost`, which is used whenever `pam_env` cannot determine any other value. The `DISPLAY` variable in turn contains the value of `REMOTEHOST`. Find more information in the comments in `/etc/security/pam_env.conf` .

## 2.4.2 pam_mount.conf

The purpose of `pam_mount` is to mount user home directories during the login process, and to unmount them during logout in an environment where a central file server keeps all the home directories of users. With this method, it is not necessary to mount a complete `/home` directory where all the user home directories would be accessible. Instead, only the home directory of the user who is about to log in, is mounted.

After installing `pam_mount`, a template of `pam_mount.conf.xml` is available in `/etc/security` . The description of the various elements can be found in the manual page `man 5 pam_mount.conf`.

A basic configuration of this feature can be done with YaST. Select *Network Settings* > *Windows Domain Membership* > *Expert Settings* to add the file server; see Раздел “Configuring Clients” (Глава 29, *Samba*, ↑Reference).

## 2.4.3 limits.conf

System limits can be set on a user or group basis in `limits.conf` , which is read by the `pam_limits` module. The file allows you to set hard limits, which may not be exceeded at all, and soft limits, which may be exceeded temporarily. For more information about the syntax and the options, see the comments in `/etc/security/limits.conf` .

# 2.5 Configuring PAM Using pam-config

The `pam-config` tool helps you configure the global PAM configuration files (`/etc/pam.d/common-*-pc` ) as well as several selected application configurations. For a list of supported modules, use the `pam-config --list-modules` command. Use the `pam-config` command to maintain your PAM configuration files. Add new modules to your PAM configurations, delete other modules or modify options to these modules. When changing global PAM configuration files, no manual tweaking of the PAM setup for individual applications is required.

A simple use case for `pam-config` involves the following:

1. **Auto-generate a fresh Unix-style PAM configuration.** Let pam-config create the simplest possible setup which you can extend later on. The `pam-config --create` command creates a simple UNIX authentication configuration. Pre-existing configuration files not maintained by pam-config are overwritten, but backup copies are kept as `*.pam-config-backup`.

2. **Add a new authentication method.** Adding a new authentication method (for example, LDAP) to your stack of PAM modules comes down to a simple `pam-config --add --ldap` command. LDAP is added wherever appropriate across all `common-*-pc` PAM configuration files.

3 **Add debugging for test purposes.** To make sure the new authentication procedure works as planned, turn on debugging for all PAM-related operations. The `pam-config --add --ldap-debug` turns on debugging for LDAP-related PAM operations. Find the debugging output in `/var/log/messages` .

4 **Query your setup.** Before you finally apply your new PAM setup, check if it contains all the options you wanted to add. The `pam-config --query --module` lists both the type and the options for the queried PAM module.

5 **Remove the debug options.** Finally, remove the debug option from your setup when you are entirely satisfied with the performance of it. The `pam-config --delete --ldap-debug` command turns off debugging for LDAP authentication. In case you had debugging options added for other modules, use similar commands to turn these off.

When you create your PAM configuration files from scratch using the `pam-config --create` command, it creates symbolic links from the `common-*` to the `common-*-pc` files. pam-config only modifies the `common-*-pc` configuration files. Removing these symbolic links effectively disables pam-config, because pam-config only operates on the `common-*-pc` files and these files are not put into effect without the symbolic links.

For more information on the `pam-config` command and the options available, refer to the manual page of `pam-config(8)`.

# 2.6 For More Information

In the `/usr/share/doc/packages/pam` directory of the installed system, find the following additional documentation:

READMEs
: In the top level of this directory, there is the general README file. The `modules` subdirectory holds README files about the available PAM modules.

The Linux-PAM System Administrators' Guide
: This document comprises everything that the system administrator should know about PAM. It discusses a range of topics, from the syntax of configuration files to the security aspects of PAM.

The Linux-PAM Module Writers' Manual
: This document summarizes the topic from the developer's point of view, with information about how to write standard-compliant PAM modules.

The Linux-PAM Application Developers' Guide
: This document comprises everything needed by an application developer who wants to use the PAM libraries.

The PAM Manual Pages
: PAM in general as well as the individual modules come with manual pages that provide a good overview of the functionality provided by the respective component.

Thorsten Kukuk has developed a number of PAM modules. Find the documentation of these modules at http://www.suse.de/~kukuk/pam/ .

# 3

# Using NIS

As soon as multiple UNIX systems in a network access common resources, it becomes imperative that all user and group identities are the same for all machines in that network. The network should be transparent to users: their environments should not vary, regardless of which machine they are actually using. This can be done by means of NIS and NFS services. NFS distributes file systems over a network and is discussed in Глава 28, *Sharing File Systems with NFS* (↑Reference).

NIS (Network Information Service) can be described as a database-like service that provides access to the contents of `/etc/passwd` , `/etc/shadow` , and `/etc/group` across networks. NIS can also be used for other purposes (making the contents of files like `/etc/hosts` or `/etc/services` available, for example), but this is beyond the scope of this introduction. People often refer to NIS as *YP*, because it works like the network's «yellow pages.»

## 3.1 Configuring NIS Servers

To distribute NIS information across networks, either install one single server (a *master*) that serves all clients, or NIS slave servers requesting this information from the master and relaying it to their respective clients.

- To configure just one NIS server for your network, proceed with Раздел 3.1.1, «Configuring a NIS Master Server» (стр. 30).
- If your NIS master server needs to export its data to slave servers, set up the master server as described in Раздел 3.1.1, «Configuring a NIS Master Server»

(стр. 30) and set up slave servers in the subnets as described in Раздел 3.1.2, «Configuring a NIS Slave Server» (стр. 35).

## 3.1.1 Configuring a NIS Master Server

To configure a NIS master server for your network, proceed as follows:

1. To check whether the YaST NIS server configuration module is already installed, start YaST and select *Software* > *Software Management*. Search for `yast2-nis-server` and install it, if needed.

2. Start *YaST* > *Network Services* > *NIS Server*.

3. If you need just one NIS server in your network or if this server is to act as the master for further NIS slave servers, select *Install and Set Up NIS Master Server*. YaST installs the required packages.

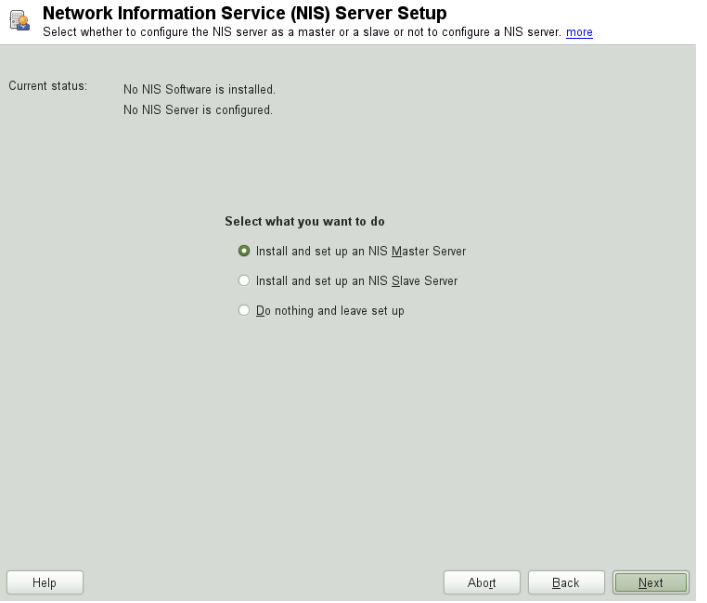
---

**ПОДСКАЗКА**

If NIS server software is already installed on your machine, initiate the creation of a NIS master server by clicking *Create NIS Master Server*.

---

***Рисунок 3.1*** *NIS Server Setup*




**4** Determine basic NIS setup options:

**4a** Enter the NIS domain name.

**4b** Define whether the host should also be a NIS client (enabling users to log in and access data from the NIS server) by selecting *This Host is also a NIS Client*.

**4c** If your NIS server needs to act as a master server to NIS slave servers in other subnets, select *Active Slave NIS Server Exists*.

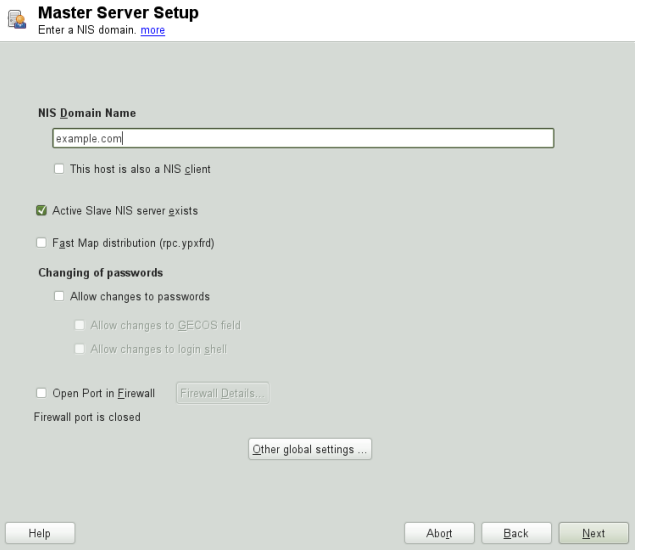
The option *Fast Map Distribution* is only useful in conjunction with *Active Slave NIS Servers Exist*. It speeds up the transfer of maps to the slaves.

**4d** Select *Allow Changes to Passwords* to allow users in your network (both local users and those managed through the NIS server) to change their passwords on the NIS server (with the command `yppasswd`). This makes the options *Allow Changes to GECOS Field* and *Allow Changes to Login Shell* available. «GECOS» means that the users can also change

their names and address settings with the command `ypchfn`. «Shell» allows users to change their default shell with the command `ypchsh` (for example, to switch from bash to sh). The new shell must be one of the predefined entries in `/etc/shells` .

**4e** Select *Open Port in Firewall* to have YaST adapt the firewall settings for the NIS server.

***Рисунок 3.2*** *Master Server Setup*




**4f** Leave this dialog with *Next* or click *Other Global Settings* to make additional settings.

*Other Global Settings* include changing the source directory of the NIS server (`/etc` by default). In addition, passwords can be merged here. The setting should be *Yes* to create the user database from the system authentication files `/etc/passwd` , `/etc/shadow` , and `/etc/group` . Also, determine the smallest user and group ID that should be offered by NIS. Click *OK* to confirm your settings and return to the previous screen.

***Рисунок 3.3*** *Changing the Directory and Synchronizing Files for a NIS Server*


5 If you previously enabled *Active Slave NIS Server Exists*, enter the hostnames used as slaves and click *Next*. If no slave servers exist, this configuration step is skipped.

6 Continue to the dialog for the database configuration. Specify the *NIS Server Maps*, the partial databases to transfer from the NIS server to the client. The default settings are usually adequate. Leave this dialog with *Next*.

7 Check which maps should be available and click *Next* to continue.

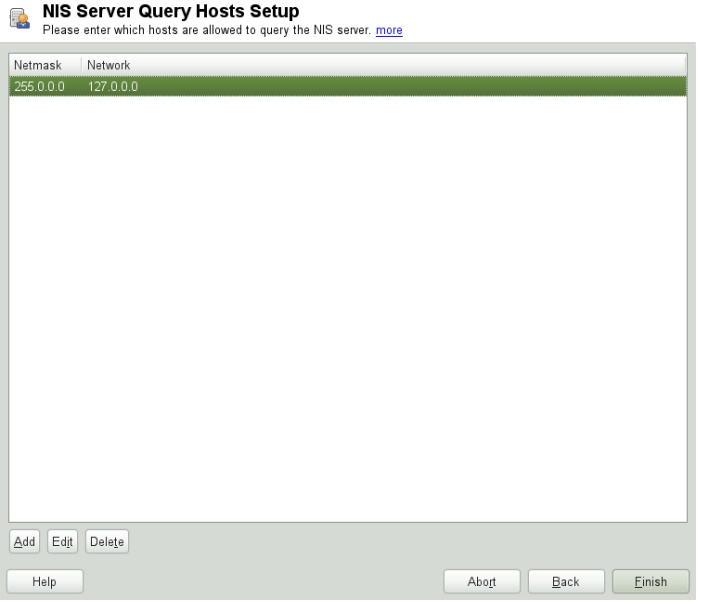
***Рисунок 3.4*** *NIS Server Maps Setup*


**8** Determine which hosts are allowed to query the NIS server. You can add, edit, or delete hosts by clicking the appropriate button. Specify from which networks requests can be sent to the NIS server. Normally, this is your internal network. In this case, there should be the following two entries:

```
255.0.0.0       127.0.0.0
0.0.0.0         0.0.0.0
```

The first entry enables connections from your own host, which is the NIS server. The second one allows all hosts to send requests to the server.

***Рисунок 3.5*** *Setting Request Permissions for a NIS Server*




**9** Click *Finish* to save your changes and exit the setup.

# 3.1.2 Configuring a NIS Slave Server

To configure additional NIS *slave servers* in your network, proceed as follows:

**1** Start *YaST* > *Network Services* > *NIS Server*.

**2** Select *Install and Set Up NIS Slave Server* and click *Next*.

**ПОДСКАЗКА**

If NIS server software is already installed on your machine, initiate the creation of a NIS slave server by clicking *Create NIS Slave Server*.

**3** Complete the basic setup of your NIS slave server:

**3a** Enter the NIS domain.

**3b** Enter hostname or IP address of the master server.

**3c** Set *This Host is also a NIS Client* if you want to enable user logins on this server.

**3d** Adapt the firewall settings with *Open Ports in Firewall*.

**3e** Click *Next*.

**4** Enter the hosts that are allowed to query the NIS server. You can add, edit, or delete hosts by clicking the appropriate button. Specify all networks from which requests can be sent to the NIS server. If it applies to all networks, use the following configuration:

```
255.0.0.0      127.0.0.0
0.0.0.0        0.0.0.0
```

The first entry enables connections from your own host, which is the NIS server. The second one allows all hosts with access to the same network to send requests to the server.

**5** Click *Finish* to save changes and exit the setup.

# 3.2 Configuring NIS Clients

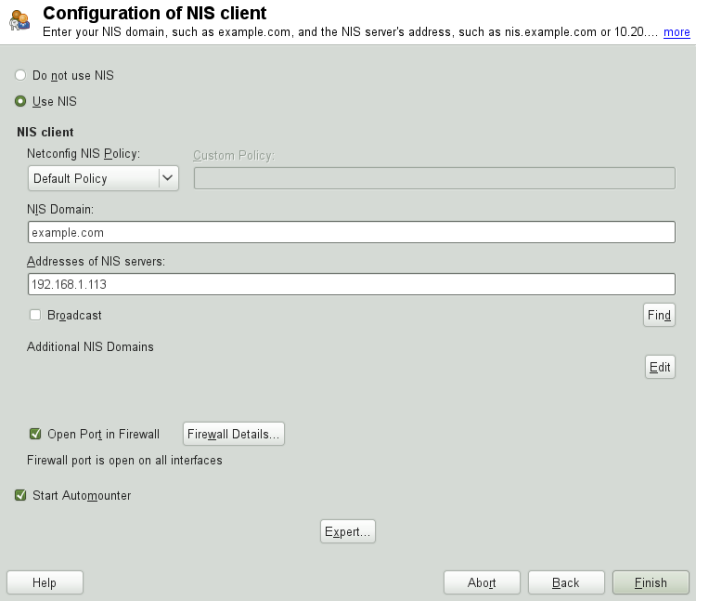
To use NIS on a workstation, do the following:

**1** Start *YaST* > *Network Services* > *NIS Client*.

**2** Activate the *Use NIS* button.

**3** Enter the NIS domain. This is usually a domain name given by your administrator or a static IP address received by DHCP. For information about DHCP, see Глава 26, *DHCP* (↑Reference).

***Рисунок 3.6*** *Setting Domain and Address of a NIS Server*




**4** Enter your NIS servers and separate their addresses by spaces. If you do not know your NIS server, click on *Find* to let YaST search for any NIS servers in your domain. Depending on the size of your local network, this may be a time-consuming process. *Broadcast* asks for a NIS server in the local network after the specified servers fail to respond.

**5** Depending on your local installation, you may also want to activate the automounter. This option also installs additional software if required.

**6** If you do not want other hosts to be able to query which server your client is using, go to the *Expert* settings and disable *Answer Remote Hosts*. By checking *Broken Server*, the client is enabled to receive replies from a server communicating through an unprivileged port. For further information, see `man ypbind`.

**7** Click *Finish* to save them and return to the YaST control center. Your client is now configured with NIS.

# 4

# LDAP—A Directory Service

The Lightweight Directory Access Protocol (LDAP) is a set of protocols designed to access and maintain information directories. LDAP can be used for user and group management, system configuration management, address management, and more. This chapter provides a basic understanding of how OpenLDAP works and how to manage LDAP data with YaST.

In a network environment it is crucial to keep important information structured and to serve it quickly. A directory service—like the common yellow pages, keeps information available in a well-structured and readily-searchable form.

Ideally, a central server stores the data in a directory and distributes it to all clients using a well-defined protocol. The structured data allow a wide range of applications to access them. A central repository reduces the necessary administrative effort. The use of an open and standardized protocol like LDAP ensures that as many different client applications as possible can access such information.

A directory in this context is a type of database optimized for quick and effective reading and searching:

- To make multiple concurrent reading accesses possible, the number of updates is usually very low. The number of read and write accesses is often limited to a few users with administrative privileges. In contrast, conventional databases are optimized for accepting the largest possible data volume in a short time.

- When static data is administered, updates of the existing data sets are very rare. When working with dynamic data, especially when data sets like bank accounts

or accounting are concerned, the consistency of the data is of primary importance. If an amount should be subtracted from one place to be added to another, both operations must happen concurrently, within one *transaction*, to ensure balance over the data stock. Traditional relational databases usually have a very strong focus on data consistency, such as the referential integrity support of transactions. Conversely, short-term inconsistencies are usually acceptable in LDAP directories. LDAP directories often do not have such strong consistency requirements as relational databases.

The design of a directory service like LDAP is not laid out to support complex update or query mechanisms. All applications are guaranteed to access this service quickly and easily.

# 4.1 LDAP versus NIS

Unix system administrators traditionally use NIS (Network Information Service) for name resolution and data distribution in a network. The configuration data contained in the files `group`, `hosts`, `mail`, `netgroup`, `networks`, `passwd`, `printcap`, `protocols`, `rpc`, and `services` in the `/etc` directory is distributed to clients all over the network. These files can be maintained without major effort because they are simple text files. The handling of larger amounts of data, however, becomes increasingly difficult due to nonexistent structuring. NIS is only designed for Unix platforms, and is not suitable as a centralized data administration tool in heterogeneous networks.

Unlike NIS, the LDAP service is not restricted to pure Unix networks. Windows servers (from 2000) support LDAP as a directory service. The application tasks mentioned above are additionally supported in non-Unix systems.

The LDAP principle can be applied to any data structure that needs to be centrally administered. A few application examples are:

- Replacement for the NIS service
- Mail routing (postfix, sendmail)
- Address books for mail clients, like Mozilla, Evolution, and Outlook
- Administration of zone descriptions for a BIND9 name server

- User authentication with Samba in heterogeneous networks

This list can be extended because LDAP is extensible, unlike NIS. The clearly-defined hierarchical structure of the data eases the administration of large amounts of data, as it can be searched more easily.

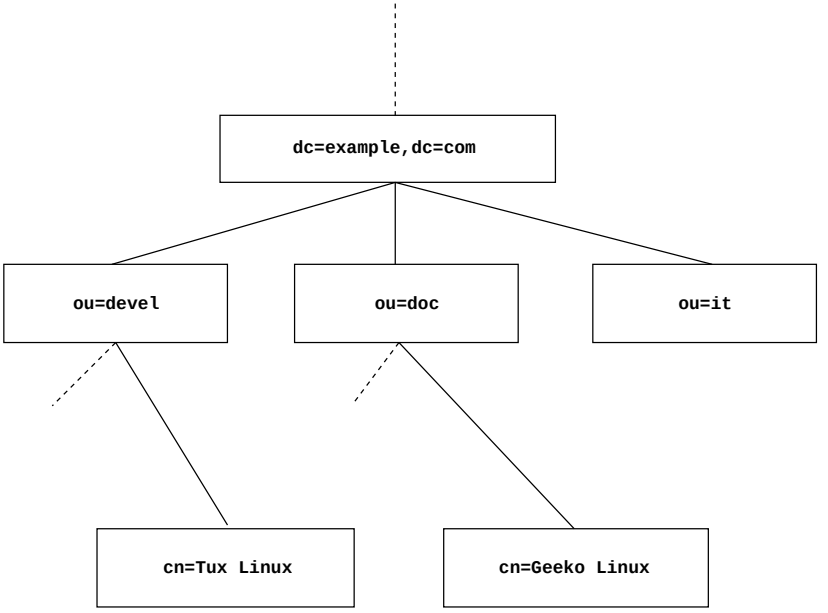
# 4.2 Structure of an LDAP Directory Tree

To get background knowledge on how a LDAP server works and how the data is stored, it is vital to understand the way the data is organized on the server and how this structure enables LDAP to provide fast access to the data. To successfully operate an LDAP setup, you also need to be familiar with some basic LDAP terminology. This section introduces the basic layout of an LDAP directory tree and provides the basic terminology used with respect to LDAP. Skip this introductory section if you already have some LDAP background knowledge and just want to learn how to set up an LDAP environment in openSUSE. Read on at Раздел 4.3, «Configuring an LDAP Server with YaST» (стр. 44) or Раздел 4.7, «Manually Configuring an LDAP Server» (стр. 63).

An LDAP directory has a tree structure. All entries (called objects) of the directory have a defined position within this hierarchy. This hierarchy is called the *directory information tree* (DIT). The complete path to the desired entry, which unambiguously identifies it, is called the *distinguished name* or DN. A single node along the path to this entry is called *relative distinguished name* or RDN.

The relations within an LDAP directory tree become more evident in the following example, shown in Рисунок 4.1, «Structure of an LDAP Directory» (стр. 42).

***Рисунок 4.1*** *Structure of an LDAP Directory*




The complete diagram is a fictional directory information tree. The entries on three levels are depicted. Each entry corresponds to one box in the image. The complete, valid *distinguished name* for the fictional employee `Geeko Linux`, in this case, is `cn=Geeko Linux,ou=doc,dc=example,dc=com`. It is composed by adding the RDN `cn=Geeko Linux` to the DN of the preceding entry `ou=doc,dc=example,dc=com`.

The types of objects that can be stored in the DIT are globally determined following a *Schema*. The type of an object is determined by the *object class*. The object class determines what attributes the relevant object must or can be assigned. The Schema, therefore, must contain definitions of all object classes and attributes used in the desired application scenario. There are a few common Schemas (see RFC 2252 and 2256). The LDAP RFC defines a few commonly used Schemas (see e.g., RFC4519). Additionally there are Schemas available for many other use cases (e.g., Samba, NIS replacement, etc.). It is, however, possible to create custom Schemas or to use multiple Schemas complementing each other (if this is required by the environment in which the LDAP server should operate).

Таблица 4.1, «Commonly Used Object Classes and Attributes» (стр. 43) offers a small overview of the object classes from `core.schema` and `inetorgperson`

`.schema` used in the example, including required attributes and valid attribute values.

***Таблица 4.1*** *Commonly Used Object Classes and Attributes*

| Object Class | Meaning | Example Entry | Required Attributes |
|---|---|---|---|
| dcObject | *domainComponent* (name components of the domain) | example | dc |
| organizationalUnit | *organizationalUnit* (organizational unit) | doc | ou |
| inetOrgPerson | *inetOrgPerson* (person-related data for the intranet or Internet) | Geeko Linux | sn and cn |

Пример 4.1, «Excerpt from schema.core» (стр. 43) shows an excerpt from a Schema directive with explanations.

***Пример 4.1*** *Excerpt from schema.core*

```
attributetype (2.5.4.11 NAME ( 'ou' 'organizationalUnitName') ❶
       DESC 'RFC2256: organizational unit this object belongs to' ❷
       SUP name ) ❸

...
objectclass ( 2.5.6.5 NAME 'organizationalUnit' ❹
       DESC 'RFC2256: an organizational unit' ❺
       SUP top STRUCTURAL ❻
       MUST ou ❼
MAY (userPassword $ searchGuide $ seeAlso $ businessCategory ❽
  $ x121Address $ registeredAddress $ destinationIndicator
  $ preferredDeliveryMethod $ telexNumber
  $ teletexTerminalIdentifier $ telephoneNumber
  $ internationaliSDNNumber $ facsimileTelephoneNumber
  $ street $ postOfficeBox $ postalCode $ postalAddress
  $ physicalDeliveryOfficeName
  $ st $ l $ description) )
  ...
```

The attribute type `organizationalUnitName` and the corresponding object class `organizationalUnit` serve as an example here.

❶ The name of the attribute, its unique OID (*object identifier*) (numerical), and the abbreviation of the attribute.

❷ A brief description of the attribute with `DESC`. The corresponding RFC, on which the definition is based, is also mentioned here.

❸ `SUP` indicates a superordinate attribute type to which this attribute belongs.

❹ The definition of the object class `organizationalUnit` begins—the same as in the definition of the attribute—with an OID and the name of the object class.

❺ A brief description of the object class.

❻ The `SUP top` entry indicates that this object class is not subordinate to another object class.

❼ With `MUST` list all attribute types that must be used in conjunction with an object of the type `organizationalUnit`.

❽ With `MAY` list all attribute types that are permitted in conjunction with this object class.

A very good introduction to the use of Schemas can be found in the OpenLDAP documentation. When installed, find it in `/usr/share/doc/packages/openldap2/guide/admin/guide.html` .

# 4.3 Configuring an LDAP Server with YaST

Use YaST to set up an LDAP server. Typical use cases for LDAP servers include the management of user account data and the configuration of mail, DNS, and DHCP servers.

***Рисунок 4.2*** *YaST LDAP Server Configuration*

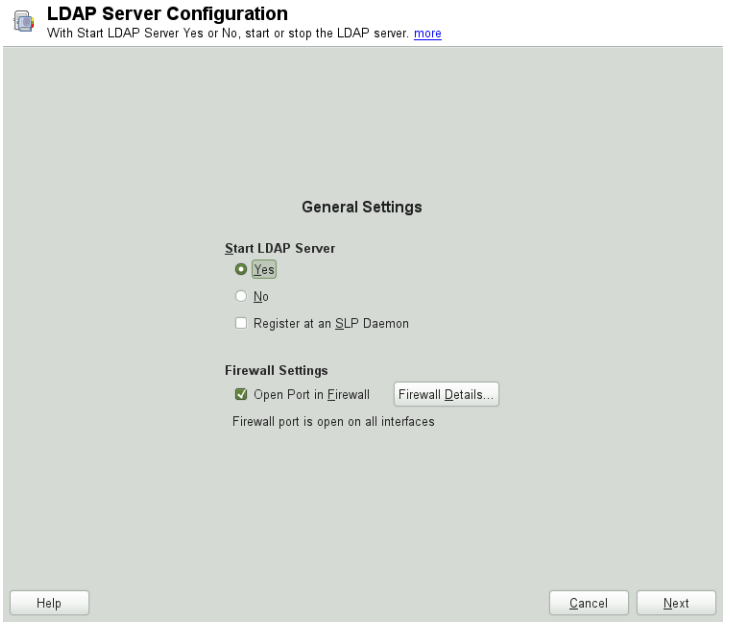
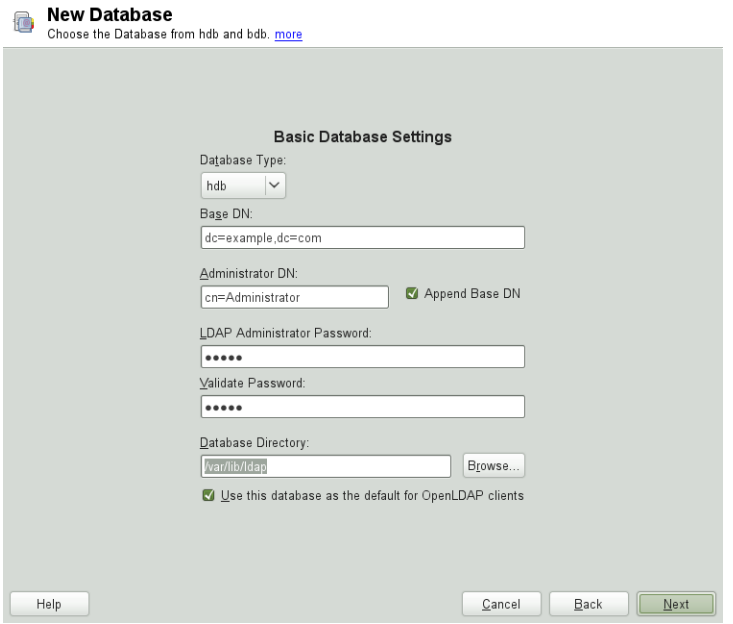


***Рисунок 4.3*** *YaST LDAP Server—New Database*




To set up an LDAP server for user account data, make sure the `yast2-ldap-server` and `openldap2` packages are installed. Then proceed as follows:

**1** Start YaST as `root` and select *Network Services* > *LDAP Server* to invoke the configuration wizard.

**2** Configure the *Global Settings* of your LDAP server (you can change these settings later)—see Рисунок 4.2, «YaST LDAP Server Configuration» (стр. 45):

**2a** Set LDAP to be started.

**2b** If the LDAP server should announce its services via SLP, check *Register at an SLP Daemon*.

**2c** Configure *Firewall Settings*.

**2d** Click *Next*.

**3** Select the server type: stand-alone server, master server in a replication setup, or replication (slave) server.

4 Select security options (*TLS Settings*).

It is strongly recommended to *Enable TLS*. For more information, see Шаг 4 (стр. 49).

**ВНИМАНИЕ: Password Encryption**

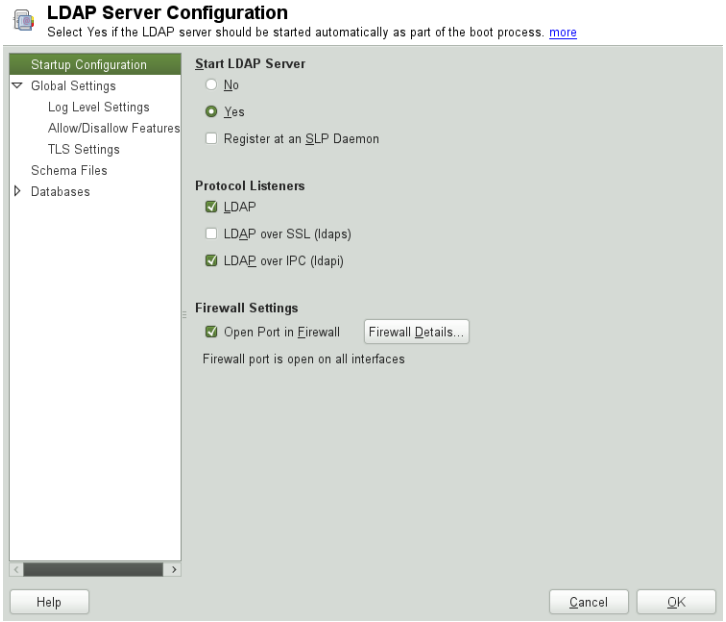
Enabling TLS ensures passwords are sent encrypted over the network. When this option is not enabled, passwords are sent unencrypted.

Also consider to use LDAP over SSL and certificates.

5 Confirm *Basic Database Settings* with entering an *LDAP Administrator Password* and then clicking *Next*—see Рисунок 4.2, «YaST LDAP Server Configuration» (стр. 45).

6 Check the *LDAP Server Configuration Summary* and click *Finish* to exit the configuration wizard.

***Рисунок 4.4*** *YaST LDAP Server Configuration*



For changes or additional configuration start the LDAP server module again and in the left pane expand *Global Settings* to make subentries visible—see Рисунок 4.4, «YaST LDAP Server Configuration» (стр. 47):

**1** With *Log Level Settings*, configure the degree of logging activity (verbosity) of the LDAP server. From the predefined list, select or deselect the logging options according to your needs. The more options are enabled, the larger your log files grow.

**2** Configure which connection types the server should offer under *Allow/Disallow Features*. Choose from:

LDAPv2 Bind Requests
: This option enables connection requests (bind requests) from clients using the previous version of the protocol (LDAPv2).

Anonymous Bind When Credentials Not Empty
: Normally the LDAP server denies any authentication attempts with empty credentials (DN or password). Enabling this option, however, makes it possible to connect with a password and no DN to establish an anonymous connection.

Unauthenticated Bind When DN Not Empty
: Enabling this option makes it possible to connect without authentication (anonymously) using a DN but no password.

Unauthenticated Update Options to Process
: Enabling this option allows non-authenticated (anonymous) update operations. Access is restricted according to ACLs and other rules.

**3** *Allow/Disallow Features* also lets you configure the server flags. Choose from:

Disable Acceptance of Anonymous Bind Requests
: The Server will no longer accept anonymous bind request. Note, that this does not generally prohibit anonymous directory access.

Disable Simple Bind Authentication
: Completely disable Simple Bind authentication.

Disable Forcing Session to Anonymous Status upon StartTLS Operation Receipt
: The server will no longer force an authenticated connection back to the anonymous state when receiving the StartTLS operation.

Disallow the StartTLS Operation if Authenticated
: The server will disallow the StartTLS operation on already authenticated connections.

**4** To configure secure communication between client and server, proceed with *TLS Settings*:

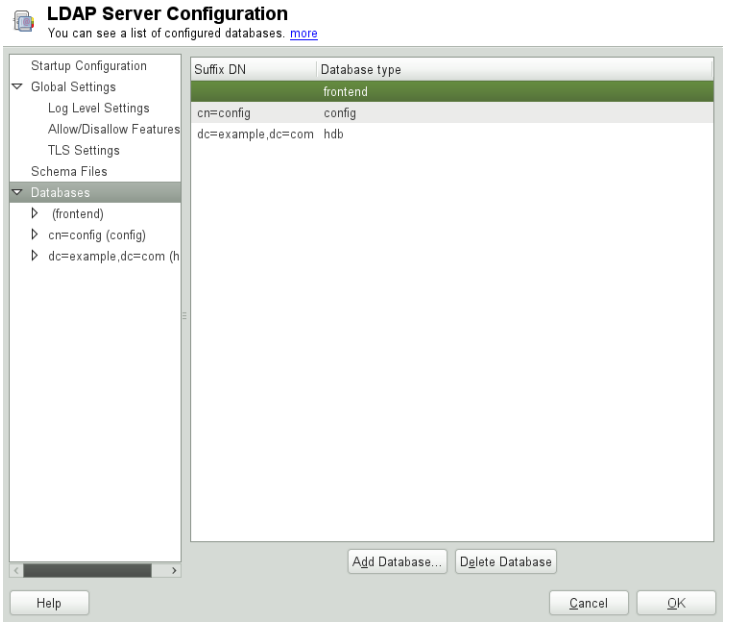
**4a** Activate *Enable TLS* to enable TLS and SSL encryption of the client/server communication.

**4b** Either *Import Certificate* by specifying the exact path to its location or enable the *Use Common Server Certificate*. If the *Use Common Server Certificate* is not available because it has not been created during installation, go for *Launch CA Management Module* first— for more information, see Раздел 16.2, «YaST Modules for CA Management» (стр. 209).

Add Schema files to be included in the server's configuration by selecting *Schema Files* in the left part of the dialog. The default selection of schema files applies to the server providing a source of YaST user account data.

YaST allows to add traditional Schema files (usually with a name ending in `.schema`) or LDIF files containing Schema definitions in OpenLDAP's LDIF Schema format.

***Рисунок 4.5*** *YaST LDAP Server Database Configuration*




To configure the databases managed by your LDAP server, proceed as follows:

**1** Select the *Databases* item in the left part of the dialog.

**2** Click *Add Database* to add a new database.

**3** Enter the requested data:

*Base DN*
: Enter the base DN of your LDAP server.

*Administrator DN*
: Enter the DN of the administrator in charge of the server. If you check *Append Base DN*, only provide the `cn` of the administrator and the system fills in the rest automatically.

LDAP Administrator Password
: Enter the password for the database administrator.

Use This Database as the Default for OpenLDAP Clients
For convenience, check this option if wanted.

**4** In the next dialog configure replication settings.

**5** In the next dialog, enable enforcement of password policies to provide extra security to your LDAP server:

**5a** Check *Enable Password Policies* to be able to specify a password policy.

**5b** Activate *Hash Clear Text Passwords* to have clear text passwords be hashed before they are written to the database whenever they are added or modified.

**5c** *Disclose "Account Locked" Status* provides a relevant error message for bind requests to locked accounts.

---

**ВНИМАНИЕ: Locked Accounts in Security Sensitive Environments**

Do not use the *Disclose "Account Locked" Status* option if your environment is sensitive to security issues, because the «Locked Account» error message provides security-sensitive information that can be exploited by a potential attacker.

---

**5d** Enter the DN of the default policy object. To use a DN other than the one suggested by YaST, enter your choice. Otherwise, accept the default settings.

**6** Complete the database configuration by clicking *Finish*.

If you have not opted for password policies, your server is ready to run at this point. If you have chosen to enable password policies, proceed with the configuration of the password policy in detail. If you have chosen a password policy object that does not yet exist, YaST creates one:

**1** Enter the LDAP server password. In the navigation tree below *Databases* expand your database object and activate the *Password Policy Configuration* item.

**2** Make sure *Enable Password Policies* is activated. Then click *Edit Policy*.

**3** Configure the password change policies:

**3a** Determine the number of passwords stored in the password history. Saved passwords may not be reused by the user.

**3b** Determine if users will be able to change their passwords and if they will need to change their passwords after a reset by the administrator. Require the old password for password changes (optional).

**3c** Determine whether and to what extent passwords should be subject to quality checking. Set the minimum password length that must be met before a password is valid. If you select *Accept Uncheckable Passwords*, users are allowed to use encrypted passwords, even though the quality checks cannot be performed. If you opt for *Only Accept Checked Passwords* only those passwords that pass the quality tests are accepted as valid.

**4** Configure the password time-limit policies:

**4a** Determine the minimum password time-limit (the time that needs to pass between two valid password changes) and the maximum password time-limit.

**4b** Determine the time between a password expiration warning and the actual password expiration.

**4c** Set the number of postponement uses of an expired password before the password expires permanently.

**5** Configure the lockout policies:

**5a** Enable password locking.

**5b** Determine the number of bind failures that trigger a password lock.

**5c** Determine the duration of the password lock.

**5d** Determine the length of time that password failures are kept in the cache before they are purged.

**6** Apply your password policy settings with *OK*.

To edit a previously created database, select its base DN in the tree to the left. In the right part of the window, YaST displays a dialog similar to the one used for the creation of a new database (with the main difference that the base DN entry is grayed out and cannot be changed).

After leaving the LDAP server configuration by selecting *Finish*, you are ready to go with a basic working configuration for your LDAP server. To fine-tune this setup, make use of OpenLDAP's dynamic configuration backend.

The OpenLDAP's dynamic configuration backend stores the configuration in an LDAP database. That database consists of a set of `.ldif` files in `/etc/openldap/slapd.d`. There is no need to access these files directly. To access the settings you can either use the YaST LDAP server module (the `yast2-ldap-server` package) or an LDAP client such as `ldapmodify` or `ldapsearch`. For more information on the dynamic configuration of OpenLDAP, see the OpenLDAP Administration Guide.

# 4.4 Configuring an LDAP Client with YaST

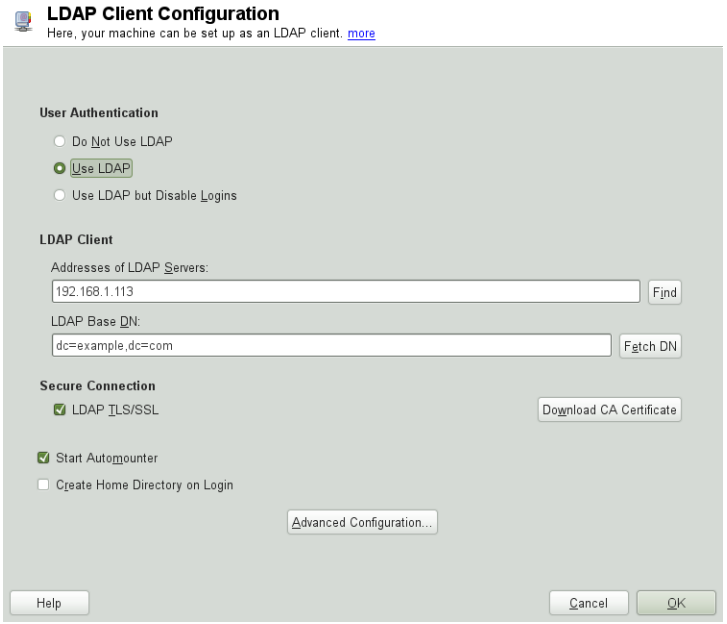
YaST includes a module to set up LDAP-based user management. If you did not enable this feature during the installation, start the module by selecting *Network Services* > *LDAP Client*. YaST automatically enables any PAM and NSS-related changes as required by LDAP and installs the necessary files. Simply connect your client to the server and let YaST manage users over LDAP. This basic setup is described in Раздел 4.4.1, «Configuring Basic Settings» (стр. 54).

Use the YaST LDAP client to further configure the YaST group and user configuration modules. This includes manipulating the default settings for new users and groups and the number and nature of the attributes assigned to a user or group. LDAP user management allows you to assign far more and different attributes to users and groups than traditional user or group management solutions. This is described in Раздел 4.4.2, «Configuring the YaST Group and User Administration Modules» (стр. 57).

# 4.4.1 Configuring Basic Settings

The basic LDAP client configuration dialog (Рисунок 4.6, «YaST: LDAP Client Configuration» (стр. 54)) opens during installation if you choose LDAP user management or when you select *Network Services* > *LDAP Client* in the YaST Control Center in the installed system.

***Рисунок 4.6*** *YaST: LDAP Client Configuration*




To authenticate users of your machine against an OpenLDAP server and to enable user management via OpenLDAP, proceed as follows:

1. Click *Use LDAP* to enable the use of LDAP. Select *Use LDAP but Disable Logins* instead if you want to use LDAP for authentication, but do not want other users to log in to this client.

2. Enter the IP address of the LDAP server to use.

3. Enter the *LDAP Base DN* to select the search base on the LDAP server. To retrieve the base DN automatically, click *Fetch DN*. YaST then checks for any

LDAP database on the server address specified above. Choose the appropriate base DN from the search results given by YaST.

4 If TLS or SSL-protected communication with the server is required, select *LDAP TLS/SSL*. Click *Download CA Certificate* to download a certificate in PEM format from a URL.

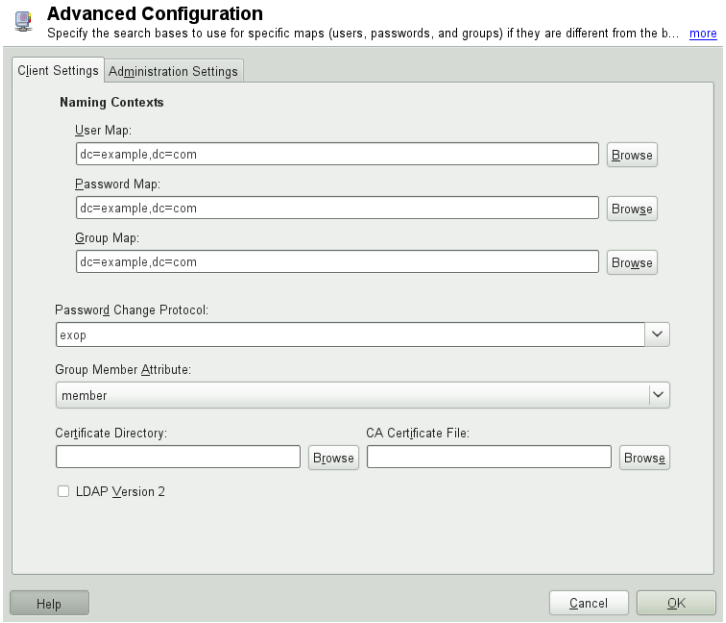
5 Select *Start Automounter* to mount remote directories on your client, such as a remotely managed `/home`.

6 Select *Create Home Directory on Login* to have a user's home automatically created on the first user login.

7 Click *Ok* to apply your settings.

To modify data on the server as administrator, click *Advanced Configuration*. The following dialog is split into two tabs. See Рисунок 4.7, «YaST: Advanced Configuration» (стр. 55).

***Рисунок 4.7*** *YaST: Advanced Configuration*




1 In the *Client Settings* tab, adjust the following settings according to your needs:

**1a** If the search base for users, passwords, and groups differs from the global search base specified in the *LDAP base DN*, enter these different naming contexts in *User Map*, *Password Map*, and *Group Map*.

**1b** Specify the password change protocol. The standard method to use whenever a password is changed is `crypt`, meaning that password hashes generated by `crypt` are used. For details on this and other options, refer to the `pam_ldap` man page.

**1c** Specify the LDAP group to use with *Group Member Attribute*. The default value for this is `member`.

**1d** If a secure connection requires certificate checking, specify where your *CA Certificate File* in PEM format is located. Or specify a directory with certificates.

**1e** If the LDAP server still uses LDAPv2, enable the use of this protocol version by selecting *LDAP Version 2*.

**2** In *Administration Settings*, adjust the following settings:

**2a** Set the base for storing your user management data via *Configuration Base DN*.

**2b** Enter the appropriate value for *Administrator DN*. This DN must be identical with the `rootdn` value specified in `/etc/openldap/slapd.conf` to enable this particular user to manipulate data stored on the LDAP server. Enter the full DN (such as `cn=Administrator,dc=example,dc=com`) or activate *Append Base DN* to have the base DN added automatically when you enter `cn=Administrator`.

**2c** Check *Create Default Configuration Objects* to create the basic configuration objects on the server to enable user management via LDAP.

**2d** If your client machine needs to act as a file server for home directories across your network, check *Home Directories on This Machine*.

**2e** Use the *Password Policy* section to select, add, delete, or modify the password policy settings to use. The configuration of password policies with YaST is part of the LDAP server setup.

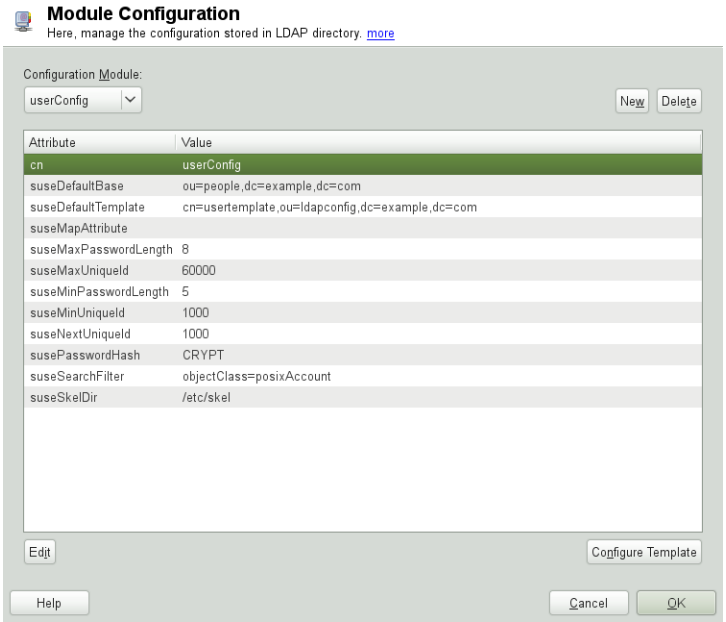
**2f** Click *OK* to leave the *Advanced Configuration*, then *Finish* to apply your settings.

Use *Configure User Management Settings* to edit entries on the LDAP server. Access to the configuration modules on the server is then granted according to the ACLs and ACIs stored on the server. Follow the procedures outlined in Раздел 4.4.2, «Configuring the YaST Group and User Administration Modules» (стр. 57).

## 4.4.2 Configuring the YaST Group and User Administration Modules

Use the YaST LDAP client to adapt the YaST modules for user and group administration and to extend them as needed. Define templates with default values for the individual attributes to simplify the data registration. The presets created here are stored as LDAP objects in the LDAP directory. The registration of user data is still done with the regular YaST modules for user and group management. The registered data is stored as LDAP objects on the server.

***Рисунок 4.8*** *YaST: Module Configuration*



The dialog for module configuration (Рисунок 4.8, «YaST: Module Configuration» (стр. 57)) allows the creation of new modules, selection and modification of existing configuration modules, and design and modification of templates for such modules.

To create a new configuration module, proceed as follows:

1. In the *LDAP Client Configuration* click *Advanced Configuration*, then open the *Administration Settings* tab. Click *Configure User Management Settings* and enter the LDAP server credentials.

2. Click *New* and select the type of module to create. For a user configuration module, select `suseUserConfiguration` and for a group configuration choose `suseGroupConfiguration`.

3. Choose a name for the new template (e.g., `userConfig`). The content view shows a table listing all attributes allowed in this module and their assigned values.

4. Accept the preset values or adjust the defaults to use in group and user configurations by selecting the relevant attribute, pressing *Edit*, and entering the new value. Rename a module by changing the `cn` attribute of the module. Clicking *Delete* deletes the currently selected module.

5. After you click *OK*, the new module is added to the selection menu.

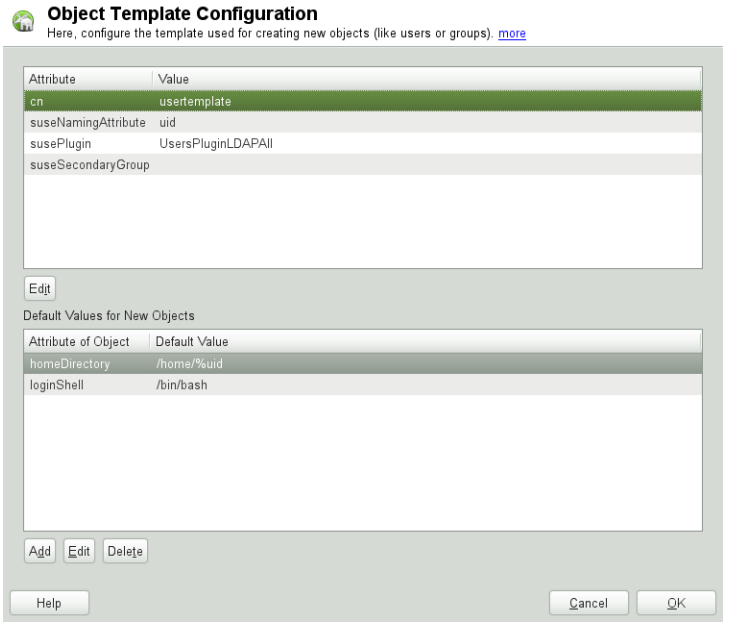
The YaST modules for group and user administration embed templates with standard values. To edit a template associated with a configuration module, start the object template configuration (Рисунок 4.9, «YaST: Configuration of an Object Template» (стр. 59)):

1. In the *Module Configuration* dialog, click *Configure Template*.

2. Determine the values of the general attributes assigned to this template according to your needs or leave them empty. Empty attributes are deleted on the LDAP server.

3. Modify, delete, or add new default values for new objects (user or group configuration objects in the LDAP tree).

***Рисунок 4.9*** *YaST: Configuration of an Object Template*




Connect the template to its module by setting the `susedefaulttemplate` attribute value of the module to the DN of the adapted template.

---

**ПОДСКАЗКА**

The default values for an attribute can be created from other attributes by using a variable instead of an absolute value. For example, when creating a new user, `cn=%sn %givenName` is created automatically from the attribute values for `sn` and `givenName`.

---

Once all modules and templates are configured correctly and ready to run, new groups and users can be registered in the usual way with YaST.

# 4.5 Configuring LDAP Users and Groups in YaST

The actual registration of user and group data differs only slightly from the procedure when not using LDAP. The following instructions relate to the administration of users. The procedure for administering groups is analogous.

**1** Access the YaST user administration with *Security and Users* > *User and Group Management*.

**2** Use *Set Filter* to limit the view of users to the LDAP users and enter the password for Root DN.

**3** Click *Add* to enter the user configuration. A dialog with four tabs opens:

**3a** Specify username, login, and password in the *User Data* tab.

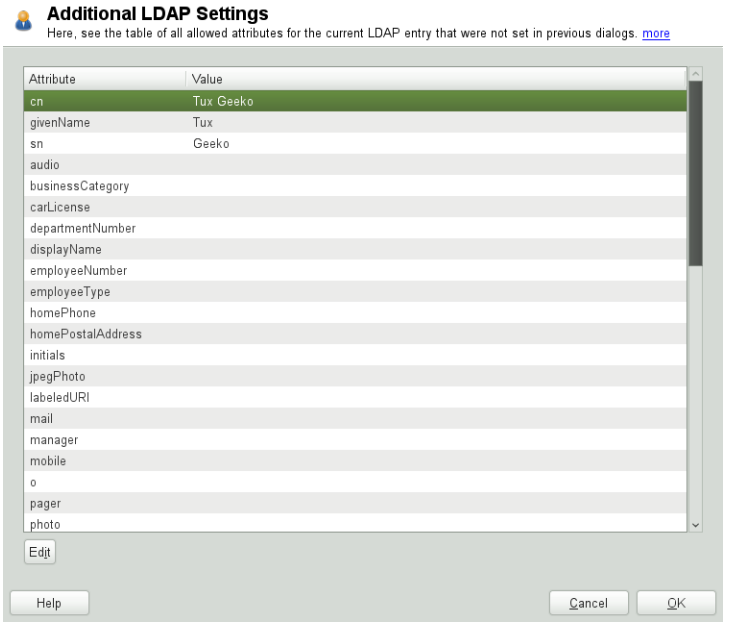
**3b** Check the *Details* tab for the group membership, login shell, and home directory of the new user. If necessary, change the default to values that better suit your needs. The default values (as well as those of the password settings) can be defined with the procedure described in Раздел 4.4.2, «Configuring the YaST Group and User Administration Modules» (стр. 57).

**3c** Modify or accept the default *Password Settings*.

**3d** Enter the *Plug-Ins* tab, select the LDAP plug-in, and click *Launch* to configure additional LDAP attributes assigned to the new user (see Рисунок 4.10, «YaST: Additional LDAP Settings» (стр. 61)).

**4** Click *OK* to apply your settings and leave the user configuration.

***Рисунок 4.10*** *YaST: Additional LDAP Settings*




The initial input form of user administration offers *LDAP Options*. This allows you to apply LDAP search filters to the set of available users. Alternatively open the module for configuring LDAP users and groups by selecting *LDAP User and Group Configuration*.

# 4.6 Browsing the LDAP Directory Tree

To conveniently browse the LDAP directory tree and all its entries, use the YaST LDAP Browser:

**1** Log in as `root`.

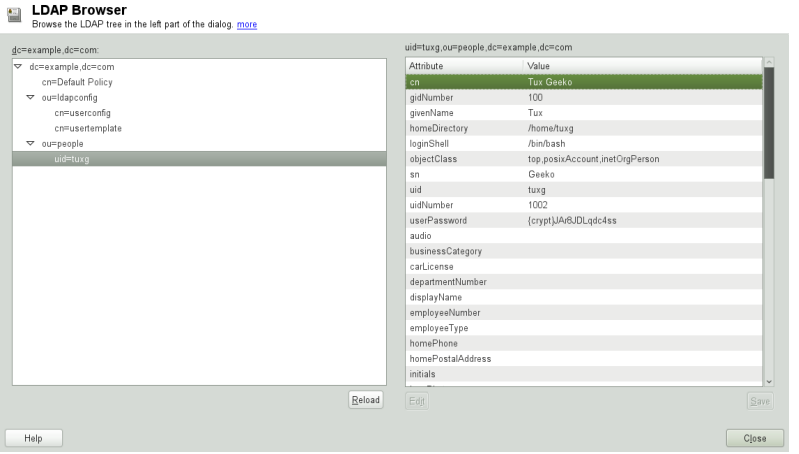
**2** Start *YaST* > *Network Services* > *LDAP Browser*.

3 Enter the address of the LDAP server, the Administrator DN, and the password for the Root DN of this server (if you need both to read and write the data stored on the server).

Alternatively, choose *Anonymous Access* and do not provide the password to gain read access to the directory.

The *LDAP Tree* tab displays the content of the LDAP directory to which your machine connected. Click to expand each item's submenu.

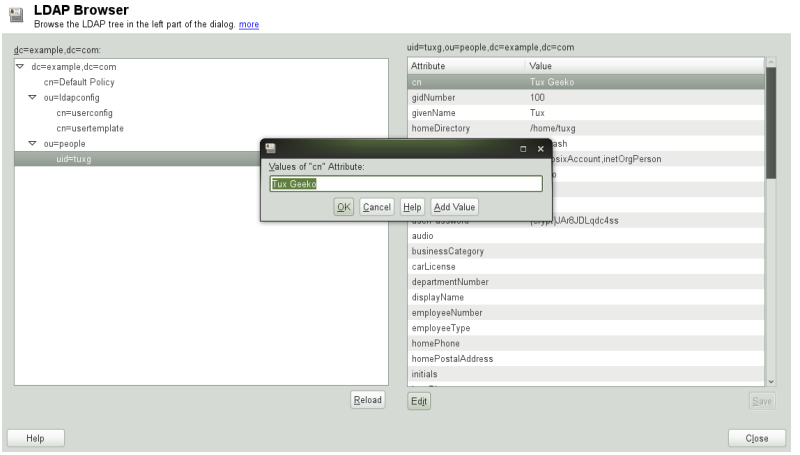
***Рисунок 4.11*** *Browsing the LDAP Directory Tree*




4 To view any entry in detail, select it in the *LDAP Tree* view and open the *Entry Data* tab.

All attributes and values associated with this entry are displayed.

***Рисунок 4.12*** *Browsing the Entry Data*




**5** To change the value of any of these attributes, select the attribute, click *Edit*, enter the new value, click *Save*, and provide the Root DN password when prompted.

**6** Leave the LDAP browser with *Close*.

# 4.7 Manually Configuring an LDAP Server

YaST uses OpenLDAP's dynamic configuration database (`back-config`) to store the LDAP server's configuration. For details about the dynamic configuration backend please see the `slapd-config(5)` man page or the OpenLDAP Software 2.4 Administrator's Guide located at `/usr/share/doc/packages/openldap2/guide/admin/guide.html` on your system if the `openldap2` package is installed.

---

**ПОДСКАЗКА: Upgrading an Old OpenLDAP Installation**

YaST does not use `/etc/openldap/slapd.conf` to store the OpenLDAP configuration anymore. In case of a system upgrade, a copy of the original `/etc/openldap/slapd.conf` file will get created as `/etc/openldap/slapd.conf.YaSTsave` .

---

To conveniently access the configuration backend, you use SASL external authentication. For example, the following `ldapsearch` command executed as `root` can be used to show the complete `slapd` configuration:

```
ldapsearch -Y external -H ldapi:/// -b cn=config
```

## 4.7.1 Starting and Stopping the Servers

Once the LDAP server is fully configured and all desired entries have been made according to the pattern described in Раздел 4.8, «Manually Administering LDAP Data» (стр. 64), start the LDAP server as `root` by entering `rcldap start`. To stop the server manually, enter the command `rcldap stop`. Query the status of the running LDAP server with `rcldap status`.

Use the YaST runlevel editor, described in Раздел “Configuring Системные службы (Уровень запуска) with YaST” (Глава 17, *Booting and Configuring a Linux System*, ↑Reference), to have the server started and stopped automatically on system bootup and shutdown. It is also possible to create the corresponding links to the start and stop scripts with the `insserv` command from a command prompt as described in Раздел “Init Scripts” (Глава 17, *Booting and Configuring a Linux System*, ↑Reference).

# 4.8 Manually Administering LDAP Data

OpenLDAP offers a series of tools for the administration of data in the LDAP directory. The four most important tools for adding to, deleting from, searching through and modifying the data stock are explained in this section.

## 4.8.1 Inserting Data into an LDAP Directory

Once your LDAP server is correctly configured (it features appropriate entries for `suffix`, `directory`, `rootdn`, `rootpw` and `index`), proceed to entering records. OpenLDAP offers the `ldapadd` command for this task. If possible, add the objects to the database in bundles (for practical reasons). LDAP is able to process

the LDIF format (LDAP data interchange format) for this. An LDIF file is a simple text file that can contain an arbitrary number of attribute and value pairs. The LDIF file for creating a rough framework for the example in Рисунок 4.1, «Structure of an LDAP Directory» (стр. 42) would look like the one in Пример 4.2, «An LDIF File» (стр. 65).

**ВАЖНО: Encoding of LDIF Files**

LDAP works with UTF-8 (Unicode). Umlauts must be encoded correctly. Otherwise, avoid umlauts and other special characters or use `iconv` to convert the input to UTF-8.

***Пример 4.2*** *An LDIF File*

```
# The Organization
dn: dc=example,dc=com
objectClass: dcObject
objectClass: organization
o: Example dc: example

# The organizational unit development (devel)
dn: ou=devel,dc=example,dc=com
objectClass: organizationalUnit
ou: devel

# The organizational unit documentation (doc)
dn: ou=doc,dc=example,dc=com
objectClass: organizationalUnit
ou: doc

# The organizational unit internal IT (it)
dn: ou=it,dc=example,dc=com
objectClass: organizationalUnit
ou: it
```

Save the file with the `.ldif` suffix then pass it to the server with the following command:

```
ldapadd -x -D dn_of_the_administrator -W -f file.ldif
```

`-x` switches off the authentication with SASL in this case. `-D` declares the user that calls the operation. The valid DN of the administrator is entered here just like it has been configured in `slapd.conf` . In the current example, this is `cn=Administrator,dc=example,dc=com`. `-W` circumvents entering the password on the command line (in clear text) and activates a separate password prompt. The `-f` option passes the filename. See the details of running `ldapadd` in Пример 4.3, «ldapadd with example.ldif» (стр. 66).

***Пример 4.3*** *ldapadd with example.ldif*

```
ldapadd -x -D cn=Administrator,dc=example,dc=com -W -f example.ldif

Enter LDAP password:
adding new entry "dc=example,dc=com"
adding new entry "ou=devel,dc=example,dc=com"
adding new entry "ou=doc,dc=example,dc=com"
adding new entry "ou=it,dc=example,dc=com"
```

The user data of individuals can be prepared in separate LDIF files. Пример 4.4, «LDIF Data for Tux» (стр. 66) adds `Tux` to the new LDAP directory.

***Пример 4.4*** *LDIF Data for Tux*

```
# coworker Tux
dn: cn=Tux Linux,ou=devel,dc=example,dc=com
objectClass: inetOrgPerson
cn: Tux Linux
givenName: Tux
sn: Linux
mail: tux@example.com
uid: tux
telephoneNumber: +49 1234 567-8
```

An LDIF file can contain an arbitrary number of objects. It is possible to pass directory branches (entirely or in part) to the server in one go, as shown in the example of individual objects. If it is necessary to modify some data relatively often, a fine subdivision of single objects is recommended.

## 4.8.2 Modifying Data in the LDAP Directory

The tool `ldapmodify` is provided for modifying the data stock. The easiest way to do this is to modify the corresponding LDIF file and pass the modified file to the LDAP server. To change the telephone number of colleague Tux from `+49 1234 567-8` to `+49 1234 567-10`, edit the LDIF file like in Пример 4.5, «Modified LDIF File tux.ldif» (стр. 66).

***Пример 4.5*** *Modified LDIF File tux.ldif*

```
# coworker Tux
dn: cn=Tux Linux,ou=devel,dc=example,dc=com
changetype: modify
replace: telephoneNumber
telephoneNumber: +49 1234 567-10
```

Import the modified file into the LDAP directory with the following command:

```
ldapmodify -x -D cn=Administrator,dc=example,dc=com -W -f tux.ldif
```

Alternatively, pass the attributes to change directly to `ldapmodify` as follows:

1. Start `ldapmodify` and enter your password:

   ```
   ldapmodify -x -D cn=Administrator,dc=example,dc=com -W
   Enter LDAP password:
   ```

2. Enter the changes while carefully complying with the syntax in the order presented below:

   ```
   dn: cn=Tux Linux,ou=devel,dc=example,dc=com
   changetype: modify
   replace: telephoneNumber
   telephoneNumber: +49 1234 567-10
   ```

For more information about `ldapmodify` and its syntax, see the `ldapmodify` man page.

## 4.8.3 Searching or Reading Data from an LDAP Directory

OpenLDAP provides, with `ldapsearch`, a command line tool for searching data within an LDAP directory and reading data from it. This is a simple query:

```
ldapsearch -x -b dc=example,dc=com "(objectClass=*)"
```

The `-b` option determines the search base (the section of the tree within which the search should be performed). In the current case, this is `dc=example,dc=com`. To perform a more finely-grained search in specific subsections of the LDAP directory (for example, only within the `devel` department), pass this section to `ldapsearch` with `-b`. `-x` requests activation of simple authentication. `(objectClass=*)` declares that all objects contained in the directory should be read. This command option can be used after the creation of a new directory tree to verify that all entries have been recorded correctly and the server responds as desired. For more information about the use of `ldapsearch`, see the `ldapsearch(1)` man page.

## 4.8.4 Deleting Data from an LDAP Directory

Delete unwanted entries with `ldapdelete`. The syntax is similar to that of the other commands. To delete, for example, the complete entry for `Tux Linux`, issue the following command:

```
ldapdelete -x -D cn=Administrator,dc=example,dc=com -W cn=Tux \
Linux,ou=devel,dc=example,dc=com
```

# 4.9 For More Information

More complex subjects (like SASL configuration or establishment of a replicating LDAP server that distributes the workload among multiple slaves) were omitted from this chapter. Find detailed information about both subjects in the *OpenLDAP 2.4 Administrator's Guide*—see at OpenLDAP 2.4 Administrator's Guide (стр. 68).

The Web site of the OpenLDAP project offers exhaustive documentation for beginner and advanced LDAP users:

OpenLDAP Faq-O-Matic
: A detailed question and answer collection applying to the installation, configuration, and use of OpenLDAP. Find it at `http://www.openldap.org/faq/data/cache/1.html` .

Quick Start Guide
: Brief step-by-step instructions for installing your first LDAP server. Find it at `http://www.openldap.org/doc/admin24/quickstart.html` or on an installed system in Section 2 of `/usr/share/doc/packages/openldap2/guide/admin/guide.html` .

OpenLDAP 2.4 Administrator's Guide
: A detailed introduction to all important aspects of LDAP configuration, including access controls and encryption. See `http://www.openldap.org/doc/admin24/` or, on an installed system, `/usr/share/doc/packages/openldap2/guide/admin/guide.html` .

Understanding LDAP
: A detailed general introduction to the basic principles of LDAP: `http://www.redbooks.ibm.com/redbooks/pdfs/sg244986.pdf` .

Printed literature about LDAP:

- *LDAP System Administration* by Gerald Carter (ISBN 1-56592-491-6)
- *Understanding and Deploying LDAP Directory Services* by Howes, Smith, and Good (ISBN 0-672-32316-8)

The ultimate reference material for the subject of LDAP are the corresponding RFCs (request for comments), 2251 to 2256.

# 5

# Active Directory Support

Active Directory* (AD) is a directory-service based on LDAP, Kerberos, and other services that is used by Microsoft Windows to manage resources, services, and people. In an MS Windows network, AD provides information about these objects, restricts access to them, and enforces policies. openSUSE® lets you join existing AD domains and integrate your Linux machine into a Windows environment.

## 5.1 Integrating Linux and AD Environments

With a Linux client (configured as an Active Directory client) that is joined to an existing Active Directory domain, benefit from various features not available on a pure openSUSE Linux client:

Browsing Shared Files and Folders with SMB
: Both Nautilus (the GNOME file manager) and Konqueror (its KDE counterpart) support browsing shared resources through SMB.

Sharing Files and Folders with SMB
: Both Nautilus (the GNOME file manager) and Konqueror (its KDE counterpart) support sharing folders and files as in Windows.

Accessing and Manipulating User Data on the Windows Server
: Through Nautilus and Konqueror, users are able to access their Windows user data and can edit, create, and delete files and folders on the Windows server.

Users can access their data without having to enter their password multiple times.

Offline Authentication
: Users are able to log in and access their local data on the Linux machine even if they are offline or the AD server is unavailable for other reasons.

Windows Password Change
: This port of AD support in Linux enforces corporate password policies stored in Active Directory. The display managers and console support password change messages and accept your input. You can even use the Linux `passwd` command to set Windows passwords.

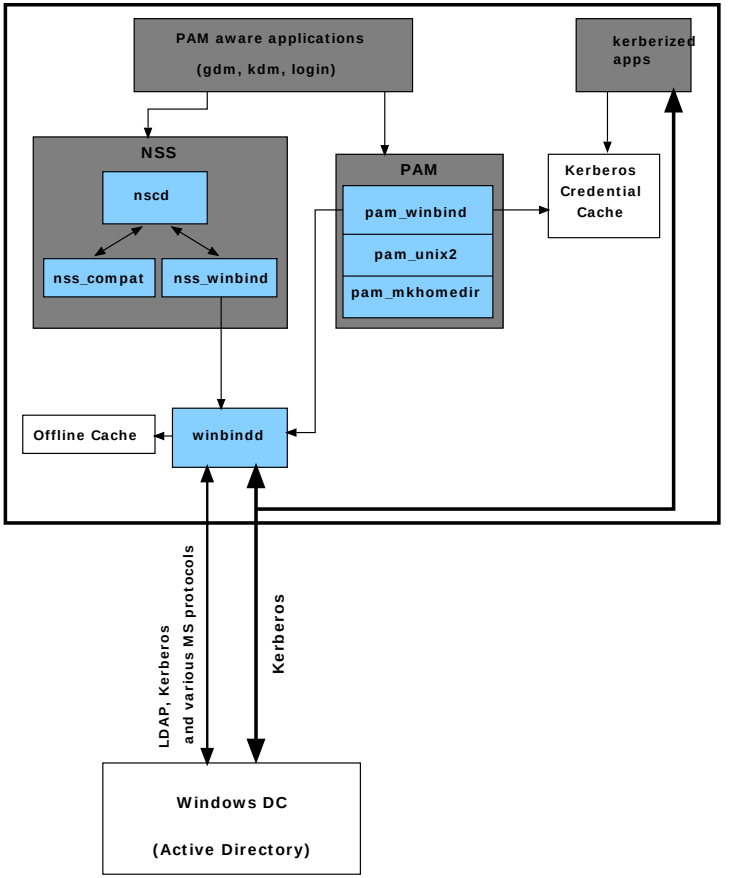
Single-Sign-On through Kerberized Applications
: Many applications of both desktops are Kerberos-enabled (*kerberized*), which means they can transparently handle authentication for the user without the need for password reentry at Web servers, proxies, groupware applications, or other locations.

A brief technical background for most of these features is given in the following section.

# 5.2 Background Information for Linux AD Support

Many system components need to interact flawlessly in order to integrate a Linux client into an existing Windows Active Directory domain. Рисунок 5.1, «Active Directory Authentication Schema» (стр. 73) highlights the most prominent ones. The following sections focus on the underlying processes of the key events in AD server and client interaction.

***Рисунок 5.1*** *Active Directory Authentication Schema*




To communicate with the directory service, the client needs to share at least two protocols with the server:

LDAP
: LDAP is a protocol optimized for managing directory information. A Windows domain controller with AD can use the LDAP protocol to exchange directory information with the clients. To learn more about LDAP in general and about the open source port of it, OpenLDAP, refer to Глава 4, *LDAP—A Directory Service* (стр. 39).

Kerberos
: Kerberos is a third-party trusted authentication service. All its clients trust Kerberos's authorization of another client's identity, enabling kerberized single-sign-on (SSO) solutions. Windows supports a Kerberos implementation, making Kerberos SSO possible even with Linux clients.

The following client components process account and authentication data:

Winbind
: The most central part of this solution is the winbind daemon that is a part of the Samba project and handles all communication with the AD server.

NSS (*Name Service Switch*)
: NSS routines provide name service information. Naming service for both users and groups is provided by `nss_winbind` . This module directly interacts with the winbind daemon.

PAM (*Pluggable Authentication Modules*)
: User authentication for AD users is done by the `pam_winbind` module. The creation of user homes for the AD users on the Linux client is handled by `pam_mkhomedir` . The `pam_winbind` module directly interacts with winbindd. To learn more about PAM in general, refer to Глава 2, *Authentication with PAM* (стр. 17).

Applications that are PAM-aware, like the login routines and the GNOME and KDE display managers, interact with the PAM and NSS layer to authenticate against the Windows server. Applications supporting Kerberos authentication (such as file managers, Web browsers, or e-mail clients) use the Kerberos credential cache to access user's Kerberos tickets, making them part of the SSO framework.

## 5.2.1 Domain Join

During domain join, the server and the client establish a secure relation. On the client, the following tasks need to be performed to join the existing LDAP and Kerberos SSO environment provided by the Window domain controller. The entire join process is handled by the YaST Domain Membership module, which can be run during installation or in the installed system. The steps involved are:

1. The Windows domain controller, providing both LDAP and KDC (Key Distribution Center) services, is located.

2 A machine account for the joining client is created in the directory service.

3 An initial ticket granting ticket (TGT) is obtained for the client and stored in its local Kerberos credential cache. The client needs this TGT to get further tickets allowing it to contact other services, like contacting the directory server for LDAP queries.

4 NSS and PAM configurations are adjusted to enable the client to authenticate against the domain controller.

During client boot, the winbind daemon is started and retrieves the initial Kerberos ticket for the machine account. winbindd automatically refreshes the machine's ticket to keep it valid. To keep track of the current account policies, winbindd periodically queries the domain controller.

## 5.2.2 Domain Login and User Homes

The login managers of GNOME and KDE (GDM and KDM) have been extended to allow the handling of AD domain login. Users can choose to log into the primary domain the machine has joined or to one of the trusted domains with which the domain controller of the primary domain has established a trust relationship.

User authentication is mediated by a number of PAM modules as described in Раздел 5.2, «Background Information for Linux AD Support» (стр. 72). The `pam_winbind` module used to authenticate clients against Active Directory or NT4 domains is fully aware of Windows error conditions that might prohibit a user's login. The Windows error codes are translated into appropriate user-readable error messages that PAM gives at login through any of the supported methods (GDM, KDM, console, and SSH):

`Password has expired`
: A message stating that the password has expired and needs to be changed is displayed. The system prompts for a new password and informs the user if the new password does not comply with corporate password policies (for example the password is too short, too simple, or already in the history). If a user's password change fails, the reason is shown and a new password prompt is given.

`Account disabled`
: The user sees an error message stating that the account has been disabled and to contact the system administrator.

`Account locked out`
: The user sees an error message stating that the account has been locked and to contact the system administrator.

`Password has to be changed`
: The user can log in but receives a warning that the password needs to be changed soon. This warning is sent three days before that password expires. After expiration, the user cannot log in.

`Invalid workstation`
: When a user is restricted to specific workstations and the current openSUSE machine is not among them, a message appears that this user cannot log in from this workstation.

`Invalid logon hours`
: When a user is only allowed to log in during working hours and tries to log in outside working hours, a message informs the user that logging in is not possible at that time.

`Account expired`
: An administrator can set an expiration time for a specific user account. If that user tries to log in after expiration, the user gets a message that the account has expired and cannot be used to log in.

During a successful authentication, `pam_winbind` acquires a ticket granting ticket (TGT) from the Kerberos server of Active Directory and stores it in the user's credential cache. It also renews the TGT in the background, requiring no user interaction.

openSUSE supports local home directories for AD users. If configured through YaST as described in Раздел 5.3, «Configuring a Linux Client for Active Directory» (стр. 77), user homes are created at the first login of a Windows (AD) user into the Linux client. These home directories look and feel entirely the same as standard Linux user home directories and work independently of the AD domain controller. Using a local user home, it is possible to access a user's data on this machine (even when the AD server is disconnected) as long as the Linux client has been configured to perform offline authentication.

It is also possible to mount server home directories automatically; for more information, see Раздел “Configuring Clients” (Глава 29, *Samba*, ↑Reference).

### 5.2.3 Offline Service and Policy Support

Users in a corporate environment must have the ability to become roaming users (for example, to switch networks or even work disconnected for some time). To enable users to log in to a disconnected machine, extensive caching was integrated into the winbind daemon. The winbind daemon enforces password policies even in the offline state. It tracks the number of failed login attempts and reacts according to the policies configured in Active Directory. Offline support is disabled by default and must be explicitly enabled in the YaST Domain Membership module.

When the domain controller has become unavailable, the user can still access network resources (other than the AD server itself) with valid Kerberos tickets that have been acquired before losing the connection (as in Windows). Password changes cannot be processed unless the domain controller is online. While disconnected from the AD server, a user cannot access any data stored on this server. When a workstation has become disconnected from the network entirely and connects to the corporate network again later, openSUSE acquires a new Kerberos ticket as soon as the user has locked and unlocked the desktop (for example, using a desktop screen saver).

## 5.3 Configuring a Linux Client for Active Directory

Before your client can join an AD domain, some adjustments must be made to your network setup to ensure the flawless interaction of client and server.

DNS
: Configure your client machine to use a DNS server that can forward DNS requests to the AD DNS server. Alternatively, configure your machine to use the AD DNS server as the name service data source.

NTP
: To succeed with Kerberos authentication, the client must have its time set accurately. It is highly recommended to use a central NTP time server for this purpose (this can also be the NTP server running on your Active Directory domain controller). If the clock skew between your Linux host and the domain controller exceeds a certain limit, Kerberos authentication fails and the client is logged in using the weaker NTLM (NT LAN Manager) authentication. For more

details about using active directory for time synchronization, see Процедура 5.1, «Joining an AD Domain» (стр. 78).

DHCP
: If your client uses dynamic network configuration with DHCP, configure DHCP to provide the same IP and hostname to the client. If possible, use static IP addresses.

Firewall
: To browse your network neighborhood, either disable the firewall entirely or mark the interface used for browsing as part of the internal zone.

  To change the firewall settings on your client, log in as `root` and start the YaST firewall module. Select *Interfaces*. Select your network interface from the list of interfaces and click *Change*. Select *Internal Zone* and apply your settings with *OK*. Leave the firewall settings with *Next* > *Accept*. To disable the firewall, just set *Service Start* to *Manually* and leave the firewall module with *Next* > *Accept*.

AD Account
: You cannot log in to an AD domain unless the AD administrator has provided you with a valid user account for that domain. Use the AD username and password to log in to the AD domain from your Linux client.

Join an existing AD domain during installation (or by later activating SMB user authentication with YaST in the installed system).

---

**ЗАМЕЧАНИЕ**

Currently only a domain administrator account, such as `Administrator`, can join openSUSE into Active Directory.

---

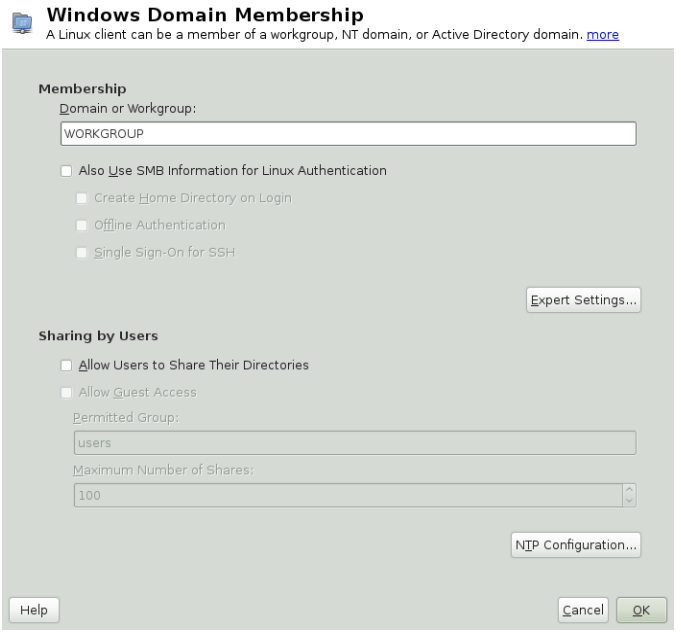
To join an AD domain in a running system, proceed as follows:

***Процедура 5.1*** *Joining an AD Domain*

1. Log in as `root` and start YaST.
2. Start *Network Services* > *Windows Domain Membership*.
3. Enter the domain to join at *Domain or Workgroup* in the *Windows Domain Membership* screen (see Рисунок 5.2, «Determining Windows Domain Membership» (стр. 79)). If the DNS settings on your host are properly

integrated with the Windows DNS server, enter the AD domain name in its DNS format (`mydomain.mycompany.com`). If you enter the short name of your domain (also known as the pre–Windows 2000 domain name), YaST must rely on NetBIOS name resolution instead of DNS to find the correct domain controller. To select from a list of available domains instead, use *Browse* to list the NetBIOS domains, then select the desired domain.

***Рисунок 5.2*** *Determining Windows Domain Membership*




4 Check *Also Use SMB Information for Linux Authentication* to use the SMB source for Linux authentication.

5 Check *Create Home Directory on Login* to automatically create a local home directory for your AD user on the Linux machine.

6 Check *Offline Authentication* to allow your domain users to log in even if the AD server is temporarily unavailable, or if you do not have a network connection.

7 Select *Expert Settings*, if you want to change the UID and GID ranges for the Samba users and groups. Let DHCP retrieve the WINS server only if you need

it. This applies when some of your machines are resolved by the WINS system only.

8 Configure NTP time synchronization for your AD environment by selecting *NTP Configuration* and entering an appropriate server name or IP address. This step is obsolete if you have already entered the appropriate settings in the standalone YaST NTP configuration module.

9 Click *Finish* and confirm the domain join when prompted for it.

10 Provide the password for the Windows administrator on the AD server and click *OK* (see Рисунок 5.3, «Providing Administrator Credentials» (стр. 80)).

***Рисунок 5.3*** *Providing Administrator Credentials*


After you have joined the AD domain, you can log in to it from your workstation using the display manager of your desktop or the console.

# 5.4 Logging In to an AD Domain

Provided your machine has been configured to authenticate against Active Directory and you have a valid Windows user identity, you can log in to your machine using the AD credentials. Login is supported for both desktop environments (GNOME and KDE), the console, SSH, and any other PAM-aware application.

**ВАЖНО: Offline Authentication**

openSUSE supports offline authentication, allowing you to remain logged in to your client machine even if the client machine is disconnected from the network.

## 5.4.1 GDM and KDM

To authenticate a GNOME client machine against an AD server, proceed as follows:

1. Select the domain.
2. Enter your Windows username and press Enter.
3. Enter your Windows password and press Enter.

To authenticate a KDE client machine against an AD server, proceed as follows:

1. Select the domain.
2. Enter your Windows username.
3. Enter your Windows password and press Enter.

If configured to do so, openSUSE creates a user home directory on the local machine on the first login of each AD authenticated user. This allows you to benefit from the AD support of openSUSE while still having a fully functional Linux machine at your disposal.

## 5.4.2 Console Login

You can not only log in to the AD client machine using a graphical front-end, but also by using the text-based console login or by using SSH.

To log in to your AD client from a console, enter *DOMAIN**user* at the `login:` prompt and provide the password.

To remotely log in to your AD client machine using SSH, proceed as follows:

1. At the login prompt, enter:

   ```
   ssh DOMAIN\\user@hostname
   ```

   The \ domain and login delimiter is escaped with another \ sign.

2. Provide the user's password.

# 5.5 Changing Passwords

openSUSE has the ability to help a user choose a suitable new password that meets the corporate security policy. The underlying PAM module retrieves the current password policy settings from the domain controller, informing the user about the specific password quality requirements a user account typically has, by means of a message on login. Like its Windows counterpart, openSUSE presents a message describing:

- Password history settings
- Minimum password length requirements
- Minimum password age
- Password complexity

The password change process cannot succeed unless all requirements have been successfully met. Feedback about the password status is given both through the display managers and the console.

GDM and KDM provide feedback about password expiration and prompt for new passwords in an interactive mode. To change passwords in the display managers, just provide the password information when prompted.

To change your Windows password, you can use the standard Linux utility, `passwd`, instead of having to manipulate this data on the server. To change your Windows password, proceed as follows:

1. Log in at the console.
2. Enter `passwd`.
3. Enter your current password when prompted.
4. Enter the new password.
5. Reenter the new password for confirmation. If your new password does not comply with the policies on the Windows server, you are prompted for another password.

To change your Windows password from the GNOME desktop, proceed as follows:

1. Click the *Computer* icon on the left edge of the panel.
2. Select *Control Center*.
3. From the *Personal* section, select *Change Password*.
4. Enter your old password.
5. Enter and confirm the new password.
6. Leave the dialog with *Close* to apply your settings.

To change your Windows password from the KDE desktop, proceed as follows:

1. Select *Personal Settings* from the main menu.
2. Select *Security & Privacy*.
3. Click *Password & User Account*.
4. Click *Change Password*.
5. Enter your current password.
6. Enter and confirm the new password and apply your settings with *OK*.
7. Leave the *Personal Settings* with *File* > *Quit*.

# 6 Network Authentication with Kerberos

An open network provides no means of ensuring that a workstation can identify its users properly, except through the usual password mechanisms. In common installations, the user must enter the password each time a service inside the network is accessed. Kerberos provides an authentication method with which a user registers only once and is trusted in the complete network for the rest of the session. To have a secure network, the following requirements must be met:

- Have all users prove their identity for each desired service and make sure that no one can take the identity of someone else.
- Make sure that each network server also proves its identity. Otherwise an attacker might be able to impersonate the server and obtain sensitive information transmitted to the server. This concept is called *mutual authentication*, because the client authenticates to the server and vice versa.

Kerberos helps you meet these requirements by providing strongly encrypted authentication. Only the basic principles of Kerberos are discussed here. For detailed technical instruction, refer to the Kerberos documentation.

## 6.1 Kerberos Terminology

The following glossary defines some Kerberos terminology.

credential
: Users or clients need to present some kind of credentials that authorize them to request services. Kerberos knows two kinds of credentials—tickets and authenticators.

ticket
: A ticket is a per-server credential used by a client to authenticate at a server from which it is requesting a service. It contains the name of the server, the client's name, the client's Internet address, a time stamp, a lifetime, and a random session key. All this data is encrypted using the server's key.

authenticator
: Combined with the ticket, an authenticator is used to prove that the client presenting a ticket is really the one it claims to be. An authenticator is built using the client's name, the workstation's IP address, and the current workstation's time, all encrypted with the session key known only to the client and the relevant server. An authenticator can only be used once, unlike a ticket. A client can build an authenticator itself.

principal
: A Kerberos principal is a unique entity (a user or service) to which it can assign a ticket. A principal consists of the following components:

  - **Primary**—the first part of the principal, which can be the same as your username in the case of a user.
  - **Instance**—some optional information characterizing the primary. This string is separated from the primary by a `/`.
  - **Realm**—this specifies your Kerberos realm. Normally, your realm is your domain name in uppercase letters.

mutual authentication
: Kerberos ensures that both client and server can be sure of each other's identity. They share a session key, which they can use to communicate securely.

session key
: Session keys are temporary private keys generated by Kerberos. They are known to the client and used to encrypt the communication between the client and the server for which it requested and received a ticket.

replay
: Almost all messages sent in a network can be eavesdropped, stolen, and resent. In the Kerberos context, this would be most dangerous if an attacker manages to obtain your request for a service containing your ticket and authenticator. The attacker could then try to resend it (*replay*) to impersonate you. However, Kerberos implements several mechanisms to deal with this problem.

server or service
: *Service* is used to refer to a specific action to perform. The process behind this action is referred to as a *server*.

# 6.2 How Kerberos Works

Kerberos is often called a third party trusted authentication service, which means all its clients trust Kerberos's judgment of another client's identity. Kerberos keeps a database of all its users and their private keys.

To ensure Kerberos is working correctly, run both the authentication and ticket-granting server on a dedicated machine. Make sure that only the administrator can access this machine physically and over the network. Reduce the (networking) services running on it to the absolute minimum—do not even run `sshd`.

## 6.2.1 First Contact

Your first contact with Kerberos is quite similar to any login procedure at a normal networking system. Enter your username. This piece of information and the name of the ticket-granting service are sent to the authentication server (Kerberos). If the authentication server knows you, it generates a random session key for further use between your client and the ticket-granting server. Now the authentication server prepares a ticket for the ticket-granting server. The ticket contains the following information—all encrypted with a session key only the authentication server and the ticket-granting server know:

- The names of both, the client and the ticket-granting server
- The current time
- A lifetime assigned to this ticket

- The client's IP address
- The newly-generated session key

This ticket is then sent back to the client together with the session key, again in encrypted form, but this time the private key of the client is used. This private key is only known to Kerberos and the client, because it is derived from your user password. Now that the client has received this response, you are prompted for your password. This password is converted into the key that can decrypt the package sent by the authentication server. The package is «unwrapped» and password and key are erased from the workstation's memory. As long as the lifetime given to the ticket used to obtain other tickets does not expire, your workstation can prove your identity.

## 6.2.2 Requesting a Service

To request a service from any server in the network, the client application needs to prove its identity to the server. Therefore, the application generates an authenticator. An authenticator consists of the following components:

- The client's principal
- The client's IP address
- The current time
- A checksum (chosen by the client)

All this information is encrypted using the session key that the client has already received for this special server. The authenticator and the ticket for the server are sent to the server. The server uses its copy of the session key to decrypt the authenticator, which gives it all the information needed about the client requesting its service, to compare it to that contained in the ticket. The server checks if the ticket and the authenticator originate from the same client.

Without any security measures implemented on the server side, this stage of the process would be an ideal target for replay attacks. Someone could try to resend a request stolen off the net some time before. To prevent this, the server does not accept any request with a time stamp and ticket received previously. In addition to that, a request with a time stamp differing too much from the time the request is received is ignored.

## 6.2.3 Mutual Authentication

Kerberos authentication can be used in both directions. It is not only a question of the client being the one it claims to be. The server should also be able to authenticate itself to the client requesting its service. Therefore, it sends an authenticator itself. It adds one to the checksum it received in the client's authenticator and encrypts it with the session key, which is shared between it and the client. The client takes this response as a proof of the server's authenticity and they both start cooperating.

## 6.2.4 Ticket Granting—Contacting All Servers

Tickets are designed to be used for one server at a time. This implies that you have to get a new ticket each time you request another service. Kerberos implements a mechanism to obtain tickets for individual servers. This service is called the «ticket-granting service». The ticket-granting service is a service (like any other service mentioned before) and uses the same access protocols that have already been outlined. Any time an application needs a ticket that has not already been requested, it contacts the ticket-granting server. This request consists of the following components:

- The requested principal
- The ticket-granting ticket
- An authenticator

Like any other server, the ticket-granting server now checks the ticket-granting ticket and the authenticator. If they are considered valid, the ticket-granting server builds a new session key to be used between the original client and the new server. Then the ticket for the new server is built, containing the following information:

- The client's principal
- The server's principal
- The current time
- The client's IP address

- The newly-generated session key

The new ticket has a lifetime, which is either the remaining lifetime of the ticket-granting ticket or the default for the service. The lesser of both values is assigned. The client receives this ticket and the session key, which are sent by the ticket-granting service, but this time the answer is encrypted with the session key that came with the original ticket-granting ticket. The client can decrypt the response without requiring the user's password when a new service is contacted. Kerberos can thus acquire ticket after ticket for the client without bothering the user.

## 6.2.5 Compatibility to Windows 2000

Windows 2000 contains a Microsoft implementation of Kerberos 5. openSUSE® uses the MIT implementation of Kerberos 5, find useful information and guidance in the MIT documentation at Раздел 6.5, «For More Information» (стр. 111).

# 6.3 Users' View of Kerberos

Ideally, a user's one and only contact with Kerberos happens during login at the workstation. The login process includes obtaining a ticket-granting ticket. At logout, a user's Kerberos tickets are automatically destroyed, which makes it difficult for anyone else to impersonate this user. The automatic expiration of tickets can lead to a somewhat awkward situation when a user's login session lasts longer than the maximum lifespan given to the ticket-granting ticket (a reasonable setting is 10 hours). However, the user can get a new ticket-granting ticket by running `kinit`. Enter the password again and Kerberos obtains access to desired services without additional authentication. To get a list of all the tickets silently acquired for you by Kerberos, run `klist`.

Here is a short list of some applications that use Kerberos authentication. These applications can be found under `/usr/lib/mit/bin` or `/usr/lib/mit/sbin` after installing the package `krb5-apps-clients`. They all have the full functionality of their common UNIX and Linux brothers plus the additional bonus of transparent authentication managed by Kerberos:

- telnet, telnetd
- rlogin

- rsh, rcp, rshd
- ftp, ftpd
- ksu

You no longer have to enter your password for using these applications because Kerberos has already proven your identity. ssh, if compiled with Kerberos support, can even forward all the tickets acquired for one workstation to another one. If you use ssh to log in to another workstation, ssh makes sure that the encrypted contents of the tickets are adjusted to the new situation. Simply copying tickets between workstations is not sufficient because the ticket contains workstation-specific information (the IP address). XDM, GDM, and KDM offer Kerberos support, too. Read more about the Kerberos network applications in *Kerberos V5 UNIX User's Guide* at `http://web.mit.edu/kerberos` .

# 6.4 Installing and Administering Kerberos

A Kerberos environment consists of several different components. A key distribution center (KDC) holds the central database with all Kerberos-relevant data. All clients rely on the KDC for proper authentication across the network. Both the KDC and the clients need to be configured to match your setup:

General Preparations
: Check your network setup and make sure it meets the minimum requirements outlined in Раздел 6.4.1, «Kerberos Network Topology» (стр. 92). Choose an appropriate realm for your Kerberos setup, see Раздел 6.4.2, «Choosing the Kerberos Realms» (стр. 93). Carefully set up the machine that is to serve as the KDC and apply tight security, see Раздел 6.4.3, «Setting Up the KDC Hardware» (стр. 94). Set up a reliable time source in your network to make sure all tickets contain valid timestamps, see Раздел 6.4.4, «Configuring Time Synchronization» (стр. 95).

Basic Configuration
: Configure the KDC and the clients, see Раздел 6.4.5, «Configuring the KDC» (стр. 96) and Раздел 6.4.6, «Configuring Kerberos Clients» (стр. 98).

Enable remote administration for your Kerberos service, so you do not need physical access to your KDC machine, see Раздел 6.4.7, «Configuring Remote Kerberos Administration» (стр. 104). Create service principals for every service in your realm, see Раздел 6.4.8, «Creating Kerberos Service Principals» (стр. 105).

Enabling Kerberos Authentication
: Various services in your network can make use of Kerberos. To add Kerberos password-checking to applications using PAM, proceed as outlined in Раздел 6.4.9, «Enabling PAM Support for Kerberos» (стр. 107). To configure SSH or LDAP with Kerberos authentication, proceed as outlined in Раздел 6.4.10, «Configuring SSH for Kerberos Authentication» (стр. 108) and Раздел 6.4.11, «Using LDAP and Kerberos» (стр. 108).

## 6.4.1 Kerberos Network Topology

Any Kerberos environment must meet the following requirements to be fully functional:

- Provide a DNS server for name resolution across your network, so clients and servers can locate each other. Refer to Глава 25, *The Domain Name System* (↑Reference) for information on DNS setup.

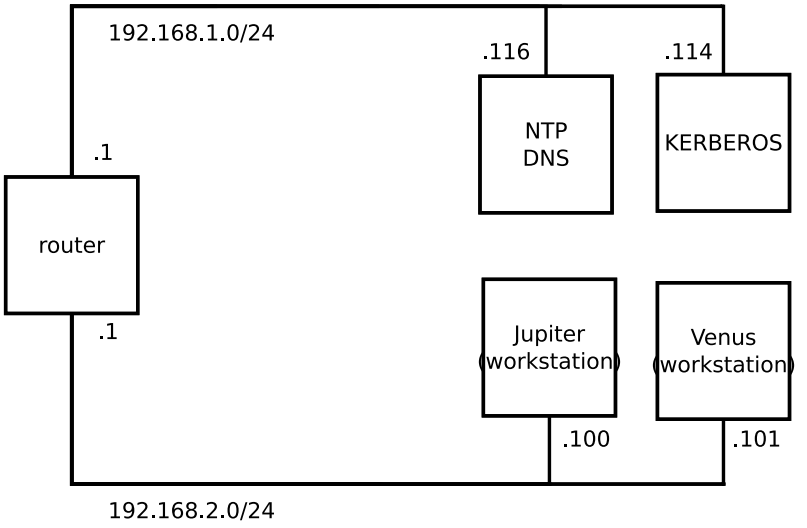
- Provide a time server in your network. Using exact time stamps is crucial to a Kerberos setup, because valid Kerberos tickets must contain correct time stamps. Refer to Глава 27, *Time Synchronization with NTP* (↑Reference) for information on NTP setup.

- Provide a key distribution center (KDC) as the center piece of the Kerberos architecture. It holds the Kerberos database. Use the tightest possible security policy on this machine to prevent any attacks on this machine compromising your entire infrastructure.

- Configure the client machines to use Kerberos authentication.

The following figure depicts a simple example network with just the minimum components needed to build a Kerberos infrastructure. Depending on the size and topology of your deployment, your setup may vary.

***Рисунок 6.1*** *Kerberos Network Topology*




**ПОДСКАЗКА: Configuring Subnet Routing**

For a setup similar to the one in Рисунок 6.1, «Kerberos Network Topology» (стр. 93), configure routing between the two subnets (192.168.1.0/24 and 192.168.2.0/24). Refer to «Configuring Routing» (Глава 23, *Basic Networking*, ↑Reference) for more information on configuring routing with YaST.

## 6.4.2 Choosing the Kerberos Realms

The domain of a Kerberos installation is called a realm and is identified by a name, such as `EXAMPLE.COM` or simply `ACCOUNTING`. Kerberos is case-sensitive, so `example.com` is actually a different realm than `EXAMPLE.COM`. Use the case you prefer. It is common practice, however, to use uppercase realm names.

It is also a good idea to use your DNS domain name (or a subdomain, such as `ACCOUNTING.EXAMPLE.COM`). As shown below, your life as an administrator can be much easier if you configure your Kerberos clients to locate the KDC and other Kerberos services via DNS. To do so, it is helpful if your realm name is a subdomain of your DNS domain name.

Unlike the DNS name space, Kerberos is not hierarchical. You cannot set up a realm named `EXAMPLE.COM`, have two «subrealms» named `DEVELOPMENT` and `ACCOUNTING` underneath it, and expect the two subordinate realms to somehow inherit principals from `EXAMPLE.COM`. Instead, you would have three separate realms for which you would have to configure crossrealm authentication for users from one realm to interact with servers or other users from another realm.

For the sake of simplicity, let us assume you are setting up just one realm for your entire organization. For the remainder of this section, the realm name `EXAMPLE.COM` is used in all examples.

## 6.4.3 Setting Up the KDC Hardware

The first thing required to use Kerberos is a machine that acts as the key distribution center, or KDC for short. This machine holds the entire Kerberos user database with passwords and all information.

The KDC is the most important part of your security infrastructure—if someone breaks into it, all user accounts and all of your infrastructure protected by Kerberos is compromised. An attacker with access to the Kerberos database can impersonate any principal in the database. Tighten security for this machine as much as possible:

1. Put the server machine into a physically secured location, such as a locked server room to which only a very few people have access.

2. Do not run any network applications on it except the KDC. This includes servers and clients—for example, the KDC should not import any file systems via NFS or use DHCP to retrieve its network configuration.

3. Install a minimal system first then check the list of installed packages and remove any unneeded packages. This includes servers, such as inetd, portmap, and cups, as well as anything X-based. Even installing an SSH server should be considered a potential security risk.

4. No graphical login is provided on this machine as an X server is a potential security risk. Kerberos provides its own administration interface.

5. Configure `/etc/nsswitch.conf` to use only local files for user and group lookup. Change the lines for `passwd` and `group` to look like this:

```
passwd:         files
```

```
group:          files
```

Edit the `passwd`, `group`, and `shadow` files in `/etc` and remove the lines that start with a + character (these are for NIS lookups).

6 Disable all user accounts except `root`'s account by editing `/etc/shadow` and replacing the hashed passwords with `*` or `!` characters.

## 6.4.4 Configuring Time Synchronization

To use Kerberos successfully, make sure that all system clocks within your organization are synchronized within a certain range. This is important because Kerberos protects against replayed credentials. An attacker might be able to observe Kerberos credentials on the network and reuse them to attack the server. Kerberos employs several defenses to prevent this. One of them is that it puts time stamps into its tickets. A server receiving a ticket with a time stamp that differs from the current time rejects the ticket.

Kerberos allows a certain leeway when comparing time stamps. However, computer clocks can be very inaccurate in keeping time—it is not unheard of for PC clocks to lose or gain half an hour over the course of a week. For this reason, configure all hosts on the network to synchronize their clocks with a central time source.

A simple way to do so is by installing an NTP time server on one machine and having all clients synchronize their clocks with this server. Do this either by running an NTP daemon in client mode on all these machines or by running `ntpdate` once a day from all clients (this solution probably works for a small number of clients only). The KDC itself needs to be synchronized to the common time source as well. Because running an NTP daemon on this machine would be a security risk, it is probably a good idea to do this by running ntpdate via a cron entry. To configure your machine as an NTP client, proceed as outlined in Раздел “Configuring an NTP Client with YaST” (Глава 27, *Time Synchronization with NTP*, ↑Reference).

A different way to secure the time service and still use the NTP daemon is to attach a hardware reference clock to a dedicated NTP server as well as an additional hardware reference clock to the KDC.

It is also possible to adjust the maximum deviation Kerberos allows when checking time stamps. This value (called *clock skew*) can be set in the `krb5.conf` file as described in «Adjusting the Clock Skew» (стр. 103).

# 6.4.5 Configuring the KDC

This section covers the initial configuration and installation of the KDC, including the creation of an administrative principal. This procedure consists of several steps:

1. **Install the RPMs** On a machine designated as the KDC, install the following software packages: `krb5`, `krb5-server` and `krb5-client` packages.

2. **Adjust the Configuration Files** The `/etc/krb5.conf` and `/var/lib/kerberos/krb5kdc/kdc.conf` configuration files must be adjusted for your scenario. These files contain all information on the KDC.

3. **Create the Kerberos Database** Kerberos keeps a database of all principal identifiers and the secret keys of all principals that need to be authenticated. Refer to «Setting Up the Database» (стр. 96) for details.

4. **Adjust the ACL Files: Add Administrators** The Kerberos database on the KDC can be managed remotely. To prevent unauthorized principals from tampering with the database, Kerberos uses access control lists. You must explicitly enable remote access for the administrator principal to enable him to manage the database. The Kerberos ACL file is located under `/var/lib/kerberos/krb5kdc/kadm5.acl`. Refer to Раздел 6.4.7, «Configuring Remote Kerberos Administration» (стр. 104) for details.

5. **Adjust the Kerberos Database: Add Administrators** You need at least one administrative principal to run and administer Kerberos. This principal must be added before starting the KDC. Refer to «Creating a Principal» (стр. 97) for details.

6. **Start the Kerberos Daemon** Once the KDC software is installed and properly configured, start the Kerberos daemon to provide Kerberos service for your realm. Refer to «Starting the KDC» (стр. 98) for details.

7. **Create a Principal for Yourself** You need a principal for yourself. Refer to «Creating a Principal» (стр. 97) for details.

## Setting Up the Database

Your next step is to initialize the database where Kerberos keeps all information about principals. Set up the database master key, which is used to protect the database from accidental disclosure (in particular if it is backed up to tape). The

master key is derived from a pass phrase and is stored in a file called the stash file. This is so you do not need to enter the password every time the KDC is restarted. Make sure that you choose a good pass phrase, such as a sentence from a book opened to a random page.

When you make tape backups of the Kerberos database (`/var/lib/kerberos/krb5kdc/principal`), do not back up the stash file (which is in `/var/lib/kerberos/krb5kdc/.k5.EXAMPLE.COM`). Otherwise, everyone able to read the tape could also decrypt the database. Therefore, keep a copy of the pass phrase in a safe or some other secure location, because you will need it to restore your database from backup tape after a crash.

To create the stash file and the database, run:

```
kdb5_util create -r EXAMPLE.COM -s
```

You will see the following output:

```
Initializing database '/var/lib/kerberos/krb5kdc/principal' for realm
 'EXAMPLE.COM',
master key name 'K/M@EXAMPLE.COM'
You will be prompted for the database Master Password.
It is important that you NOT FORGET this password.
Enter KDC database master key:  ❶
Re-enter KDC database master key to verify:  ❷
```

❶ Type the master password.

❷ Type the password again.

To verify, use the list command:

```
kadmin.local

kadmin> listprincs
```

You will see several principals in the database, which are for internal use by Kerberos:

```
K/M@EXAMPLE.COM
kadmin/admin@EXAMPLE.COM
kadmin/changepw@EXAMPLE.COM
krbtgt/EXAMPLE.COM@EXAMPLE.COM
```

## Creating a Principal

Create two Kerberos principals for yourself: one normal principal for everyday work and one for administrative tasks relating to Kerberos. Assuming your login name is `geeko`, proceed as follows:

```
kadmin.local
```

```
kadmin> ank geeko
```

You will see the following output:

```
geeko@EXAMPLE.COM's Password: ❶
Verifying password: ❷
```

❶ Type geeko's password.

❶ Type geeko's password again.

Next, create another principal named `geeko/admin` by typing `ank geeko/admin` at the `kadmin` prompt. The `admin` suffixed to your username is a *role*. Later, use this role when administering the Kerberos database. A user can have several roles for different purposes. Roles are basically completely different accounts with similar names.

## Starting the KDC

Start the KDC daemon and the kadmin daemon. To start the daemons manually, enter `rckrb5kdc start` and `rckadmind start`. Also make sure that KDC and kadmind are started by default when the server machine is rebooted with the command `insserv krb5kdc` and `insserv kadmind` or use the YaST runlevel editor.

# 6.4.6 Configuring Kerberos Clients

Once the supporting infrastructure is in place (DNS, NTP) and the KDC has been properly configured and started, configure the client machines. You can either use YaST to configure a Kerberos client or use one of the two manual approaches described below.

## Configuring a Kerberos Client with YaST

Rather than manually editing all relevant configuration files when configuring a Kerberos client, let YaST do the job for you. You can either perform the client configuration during the installation of your machine or in the installed system as follows:

**1** Log in as `root` and select *Network Services* > *Kerberos Client*.

**2** Select *Use Kerberos*.

**3** To configure a DNS-based Kerberos client, proceed as follows:

**3a** Enable *Use DNS to acquire the configuration data at runtime* and confirm the *Basic Kerberos Settings* that are displayed.

---

**ЗАМЕЧАНИЕ: Using DNS Support**

The *Use DNS* option cannot be selected if the DNS server does not provide such data.

---

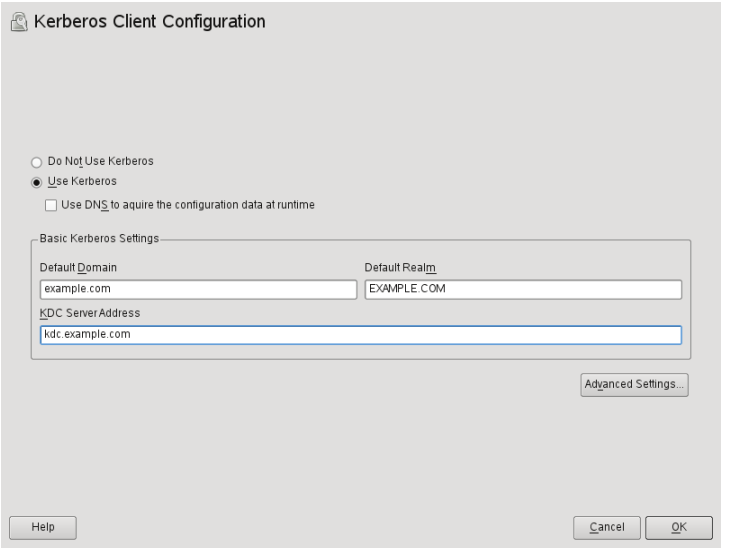
**3b** Click *Advanced Settings* to configure details on ticket-related issues, OpenSSH support, time synchronization, and extended PAM configurations.

**4** To configure a static Kerberos client, proceed as follows:

**4a** Set *Default Domain*, *Default Realm*, and *KDC Server Address* to the values that match your setup.

**4b** Click *Advanced Settings* to configure details on ticket-related issues, OpenSSH support, time synchronization, and extended PAM configurations.

***Рисунок 6.2*** *YaST: Basic Configuration of a Kerberos Client*



To configure ticket-related options in the *Advanced Settings* dialog, choose from the following options:

- Specify the *Default Ticket Lifetime* and the *Default Renewable Lifetime* in days, hours, or minutes (using the units of measurement *d*, *h*, and *m*, with no blank space between the value and the unit).

- To forward your complete identity (to use your tickets on other hosts), select *Forwardable*.

- Enable the transfer of certain tickets by selecting *Proxiable*.

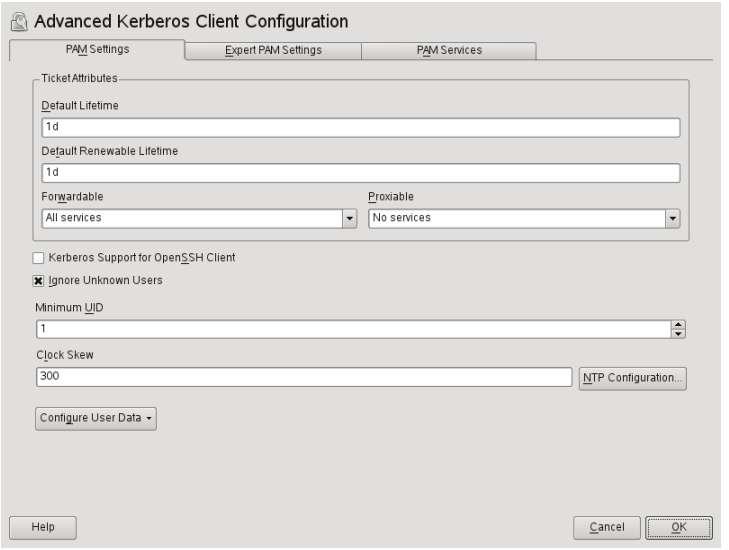
- Enable Kerberos authentication support for your OpenSSH client by selecting the corresponding check box. The client then uses Kerberos tickets to authenticate with the SSH server.

- Exclude a range of user accounts from using Kerberos authentication by providing a value for the *Minimum UID* that a user of this feature must have. For instance, you may want to exclude the system administrator (`root`).

- Use *Clock Skew* to set a value for the allowable difference between the time stamps and your host's system time.

- To keep the system time in sync with an NTP server, you can also set up the host as an NTP client by selecting *NTP Configuration*, which opens the YaST NTP client dialog that is described in Раздел “Configuring an NTP Client with YaST” (Глава 27, *Time Synchronization with NTP*, ↑Reference). After finishing the configuration, YaST performs all the necessary changes and the Kerberos client is ready to use.

***Рисунок 6.3*** *YaST: Advanced Configuration of a Kerberos Client*




For more information about the configuration of *Expert PAM Settings* and *PAM Services* tabs, see the official documentation referenced in Раздел 6.5, «For More Information» (стр. 111) and the manual page `man 5 krb5.conf`.

## Manually Configuring Kerberos Clients

When configuring Kerberos, there are basically two approaches you can take—static configuration in the `/etc/krb5.conf` file or dynamic configuration with DNS. With DNS configuration, Kerberos applications try to locate the KDC services using DNS records. With static configuration, add the hostnames of your KDC server to `krb5.conf` (and update the file whenever you move the KDC or reconfigure your realm in other ways).

DNS-based configuration is generally a lot more flexible and the amount of configuration work per machine is a lot less. However, it requires that your realm name is either the same as your DNS domain or a subdomain of it. Configuring Kerberos via DNS also creates a minor security issue—an attacker can seriously disrupt your infrastructure through your DNS (by shooting down the name server, spoofing DNS records, etc.). However, this amounts to a denial of service at worst. A similar scenario applies to the static configuration case unless you enter IP addresses in `krb5.conf` instead of hostnames.

## Static Configuration

One way to configure Kerberos is to edit `/etc/krb5.conf`. The file installed by default contains various sample entries. Erase all of these entries before starting. `krb5.conf` is made up of several sections (stanzas), each introduced by the section name in brackets like `[this]`.

To configure your Kerberos clients, add the following stanza to `krb5.conf` (where `kdc.example.com` is the hostname of the KDC):

```
[libdefaults]
        default_realm = EXAMPLE.COM

[realms]
        EXAMPLE.COM = {
                kdc = kdc.example.com
                admin_server = kdc.example.com
        }
```

The `default_realm` line sets the default realm for Kerberos applications. If you have several realms, just add additional statements to the `[realms]` section.

Also add a statement to this file that tells applications how to map hostnames to a realm. For example, when connecting to a remote host, the Kerberos library needs to know in which realm this host is located. This must be configured in the `[domain_realms]` section:

```
[domain_realm]
        .example.com = EXAMPLE.COM
        www.foobar.com = EXAMPLE.COM
```

This tells the library that all hosts in the `example.com` DNS domains are in the `EXAMPLE.COM` Kerberos realm. In addition, one external host named `www.foobar.com` should also be considered a member of the `EXAMPLE.COM` realm.

## DNS-Based Configuration

DNS-based Kerberos configuration makes heavy use of SRV records. See *(RFC2052) A DNS RR for specifying the location of services* at `http://www.ietf.org`.

The name of an SRV record, as far as Kerberos is concerned, is always in the format `_service._proto.realm`, where realm is the Kerberos realm. Domain names in DNS are case insensitive, so case-sensitive Kerberos realms would break when

using this configuration method. `_service` is a service name (different names are used when trying to contact the KDC or the password service, for example). `_proto` can be either `_udp` or `_tcp`, but not all services support both protocols.

The data portion of SRV resource records consists of a priority value, a weight, a port number, and a hostname. The priority defines the order in which hosts should be tried (lower values indicate a higher priority). The weight value is there to support some sort of load balancing among servers of equal priority. You probably do not need any of this, so it is okay to set these to zero.

MIT Kerberos currently looks up the following names when looking for services:

_kerberos
: This defines the location of the KDC daemon (the authentication and ticket granting server). Typical records look like this:

```
_kerberos._udp.EXAMPLE.COM.  IN  SRV    0 0 88 kdc.example.com.
_kerberos._tcp.EXAMPLE.COM.  IN  SRV    0 0 88 kdc.example.com.
```

_kerberos-adm
: This describes the location of the remote administration service. Typical records look like this:

```
_kerberos-adm._tcp.EXAMPLE.COM. IN  SRV    0 0 749 kdc.example.com.
```

  Because kadmind does not support UDP, there should be no `_udp` record.

As with the static configuration file, there is a mechanism to inform clients that a specific host is in the `EXAMPLE.COM` realm, even if it is not part of the `example.com` DNS domain. This can be done by attaching a TXT record to `_kerberos.hostname`, as shown here:

```
_kerberos.www.foobar.com.  IN TXT "EXAMPLE.COM"
```

## Adjusting the Clock Skew

The *clock skew* is the tolerance for accepting tickets with time stamps that do not exactly match the host's system clock. Usually, the clock skew is set to 300 seconds (five minutes). This means a ticket can have a time stamp somewhere between five minutes behind and five minutes ahead of the server's clock.

When using NTP to synchronize all hosts, you can reduce this value to about one minute. The clock skew value can be set in `/etc/krb5.conf` like this:

```
[libdefaults]
        clockskew = 60
```

## 6.4.7 Configuring Remote Kerberos Administration

To be able to add and remove principals from the Kerberos database without accessing the KDC's console directly, tell the Kerberos administration server which principals are allowed to do what by editing `/var/lib/kerberos/krb5kdc/kadm5.acl`. The ACL (access control list) file allows you to specify privileges with a precise degree of control. For details, refer to the manual page with `man 8 kadmind`.

For now, just grant yourself the privilege to administer the database by putting the following line into the file:

```
geeko/admin              *
```

Replace the username `geeko` with your own. Restart kadmind for the change to take effect.

You should now be able to perform Kerberos administration tasks remotely using the kadmin tool. First, obtain a ticket for your admin role and use that ticket when connecting to the kadmin server:

```
kadmin -p geeko/admin
Authenticating as principal geeko/admin@EXAMPLE.COM with password.
Password for geeko/admin@EXAMPLE.COM:
kadmin:  getprivs
current privileges: GET ADD MODIFY DELETE
kadmin:
```

Using the `getprivs` command, verify which privileges you have. The list shown above is the full set of privileges.

As an example, modify the principal `geeko`:

```
kadmin -p geeko/admin
Authenticating as principal geeko/admin@EXAMPLE.COM with password.
Password for geeko/admin@EXAMPLE.COM:

kadmin:  getprinc geeko
Principal: geeko@EXAMPLE.COM
Expiration date: [never]
```

```
Last password change: Wed Jan 12 17:28:46 CET 2005
Password expiration date: [none]
Maximum ticket life: 0 days 10:00:00
Maximum renewable life: 7 days 00:00:00
Last modified: Wed Jan 12 17:47:17 CET 2005 (admin/admin@EXAMPLE.COM)
Last successful authentication: [never]
Last failed authentication: [never]
Failed password attempts: 0
Number of keys: 2
Key: vno 1, Triple DES cbc mode with HMAC/sha1, no salt
Key: vno 1, DES cbc mode with CRC-32, no salt
Attributes:
Policy: [none]

kadmin:  modify_principal -maxlife "8 hours" geeko
Principal "geeko@EXAMPLE.COM" modified.
kadmin:  getprinc joe
Principal: geeko@EXAMPLE.COM
Expiration date: [never]
Last password change: Wed Jan 12 17:28:46 CET 2005
Password expiration date: [none]
Maximum ticket life: 0 days 08:00:00
Maximum renewable life: 7 days 00:00:00
Last modified: Wed Jan 12 17:59:49 CET 2005 (geeko/admin@EXAMPLE.COM)
Last successful authentication: [never]
Last failed authentication: [never]
Failed password attempts: 0
Number of keys: 2
Key: vno 1, Triple DES cbc mode with HMAC/sha1, no salt
Key: vno 1, DES cbc mode with CRC-32, no salt
Attributes:
Policy: [none]
kadmin:
```

This changes the maximum ticket life time to eight hours. For more information about the `kadmin` command and the options available, see the `krb5-doc` package, refer to http://web.mit.edu/kerberos/www/krb5-1.8/krb5-1.8.3/doc/krb5-admin.html#Kadmin%20Options or the `man8 kadmin` manual page.

## 6.4.8 Creating Kerberos Service Principals

So far, only user credentials have been discussed. However, Kerberos-compatible services usually need to authenticate themselves to the client user, too. Therefore, special service principals must be present in the Kerberos database for each service offered in the realm. For example, if ldap.example.com offers an LDAP service,

you need a service principal, `ldap/ldap.example.com@EXAMPLE.COM`, to authenticate this service to all clients.

The naming convention for service principals is *`service/hostname@REALM`*, where *`hostname`* is the host's fully qualified hostname.

Valid service descriptors are:

| Service Descriptor | Service |
|---|---|
| `host` | Telnet, RSH, SSH |
| `nfs` | NFSv4 (with Kerberos support) |
| `HTTP` | HTTP (with Kerberos authentication) |
| `imap` | IMAP |
| `pop` | POP3 |
| `ldap` | LDAP |

Service principals are similar to user principals, but have significant differences. The main difference between a user principal and a service principal is that the key of the former is protected by a password—when a user obtains a ticket-granting ticket from the KDC, he needs to type his password so Kerberos can decrypt the ticket. It would be quite inconvenient for the system administrator if he had to obtain new tickets for the SSH daemon every eight hours or so.

Instead, the key required to decrypt the initial ticket for the service principal is extracted by the administrator from the KDC only once and stored in a local file called the *keytab*. Services such as the SSH daemon read this key and use it to obtain new tickets automatically, when needed. The default keytab file resides in `/etc/krb5.keytab` .

To create a host service principal for `jupiter.example.com` enter the following commands during your kadmin session:

```
kadmin -p geeko/admin
Authenticating as principal geeko/admin@EXAMPLE.COM with password.
Password for geeko/admin@EXAMPLE.COM:
kadmin:  addprinc -randkey host/jupiter.example.com
```

```
WARNING: no policy specified for host/jupiter.example.com@EXAMPLE.COM;
defaulting to no policy
Principal "host/jupiter.example.com@EXAMPLE.COM" created.
```

Instead of setting a password for the new principal, the `-randkey` flag tells `kadmin` to generate a random key. This is used here because no user interaction is wanted for this principal. It is a server account for the machine.

Finally, extract the key and store it in the local keytab file `/etc/krb5.keytab` . This file is owned by the superuser, so you must be `root` to execute the next command in the kadmin shell:

```
kadmin:  ktadd host/jupiter.example.com
Entry for principal host/jupiter.example.com with kvno 3, encryption type
 Triple
DES cbc mode with HMAC/sha1 added to keytab WRFILE:/etc/krb5.keytab.
Entry for principal host/jupiter.example.com with kvno 3, encryption type
 DES
cbc mode with CRC-32 added to keytab WRFILE:/etc/krb5.keytab.
kadmin:
```

When completed, make sure that you destroy the admin ticket obtained with kinit above with `kdestroy`.

## 6.4.9 Enabling PAM Support for Kerberos

openSUSE® comes with a PAM module named `pam_krb5` , which supports Kerberos login and password update. This module can be used by applications such as console login, su, and graphical login applications like KDM (where the user presents a password and would like the authenticating application to obtain an initial Kerberos ticket on his behalf). To configure PAM support for Kerberos, use the following command:

```
pam-config --add --krb5
```

The above command adds the `pam_krb5` module to the existing PAM configuration files and makes sure it is called in the right order. To make precise adjustments to the way in which `pam_krb5` is used, edit the file `/etc/krb5.conf` and add default applications to `pam`. For details, refer to the manual page with `man 5 pam_krb5`.

The `pam_krb5` module was specifically not designed for network services that accept Kerberos tickets as part of user authentication. This is an entirely different matter, and is discussed below.

## 6.4.10 Configuring SSH for Kerberos Authentication

OpenSSH supports Kerberos authentication in both protocol version 1 and 2. In version 1, there are special protocol messages to transmit Kerberos tickets. Version 2 does not use Kerberos directly anymore, but relies on GSSAPI, the General Security Services API. This is a programming interface that is not specific to Kerberos—it was designed to hide the peculiarities of the underlying authentication system, be it Kerberos, a public-key authentication system like SPKM, or others. However, the included GSSAPI library only supports Kerberos.

To use sshd with Kerberos authentication, edit `/etc/ssh/sshd_config` and set the following options:

```
# These are for protocol version 1
#
# KerberosAuthentication yes
# KerberosTicketCleanup yes

# These are for version 2 - better to use this
GSSAPIAuthentication yes
GSSAPICleanupCredentials yes
```

Then restart your SSH daemon using `rcsshd restart`.

To use Kerberos authentication with protocol version 2, enable it on the client side as well. Do this either in the systemwide configuration file `/etc/ssh/ssh_config` or on a per-user level by editing `~/.ssh/config`. In both cases, add the option `GSSAPIAuthentication yes`.

You should now be able to connect using Kerberos authentication. Use `klist` to verify that you have a valid ticket, then connect to the SSH server. To force SSH protocol version 1, specify the `-1` option on the command line.

---

**ПОДСКАЗКА: Additional Information**

The file `/usr/share/doc/packages/openssh/README.kerberos` discusses the interaction of OpenSSH and Kerberos in more detail.

---

## 6.4.11 Using LDAP and Kerberos

When using Kerberos, one way to distribute the user information (such as user ID, groups, and home directory) in your local network is to use LDAP. This requires a strong authentication mechanism that prevents packet spoofing and other attacks. One solution is to use Kerberos for LDAP communication, too.

OpenLDAP implements most authentication flavors through SASL, the simple authentication session layer. SASL is basically a network protocol designed for authentication. The SASL implementation is cyrus-sasl, which supports a number of different authentication flavors. Kerberos authentication is performed through GSSAPI (General Security Services API). By default, the SASL plug-in for GSSAPI is not installed. Install the `cyrus-sasl-gssapi` with YaST.

To enable Kerberos to bind to the OpenLDAP server, create a principal `ldap/ldap.example.com` and add that to the keytab.

By default, the LDAP server slapd runs as user and group `ldap`, while the keytab file is readable by `root` only. Therefore, either change the LDAP configuration so the server runs as `root` or make the keytab file readable by the group `ldap`. The latter is done automatically by the OpenLDAP start script (`/etc/init.d/ldap` ) if the keytab file has been specified in the `OPENLDAP_KRB5_KEYTAB` variable in `/etc/sysconfig/openldap` and the `OPENLDAP_CHOWN_DIRS` variable is set to `yes`, which is the default setting. If `OPENLDAP_KRB5_KEYTAB` is left empty, the default keytab under `/etc/krb5.keytab` is used and you must adjust the privileges yourself as described below.

To run slapd as `root`, edit `/etc/sysconfig/openldap` . Disable the `OPENLDAP_USER` and `OPENLDAP_GROUP` variables by putting a comment character in front of them.

To make the keytab file readable by group LDAP, execute

```
chgrp ldap /etc/krb5.keytab
chmod 640 /etc/krb5.keytab
```

A third (and maybe the best) solution is to tell OpenLDAP to use a special keytab file. To do this, start kadmin, and enter the following command after you have added the principal ldap/ldap.example.com:

```
ktadd -k /etc/openldap/ldap.keytab ldap/ldap.example.com@EXAMPLE.COM
```

Then in the shell run:

```
chown ldap.ldap /etc/openldap/ldap.keytab
chmod 600 /etc/openldap/ldap.keytab
```

To tell OpenLDAP to use a different keytab file, change the following variable in `/etc/sysconfig/openldap` :

```
OPENLDAP_KRB5_KEYTAB="/etc/openldap/ldap.keytab"
```

Finally, restart the LDAP server using `rcldap restart`.

## Using Kerberos Authentication with LDAP

You are now able to automatically use tools such as ldapsearch with Kerberos authentication.

```
ldapsearch -b ou=people,dc=example,dc=com '(uid=geeko)'

SASL/GSSAPI authentication started
SASL SSF: 56
SASL installing layers
[...]

# geeko, people, example.com
dn: uid=geeko,ou=people,dc=example,dc=com
uid: geeko
cn: Olaf Kirch
[...]
```

As you can see, ldapsearch prints a message that it started GSSAPI authentication. The next message is very cryptic, but it shows that the *security strength factor* (SSF for short) is 56 (The value 56 is somewhat arbitrary. Most likely it was chosen because this is the number of bits in a DES encryption key). What this tells you is that GSSAPI authentication was successful and that encryption is being used to protect integrity and provide confidentiality for the LDAP connection.

In Kerberos, authentication is always mutual. This means that not only have you authenticated yourself to the LDAP server, but also the LDAP server has authenticated itself to you. In particular, this means communication is with the desired LDAP server, rather than some bogus service set up by an attacker.

## Kerberos Authentication and LDAP Access Control

Now, allow each user to modify the login shell attribute of their LDAP user record. Assuming you have a schema where the LDAP entry of user `joe` is located at `uid=joe,ou=people,dc=example,dc=com` , set up the following access controls in `/etc/openldap/slapd.conf` :

```
# This is required for things to work _at all_
access to dn.base="" by * read
# Let each user change their login shell
access to dn="*,ou=people,dc=example,dc=com" attrs=loginShell
       by self write
# Every user can read everything
access to *
       by users read
```

The second statement gives authenticated users write access to the `loginShell` attribute of their own LDAP entry. The third statement gives all authenticated users read access to the entire LDAP directory.

There is one minor piece of the puzzle missing—how the LDAP server can find out that the Kerberos user `joe@EXAMPLE.COM` corresponds to the LDAP distinguished name `uid=joe,ou=people,dc=example,dc=com`. This sort of mapping must be configured manually using the `saslExpr` directive. In this example, add the following to `slapd.conf` :

```
authz-regexp
   uid=(.*),cn=GSSAPI,cn=auth
   uid=$1,ou=people,dc=example,dc=com
```

To understand how this works, you need to know that when SASL authenticates a user, OpenLDAP forms a distinguished name from the name given to it by SASL (such as `joe`) and the name of the SASL flavor (`GSSAPI`). The result would be `uid=joe,cn=GSSAPI,cn=auth`.

If a `authz-regexp` has been configured, it checks the DN formed from the SASL information using the first argument as a regular expression. If this regular expression matches, the name is replaced with the second argument of the `authz-regexp` statement. The placeholder `$1` is replaced with the substring matched by the `(.*)` expression.

More complicated match expressions are possible. If you have a more complicated directory structure or a schema in which the username is not part of the DN, you can even use search expressions to map the SASL DN to the user DN.

# 6.5 For More Information

The official site of the MIT Kerberos is `http://web.mit.edu/kerberos` . There, find links to any other relevant resource concerning Kerberos, including Kerberos installation, user, and administration guides.

The paper at ftp://athena-dist.mit.edu/pub/kerberos/doc/usenix.PS gives quite an extensive insight to the basic principles of Kerberos, without being too difficult to read. It also provides a lot of opportunities for further investigation and reading about Kerberos.

The official Kerberos FAQ is available at http://www.nrl.navy.mil/CCS/people/kenh/kerberos-faq.html . The book *Kerberos —A Network Authentication System* by Brian Tung (ISBN 0-201-37924-4) offers extensive information.

# 7 Использование сканера отпечатков пальцев

Если у Вам есть сканер отпечатков пальцев, Вы можете использовать биометрическую аутентификацию в дополнение к стандартной (по средствам логина и пароля). После регистрации своих отпечатков пальцев, пользователь может войти в систему, проведя пальцем по сканеру, или введя пароль. openSUSE® поддерживает большое количество подобных сканеров. Список поддерживаемых устройств можно найти на http://reactivated.net/fprint/wiki/Supported_devices .

Если openSUSE® находит сканер отпечатков пальцев, который интегрирован с ноутбуком (или просто подключенного к вашей системе), пакеты `libfprint`, `pam_fp`, и `yast2-fingerprint-reader` будут автоматически установленны.

В настоящее время может быть зарегистрирован только один отпечаток пальца для каждого пользователя. Он хранится в `/home/`*`login`*`/.fprint/` .

# 7.1 Программы, поддерживающие биометрическую аутентификацию

PAM модуль `pam_fp` поддерживает аутентификации распознавания отпечатка пальца в следующих случаях (хотя и не во всех случаях Вам может быть предложено аутентифицировать себя таким образом):

- Авторизация в GDM/KDM или при использовании программы login
- Блокировка экрана в GNOME/KDE
- Запуск YaST и YaST модулей
- Запуск приложений, которые требуют права `root`: `sudo` или `gnomesu`
- Вход в систему от имени другого пользователся при помощи `su` или `su - username`

---

**ЗАМЕЧАНИЕ: Устройства для считывания отпечатка пальца и шифрование домашней директории**

Если Вы хотите аутентифицировать себя с помощью сканера, Вы не можете при этом использовать зашифрованную домашнюю директорию (см. Глава 9, *Managing Users with YaST* (↑Reference) для получения дополнительной информации). В противном случае аутентифицировать себя таким образом не получится, т.к. до успешного окончания процесса авторизации, т.е. когда используется устройство считывания отпечатков пальцев, невозможно расшифровать домашнюю директорию.

---

# 7.2 Управление биометрической аутентификации через YaST

***Процедура 7.1*** *Включение биометрической аутентификации*

Для использования биометрической аутентификации Вы должны настроить PAM. Как правило, это происходит автоматически во время установки системы, когда openSUSE обнаруживает поддерживаемый сканер. Если этого не произошло, Вы можете включить поддержку отпечатков пальцев в YaST следующим образом:

1. Запустите YaST и выберете *Оборудование* > *Распознавание отпечатков пальцев*.

2. В окне настроек, выберете *Использовать распознавание отпечатков пальцев* и нажмите*Готово* для сохранения настроек.

После этого Вы можете аутентифицировать себя с помощью сканера.

***Процедура 7.2*** *Регистрация отпечатков пальцев*

1. В YaST, нажмите *Безопасность и пользователи* > *Управление пользователями* для открытия окна *User and Group Administration*. В нем отображается список пользователей и групп в системе.

2. Выберете пользователя, для которого Вы хотите зарегистрировать отпечаток пальца и нажмите *Редактировать*.

3. Во вкладке *Plug-Ins*, выберете the fingerprint entry и нажмите *Launch* для открытия окна *Конфигурация отпечатков пальцев*.

4. YaST попросит пользователя сканировать отпечаток пальца до тех пор, пока не будет сделанно три четких снимка.


5 После того, как отпечатки были сняты, нажмите кнопку *Применить*, чтобы закрыть окно *Конфигурация отпечатков пальцев*.

6 Если Вы так же хотите использовать отпечатки пальцев для аутентификации при запуске YaST или YaST модулей, Вы должны настроить использование отпечатков для пользователя `root`.

Чтобы сделать это, установите фильтр *System Users* в окне *User and Group Administration*, и выберете пользователя `root`, а так же оставте 3 четких отпечатка пальца, как описанно выше.

7 После регистрации отпечатков пальцев для желаемого пользователя, нажмите *Finish*, чтобы закрыть диалоговое окно и сохранить изменения.

Как только отпечатки пальцев зарегистрированы, пользователь может выбрать метод аутентификации: или отпечаток пальца, или пароль, которые будут использоваться для доступа к программам, перечисленным в Раздел 7.1, «Программы, поддерживающие биометрическую аутентификацию» (стр. 114).

В настоящее время в YaST не реализована функция проверки или удаления существующих отпечатков пальцев. Если Вы все же хотите удалить их, просто удалите директорию `/home/login/.fprint` .

Для получения дополнительной технической информации см. `http://reactivated.net/fprint/` .

# Часть II. Локальная безопасность

# Конфигурация настроек безопасности с помощью YaST

8

Модуль *Центр Безопасности* YaST предназначен для изменения настроек openSUSE связанных с безопасностью системы. Этот модуль используется для настройки таких аспектов безопасности, как вход в систему, установка пароля, опции загрузки, создание пользователей и права доступа к файлам по умолчанию. Он запускается из Центра Управления YaST *Безопасность и Пользователи* > *Центр Безопасности*. После запуска *Центра Безопасности* активным является диалог *Обзор безопасности*, остальные диалоги настроек доступны в правой панели.

## 8.1 *Обзор безопасности*

*Обзор безопасности* отображает понятный список самых важных настроек безопасности Вашей системы. Статус безопасности каждого пункта списка очевиден. Зеленая галка соответствует безопасным значениям, в то время как красный крест говорит о том, что значение данного пункта списка не является безопасным. Нажав *Описание* Вы получите обзор настроек и информацию о том, как обезопасить систему. Для изменения настроек нажмите соответствующую ссылку в колонке Состояние. В зависимости от настройки доступны следующие значения:

*Включено/Выключено*
: Нажав на этот элемент Вы можете включить или отключить соответствующую опцию.

*Настроить*

Нажав на этот элемент Вы запустите соответствующий модуль YaST для изменения настроек. Вы вернетесь в диалог Обзор безопасности, как только модуль будет закрыт.

*Неизвестно*

Данный статус означает, что соответствующая служба не установлена. Он не является индикатором потенциальных проблем безопасности.

***Рисунок 8.1*** *YaST Local Security - Security Overview*


# 8.2 *Предопределенные настройки безопасности*

В openSUSE есть три предопределенных набора настроек безопасности. Эти наборы применяются ко всем настройкам модуля *Центр Безопасности*. Каждый из них может быть изменен по своему усмотрению используя диалоги в правой панели. Список наборов следующий:

*Домашняя рабочая станция*
: Этот набор настроек разработан для компьютера, который не является частью локальной сети и не подключен к Интернету. Соответствует состоянию с наименьшей безопасностью.

*Сетевая рабочая станция*
: Данная конфигурация используется для компьютера, подключенного к локальной сети либо Интернету.

*Сервер сети*
: Конфигурация разработана для компьютера предоставляющего сетевые сервисы: вебсервера, файлового сервера, DNS сервера и т.д. Соответствует наиболее безопасным значениям настроек.

*Пользовательские настройки*
: Если пункт *Пользовательские настройки* выбран при открытии диалога *Предопределенные настройки безопасности* это говорит о том, что значения одного из предустановленных наборов настроек были изменены. Самостоятельное переключение на этот пункт с любого другого не изменяет настроек безопасности - Вы должны изменять их с помощью диалога *Обзор безопасности*.

## 8.3 *Настройки пароля*

Одной из самых важных проблем безопасности являются легко подбираемые пароли. Средства диалога *Настройки пароля* предназначены для проверки безопасности используемых паролей.

*Проверять новые пароли*
: Если этот пункт активирован, пользователь получит предупреждение, при использовании в качестве пароля слова из словаря или имени собственного. Для ограничения минимальной длины пароля введите ее значение в поле *Минимальная приемлемая длина пароля* после активации *Проверять новые пароли*.

Число запоминаемых паролей
: Когда проверка возраста пароля активирована, эта настройка используется для сохранения заданного числа предыдущих паролей пользователя, предотвращая их повторное использование.

Метод шифрования пароля
: Алгоритм шифрования пароля. Значение по умолчанию (Blowfish) обычно не требует изменений.

Возраст пароля
: Проверка возраста пароля активируется путем указания минимального и максимального значений (в днях). Установовив минимальное значение больше `0` дней, вы можете запретить пользователю повторную немедленную смену пароля (и следующее за ней окончание времени жизни пароля). Для отключения проверки срока действия пароля используются значения `0` и `99999` соответственно.

Дней до предупреждения об истечении срока действия пароля
: Пользователь может заблаговременно получать предупреждение об истечении срока действия пароля. В этом поле указывается количество дней до истечения срока действия пароля, по достижении которого пользователь будет получать предупреждение о необходимости сменить пароль.

# 8.4 Настройки загрузки

Этот диалог устанавливает, кому из пользователей разрешено выключать компьютер через менеджер авторизации. Здесь также можно указать, как будет интерпретироваться Ctrl + Alt + Delete.

# 8.5 Настройки входа в систему

Диалог позволяет установить настройки безопасности, связанные со входом в систему:

Задержка после неправильной попытки входа
: Определяет задержку (в секундах) после неудачной попытки входа в систему. Рекомендуется установить данное значение для затруднения проникновения в систему путем перебора паролей. Поскольку эта настройка влияет на пользователей, допустивших ошибку при наборе пароля, не заставляйте их ждать повторной авторизации слишком долго.

Записывать успешные попытки входа
: При включении данной опции последняя удачная попытка авторизации будет сохраняться в файл `/var/log/lastlog` и отображаться при

последующем входе в систему. Эти данные также используются командой `finger`.

**ЗАМЕЧАНИЕ**

Внимание! Эта опция не влияет на журнал `/var/log/wtmp` , который содержит дату и время всех авторизаций и перезагрузок системы. Содержимое `/var/log/wtmp` отображается с помощью команды `last`.

Разрешить удаленный графический вход

Если включено, графический менеджер авторизации (например gdm или kdm) будет доступен из сети. Включение представляет потенциальную опасность для системы.

# 8.6 Добавление пользователя

Минимальные и максимальные значения идентификаторов групп и пользователей. Изменение значений по умолчанию требуется крайне редко.

# 8.7 Различные настройки

Здесь представлены настройки безопасности, не соответствующие остальным категориям:

Разрешения файлов

openSUSE предлагает три предустановленных уровня файловых привилегий для системных файлов. Эти наборы привилегий определяют, может ли обычный пользователь читать файлы журналов или запускать определенные программы. Уровень *Легкий* предназначен для системы с одним пользователем и позволяет, например, читать большинство системных файлов обычному пользователю. Полный список привилегий доступен в файле `/etc/permissions.easy` . Уровень *Безопасный* разработан для многопользовательских систем с доступом к сети. Подробное объяснение его настроек можно посмотреть в файле `/etc/permissions.secure` . Наиболее жестким является уровень *Параноидальный*, использовать который следует осторожно. Информацию об этом уровне можно получить из файла `/etc/permissions.paranoid` .

Пользователь, запускающий updatedb

Программа `updatedb` сканирует систему и создает базу данных размещения файлов, используемую командой `locate`. При запуске `updatedb` от пользователя nobody, в базу данных добавляются только файлы доступные на чтение всем пользователям. При запуске ее от пользователя `root`, в базу данных попадут практически все файлы (за исключение тех, к которым root не имеет доступа на чтение).

*Текущий каталог в пути root* / *Текущий каталог в пути обычных пользователей*

При запуске программы без указания полного пути к ее исполняемому файлу, система производит поиск этой программы по пути установленному переменной `$PATH`. По умолчанию в список директорий для поиска команды не входит текущая директория. Это необходимо для того, чтобы, например, при запуске команды `ls` запускалась программа `/bin/ls` , а не троян из `/` *`текущий каталог`*`/ls` . Для запуска программ из текущей директории к ее имени нужно добавить префикс `./` . При изменении этой опции текущая директория ( `.` ) будет добавлена в путь для поиска команды. Изменять значение по умолчанию для этих опций не рекомендуется.

*Разрешить магические клавиши SysRq*

Волшебная кнопка SysRq - это клавиатурное сочетание, позволяющее контролировать систему, даже если в ней произошел сбой. Для получения подробной информации обратитесь к файлу `/usr/src/linux/Documentation/sysrq.txt` (требуется установка пакета `kernel-source`).

# 9 PolicyKit

PolicyKit is an application framework that acts as a negotiator between the unprivileged user session and the privileged system context. Whenever a process from the user session tries to carry out an action in the system context, PolicyKit is queried. Based on its configuration—specified in a so-called «policy»—the answer could be «yes», «no», or « authentication needed». Unlike classical privilege authorization programs such as sudo, PolicyKit does not grant `root` permissions to an entire process, following the «least privilege» concept.

**ЗАМЕЧАНИЕ: Two `PolicyKit` Versions in Parallel**

At the moment, there are two PolicyKit versions available with openSUSE in parallel: the «old» `PolicyKit` and the «new» `polkit` version (polkit-1), which is a re-write of the old `PolicyKit` version. The following sections are basically documentation on the «old» `PolicyKit` version.

## 9.1 Available Policies and Supported Applications

At the moment, not all applications requiring privileges make use of PolicyKit. In the following the most important policies available on openSUSE® are listed.

PulseAudio

Set scheduling priorities for the PulseAudio daemon

smpppd

Controlling dial-up connections

CUPS

Add, remove, edit, enable or disable printers

Backup Manager

Modify schedule

GNOME

Modify system and mandatory values with GConf
Change the system time

libvirt

Manage and modify local virtualized systems

NetworkManager

Apply and modify connections

PolicyKit

Read and change privileges for other users
Modify defaults

PackageKit

Update and remove packages
Refresh repositories

System

Wake on LAN
Mount or unmount fixed, hotpluggable and encrypted devices
Eject and decrypt removable media
Enable or disable WLAN
Enable or disable Bluetooth
Device access
Stop, suspend, hibernate and restart the system
Undock a docking station

YaST

Register product
Change the system time and language

# 9.2 Authorization Types

Every time a PolicyKit-enabled process carries out a privileged operation, PolicyKit is asked whether this process is entitled to do so. The answer PolicyKit gives depends on the policy defined for this process. It can be «yes», «no», or «authentication needed». By default, a policy contains «implicit» privileges, which automatically apply to all users. It is also possible to specify «explicit» privileges which apply to a specific user.

## 9.2.1 Implicit Privileges

Implicit privileges can be defined for any, active, and inactive sessions. An active session is the one in which you are currently working. It becomes inactive when you switch to another console for example. When setting implicit privileges to «no», no user is authorized, whereas «yes» authorizes all users. However, in most cases it is useful to demand authentication.

A user can either authorize by authenticating as `root` or by authenticating as self. Both authentication methods exist in four variants:

Authentication
: The user always has to authenticate

One Shot Authentication
: The authentication is bound to the instance of the program currently running. Once the program is restarted, the user is required to authenticate again.

Keep Session Authentication
: The authentication dialog box offers a check button *Remember authorization for this session*. If checked, the authentication is valid until the user logs out.

Keep Indefinitely Authentication
: The authentication dialog box offers a check button *Remember authorization*. If checked, the user has to authenticate only once.

## 9.2.2 Explicit Privileges

Explicit privileges can be granted to specific users. They can either be granted without limitations, or, when using constraints, limited to an active session and/or a local console.

It is not only possible to grant privileges to a user, a user can also be blocked. Blocked users will not be able to carry out an action requiring authorization, even though the default implicit policy allows authorization by authentication.

# 9.3 Modifying and Setting Privileges

To modify implicit privileges or to set explicit ones, you can either use the graphical *System Policies* tool available in the Advanced tab of the KDE System Settings, use the command line tools shipped with PolicyKit, or modify the configuration files. While the GUI and the command line tools are a good solution for making temporary changes, editing the configuration files should be the preferred way to make permanent changes.

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**ЗАМЕЧАНИЕ: The graphical GNOME *Authorizations* tool**

The graphical *Authorizations* tool available with GNOME is for the old PolicyKit. Better use the above mentioned tools.

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## 9.3.1 Using the Command Line Tools

At the moment, there are two PolicyKit versions available in parallel with openSUSE: the «old» `PolicyKit` and the «new» `polkit` version (polkit-1), which is a re-write of the old `PolicyKit` version.

### `PolicyKit`

PolicyKit (`PolicyKit`) comes with two command line tools for changing implicit privileges and for assigning explicit privileges. Each existing policy has got a speaking, unique name with which it can be identified and which is used with the command line tools. List all available policies with the command `polkit-action`.

`polkit-action`
: List and modify implicit privileges. Using this command you can also reset all policies to the default value. When invoked with no parameters, the command `polkit-action` shows a list of all policies. See `man 1 polkit-action` for more information.

`polkit-auth`
: Inspect, grant, block and revoke explicit privileges. To print a list of explicit privileges for a specific user, use the command `polkit-auth --explicit-detail --user` *`USER`* where *`USER`* has to be replaced by a valid username. If the `--user` option is left out, privileges for the user executing the command are shown. See `man 1 polkit-auth` for more information.

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**ЗАМЕЧАНИЕ: Restrictions of `polkit-action` on openSUSE**

Using the option `--show-overrides`, `polkit-action` lists all policies that differ from the default values. With `--reset-defaults` *`action`* one can reset the privileges for a given action to the defaults. However, `polkit-action` always operates on the upstream defaults, so it is not possible to list or restore the defaults shipped with openSUSE. Refer to Раздел 9.3.3, «Restoring the Default Privileges» (стр. 132) for further information.

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Раздел 9.3.2, «Modifying Configuration Files» (стр. 129) and Раздел 9.3.3, «Restoring the Default Privileges» (стр. 132) apply for the «old» `PolicyKit` only.

### `polkit`

For more information about `polkit`, see `http://hal.freedesktop.org/docs/polkit/` .

## 9.3.2 Modifying Configuration Files

Adjusting privileges by modifying configuration files is useful when you want to deploy the same set of policies to different machines, for example to the computers of a specific team. It is possible to change implicit as well as explicit privileges by modifying configuration files.

## Modifying Configuration Files for Implicit Privileges

openSUSE ships with two sets of default authorizations located in `/etc/polkit-default-privs.standard` and `/etc/polkit-default-privs.restrictive`. The `.standard` file defines privileges suitable for most desktop systems. It is active by default. The `.restrictive` set of privileges is designed for machines administrated centrally. Activate it by setting `POLKIT_DEFAULT_PRIVS` to `restrictive` in `/etc/sysconfig/security` and run `set_polkit_default_privs` as `root` afterwards. Do not modify these two files.

In order to define your custom set of privileges, use `/etc/polkit-default-privs.local`. Privileges defined here will always take precedence over the ones defined in the other configuration files. To define a privilege, add a line for each policy with the following format:

*privilege_name any_session*:*inactive_session*:*active_session*

For a list of all privilege names available, run the command `polkit-action`. The following values are valid for the session parameters:

`yes`
: grant privilege

`no`
: block

`auth_self`
: user needs to authenticate with own password every time the privilege is requested

`auth_self_keep_session`
: user needs to authenticate with own password once per session, privilege is granted for the whole session

`auth_self_keep_always`
: user needs to authenticate with own password once, privilege is granted for the current and for future sessions

`auth_admin`
: user needs to authenticate with `root` password every time the privilege is requested

`auth_admin_keep_session`
: user needs to authenticate with `root` password once per session, privilege is granted for the whole session

`auth_admin_keep_always`
: user needs to authenticate with `root` password once, privilege is granted for the current and for future sessions

Run `set_polkit_default_privs` to activate your settings.

## Modifying Configuration Files for Explicit Privileges

Explicit privileges can be set in `/etc/PolicyKit/PolicyKit.conf` . This configuration file is written in XML using the PolicyKit DTD. The file that is shipped with openSUSE already contains the necessary headers and the root element `<config>`. Place your edits inside the `<config>` tags.

`match`
: Specify an action or a user. `match` knows two attributes, `user` and `action`, but only a single attribute is allowed. Use nested `match` statements to combine attributes. POSIX Extended Regular Expressions are allowed as attribute values.

  `user=`*`USER`*
  : Specify one or more login names. Separate multiple names by the «|» symbol.

  `action=`*`policy`*
  : Specify a policy by it's unique identifier. To get a list of all available policy identifiers use the command `polkit-action`.

`return`
: Specify the answer PolicyKit will return. Takes a single attribute, `result=`*`value`* with one of the values listed under «Modifying Configuration Files for Implicit Privileges» (стр. 130).

`define_admin_auth`
: Specify users or groups allowed to authorize with their own password where normally the `root` password would be required. Takes the attributes `user=`*`USER`* or `group=`*`GROUP`*, but only one may be used at a time. Multiple

attribute values must be separated by «|», Extended POSIX Regular Expressions are not supported. Applies to all policies when used at the top level, or to specific policies when used within `<match>` statements.

***Пример 9.1*** *An example /etc/PolicyKit/PolicyKit.conf file*

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE pkconfig PUBLIC "-//freedesktop//DTD PolicyKit Configuration 1.0//
EN"
"http://hal.freedesktop.org/releases/PolicyKit/1.0/config.dtd">❶
<config version="0.1">❷
  <match action="org.freedesktop.packagekit.system-update">❸
    <match user="tux">
      <return result="yes"/>
    </match>
  </match>
  <match action="org.freedesktop.policykit.*">❹
    <match user="tux|wilber">
      <return result="no"/>
    </match>
  </match>
  <define_admin_auth group="administrators"/>❺
</config>
```

❶ The first three lines of the config file are the XML header. These lines are already present in the template file, leave them untouched.

❷ The XML root element must always be present. The attribute `version` is mandatory, currently the only valid value is `0.1`. Already present in the template file.

❸ A statement granting the user tux the privilege to update packages via PackageKit without having to authorize.

❹ Withdraw privileges for all PolicyKit related policies from the users tux and wilber.

❺ This statement allows all members of the group `administrators` to authenticate with their own password whenever authentication with the `root` password would be required. Since this statement is not nested within constraining match statements, it applies to all policies.

## 9.3.3 Restoring the Default Privileges

Each application supporting PolicyKit comes with a default set of implicit policies defined by the application's developers, the so-called «upstream defaults». The

privileges defined by the upstream defaults are not necessarily the ones that are activated by default on openSUSE. openSUSE comes with a predefined set of privileges (see «Modifying Configuration Files for Implicit Privileges» (стр. 130) for more information) that is activated by default, overriding the upstream defaults.

Since the Authorization tool and the PolicyKit command line utilities always operate on the upstream defaults, openSUSE comes with the command-line tool `set_polkit_default_privs` that resets privileges to the values defined in `/etc/polkit-default-privs.*` . However, `set_polkit_default_privs` will only reset policies that are set to the upstream defaults. To reset all policies to the upstream defaults first and then apply the openSUSE defaults, run the following command:

```
rm -f /var/lib/PolicyKit-public/* && set_polkit_default_privs
```

**ВАЖНО: `/etc/polkit-default-privs.local`**

In order to apply the openSUSE defaults, make sure `/etc/polkit-default-privs.local` does not contain any overrides, otherwise these will be applied on top of the defaults when running `set_polkit_default_privs`.

# 9.4 For more information

PolicyKit: http://hal.freedesktop.org/docs/PolicyKit/
polkit: http://hal.freedesktop.org/docs/polkit/

# 10 Списки управления доступом в Linux

POSIX ACLs (access control lists - списки управления доступом) могут быть использованы как расширение традиционной концепции привилегий для объектов файловой системы. С помощью ACL привилегии могут быть установлены более гибко, чем при помощи традиционной концепции.

Термин *POSIX ACL* предполагает, что это настоящий стандарт POSIX (*portable operating system interface* переносимый интерфейс операционных систем). Соответствующие черновые стандарты POSIX 1003.1e и POSIX 1003.2c были исключены по ряду причин. Тем не менее, ACLs (в том виде, в котором они реализованы во многих системах, принадлежащих семейству UNIX) основаны на этих черновиках. Реализация ACL для файловой системы (описанная в этой главе) также следует этим двум стандартам.

## 10.1 Традиционные файловые привилегии

Вы можете найти подробную информацию о традиционных файловых привилегиях на Info странице пакета GNU Coreutils, секция *File permissions* (`info coreutils "File permissions"`). Существуют также дополнительные аттрибуты setuid, setgid, sticky bit.

## 10.1.1 Бит setuid

В некоторых ситуациях привилегии доступа могут быть слишком строгими. Поэтому в Linux существуют дополнительные настройки, позволяющие для определенного действия временно сменить идентификатор текущего пользователя или группы. Например, программа `passwd` обычно требует привилегий суперпользователя для доступа к файлу `/etc/passwd` . Этот файл содержит важную информацию, такую как домашние каталоги пользователей, идентификаторы пользователей и групп. Таким образом обычный пользователь не сможет изменить `passwd`, потому что предоставлять всем пользователям прямой доступ к этому файлу слишком опасно. Возможным решением этой проблемы является механизм *setuid*. setuid (set user ID - установка идентификатора пользователя) это специальный файловый аттрибут, который сообщает системе, что программу нужно выполнять используя определенный идентификатор пользователя. Рассмотрим команду `passwd`:

```
-rwsr-xr-x  1 root shadow 80036 2004-10-02 11:08 /usr/bin/passwd
```

Вы видите `s`, что указывает на установленный бит setuid для привилегий пользователя. Согласно ему, все пользователи, запускающие команду `passwd`, выполнят ее от пользователя `root`.

## 10.1.2 Бит setgid

Бит setuid применяется к пользователям. Однако существует аналогичное свойство для групп: бит *setgid*. Если этот бит установлен для программы, то программа будет использовать при работе идентификатор собственной группы, вне зависимости от того, какой пользователь ее запустил. В директории с установленным битом setgid, все вновь созданные поддиректории и файлы будут принадлежать к той же группе, к которой принадлежит директория. Рассмотрим следующую директорию:

```
drwxrws--- 2 tux archive 48 Nov 19 17:12  backup
```

Вы видите `s`, что указывает на установленный бит setgid для привилегий группы. Владелец директории и члены группы `archive` будут иметь доступ к этой директории. Пользователи, не принадлежащие к этой группе, «отразятся» на нее. Эффективным идентификатором группы для для всех записанных в директорию файлов будет `archive`. Например, программе резервного копирования, работающей с идентификатором группы `archive`, не понадобятся привилегии суперпользователя для доступа к этой директории.

### 10.1.3 Sticky Bit

Существует также *sticky bit*. Его поведение отличается для файлов и директорий. Если он установлен для исполняемого файла, то соответствующая программа не будет выгружаться из оперативной памяти, чтобы избежать повторной загрузки с жесткого диска. Поскольку современные жесткие диски достаточно производительны, используется это редко. Если этот бит установлен для директории, пользователи не смогут удалять из нее чужие файлы. Типичными примерами являются директории `/tmp` и `/var/tmp` :

```
drwxrwxrwt 2 root root 1160 2002-11-19 17:15 /tmp
```

## 10.2 Преимущества ACL

Традиционно в Linux для каждого файлового объекта задано три набора привилегий. Они включают в себя права на чтение (`r`), запись (`w`) и исполнение (`x`) для каждого из трех типов пользователей: владельца файла, группы, и остальных пользователей. Помимо этого можно установить *set user id*, *set group id* и *sticky* бит. Эта скудная концепция вполне применима в большинстве ситуаций. Однако для более сложных сценариев или передовых приложений системные администраторы должны были использовать обходные пути, чтобы преодолеть ограничения традиционной концепции привилегий.

ACL могут быть использованы как расширение традиционной концепции привилегий. Они позволяют предоставлять доступ индивидуальным пользователям или группам даже если те не являются владельцем или группой-владельцем. Списки управления доступом — это компонент ядра Linux, который в настоящее время поддерживается ReiserFS, Ext2, Ext3, JFS и XFS. С помощью ACL сложные сценарии могут быть реализованы без использования сложных моделей привилегий на уровне приложения.

Если Вы хотите заменить Windows сервер на Linux сервер, то преимущества ACL очевидны. Некоторые из подключенных рабочих машин могут работать под Windows даже после миграции. ОС Linux предоставляет службы печати и доступа к файлам клиентам Windows посредством Samba. Поскольку Samba поддерживает списки управления доступом, привилегии пользователя могут быть установлены используя графический интерфейс как на сервере Linux, так и в Windows (только для Windows NT и более поздних). С помощью части пакета Samba `winbindd`, возможно также назначить привилегии пользователям

существующим только в домене Windows и не имеющим аккаунта на сервере Linux.

# 10.3 Определения

Класс пользователя
: Стандартная концепция привилегий POSIX использует три *класса* пользователей для назначения привилегий файловой системы: владелец, группа-владелец и другие пользователи. Три бита привилегий могут быть установлены для каждого класса пользователей предоставляя доступ на чтение (`r`), запись (`w`) и выполнение (`x`).

ACL
: Привилегии пользователя и группы для всех видов объектов файловой системы (файлов и директорий) определяются посредством ACL.

Неявные ACL
: Неявные ACL могут применяться только к директориям. Они определяют привилегии, которые объект файловой системы наследует от родительской директории при создании.

Запись ACL
: Каждый список управления доступом состоит из набора записей ACL. Запись ACL содержит тип, описатель пользователя или группы, на который ссылается эта запись, и набор привилегий. Для некоторых типов записей описатель группы и пользователя не указывается.

# 10.4 Работа с ACL

Таблица 10.1, «Типы записей ACL» (стр. 139) отражает 6 существующих типов записей ACL, каждый из которых определяет привилегии пользователя или группы пользователей. Запись *владелец* определяет привилегии владельца файла или директории. Запись *группа-владелец* определяет привилегии группы, владеющей файлом. Суперпользователь может сменить владельца или группу-владельца при помощи команд `chown` и `chgrp`, в случае чего владелец и группа-владелец будут относиться к новому владельцу или группе-

владельцу. Каждая запись *именованный пользователь* определяет привилегии пользователя, указанного в поле "квалификатор" этой записи. Каждая запись *именованная группа* определяет привилегии группы, указанной в поле "квалификатор" этой записи. Поле "квалификатор" заполнено только для записей типа именованный пользователь и именованная группа. Запись *другие* определяет привилегии всех остальных пользователей.

Запись *маска* ограничивает привилегии именованного пользователя, именованной группы и группы-владельца определяя, какие разрешения этих записей применяться, а какие - маскироваться. Если право существует в одной из этих записей и в маске, то оно применяется. Права, содержащиеся только в маске или только в записи не применяются, и доступ в этом случае не будет разрешен. Права владельца и группы-владельца применяются всегда. Таблица 10.2, «Маскировка привилегий доступа» (стр. 140) демонстрирует этот механизм.

Существует два основных класса ACL: *минимальный* ACL — содержит записи типов «владелец», «группа-владелец» и «другие», соответствующие традиционным битам доступа для файлов и директорий. *Расширенный* ACL более продвинут. Он должен содержать маску и может включать в себя несколько записей для именованных пользователей и именованных групп.

***Таблица 10.1*** *Типы записей ACL*

| Тип | Текстовая форма |
|---|---|
| владелец | `user::rwx` |
| именованный пользователь | `user:name:rwx` |
| группа-владелец | `group::rwx` |
| именованная группа | `group:name:rwx` |
| маска | `mask::rwx` |
| другие | `other::rwx` |

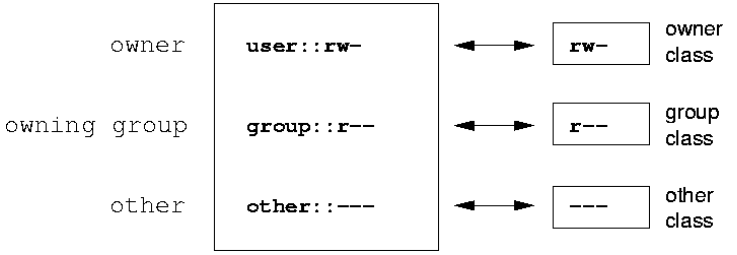
***Таблица 10.2*** *Маскировка привилегий доступа*

| Тип записи | Текстовая форма | Привилегии |
|---|---|---|
| именованный пользователь | `user:geeko:r-x` | `r-x` |
| маска | `mask::rw-` | `rw-` |
| | эффективные привилегии: | `r--` |

# 10.4.1 Записи ACL и биты доступа

Рисунок 10.1, «Минимальный ACL: Сравнение записей ACL с битами доступа» (стр. 140) и Рисунок 10.2, «Расширенный ACL: Сравнение записей ACL с битами доступа» (стр. 141) соответствуют минимальному и расширенному ACL. На рисунках изображены три блока: левый показывает тип спецификации записей ACL, центральный отображает пример ACL, и правый блок соответствует битам доступа традиционной концепции привилегий (отображаемым, например, командой `ls -l`). В обоих случаях привилегии класса *владелец* отображаются на запись ACL «владелец». Привилегии класса *другие* отображаются на соответствующую запись ACL. Однако отображение прав доступа класса *группа* отличается для каждого из случаев.

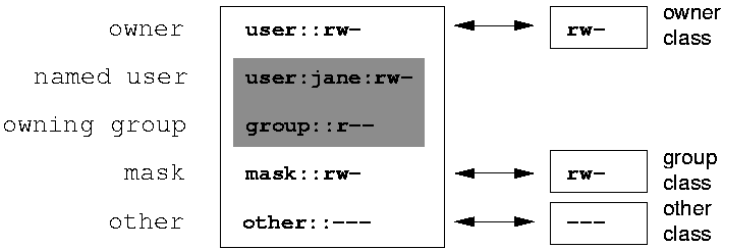
***Рисунок 10.1*** *Минимальный ACL: Сравнение записей ACL с битами доступа*




В случае минимального ACL — без маски — права доступа группы отражаются на запись ACL группа-владелец, как показывает Рисунок 10.1, «Минимальный ACL: Сравнение записей ACL с битами доступа» (стр. 140). В случае расширенного ACL— с маской — права доступа группы отображаются на маску,

Рисунок 10.2, «Расширенный ACL: Сравнение записей ACL с битами доступа» (стр. 141).

***Рисунок 10.2*** *Расширенный ACL: Сравнение записей ACL с битами доступа*




Это отображение используется для упрощения взаимодействия с приложениями, избавляя от небходимости поддержки ACL приложением. Привилегии доступа, назначенные посредством битов доступа, задают верхний предел для всех «тонких настроек», сделанных при помощи ACL. Изменение битов доступа отражается на ACL и наоборот.

## 10.4.2 Директория с ACL

Вы можете получить доступ к ACL с помощью команд `getfacl` и `setfacl`. Использование этих команд показано в следующем примере.

Перед созданием директории используйте команду `umask`, чтобы задать биты доступа маскируемые при создании файлового объекта. Команда `umask 027` устанавливает привилегии по умолчанию следующим образом: владелец получает полный доступ (`0`), группе запрещен доступ на запись (`2`), доступ остальным пользователям закрыт (`7`). В действительности `umask` маскирует соответствующие биты доступа или сбрасывает их. Подробности можно узнать на man странице `umask`.

`mkdir mydir` создает директорию `mydir` с привилегиями, установленными командой `umask`. С помощью `ls -dl mydir` можно определить правильность установки привилегий. Для данного примера вывод будет следующим:

```
drwxr-x--- ... tux project3 ... mydir
```

Используя `getfacl mydir`, проверьте исходное состояние ACL. Будет отображена следующая информация:

```
# file: mydir
# owner: tux
# group: project3
```

```
user::rwx
group::r-x
other::---
```

Первые три строки вывода отображают имя, владельца и группу-владельца директории. Следующие три строки содержат три записи ACL: «владелец», «группа-владелец» и «другие». Фактически мы имеет дело с минимальным ACL и команда `getfacl` не дает дополнительной информации по сравнению с командой `ls`.

Измените ACL, разрешив доступ на чтение, запись и выполнение пользователю `geeko` и группе `mascots` командой:

```
setfacl -m user:geeko:rwx,group:mascots:rwx mydir
```

Опция `-m` указывает `setfacl` изменить существующий ACL. Следующий за ней аргумент определяет записи ACL, которые будут изменены (можно указать несколько записей, разделяя из запятыми). Последняя часть определяет имя директории, к которой будут применены эти изменения. Используйте команду `getfacl`, чтобы узнать полученные ACL.

```
# file: mydir
# owner: tux
# group: project3
user::rwx
user:geeko:rwx
group::r-x
group:mascots:rwx
mask::rwx
other::---
```

В дополнение к записям, созданным для пользователя `geeko` и группы `mascots`, была добавлена запись с маской. Эта запись была создана автоматически, таким образом, что все заданные права доступа будут применены. `setfacl` автоматически адаптирует существующие записи с масками к изменяемым битам. Это поведение можно изменить используя опцию `-n`. Маска определяет максимальные эффективные привилегии для класса «группа», включая именованного пользователя, именованную группу и группу-владельца. Биты доступа класса «группа», отображаемые командой `ls`, `-dl mydir` теперь соответствуют записи `маска`.

```
drwxrwx---+ ... tux project3 ... mydir
```

Первый столбец вывода теперь содержит дополнительно знак `+`, указывая на существование *расширенных* ACL для этого элемента.

Согласно выводу команды `ls`, маска включает в себя доступ на запись. Традиционно эти биты означали бы, что группа-владелец (`project3`) также

имеет право на запись в директорию `mydir`. Однако эффективные права доступа соответствуют сочетанию прав заданных для группы-владельца и маски — `r-x` в нашем примере (Таблица 10.2, «Маскировка привилегий доступа» (стр. 140)). Поэтому в отношении эффективных привилегий группы-владельца, даже после добавления дополнительных записей ACL, ничего не изменилось.

Измените значение маски с помощью команд `setfacl` или `chmod`. Например используйте `chmod g-w mydir`. `ls -dl mydir` покажет:

```
drwxr-x---+ ... tux project3 ... mydir
```

`getfacl mydir` даст следующий вывод:

```
# file: mydir
# owner: tux
# group: project3
user::rwx
user:geeko:rwx          # effective: r-x
group::r-x
group:mascots:rwx       # effective: r-x
mask::r-x
other::---
```

После сброса бита доступа на запись для группы командой `chmod`, вывода команды `ls` достаточно, чтобы увидеть, что биты маски изменились: доступ на запись снова есть только у владельца `mydir`. Вывод `getfacl` подтверждает это. Он включает в себя комментарий для всех записей, в которых биты доступа не соответствуют реальным привилегиям из-за применения маски. Оригинальные права могут быть восстановлены в любое время командой `chmod g+w mydir`.

# 10.4.3 Директория с ACL по умолчанию

Директории могут иметь ACL по умолчанию, которые являются специальной разновидностью ACL, определяющей права доступа, наследуемые объектами в этой директории при их создании. ACL по умолчанию влияет на поддиректории и файлы.

## Действия ACL по умолчанию

Существует два пути передачи ACL по умолчанию файлам и поддиректориям:

- Поддиректория наследует ACL родительской директории как свои ACL по умолчанию и обычные ACL.

- Файл наследует ACL по умолчанию как свои ACL.

Все системные вызовы, создающие объекты файловой системы, используют параметр `режим`, который определяет режим доступа к созданному объекту. Если родительская директория не имеет ACL по умолчанию, заданные `umask` биты доступа вычитаются из битов доступа параметра `режим`, а результат устанавливается созданному объекту. Если же ACL по умолчанию задан, биты доступа нового объекта соответствуют совпадающим частям параметра `режим` и разрешениям ACL по умолчанию. В этом случае `umask` не учитывается.

## Применение ACL по умолчанию

Следующие три примера показывают основные операции для директорий и ACL по умолчанию:

1. Добавить ACL по умолчанию существующей директории `mydir`:

   ```
   setfacl -d -m group:mascots:r-x mydir
   ```

   Опция `-d` команды `setfacl` указывает `setfacl` выполнить изменения (опция `-m`) для ACL по умолчанию.

   Взглянем поближе на результат выполнения этой команды:

   ```
   getfacl mydir

   # file: mydir
   # owner: tux
   # group: project3
   user::rwx
   user:geeko:rwx
   group::r-x
   group:mascots:rwx
   mask::rwx
   other::---
   default:user::rwx
   default:group::r-x
   default:group:mascots:r-x
   default:mask::r-x
   default:other::---
   ```

   `getfacl` возвращает как ACL, так и ACL по умолчанию. ACL по умолчанию соответствуют строкам, начинающимся с `default`. Несмотря на то, что Вы передали команде `setfacl` только запись ACL по умолчанию для группы `mascots`, `setfacl` автоматически скопировала все остальные записи из ACL, чтобы создать валидный ACL по умолчанию. ACL по умолчанию не

оказывает моментального влияния на доступ к объекту. Они вступают в игру при создании новых объектов. Эти новые объекты наследуют привилегии только от ACL по умолчанию своей родительской директории.

2. В следующем примере используйте команду `mkdir`, чтобы создать в `mydir` поддиректорию, которая унаследует ACL по умолчанию.

```
mkdir mydir/mysubdir

getfacl mydir/mysubdir

# file: mydir/mysubdir
# owner: tux
# group: project3
user::rwx
group::r-x
group:mascots:r-x
mask::r-x
other::---
default:user::rwx
default:group::r-x
default:group:mascots:r-x
default:mask::r-x
default:other::---
```

Как и ожидалось, вновь созданная директория `mysubdir` получила права доступа из ACL по умолчанию родительской директории. ACL директории `mysubdir` является точным отражением ACL по умолчанию директории `mydir`. Поддиректория передаст эти права вложенным в нее объектам и т.д.

3. Используйте `touch` для создания файла в директории `mydir`, например, `touch mydir/myfile`. `ls -l mydir/myfile` покажет:

```
-rw-r-----+ ... tux project3 ... mydir/myfile
```

Вывод `getfacl mydir/myfile`:

```
# file: mydir/myfile
# owner: tux
# group: project3
user::rw-
group::r-x          # effective:r--
group:mascots:r-x   # effective:r--
mask::r--
other::---
```

Если ACL по умолчанию и `umask` не накладывают никаких ограничений, `touch` при создании новых файлов использует `режим` со значением `0666`, создавая файлы с доступом на чтение и запись для всех («Действия ACL по

умолчанию» (стр. 143)). Также это означает, что все права доступа, которые не содержит значение `режим` будут удалены из соответствующих записей ACL. Несмотря на то, что записи для группы не были удалены из ACL, значение маски было модифицировано для маскировки прав не заданных значением `режим`.

Эта модель необходима для правильного взаимодействия приложений (например, компиляторов) с ACL. Вы можете создавать файлы с ограниченным доступом и затем помечать их как исполняемые. Механизм `mask` гарантирует, что нужные пользователи и группы смогут запускать их как им заблагорассудится.

## 10.4.4 Алгоритм проверки ACL

Алгоритм проверки применяется перед тем, как любому процессу или приложению будет предоставлен доступ к защищенному ACL объекту файловой системы. Основное правило проверки заключается в том, что записи ACL проверяются в следующем порядке: владелец, именованный пользователь, группа-владелец или именованная группа, другие пользователи. Доступ предоставляется в соответствии с записью, которая более подходит процессу. Привилегии не накапливаются.

Все усложняется, если процесс принадлежит более чем к одной группе и потенциально соответствует нескольким групповым записям. В этом случае из множества выбирается произвольная запись с требуемыми привилегиями. Неважно, какая из записей приведет к результату «доступ разрешен». Аналогично, если ни одна из групповых записей не содержит требуемых привилегий, случайно выбранная запись приведет к конечному результату «доступ запрещен».

# 10.5 Поддержка ACL приложениями

ACL могут быть использованы для реализации очень сложных моделей привилегий, которые соответствуют требованиям современных приложений. Традиционная система привилегий и ACL могут эффективно сочетаться.

Основные файловые команды (`cp`, `mv`, `ls`, и т.д.) поддерживают ACL, равно как Samba и Konqueror.

К сожалению множество редакторов и файловых менеджеров до сих пор не поддерживает ACL. Например, копирование файлов с помощью Emacs приводит к потере ACL. При изменении файлов в редакторе ACL иногда сохраняются, а иногда нет, в зависимости от того способа, которым редактор создает резервные копии. Если редактор записывает изменения в оригинальный файл, ACL сохраняются. Если измененное содержание сохраняется в новый файл, который впоследствии получает имя оригинального файла и редактор не поддерживает ACL, они могут быть потеряны. За исключением архиватора star в настоящее время не существует программ резервного копирования, сохраняющих ACL.

# 10.6 Дополнительная информация

За подробной информацией об ACL обращайтесь в справку по командам `getfacl(1)`, `acl(5)` и `setfacl(1)`.

# 11 Шифрование файлов и разделов

Большинство пользователей имеет на своих компьютерах конфиденциальные данные, доступ к которым должен быть закрыт для третьих лиц. Чем больше Вы полагаетесь на переносные компьютеры и работу в различном окружении и разных сетях, тем более осторожным Вам следует быть со своими данными. При наличии сетевого или физического доступа к Вашей системе посторонних лиц рекомендуется шифровать файлы или целые дисковые разделы. Ноутбуки или носители информации, такие как внешние жесткие диски или USB-накопители, могут быть потеряны или украдены. Поэтому рекомендуется шифровать часть файловой системы, хранящую конфиденциальные данные.

Существует несколько способов защиты данных при помощи шифрования:

Шифрование раздела жесткого диска
: Вы можете создать зашифрованный раздел во время инсталляции или на уже установленной системе при помощи YaST. Более подробная информация содержится в Раздел 11.1.1, «Создание зашифрованного раздела во время инсталляции» (стр. 151) и Раздел 11.1.2, «Создание зашифрованного раздела на работающей системе» (стр. 152). Этот же способ может быть использован для сменных накопителей, таких как внешние жесткие диски, как описано в Раздел 11.1.4, «Шифрование содержимого съемных носителей» (стр. 153).

Создание зашифрованного файла в качестве контейнера
: Вы можете создать зашифрованный файл на своем жестком диске или сменном накопителе при помощи YaST. Этот файл может быть использован для того, чтобы *хранить* другие файлы и каталоги. За дополнительной

информацией обратитесь к Раздел 11.1.3, «Создание зашифрованного файла в качестве контейнера» (стр. 152).

Шифрование домашних каталогов
: С помощью openSUSE Вы также можете создавать зашифрованные домашние директории пользователей. Когда пользователь входит в систему, зашифрованная домашняя директория монтируется, и ее содержимое становится доступно пользователю. За подробной информацией обратитесь к Раздел 11.2, «Использование зашифрованных домашних директорий » (стр. 154)

Шифрование отдельных текстовых файлов ASCII
: Если вся Ваша конфиденциальная информация хранится в нескольких текстовых файлах ASCII, Вы можете зашифровать их отдельно и защитить паролем используя Kgpg или редактор vi. За дальнейшей информацией обратитесь к Раздел 11.3, «Использование vi для шифрования отдельных текстовых ASCII файлов» (стр. 155) .

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**ВНИМАНИЕ: Зашифрованный носитель предлагает ограниченную защиту**

Описанные в этой главе методы предлагают только ограниченную защиту. Вы не можете защитить запущенную систему от взлома. После того, как зашифрованный носитель был благополучно смонтирован, любой пользователь с соответствующими привилегиями будет иметь к нему доступ. Однако зашифрованный носитель будет полезен в случае потери или кражи Вашего компьютера или для предотвращения чтения Ваших конфиденциальных данных третьими лицами.

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# 11.1 Создание зашифрованной файловой системы при помощи YaST

YaST можно использовать для шифрования разделов или частей Вашей файловой системы как во время инсталляции, так и на уже установленной системе. Однако шифрование раздела уже установленной системы более трудоемко, поскольку оно требует внесения изменений в таблицу разделов.

В этом случае более целесообразным может быть создание зашифрованного файла определенной области, которая будет использована для *хранения* других файлов или частей Вашей файловой системы. Чтобы зашифровать целый раздел, выделите в таблице разделов раздел для шифрования. Разметка, предлагаемая YaST по умолчанию, не содержит зашифрованых разделов. Добавьте их вручную в диалоге разметки диска.

## 11.1.1 Создание зашифрованного раздела во время инсталляции

**ВНИМАНИЕ: Ввввод пароля**

Убедитесь, что Вы хорошо запомнили пароль для зашифрованного раздела. Без этого пароля Вы не сможете ни получить доступ, ни восстановить зашифрованные данные.

Диалог YaST Разметка предоставляет возможность создания зашифрованного раздела. Чтобы создать новый зашифрованный раздел:

1. Запустите модуль YaST Разметка *Компьютер* > *Система* > *Разметка*.
2. Выберите жесткий диск, нажмите *Добавить* и выберите первичный или расширеный раздел.
3. Выберите размер раздела или область для использования на диске.
4. Выберите файловую систему и точку монтирования раздела.
5. Отметьте *Шифровать устройство*.

**ЗАМЕЧАНИЕ: Требуется дополнительное программное обеспечение**

После выбора *Шифровать устройство*, возможно появление всплывающего окна, запрашивающего установку дополнительного програмного обеспечения. Подтвердите установку всех требуемых пакетов если хотите, чтобы зашифрованный раздел был работоспособен.

6 Нажмите *Далее* и введите пароль, который будет использоваться для шифрования раздела. Он не будет отображаться на экране, поэтому во избежание ошибок его нужно будет ввести дважды.

7 Завершите процесс нажав *Завершить*, после чего будет создан новый зашифрованный раздел.

Когда Вам понадобится смонтировать зашифрованный раздел, откройте файловый менеджер и во вкладке, отображающей общие места Вашей файловой системы, выберите запись с разделом. У Вас будет запрошен пароль, после чего раздел будет смонтирован.

При инсталляции системы на компьютер с уже существующими разделами Вы можете зашифровать существующий раздел. В этом случае следуйте описанию в Раздел 11.1.2, «Создание зашифрованного раздела на работающей системе» (стр. 152) и имейте в виду, что все существующие данные будут уничтожены во время этой операции.

## 11.1.2 Создание зашифрованного раздела на работающей системе

**ВНИМАНИЕ: Активация шифрования на работающей системе**

Возможно также создать зашифрованный раздел на работающей системе. Однако шифрование существующего раздела уничтожит все данные на нем, а также потребует изменения размеров и структуры существующих разделов.

На запущенной системе выберите *Система* > *Разметка* в Центре управления YaST. Нажмите *Да* чтобы продолжить. В *Экспертной разметке* выберите раздел для шифрования и нажмите *Редактировать*. Остальная процедура сходна с описанной в Раздел 11.1.1, «Создание зашифрованного раздела во время инсталляции» (стр. 151).

## 11.1.3 Создание зашифрованного файла в качестве контейнера

Вместо использования раздела можно создать зашифрованный файл, который будет содержать в себе другие файлы и каталоги с конфиденциальными данными. Такие контейнерные файлы создаются из диалога Экспертная разметка YaST. Выберите *Шифрованные файлы* > *Добавить шифрованный файл* и введите полный путь к файлу и его размер. Если YaST должен создать контейнерный файл, активируйте опцию *Создать петлевой файл*. Подтвердите или измените предлагаемые настройки форматирования и тип файловой системы. Укажите точку монтирования и убедитесь, что опция *Зашифровать устройство* выбрана.

Нажмите *Далее*, введите пароль для дешифрования файла и примените изменения нажав *Завершить*.

Преимущество зашифрованных файлов-контейнеров над разделами заключается в том, что они могут быть добавлены без изменения разметки жесткого диска. Они монтируются при помощи петлевого устройства и ведут себя как обычные разделы.

## 11.1.4 Шифрование содержимого съемных носителей

YaST относится к съемному носителю (такому, как жесткий диск или USB flash) так же, как любому жесткому диску. Файлы-контейнеры или разделы на таких устройствах могут быть зашифрованы по инструкции выше. Однако не разрешайте им монтирование во время загрузки, поскольку съемные носители обычно подключаются к уже запущенной системе

Если съемное устройство было зашифровано при помощи YaST, среды KDE и GNOME автоматически распознают зашифрованный раздел и запросят пароль при обнаружении устройства. Если Вы подключите съемное устройство отформатированное в FAT при запущенном KDE или GNOME, пользователь после ввода пароля автоматически станет владельцем устройства и сможет читать и записывать файлы. Для других файловых систем необходимо явно указать владельца отличного от `root`, чтобы разрешить этим пользователям чтение или запись файлов на устройство.

# 11.2 Использование зашифрованных домашних директорий

Для защиты данных в домашних директориях от кражи и последующего несанкционированного доступа, используйте модуль YaST Управление пользователями, чтобы разрешить шифрование домашних директорий. Вы можете создавать зашифрованные домашние директории для новых и существующих пользователей. Для шифрования или дешифрования домашних директорий уже существующих пользователей Вы должны знать их пароли. Раздел “Managing Encrypted Home Directories” (Глава 9, *Managing Users with YaST*, ↑Reference) подробно описывает эту процедуру.

Зашифрованные домашние разделы создаются внутри файла-контейнера как описано в Раздел 11.1.3, «Создание зашифрованного файла в качестве контейнера» (стр. 152). В директории `/home` создается два файла для каждой зашифрованной домашней директории:

*`LOGIN`*`.img`
: Содержащий директорию образ

*`LOGIN`*`.key`
: Ключ к образу защищенный паролем пользователя.

При входе в систему домашняя директория дешифруется автоматически. Для этого используется модуль pam называемый *pam_mount*. Если Вам надо добавить дополнительный метод входа в систему, который обеспечивает зашифрованные домашние директории, добавьте этот модуль в соответствующий конфигурационный файл `/etc/pam.d/` . За подробностями обратитесь в Глава 2, *Authentication with PAM* (стр. 17) и man странице `pam_mount`.

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**ВНИМАНИЕ: Ограничения безопасности**

Шифрование домашней директории пользователя не обеспечивает высокого уровня защиты от других пользователей. Его можно добиться только не разделяя систему с другими пользователями физически.

Для усиления безопасности Вы можете также зашифровать `swap` раздел, а также директории `/tmp` и `/var/tmp` , поскольку они могут

содержать временные образы или критические данные. Зашифровать `swap`, `/tmp` и `/var/tmp` при помощи модуля Разметка YaST как описано в Раздел 11.1.1, «Создание зашифрованного раздела во время инсталляции» (стр. 151) или Раздел 11.1.3, «Создание зашифрованного файла в качестве контейнера» (стр. 152).

# 11.3 Использование vi для шифрования отдельных текстовых ASCII файлов

Недостаток использования зашифрованных разделов очевиден: когда раздел смотирован по крайней мере `root` будет также иметь доступ к данным в этом разделе. Для предотвращения этого можно использовать vi в режиме шифрования.

Чтобы отредактировать новый файл используйте команду `vi -x` *`filename`*. vi предложит Вам установить пароль, после чего он зашифрует содержимое файла. Откуда бы Вы не запросили доступ к этому файлу vi будет запрашивать пароль для доступа.

Для еще большей безопасности Вы можете разместить зашифрованный файл на зашифрованном разделе. Это рекомендуется поскольку шифрование используемое в vi не слишком устойчиво.

# 12 Обнаружение вторжений при помощи AIDE

Защита системы - обязательная задача для любого ответственного системного администратора. Поскольку невозможно гарантировать, что система не подвергнется взлому, очень важно производить дополнительные проверки регулярно (например по крону), чтобы убедиться в том, что система до сих пор под Вашим контролем. Для этого удобно использовать AIDE *Advanced Intrusion Detection Environment - усовершенствованную среду обнаружения вторжений*.

## 12.1 Для чего нужна AIDE?

Простая проверка, которая часто помогает обнаружить нежелательные изменения, может быть произведена с помощью RPM. В пакетном менеджере есть встроенная функция проверки изменений в файлах системы. Для проверки всех файлов, выполните команду `rpm -Va`. Однако эта команда также отобразит изменения в файлах конфигурации и Вам придется произвести фильтрацию, чтобы определить только важные изменения.

Еще одна проблема с RPM заключается, в том, что умный взломщик может подменить `rpm`, чтобы замаскировать все изменения. Это может быть сделано при помощи руткита, который позволит взломщику скрыть вторжение и получить привилегии суперпользователя. Поэтому Вы должны реализовать еще одну проверку, которую можно производить независимо от установленной системы.

# 12.2 Установка базы данных AIDE

**ВАЖНО: Инициализируйте базу данных AIDE после установки**

Перед тем, как вы установите систему проверьте контрольную сумму носителя («Checking Media» (Приложение A, *Помощь и решение проблем*, ↑Вступление)), чтобы убедиться в его подлинности. После установки системы, инициализируйте базу данных AIDE. Чтобы удостовериться, что все прошло успешно во время и после инсталляции, произведите инсталляцию прямо из консоли, на компьютер не подключенный к сети. Не оставляйте компьютер без присмотра и не подключайте его к сети пока до того, до создания базы данных AIDE.

AIDE по умолчанию не установлена на openSUSE. Для установки используйте *Компьютер* > *Установка программ*, или введите `zypper install aide` в командной строке от `root`.

Чтобы указать AIDE какие атрибуты каких файлов должны проверяться, используйте конфигурационный файл `/etc/aide.conf` . Он должен быть изменен, чтобы вступить в силу. Первая секция управляет общими параметрами, такими как размещение файла базы данных AIDE. К локальным настройкам относятся секции `Custom Rules` и `Directories and Files`. Типичное правило выглядит следующим образом:

```
Binlib      = p+i+n+u+g+s+b+m+c+md5+sha1
```

После определения переменной `Binlib`, соответствующие опции проверки используются в секции файлов. Важными настройками являются следующие:

***Таблица 12.1*** *Важные настройки проверок AIDE*

| Опция | Описание |
|---|---|
| p | Проверяет пермиссии выбранных файлов и директорий. |
| i | Проверяет номер файлового дескриптора (inode). Каждому имени файла соответствует уникальный |

| Опция | Описание |
|---|---|
| | номер дескриптора, который не должен изменяться. |
| n | Проверяет число ссылок на соответствующий файл. |
| u | Проверяет, изменился ли владелец файла. |
| g | Проверяет, изменилась ли группа файла. |
| s | Проверяет, изменился ли размер файла. |
| b | Проверяет, изменилось ли число используемых файлом блоков. |
| m | Проверяет, изменилось ли время модификации файла. |
| c | Проверяет, изменилось ли время последнего доступа к файлу. |
| md5 | Проверяет, изменилась ли у файла контрольная сумма md5. |
| sha1 | Проверяет, изменилась ли у файла контрольная сумма sha1 (160 бит). |

Вот конфигурация, проверяющая все файлы в директории `/sbin` с опциями заданными в `Binlib` за исключением директории `/sbin/conf.d/` :

```
/sbin  Binlib
!/sbin/conf.d
```

Для создания базы данных AIDE выполните следующие действия:

**1** Откройте `/etc/aide.conf` .

2 Укажите файлы, которые необходимо проверять и настройки проверки. За подробным списком настроек обратитесь к `/usr/share/doc/packages/aide/manual.html` . Определение файлов требует некоторых знаний о регулярных выражениях. Сохраните Ваши изменения.

3 Чтобы проверить правильность конфигурационного файла, выполните:

```
aide --config-check
```

Любой вывод, произведенный этой командой, является подсказкой об ошибках в конфигурации. Например вы можете увидеть следующее:

```
aide --config-check
35:syntax error:!
35:Error while reading configuration:!
Configuration error
```

The error is to be expected in line 36 of `/etc/aide.conf` . Обратите внимание, что сообщение об ошибке содержит последнюю успешно считанную строку конфигурационного файла.

4 Инициализируйте базу данных AIDE. Выполните команду:

```
aide -i
```

5 Скопируйте созданную базу в безопасное место, например CD-R или DVD-R, удаленный сервер или USB диск для последующего использования.

---

**ВАЖНО:**

Этот шаг важен, поскольку помогает избежать подделки базы данных. Чтобы предотвратить изменение базы данных, рекомендуется использовать носитель, который может быть записан только один раз. *Никогда* не оставляйте ее на компьютере, за которым Вы хотите наблюдать.

---

# 12.3 Локальные проверки AIDE

Чтобы проверить файловую систему, выполните следующие шаги:

1 Переименуйте базу данных:

```
mv /var/lib/aide/aide.db.new /var/lib/aide/aide.db
```

2 После любых изменений конфигурации вы всегда должны переинициализировать базу данных AIDE перенести вновь созданную базу данных. Создание резервной копии базы также хорошая идея. Подробнее об этом рассказывает Раздел 12.2, «Установка базы данных AIDE» (стр. 158).

3 Выполните проверку при помощи следующей команды:

```
aide --check
```

Если вывод пуст - все хорошо. Если AIDE найдет изменения, будет отображает сводный отчет изменений, например:

```
aide --check
AIDE found differences between database and filesystem!!

Summary:
  Total number of files:        1992
  Added files:                  0
  Removed files:                0
  Changed files:                1
```

Чтобы подробнее узнать об изменениях, смените уровень детализации проверки с помощью параметра `-V`. Для предыдущего примера, результат может выглядеть следующим образом:

```
aide --check -V
AIDE found differences between database and filesystem!!
Start timestamp: 2009-02-18 15:14:10

Summary:
  Total number of files:        1992
  Added files:                  0
  Removed files:                0
  Changed files:                1


---------------------------------------------------
Changed files:
---------------------------------------------------

changed: /etc/passwd

---------------------------------------------------
Detailed information about changes:
---------------------------------------------------


File: /etc/passwd
  Mtime    : 2009-02-18 15:11:02              , 2009-02-18 15:11:47
  Ctime    : 2009-02-18 15:11:02              , 2009-02-18 15:11:47
```

В этом примере мы обработали файл `/etc/passwd` командой `touch`.

# 12.4 Проверка из независимой системы

Для ответственных администраторов (которыми мы все являемся) рекомендуется запуск бинарного файла AIDE из доверенного источника. Это исключает возможность модификации файла AIDE взломщиком для скрытия следов проникновения в систему.

Для этого AIDE должен быть запущен в системе, независимой от установленной системы. При помощи openSUSE относительно легко добавить в Систему восстановления произвольные программы для достижения требуемого функционала.

Перед началом использования Системы восстановления Вы должны предоставить системе два пакета. Они включаются в нее точно также, как диск обновления драйверов. За подробным описанием возможностей linuxrc используемых для этих целей обратитесь к `http://en.opensuse.org/SDB:Linuxrc` . Далее будет описан один из возможных способов.

***Процедура 12.1*** *Запуск Системы восстановления с AIDE*

1. Укажите FTP сервер в качестве второго компьютера.

2. Скопируйте пакеты `aide` и `mhash` в директорию FTP сервера, в нашем случае `/srv/ftp/` . Замените *`ARCH`* и *`VERSION`* на Ваши значения:

   ```
   cp DVD1/suse/ARCH/aideVERSION.ARCH.rpm /srv/ftp
   cp DVD1/suse/ARCH/mhashVERSION.ARCH.rpm /srv/ftp
   ```

3. Создайте файл `/srv/ftp/info.txt` , содержащий параметры загрузки Системы восстановления:

   ```
   dud:ftp://ftp.example.com/aideVERSION.ARCH.rpm
   dud:ftp://ftp.example.com/mhashVERSION.ARCH.rpm
   ```

   Замените имя домена FTP, *`VERSION`* и *`ARCH`* значениями, используемыми на Вашей системе.

4. Перезапустите сервер, который необходимо проверить при помощи AIDE используя Восстановление системы Вашего DVD. Добавьте следующую строку в параметры загрузки:

```
info=ftp://ftp.example.com/info.txt
```

Этот параметр указывает linuxrc считать всю информацию из файла `info.txt` .

После загрузки Системы восстановления программа AIDE готова к использованию.

# 12.5 Для дальнейшей информации

Информация об AIDE доступна:

- Домашняя страница AIDE http://aide.sourceforge.net .
- В документированном образце конфигурации `/etc/aide.conf` .
- В нескольких файлах, перечисленных ниже `/usr/share/doc/packages/aide` после установки пакета `aide`.
- В рассылке новостей AIDE https://mailman.cs.tut.fi/mailman/listinfo/aide .

# Часть III. Сетевая безопасность

# 13 SSH: Безопасная работа в сети

Часто бывает необходимо получить доступ к компьютеру удаленно. Если пользователь отправляет логин и пароль в виде обычного текста, они могут быть перехваченны и использованны злоумышеленником для того, чтобы получить доступ к удаленной системе от именни этого пользователя. Это откроет доступ нападавшему ко всем файлам пользователя, так же может быть использован для попытки получения `root` привилегий или попытки проникновения на другую систему. В прошлом для удаленных соединений использовалась программа telnet, которая не шифрует передаваемый траффик и не предпринимает ничего для предотвращения прослушивания. Есть и другие незащищенные каналы связи, создаваемые, например, при использовании FTP или других программ для копирования через сеть.

Комплект программ SSH обеспечивает необходимую защиту, шифруя передаваемый траффик, включая логин и пароль. При использовании SSH данные все же могут быть перехвачены, но без ключа, использующегося для шифрования, их невозможно будет расшифровать. Таким образом SSH обеспечивает безопасное соединение в небезопасной сети, такой как интернет. Комплект программ SSH доступен в openSUSE в пакете OpenSSH.

## 13.1 Пакет OpenSSH

В openSUSE пакет OpenSSH установлен по умолчанию. Программы `ssh`, `scp`, и `sftp` предоставляют альтернативу `telnet`, `rlogin`, `rsh`, `rcp` и `ftp`. В конфигурации по умолчанию доступ к openSUSE возможен только с помощью

служебных программ из комплекта OpenSSH, и только если запущен `sshd` и открыты соответствующие порты в брандмауэре.

# 13.2 ssh

Используя ssh, можно подключиться к удаленным системам и работать в интерактивном режиме. Это заменяет и telnet и rlogin. Программа slogin является всего лишь линком на ssh. Например, для того, чтобы залогиниться в системе `sun`, используйте команду `ssh sun`, после чего надо будет ввести пароль, т.е. пройти аутентификацию в системе `sun`.

После успешной аутентификации можно использовать либо консоль, либо интерактивные приложения, такие как YaST. Если имя пользователся на локальной машине отличается от имени на удаленной, используйте команду `ssh -l augustine sun` или `ssh augustine@sun`.

Кроме того, ssh позволяет выполнять команды на удаленных системмах, используя rsh. В следующем примере запускается команда `uptime` на машине sun и создается директория с именем `tmp`. Вывод команды можно видеть на локальном терминале системы jupiter.

```
ssh otherplanet "uptime; mkdir tmp"
Password:
1:21pm  up  2:17,  9 users,  load average: 0.15, 0.04, 0.02
```

Кавычки здесь необходимы, чтобы посылать обе инструкции в одной команде. Вторая команда создает директорию `tmp` в системе sun, сразу после окончания работы `uptime`.

# 13.3 scp—безопасное копирование

scp копирует файлы на удаленную машину. Это более безопасная замена для rcp. Например `scp MyLetter.tex sun:` скопирует файл `MyLetter.tex` из системы jupiter в sun. Если имя пользователей в системе jupiter отличается от имени в системе sun, укажите его, используя такой формат: `username@host`. Ключ `-l` имеет другое значение для этой команды.

После того, как правильный пароль введен, scp начинает передачу данных и показывает растущий ряд звездочек, имитируя процентное соотношение выполнения процесса. Кроме того, программа показывает предполагаемое время до его завершения. Если указан ключ `-q`, программа не будет ничего выводить на терминал.

scp также поддерживает рекурсивное копирование. Команда `scp -r src/ sun:backup/` скопирует содержимое всей директории `src`, включая все поддиректории, в папку `backup` системы sun. Если эти поддиректории не существуют, они будут созданны автоматически.

При использовании ключа `-p`, scp сохранит дату последнего изменения как у источника. Ключ `-C` позволит сжать передаваеммые данные. Это минимизирует объем передаваемых данных, но нагрузит процессор.

# 13.4 sftp—безопасная передача файлов

Для безопасной передачи данных, вместо программы scp, может использоваться sftp. Во время sftp-сессии доступны многие из команд, используемых при работе с ftp. Использование sftp может быть более лучшим выбором чем scp, особенно если не известны имена копируемых файлов.

# 13.5 Демон SSH (sshd)—серверная часть

Для работы с программами ssh и scp, в фоновом режиме должнен быть запущен SSH-демон, который будет использовать порт `22 TCP/IP`. При запуске в первый раз, демон генерирует три пары ключей. Каждая пара стоит из секретного и открытого ключа. Чтобы гарантировать безопасность соединения через SSH, доступ к файлу с секретным ключем должен быть только у системного администратора. По умолчанию, этот файл имеет именно такие права. Секретный ключ используется только локальным SSH-демоном и не должен быть предоставлен кому-то ещё. Открытый ключ (узнаваемый

по расширению файла `.pub` ) отправляется клиенту, запросившему соединение. Файл, в котором находится открытый ключ, может прочитать любой пользователь системы.

Связь инициирует SSH-клиент. SSH-демон ожидает запроса от SSH-клиента для создания соединения. Первым шагом они обмениваются информацией идентификации, проверяя протокол и версию SSH, а так же уточняя номер порта, т.к. дочерние процессы, порожденные SSH-демоном, могут одновременно обслуживать несколько SSH-сессий.

OpenSSH для связи между SSH-сервером и SSH-клиентом поддерживает первую и вторую версию протокола SSH. По умолчанию используется вторая версия. Если Вы хотите использовать первую версию, используйте ключ `-1`.

При использовании версии 1, SSH-сервер посылает свой открытый ключ и так называемый "ключ сервера", которые генерируются раз в час. На основании этих ключей SSH-клиент генерирует ключ сессии, который в последствии он посылает SSH-серверу. SSH-клиент также говорит серверу какой метод шифрования использовать. Вторая версия протокола SSH не требуют ключа сервера. Обе стороны используют алгоритм Диффи-Хеллмана (Diffie-Hellman) для обмена ключами.

Секретный и серверный ключи необходимы для расшифровки ключа сессии и не могут быть получены, при использовании лишь открытых ключей. Только при соединении SSH-демон может расшифровать ключ сессии, используя свои секретные ключи. Эта начальная фаза установки соединиенения более детально будет показана (включая отладочную информацию) при использовании ключа `-v`.

Клиент сохраняет открытые host-ключи в файле `~/.ssh/known_hosts` , после первого соединения с удаленной системой. Это предотвращает любые попытки "нападений посредине" внешними SSH серверами, использующими поддельные имена или IP-адреса. Такие нападения будут сразу же обнаружены по отличному ключу, которого нет в `~/.ssh/known_hosts` или неспособностью сервера расшифровать ключ сессии из-за отсутсвия соответствующих секретных ключей.

Рекомендуестся сохранять секретные и открытые ключи, которые находятся в `/etc/ssh/` , на каком-нибудь безопасном внешнем носителе. В этом случае эти ключи могут быть снова использованны, к примеру, после переустановки системы.

# 13.6 Механизм аутентификации SSH

Аутентификация в своей простейшей форме, как упоминалось выше, это просто ввод пароля. Цель SSH сосоит в том, чтобы предоставить пользователю безопасное программное обеспечение, которое так же просто в использовании. Поскольку при создании подразумевалась альтернатива rsh и rlogin, SSH так же предоставило очень простые методы аутентификации, подходящие для ежедневного использования. Достигается это посредством еще одной пары ключей, создаваемых пользователем. В составе openssh-пакета специально для этого есть вспомогательная программа ssh-keygen. После команд `ssh-keygen -t rsa` или `ssh-keygen -t dsa`, генерируется эта пара ключей.

Подтвердите использование установок по умолчанию и введите пароль. Пароль должен содержать (рекомендованное количество для процедуры, описанной тут) от 10 до 30 символов. Не используйте простые или короткие слова или фразы. Подтвердите пароль (введите его еще раз). После этого секретный и открытый ключи, в этом примере, будут сохраненны в `id_rsa` и `id_rsa.pub` .

Используйте `ssh-keygen -p -t rsa` или `ssh-keygen -p -t dsa`, чтобы изменить пароль. Скопируйте открытый ключ (`id_rsa.pub` в этом примере) на другую машину и сохраните его в `~/.ssh/authorized_keys` . При следующем соединении будет предложенно идентифицировать себя, т.е. подтвердить пароль еще раз. Если этого не произойдет, проверьте расположение и содержимое этих файлов.

Эта процедура не так удобна, чем ввод пароля при каждом новом соединении. По этой причине пакет openssh предоставляет другую программу, ssh-agent, который сохраняет секретные ключи на время X-сессии. Все X-сессии запускаются как дочерний процесс ssh-agent. Самый простой способ сделать это - установить параметр `yes` для переменной `usessh` в начале файла `.xsession` , выйти и зайти в систему снова, используя, к примеру, KDM или GDM. Можно так же просто сделать `ssh-agent startx`.

После этого Вы можете использовать `ssh` или `scp` как обычно. Если Вы создадите свой открытый ключ, как описанно выше, Вам не придется больше вводить свой пароль. Не забывайте о завершении X-сессии, а так же ее защите при помощи пароля, используя, например, xlock.

**ЗАМЕЧАНИЕ: Права доступа к файлам при использовании host-аутентификации**

При использовании host-аутентификации, файл `/usr/lib/ssh/ssh-keysign` или `/usr/lib64/ssh/ssh-keysign` должен иметь SETUID бит, который в openSUSE не установлен по умолчанию. Вы должны установить его сами в ручную. Используйте для этого файл `/etc/permissions.local` , чтобы быть уверенным, что SETUID бит сохраниться и после обновления OpenSSH.

# 13.7 X, аутентификация и механизмы переадресации

Помимо описанных выше возможностей, через SSH также можно работать с удаленными X-приложениями. При использовании `ssh` с ключем `-X`, переменная `DISPLAY` автоматически устанавливается на удаленной машине, и весь вывод X-приложения экспортируется через SSH-соединение. Другими словами, X-приложение запускается на удаленной системе, но работать с ней можно локально, при этом передаваемые данные не могут быть перехвачены злоумышленником.

При использовании ключа `-A`, для механизма аутентификации ssh-agent используется следующая машина. Таким образом, можно подключаться с различных машин без необходимости вводить пароль. Этот механизм работает лишь в том случае, если на них есть открытый ключ пользователя, от имени которого создается соединение.

Оба механизма не используются по умолчанию, но могут быть в любое время включены. Для этого отредактируйте системный конфигурационный файл `/etc/ssh/sshd_config` или пользовательский `~/.ssh/config` .

ssh также может быть использован для перенаправления TCP/IP соединения. В приведенном ниже примере SSH перенаправляет SMTP и POP3 порт:

```
ssh -L 25:sun:25 jupiter
```

С помощью этой команды, все соединения на 25 порт (SMTP) системы jupiter будут перенаправляться через зашифрованный канал на SMTP порт системы sun. Это особенно полезно для тех, кто использует SMTP серверы без SMTP-AUTH или POP-before-SMTP. Электронная почта, откуда бы она ни

пришла, будет переданна для дальнейшей доставки «домашнему» почтовому серверу. Точно так же все POP3 запросы (порт 110) на jupiter могут быть перенаправленны на POP3 порт sun, при помощи следующей команды:

```
ssh -L 110:sun:110 jupiter
```

Обе команды должны быть выполненны с правами `root`, так как соединение использует привилегированные порты. При использовании электронной почты обычными пользователями будет использоваться SSH соединение. Дополнительную информацию можно найти в man-руководствах для каждой из программ, описанной выше, а также в документации проекта OpenSSH: `/usr/share/doc/packages/openssh` .

# 13.8 Настройка SSH-демона с помощью YaST

YaST-модуль, отвечающий за настройку SSHD, не устанавливается по умолчанию. Для его установки запустите YaST, выберете *Software* > *Software Management* и найдите и установите пакет `yast2-sshd`.

Для настройки sshd-сервера с помошью YaST запустите YaST и выберете *Сетевые службы* > *Настройка SSHD*. Затем сделайте следующее:

1. На вкладке *Общие*, в таблице *SSHD TCP Ports*, выберите порты, которые должен использовать SSHD. По умолчанию используется порт 22. Вы можете выбрать несколько портов. Чтобы добавить новый порт, нажмите кнопку *Добавить*, введите номер порта и нажмите кнопку *OK*. Для удаления порта, найдите его в таблице, нажмите кнопку *Удалить* и подтвердите удаление.

2. На вкладке "Общие" находятся и другие настройки, поддерживаемые sshd-демоном. Для отключения переадресации TCP (TCP Forwarding), снимите флажок *Разрешить TCP переадресацию*. Отключение переадресации TCP не улучшает безопасность, если пользователи не имеют доступа к терминалу, так как они всегда могут установить свои собственные переадресации. См. Раздел 13.7, «X, аутентификация и механизмы переадресации» (стр. 172) для получения дополнительной информации о переадресации TCP.

   Чтобы отключить переадресацию X, снимите флажок *Разрешить X11 переадресацию*. Если эта опция отключена, любые запросы переадресации X11 вперед будут приводить к ошибке. Однако пользователи всегда

могут установить свою собственную переадресацию. См.Раздел 13.7, «X, аутентификация и механизмы переадресации» (стр. 172) для получения дополнительной информации о переадресации X.

Опция *Разрешить сжатие* определяет, должна ли связь между сервером и клиентам быть сжата.

3 Вкладка *Настройки входа в систему* содержит общие настройки входа в систему и аутентификации. В *Показывать Сообщение дня после входа в систему* определяется, должен ли sshd выводить сообщение из `/etc/motd` при интерактивном режиме входа в систему. Если Вы хотит отключить возможность входить в систему пользователю `root`, отключите *Разрешать вход администратора в систему*.

В *Максимальном числе попыток аутентификации* устанавливается максимальное количество попыток аутентификации за одно соединение. *Аутентификация RSA* определяет, разрешенна ли аутентификация RSA. Этот параметр применяется только к первой версии протокола SSH. *Аутентификация по открытому ключу* определяет, разрешеа ли аутентификация пользователя с помощью открытого ключа. Этот параметр используется только во второй версии протокола SSH.

4 На вкладке *Протокол и шифрования* определяются версии протокола SSH, которые должны поддерживатся. Вы можете выбрать первую или вторую версию, а так же параллельную поддержку обоих SSH-протоколов.

В *Поддерживаемые методы шифрования* перечисленны все поддерживаемые алгоритмы шифрования. Вы можете удалить шифр, выбрав его в списке и нажав кнопку *Удалить*. Чтобы добавить шифр, выберите его из выпадающего меню и нажмите кнопку *Добавить*.

5 Нажмите *Finish* для сохранения настроек.

# 13.9 Дополнительная информация

`http://www.openssh.com/ru`
Страница проекта OpenSSH

`man ssh_config`
: man-страница о конфигурационных файлах OpenSSH.

`man sshd`
: man-страница о OpenSSH-демоне

`man scp` , `man sftp` , `man slogin` , `man ssh` , `man ssh-add` , `man ssh-agent` , `man ssh-copy-id` , `man ssh-keyconvert` , `man ssh-keygen` , `man ssh-keyscan`
: man-страницы о программах копирования файлов (`scp`, `sftp`), login (`slogin`, `ssh`), и ключах.

# 14 Masquerading and Firewalls

Whenever Linux is used in a network environment, you can use the kernel functions that allow the manipulation of network packets to maintain a separation between internal and external network areas. The Linux netfilter framework provides the means to establish an effective firewall that keeps different networks apart. With the help of iptables—a generic table structure for the definition of rule sets—precisely control the packets allowed to pass a network interface. Such a packet filter can be set up quite easily with the help of SuSEfirewall2 and the corresponding YaST module.

## 14.1 Packet Filtering with iptables

The components netfilter and iptables are responsible for the filtering and manipulation of network packets as well as for network address translation (NAT). The filtering criteria and any actions associated with them are stored in chains, which must be matched one after another by individual network packets as they arrive. The chains to match are stored in tables. The `iptables` command allows you to alter these tables and rule sets.

The Linux kernel maintains three tables, each for a particular category of functions of the packet filter:

filter
: This table holds the bulk of the filter rules, because it implements the *packet filtering* mechanism in the stricter sense, which determines whether packets are let through (`ACCEPT`) or discarded (`DROP`), for example.

nat
: This table defines any changes to the source and target addresses of packets. Using these functions also allows you to implement *masquerading*, which is a special case of NAT used to link a private network with the Internet.

mangle
: The rules held in this table make it possible to manipulate values stored in IP headers (such as the type of service).

These tables contain several predefined chains to match packets:

PREROUTING
: This chain is applied to incoming packets.

INPUT
: This chain is applied to packets destined for the system's internal processes.

FORWARD
: This chain is applied to packets that are only routed through the system.

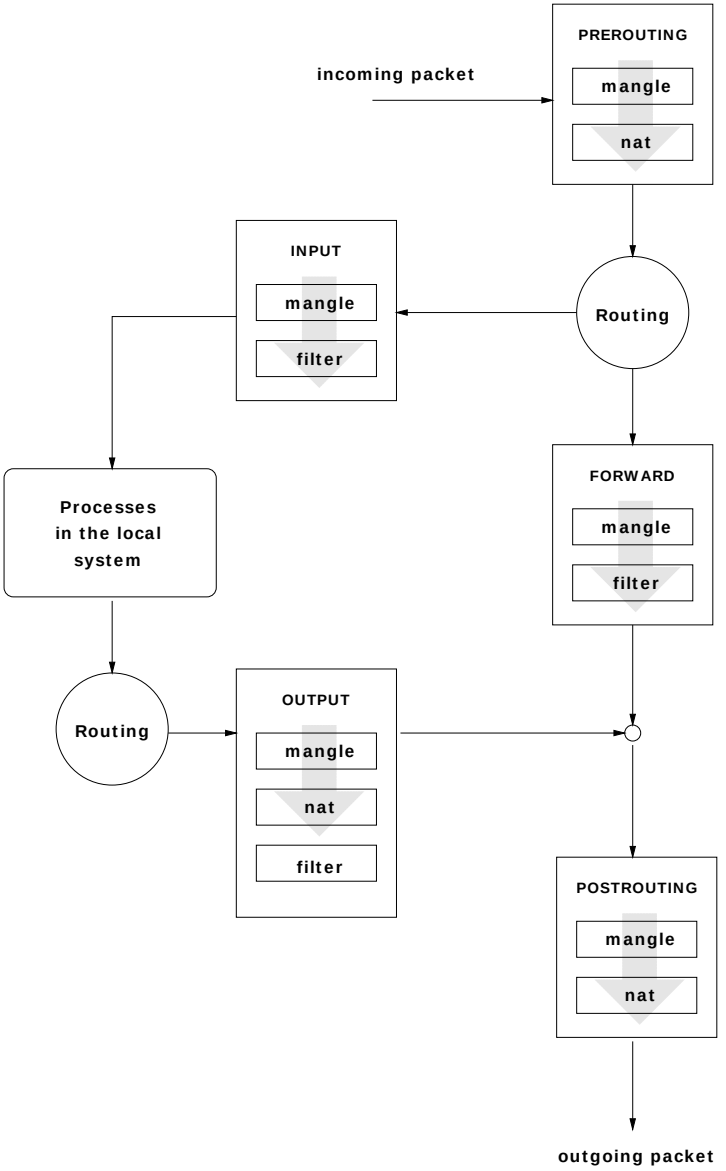
OUTPUT
: This chain is applied to packets originating from the system itself.

POSTROUTING
: This chain is applied to all outgoing packets.

Рисунок 14.1, «iptables: A Packet's Possible Paths» (стр. 179) illustrates the paths along which a network packet may travel on a given system. For the sake of simplicity, the figure lists tables as parts of chains, but in reality these chains are held within the tables themselves.

In the simplest of all possible cases, an incoming packet destined for the system itself arrives at the `eth0` interface. The packet is first referred to the `PREROUTING` chain of the `mangle` table then to the `PREROUTING` chain of the `nat` table. The following step, concerning the routing of the packet, determines that the actual target of the packet is a process of the system itself. After passing the `INPUT` chains of the `mangle` and the `filter` table, the packet finally reaches its target, provided that the rules of the `filter` table are actually matched.

***Рисунок 14.1*** *iptables: A Packet's Possible Paths*




# 14.2 Masquerading Basics

Masquerading is the Linux-specific form of NAT (network address translation). It can be used to connect a small LAN (where hosts use IP addresses from the private range—see Раздел “Netmasks and Routing” (Глава 23, *Basic Networking*, ↑Reference)) with the Internet (where official IP addresses are used). For the LAN hosts to be able to connect to the Internet, their private addresses are translated to an official one. This is done on the router, which acts as the gateway between the LAN and the Internet. The underlying principle is a simple one: The router has more than one network interface, typically a network card and a separate interface connecting with the Internet. While the latter links the router with the outside world, one or several others link it with the LAN hosts. With these hosts in the local network connected to the network card (such as `eth0`) of the router, they can send any packets not destined for the local network to their default gateway or router.

---

**ВАЖНО: Using the Correct Network Mask**

When configuring your network, make sure both the broadcast address and the netmask are the same for all local hosts. Failing to do so prevents packets from being routed properly.

---

As mentioned, whenever one of the LAN hosts sends a packet destined for an Internet address, it goes to the default router. However, the router must be configured before it can forward such packets. For security reasons, this is not enabled in a default installation. To enable it, set the variable `IP_FORWARD` in the file `/etc/sysconfig/sysctl` to `IP_FORWARD=yes`.

The target host of the connection can see your router, but knows nothing about the host in your internal network where the packets originated. This is why the technique is called masquerading. Because of the address translation, the router is the first destination of any reply packets. The router must identify these incoming packets and translate their target addresses, so packets can be forwarded to the correct host in the local network.

With the routing of inbound traffic depending on the masquerading table, there is no way to open a connection to an internal host from the outside. For such a connection, there would be no entry in the table. In addition, any connection already established has a status entry assigned to it in the table, so the entry cannot be used by another connection.

As a consequence of all this, you might experience some problems with a number of application protocols, such as ICQ, cucme, IRC (DCC, CTCP), and FTP (in PORT

mode). Web browsers, the standard FTP program, and many other programs use the PASV mode. This passive mode is much less problematic as far as packet filtering and masquerading are concerned.

# 14.3 Firewalling Basics

*Firewall* is probably the term most widely used to describe a mechanism that provides and manages a link between networks while also controlling the data flow between them. Strictly speaking, the mechanism described in this section is called a *packet filter*. A packet filter regulates the data flow according to certain criteria, such as protocols, ports, and IP addresses. This allows you to block packets that, according to their addresses, are not supposed to reach your network. To allow public access to your Web server, for example, explicitly open the corresponding port. However, a packet filter does not scan the contents of packets with legitimate addresses, such as those directed to your Web server. For example, if incoming packets were intended to compromise a CGI program on your Web server, the packet filter would still let them through.

A more effective but more complex mechanism is the combination of several types of systems, such as a packet filter interacting with an application gateway or proxy. In this case, the packet filter rejects any packets destined for disabled ports. Only packets directed to the application gateway are accepted. This gateway or proxy pretends to be the actual client of the server. In a sense, such a proxy could be considered a masquerading host on the protocol level used by the application. One example for such a proxy is Squid, an HTTP and FTP proxy server. To use Squid, the browser must be configured to communicate via the proxy. Any HTTP pages or FTP files requested are served from the proxy cache and objects not found in the cache are fetched from the Internet by the proxy.

The following section focuses on the packet filter that comes with openSUSE. For further information about packet filtering and firewalling, read the Firewall HOWTO included in the `howto` package. If this package is installed, read the HOWTO with

```
less /usr/share/doc/howto/en/txt/Firewall-HOWTO.gz
```

# 14.4 SuSEfirewall2

SuSEfirewall2 is a script that reads the variables set in `/etc/sysconfig/SuSEfirewall2` to generate a set of iptables rules. It defines three security

zones, although only the first and the second one are considered in the following sample configuration:

External Zone
: Given that there is no way to control what is happening on the external network, the host needs to be protected from it. In most cases, the external network is the Internet, but it could be another insecure network, such as a WLAN.

Internal Zone
: This refers to the private network, in most cases the LAN. If the hosts on this network use IP addresses from the private range (see Раздел “Netmasks and Routing” (Глава 23, *Basic Networking*, ↑Reference)), enable network address translation (NAT), so hosts on the internal network can access the external one.

Demilitarized Zone (DMZ)
: While hosts located in this zone can be reached both from the external and the internal network, they cannot access the internal network themselves. This setup can be used to put an additional line of defense in front of the internal network, because the DMZ systems are isolated from the internal network.

Any kind of network traffic not explicitly allowed by the filtering rule set is suppressed by iptables. Therefore, each of the interfaces with incoming traffic must be placed into one of the three zones. For each of the zones, define the services or protocols allowed. The rule set is only applied to packets originating from remote hosts. Locally generated packets are not captured by the firewall.

The configuration can be performed with YaST (see Раздел 14.4.1, «Configuring the Firewall with YaST» (стр. 182)). It can also be made manually in the file `/etc/sysconfig/SuSEfirewall2` , which is well commented. Additionally, a number of example scenarios are available in `/usr/share/doc/packages/SuSEfirewall2/EXAMPLES` .

## 14.4.1 Configuring the Firewall with YaST

**ВАЖНО: Automatic Firewall Configuration**

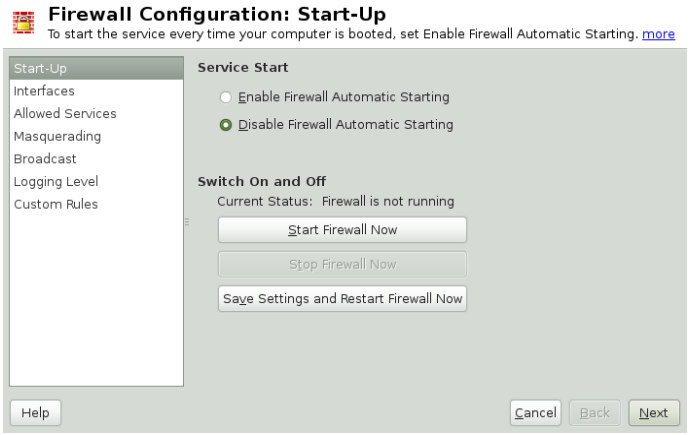
After the installation, YaST automatically starts a firewall on all configured interfaces. If a server is configured and activated on the system, YaST can modify the automatically-generated firewall configuration with the options *Open Ports on Selected Interface in Firewall* or *Open Ports on Firewall* in the server configuration modules. Some server module dialogs include

a *Firewall Details* button for activating additional services and ports. The YaST firewall configuration module can be used to activate, deactivate, or reconfigure the firewall.

The YaST dialogs for the graphical configuration can be accessed from the YaST Control Center. Select *Security and Users* > *Firewall*. The configuration is divided into seven sections that can be accessed directly from the tree structure on the left side.

Start-Up
: Set the start-up behavior in this dialog. In a default installation, SuSEfirewall2 is started automatically. You can also start and stop the firewall here. To implement your new settings in a running firewall, use *Save Settings and Restart Firewall Now*.

**Рисунок 14.2** *The YaST Firewall Configuration*




Interfaces
: All known network interfaces are listed here. To remove an interface from a zone, select the interface, press *Change*, and choose *No Zone Assigned*. To add an interface to a zone, select the interface, press *Change* and choose any of the available zones. You may also create a special interface with your own settings by using *Custom*.

Allowed Services
: You need this option to offer services from your system to a zone from which it is protected. By default, the system is only protected from external zones.

Explicitly allow the services that should be available to external hosts. After selecting the desired zone in *Allowed Services for Selected Zone*, activate the services from the list.

Masquerading
: Masquerading hides your internal network from external networks (such as the Internet) while enabling hosts in the internal network to access the external network transparently. Requests from the external network to the internal one are blocked and requests from the internal network seem to be issued by the masquerading server when seen externally. If special services of an internal machine need to be available to the external network, add special redirect rules for the service.

Broadcast
: In this dialog, configure the UDP ports that allow broadcasts. Add the required port numbers or services to the appropriate zone, separated by spaces. See also the file `/etc/services` .

  The logging of broadcasts that are not accepted can be enabled here. This may be problematic, because Windows hosts use broadcasts to know about each other and so generate many packets that are not accepted.

IPsec Support
: Configure whether the IPsec service should be available to the external network in this dialog. Configure which packets are trusted under *Details*.

Logging Level
: There are two rules for the logging: accepted and not accepted packets. Packets that are not accepted are DROPPED or REJECTED. Select from *Log All*, *Log Only Critical*, or *Do Not Log Any* for both of them.

Custom Rules
: Here, set special firewall rules that allow connections, matching specified criteria such as source network, protocol, destination port, and source port. Configure such rules for external, internal, and demilitarized zones.

When finished with the firewall configuration, exit this dialog with *Next*. A zone-oriented summary of your firewall configuration then opens. In it, check all settings. All services, ports, and protocols that have been allowed and all custom rules are listed in this summary. To modify the configuration, use *Back*. Press *Finish* to save your configuration.

## 14.4.2 Configuring Manually

The following paragraphs provide step-by-step instructions for a successful configuration. Each configuration item is marked as to whether it is relevant to firewalling or masquerading. Use port range (for example, `500:510`) whenever appropriate. Aspects related to the DMZ (demilitarized zone) as mentioned in the configuration file are not covered here. They are applicable only to a more complex network infrastructure found in larger organizations (corporate networks), which require extensive configuration and in-depth knowledge about the subject.

First, use the YaST module Системные службы (Уровень запуска) to enable SuSEfirewall2 in your runlevel (3 or 5 most likely). It sets the symlinks for the SuSEfirewall2_* scripts in the `/etc/init.d/rc?.d/` directories.

`FW_DEV_EXT` (firewall, masquerading)
: The device linked to the Internet. For a modem connection, enter `ppp0`. For an ISDN link, use `ippp0`. DSL connections use `dsl0`. Specify `auto` to use the interface that corresponds to the default route.

`FW_DEV_INT` (firewall, masquerading)
: The device linked to the internal, private network (such as `eth0`). Leave this blank if there is no internal network and the firewall protects only the host on which it runs.

`FW_ROUTE` (firewall, masquerading)
: If you need the masquerading function, set this to `yes`. Your internal hosts will not be visible to the outside, because their private network addresses (e.g., `192.168.x.x`) are ignored by Internet routers.

  For a firewall without masquerading, set this to `yes` if you want to allow access to the internal network. Your internal hosts need to use officially registered IP addresses in this case. Normally, however, you should *not* allow access to your internal network from the outside.

`FW_MASQUERADE` (masquerading)
: Set this to `yes` if you need the masquerading function. This provides a virtually direct connection to the Internet for the internal hosts. It is more secure to have a proxy server between the hosts of the internal network and the Internet. Masquerading is not needed for services that a proxy server provides.

FW_MASQ_NETS (masquerading)
: Specify the hosts or networks to masquerade, leaving a space between the individual entries. For example:

```
FW_MASQ_NETS="192.168.0.0/24 192.168.10.1"
```

FW_PROTECT_FROM_INT (firewall)
: Set this to yes to protect your firewall host from attacks originating in your internal network. Services are only available to the internal network if explicitly enabled. Also see FW_SERVICES_INT_TCP and FW_SERVICES_INT_UDP.

FW_SERVICES_EXT_TCP (firewall)
: Enter the TCP ports that should be made available. Leave this blank for a normal workstation at home that should not offer any services.

FW_SERVICES_EXT_UDP (firewall)
: Leave this blank unless you run a UDP service and want to make it available to the outside. The services that use UDP include include DNS servers, IPsec, TFTP, DHCP and others. In that case, enter the UDP ports to use.

FW_SERVICES_ACCEPT_EXT (firewall)
: List services to allow from the Internet. This is a more generic form of the FW_SERVICES_EXT_TCP and FW_SERVICES_EXT_UDP settings, and more specific than FW_TRUSTED_NETS. The notation is a space-separated list of *net*,*protocol*[,*dport*][,*sport*], for example 0/0,tcp,22 or 0/0,tcp,22,,hitcount=3,blockseconds=60,recentname=ssh, which means: allow at most three ssh connects per minute from the same IP address.

FW_SERVICES_INT_TCP (firewall)
: With this variable, define the services available for the internal network. The notation is the same as for FW_SERVICES_EXT_TCP, but the settings are applied to the *internal* network. The variable only needs to be set if FW_PROTECT_FROM_INT is set to yes.

FW_SERVICES_INT_UDP (firewall)
: See FW_SERVICES_INT_TCP.

FW_SERVICES_ACCEPT_INT (firewall)
: List services to allow from internal hosts. See FW_SERVICES_ACCEPT_EXT.

FW_SERVICES_ACCEPT_RELATED_* (firewall)
: This is how the SuSEfirewall2 implementation considers packets RELATED by netfilter.

  For example, to allow finer grained filtering of Samba broadcast packets, RELATED packets are not accepted unconditionally. Variables starting with FW_SERVICES_ACCEPT_RELATED_ allow restricting RELATED packets handling to certain networks, protocols and ports.

  This means that adding connection tracking modules (conntrack modules) to FW_LOAD_MODULES does not automatically result in accepting the packets tagged by those modules. Additionally, you must set variables starting with FW_SERVICES_ACCEPT_RELATED_ to a suitable value.

FW_CUSTOMRULES (firewall)
: Uncomment this variable to install custom rules. Find examples in /etc/sysconfig/scripts/SuSEfirewall2-custom .

After configuring the firewall, test your setup. The firewall rule sets are created by entering SuSEfirewall2 start as root. Then use telnet, for example, from an external host to see whether the connection is actually denied. After that, review /var/log/messages , where you should see something like this:

```
Mar 15 13:21:38 linux kernel: SFW2-INext-DROP-DEFLT IN=eth0
OUT= MAC=00:80:c8:94:c3:e7:00:a0:c9:4d:27:56:08:00 SRC=192.168.10.0
DST=192.168.10.1 LEN=60 TOS=0x10 PREC=0x00 TTL=64 ID=15330 DF PROTO=TCP
SPT=48091 DPT=23 WINDOW=5840 RES=0x00 SYN URGP=0
OPT (020405B40402080A061AFEBC0000000001030300)
```

Other packages to test your firewall setup are Nmap (portscanner) or OpenVAS (Open Vulnerability Assessment System). The documentation of Nmap is found at /usr/share/doc/packages/nmap after installing the package and the documentation of openVAS resides at http://www.openvas.org .

# 14.5 For More Information

The most up-to-date information and other documentation about the SuSEfirewall2 package is found in /usr/share/doc/packages/SuSEfirewall2 . The home page of the netfilter and iptables project, http://www.netfilter.org , provides a large collection of documents in many languages.

# 15 Configuring VPN Server

Nowadays, the Internet connection is cheap and available almost everywhere. It is important that the connection is as secure as possible. Virtual Private Network (VPN), is a secure network within a second, insecure network such as the Internet or WLAN. It can be implemented in different ways and serves several purposes. In this chapter, we focus on VPNs to link branch offices via secure wide area networks (WANs).

## 15.1 Overview

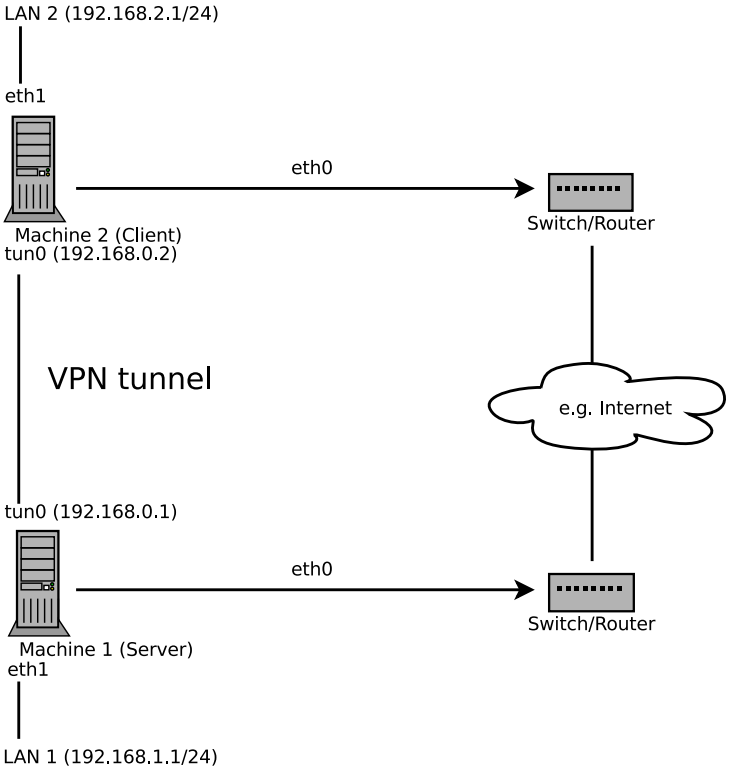
This section introduces a brief overview of some scenarios which VPN offers, and some relevant terminology as well.

### 15.1.1 VPN Scenarios

There are many solutions to set up and build of a VPN connection. This chapter focuses on the OpenVPN package. Compared to other VPN software, OpenVPN can be operated in two modes:

Routed VPN
: Routing is an easy solution to set up. It is more efficient and scales better than bridged VPN. Furthermore, it allows the user to tune MTU (Maximum Transfer Unit) to raise efficiency. However, in a heterogeneous environment NetBIOS broadcasts do not work if you do not have a Samba server on the gateway. If you need IPv6, each tun drivers on both ends must support this protocol explicitly.

***Рисунок 15.1*** *Routed VPN*




Bridged VPN

Bridging is a more complex solution. It is recommended when you need to browse Windows file shares across the VPN without setting up a Samba or WINS server. Bridged VPN is also needed if you want to use non-IP protocols (such as IPX) or applications relying on network broadcasts. However, it is less efficient than routed VPN. Another disadvantage is that it does not scale well.

***Рисунок 15.2*** *Bridged VPN - Scenario 1*

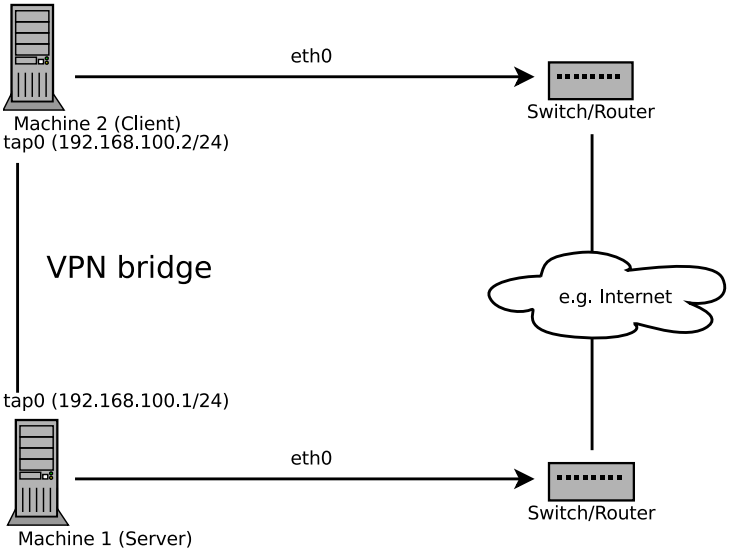



***Рисунок 15.3*** *Bridged VPN - Scenario 2*

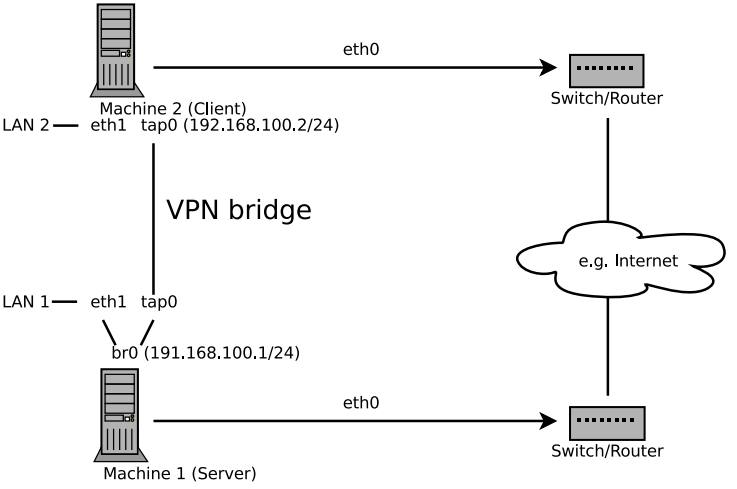
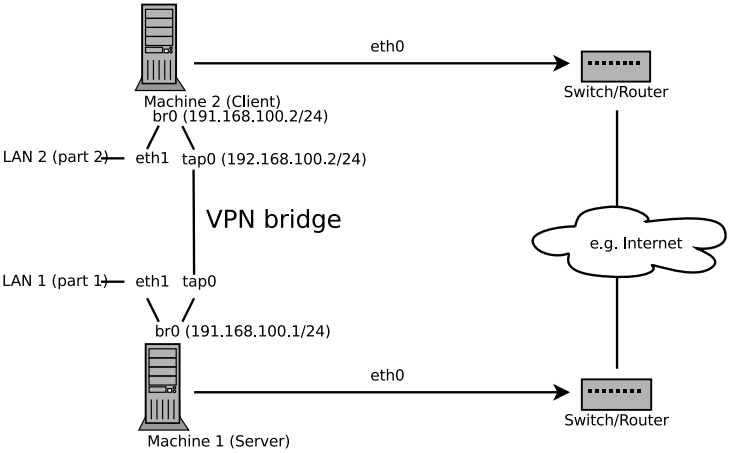


***Рисунок 15.4*** *Bridged VPN - Scenario 3*




The major difference between bridging and routing is that a routed VPN cannot IP-broadcast while a bridged VPN can.

## 15.1.2 Tun and Tap Devices

Whenever you setup a VPN connection your IP packets are transferred over your secured tunnel. The connection between the client's device and the server's device is called a *tunnel*. A tunnel can use a so-called *tun* or *tap* device. They are virtual network kernel drivers which implement the transmission of ethernet frames or ip frames/packets:

tun device
: A tun device simulates a point-to-point network (layer 3 packets in the OSI model such as Ethernet frames). A tun device is used with routing and works with IP frames.

tap device
: A tap device simulates an ethernet device (layer 2 packets in the OSI model such as IP packets). A tap device is used for creating a network bridge. It works with Ethernet frames.

The userspace program OpenVPN can attach itself to a tun or tap device to receive packets sent by your OS. The program is also able to write packets to the

device. For more information, see `/usr/src/linux/Documentation/networking/tuntap.txt` . You must install the `kernel-source` package to read this file.

# 15.2 Creating the Simplest VPN Example

The following example creates a point-to-point VPN tunnel. It demonstrates how to create a VPN tunnel between one client and a server. It is assumed that your VPN server will use private IP addresses like `192.168.1.120` and your client the IP address `192.168.2.110`. You can modify these private IP addresses to your needs but make sure you select addresses which do not conflict with other IP addresses.

**ВНИМАНИЕ: Use It Only For Testing**

This scenario is only useful for testing and is considered as an example to get familiar with VPN. *Do not use* this as a real world scenario to connect as it can compromise your security and the safety of your IT infrastructure!

## 15.2.1 Configuring the VPN Server

To configure a VPN server, proceed as follows:

***Процедура 15.1*** *VPN Server Configuration*

1. Install the package `openvpn` on the machine that will later become your VPN server.

2. Open a shell, become `root` and create the VPN secret key:

   ```
   openvpn --genkey --secret /etc/openvpn/secret.key
   ```

3. Copy the secret key to your client:

   ```
   scp /etc/openvpn/secret.key root@192.168.2.110:/etc/openvpn/
   ```

4. Create the file `/etc/openvpn/server.conf` with the following content:

```
dev tun
ifconfig 192.168.1.120 192.168.2.110
secret secret.key
```

5 If you use a firewall, start YaST and open UDP port 1194 (*Security and Users* > *Firewall* > *Allowed Services*.

6 Start the OpenVPN service as `root`:

```
rcopenvpn start
```

## 15.2.2 Configuring the VPN Client

To configure the VPN client, do the following:

***Процедура 15.2*** *VPN Client Configuration*

1 Install the package `openvpn` on your client VPN machine.

2 Create `/etc/openvpn/client.conf` with the following content:

```
remote IP_OF_SERVER
dev tun
ifconfig 192.168.2.110 192.168.1.120
secret secret.key
```

Replace the placeholder *`IP_OF_SERVER`* in the first line with either the domain name, or the public IP address of your server.

3 If you use a firewall, start YaST and open UDP port 1194 as described in Шаг 5 (стр. 194) of Процедура 15.1, «VPN Server Configuration» (стр. 193).

4 Start the OpenVPN service as `root`:

```
rcopenvpn start
```

## 15.2.3 Testing the VPN Example

After the OpenVPN is successfully started, test if the tun device is available with the following command:

```
ifconfig tun0
```

To verify the VPN connection, use `ping` on both client and server to see if you can reach each other. Ping server from client:

```
ping -I tun0 192.168.1.120
```

Ping client from server:

```
ping -I tun0 192.168.2.110
```

# 15.3 Setting Up Your VPN Server Using Certificate Authority

The example shown in Раздел 15.2 (стр. 193) is useful for testing, but not for daily work. This section explains how to build a VPN server that allows more than one connection at the same time. This is done with a public key infrastructure (PKI). A PKI consists of a pair of public and private keys for the server and each client and a master certificate authority (CA), which is used to sign every server and client certificate.

The general overview of this process involves the following steps explained in these sections:

**1** Раздел 15.3.1, «Creating Certificates» (стр. 195)

**2** Раздел 15.3.2, «Configuring the Server» (стр. 198)

**3** Раздел 15.3.3, «Configuring the Clients» (стр. 199)

## 15.3.1 Creating Certificates

Before a VPN connection gets established, the client must authenticate the server certificate. Conversely, the server must also authenticate the client certificate. This is called *mutual authentication*.

You can use two methods to create the respective certificates and keys:

- Use the YaST CA module (see Глава 16, *Managing X.509 Certification* (стр. 205)), or

- Use the scripts included with the `openvpn` package.

## Generating Certificates with easy-rsa

The easy-rsa utilities use the `openssl.cnf` file stored under `/usr/share/openvpn/easy-rsa/VER`. In most cases you can leave this file as it is.

***Процедура 15.3*** *Generate the Master CA And Key*

1. Open a shell and become `root`.
2. Change the directory to `/usr/share/openvpn/easy-rsa/VER/`. Replace the placeholder *VER* with either `1.0` or `2.0`, the current versions.
3. Copy the file `vars` to `/etc/openvpn` and set `export EASY_RSA` to `/usr/share/openvpn/easy-rsa`:

   ```
   export EASY_RSA="/usr/share/openvpn/easy-rsa/VER"
   ```
4. In the `vars` file change the `KEY_COUNTRY`, `KEY_PROVINCE`, `KEY_CITY`, `KEY_ORG`, and `KEY_EMAIL` variables according to your needs.
5. Initialize the PKI:

   ```
   source /etc/openvpn/vars && ./clean-all && ./build-ca
   ```
6. Enter the data required by the `build-ca` script. Usually you can take the defaults that you have set in Шаг 4 (стр. 196). Additionally set `Organizational Unit Name` and `Common Name` that were not set previously.

Once done, the master certificate and key are saved as `/usr/share/openvpn/easy-rsa/VER/keys/ca.*`.

***Процедура 15.4*** *Generate The Private Server Key*

1. Change to the `/usr/share/openvpn/easy-rsa/VER/` directory.
2. Run the following script:

   ```
   ./build-key-server server
   ```

   The argument (here: `server`) is used for the private key filename.

3 Accept the default parameters, but fill `server` for the `Common Name` option.

4 Answer the next two questions («Sign the certificate? [y/n]» and «1 out of 1 certificate requests certified, commit? [y/n]») with `y` (yes).

Once done, the private server key is saved as `/usr/share/openvpn/easy-rsa/VER/keys/server.*`.

***Процедура 15.5*** *Generate Certificates and Keys for a Client*

1 Change to the `/usr/share/openvpn/easy-rsa/VER/` directory. Replace the placeholder *VER* with either `1.0` or `2.0`.

2 Create the key as in Шаг 2 (стр. 196) of Процедура 15.4, «Generate The Private Server Key» (стр. 196):

```
./build-key client
```

3 Repeat the previous step for each client that is allowed to connect to the VPN server. Make sure you use a different name (other than «`client`») and an appropriate `Common Name`, because this parameter has to be unique for each client.

Once done, the client certificate keys are saved as `/usr/share/openvpn/easy-rsa/keys/client.*` (depending on the name that you have given for the `build-key` command).

***Процедура 15.6*** *Final Configuration Steps*

1 Make sure your current working directory is `/usr/share/openvpn/easy-rsa/VER/`.

2 Create the Diffie-Hellman parameter:

```
./build-dh
```

3 Create the `/etc/openvpn/ssl` directory.

4 Copy the following files to `/etc/openvpn/ssl`:

```
cp keys/ca.{crt,key} keys/dh1024.pem keys/server.{crt,key} /etc/openvpn/
ssl
```

5 Copy the client keys to the relevant client machine. You should have the files `client.crt` and `client.key` in the `/etc/openvpn/ssl` directory.

## 15.3.2 Configuring the Server

The configuration file is mostly a summary of `/usr/share/doc/packages/openvpn/sample-config-files/server.conf` without the comments and with some small changes concerning some paths.

***Пример 15.1*** *VPN Server Configuration File*

```
# /etc/openvpn/server.conf
port 1194 ❶
proto udp ❷
dev tun0 ❸

# Security ❹
ca   ssl/ca.crt
cert ssl/server.crt
key  ssl/server.key
dh   ssl/dh1024.pem

server 192.168.1.120  255.255.255.0 ❺
ifconfig-pool-persist /var/run/openvpn/ipp.txt ❻

# Privileges ❼
user nobody
group nobody

# Other configuration ❽
keepalive 10 120
comp-lzo
persist-key
persist-tun
status      /var/log/openvpn-status.log
log-append  /var/log/openvpn.log
verb 4
```

❶ The TCP/UDP port to which OpenVPN listens. You have to open up the port in the Firewall, see Глава 14, *Masquerading and Firewalls* (стр. 177). The standard port for VPN is 1194, so in most cases you can leave that as it is.

❷ The protocol, either UDP or TCP.

❸ The tun or tap device, see Раздел 15.1.2, «Tun and Tap Devices» (стр. 192) for the differences.

❹ The following lines contain the relative or absolute path to the root server CA certificate (`ca`), the root CA key (`cert`), the private server key (`key`) and the Diffie-Hellman parameters (`dh`). These were generated in Раздел 15.3.1, «Creating Certificates» (стр. 195).

❺ Supplies a VPN subnet. The server can be reached by `192.168.1.120`.

❻ Records a mapping of clients and its virtual IP address in the given file. Useful when the server goes down and (after the restart) the clients get their previously assigned IP address.

❼ For security reasons it is a good idea to run the OpenVPN daemon with reduced privileges. For this reason the group and user `nobody` is used.

❽ Several other configurations, see comment in the original configuration from `/usr/share/doc/packages/openvpn/sample-config-files`.

After this configuration, you can see log messages from your OpenVPN server under `/var/log/openvpn.log` . When you have started it for the first time, it should finish it with:

```
... Initialization Sequence Completed
```

If you do not see this message, check the log carefully. Usually OpenVPN gives you some hints what is wrong in your configuration file.

## 15.3.3 Configuring the Clients

The configuration file is mostly a summary from `/usr/share/doc/packages/openvpn/sample-config-files/client.conf` without the comments and with some small changes concerning some paths.

***Пример 15.2*** *VPN Client Configuration File*

```
# /etc/openvpn/client.conf
client ❶
dev tun ❷
proto udp ❸
remote IP_OR_HOSTNAME 1194 ❹
resolv-retry infinite
nobind

# Privileges ❺
user nobody
group nobody

# Try to preserve some state across restarts.
persist-key
persist-tun

# Security ❻
ca   ssl/ca.crt
cert ssl/client.crt
key  ssl/client.key

comp-lzo ❼
```

❶ We must specify that this machine is a client.

❷ The network device. Both clients and server must use the same device.

❸ The protocol. Use the same settings as on the server.

❹ Replace the placeholder *IP_OR_HOSTNAME* with the respective hostname or IP address of your VPN server. After the hostname the port of the server is given. You can have multiple lines of `remote` entries pointing to different VPN servers. This is useful for load balancing between different VPN servers.

❺ For security reasons it is a good idea to run the OpenVPN daemon with reduced privileges. For this reason the group and user `nobody` is used.

❻ Contains the client files. For security reasons, it is better to have a separate file pair for each client.

❼ Turns compression on. Use it only when the server has this parameter switched on as well.

# 15.4 Changing Nameservers in VPN

If you need to change nameservers before or during your VPN session, use `netconfig`.

Use the following procedure to change a nameserver:

***Процедура 15.7*** *Changing Nameservers*

**1** Open a shell and log in as `root`.

**2** Create the file `/etc/openvpn/client.up` with the following contents:

```
/sbin/netconfig modify -i "${1}" -s openvpn <<EOT
DNSSEARCH='${domain}'
DNSSERVERS='${dns[*]}'
EOT
```

**3** Start your VPN connection with `rcopenvpn start`.

**4** Create the file `/etc/openvpn/client.down` with the following contents:

```
/sbin/netconfig remove -i "${1}" -s openvpn
```

**5** Run `netconfig` and replace the line `DNSSERVERS` with your respective entry:

```
netconfig modify -i tun0 -s openvpn <<EOT
DNSSEARCH='mt-home.net'
DNSSERVERS='192.168.1.116'
EOT
```

To check, if the entry has been successfully inserted into `/etc/resolv.conf`, execute:

```
grep -v ^# /etc/resolv.conf
search mt-home.net mat-home.net
nameserver ...
nameserver ...
nameserver 192.168.1.116
```

**6** To remove the DNS entry, execute:

```
netconfig remove -i tun0 -s openvpn
```

Find another example in `/usr/share/doc/packages/openvpn/contrib/pull-resolv-conf/`.

If you need to specify a ranking list of fallback services, use the `NETCONFIG_DNS_RANKING` variable in `/etc/sysconfig/network/config`. The default value is `auto` which resolves to:

```
+strongswan +openswan +racoon +openvpn -avahi
```

Preferred service names have the + prefix, fallback services the − prefix.

# 15.5 KDE- and GNOME Applets For Clients

The following sections describe the setup of OpenVPN connections with GNOME and KDE desktop tools.

## 15.5.1 KDE

To setup an OpenVPN connection in KDE4 that can be easily turned on or off, proceed as follows:

1. Make sure you have installed the `NetworkManager-openvpn-kde4` package with all dependencies resolved.
2. Right-click on a widget of your panel and select *Panel Options* > *Add Widgets...*.
3. Select *Networks*.
4. Right-click on the icon and choose *Manage Connections*.
5. Add a new VPN connection with *Add* > *OpenVPN*. A new window opens.
6. Choose the *Connection Type* between *X.509 Certificates* or *X.509 With Password* depending on what you have setup with your OpenVPN server.
7. Insert the necessary files into the respective text fields. From our example configuration these are:

| | |
|---|---|
| *CA file* | `/etc/openvpn/ssl/ca.crt` |
| *Certificate* | `/etc/openvpn/ssl/client1.crt` |

| | |
|---|---|
| *Key* | `/etc/openvpn/ssl/client1.key` |
| *Username* | The user |
| *Password* | The password for the user |

8 If you have not used the KDE Wallet System, you are asked if you want to configure it. Follow the steps in the wizard. After you have finished this step, you are reverted back to the *Network Settings* dialog.

9 Finish with *Ok*.

10 Enable the connection with your Network manager applet.

## 15.5.2 GNOME

To setup a OpenVPN connection in GNOME that can be easily turned on or off, proceed as follows:

1 Make sure you have installed the `NetworkManager-openvpn-gnome` package with all dependencies resolved.

2 Start the Network Connection Editor with Alt + F2 and insert `nm-connection-editor` into the text field. A new window appears.

3 Select the *VPN* tab and click *Add*.

4 Choose the VPN connection type, in this case *OpenVPN*.

5 Choose the *Authentication* type. Select between *Certificates (TLS)* or *Password with Certificates (TLS)* depending on the setup of your OpenVPN server.

6 Insert the necessary files into the respective text fields. According to the example configuration, these are:

| | |
|---|---|
| *Username* | The user (only available when you have selected *Password with Certificates (TLS)*) |

| | |
|---|---|
| *Password* | The password for the user (only available when you have selected *Password with Certificates (TLS)*) |
| *User Certificate* | `/etc/openvpn/ssl/client1.crt` |
| *CA Certificate* | `/etc/openvpn/ssl/ca.crt` |
| *Private Key* | `/etc/openvpn/ssl/client1.key` |

7 Finish with *Apply* and *Close*.

8 Enable the connection with your Network Manager applet.

# 15.6 For More Information

For more information about VPN, visit:

- `http://www.openvpn.net` : Homepage of VPN
- `/usr/share/doc/packages/openvpn/sample-config-files/`: Examples of configuration files for different scenarios

# 16 Managing X.509 Certification

An increasing number of authentication mechanisms are based on cryptographic procedures. Digital certificates that assign cryptographic keys to their owners play an important role in this context. These certificates are used for communication and can also be found, for example, on company ID cards. The generation and administration of certificates is mostly handled by official institutions that offer this as a commercial service. In some cases, however, it may make sense to carry out these tasks yourself. For example, if a company does not wish to pass personal data to third parties.

YaST provides two modules for certification, which offer basic management functions for digital X.509 certificates. The following sections explain the basics of digital certification and how to use YaST to create and administer certificates of this type. For more detailed information, refer to http://www.ietf.org/html.charters/pkix-charter.html .

## 16.1 The Principles of Digital Certification

Digital certification uses cryptographic processes to encrypt data, protect the data from access by unauthorized people. The user data is encrypted using a second data record, or *key*. The key is applied to the user data in a mathematical process, producing an altered data record in which the original content can no longer be identified. Asymmetrical encryption is now in general use (*public key method*). Keys always occur in pairs:

Private Key
: The private key must be kept safely by the key owner. Accidental publication of the private key compromises the key pair and renders it useless.

Public Key
: The key owner circulates the public key for use by third parties.

## 16.1.1 Key Authenticity

Because the public key process is in widespread use, there are many public keys in circulation. Successful use of this system requires that every user be sure that a public key actually belongs to the assumed owner. The assignment of users to public keys is confirmed by trustworthy organizations with public key certificates. Such certificates contain the name of the key owner, the corresponding public key, and the electronic signature of the person issuing the certificate.

Trustworthy organizations that issue and sign public key certificates are usually part of a certification infrastructure that is also responsible for the other aspects of certificate management, such as publication, withdrawal, and renewal of certificates. An infrastructure of this kind is generally referred to as a *public key infrastructure* or *PKI*. One familiar PKI is the *OpenPGP* standard in which users publish their certificates themselves without central authorization points. These certificates become trustworthy when signed by other parties in the «web of trust.»

The *X.509 Public Key Infrastructure* (PKIX) is an alternative model defined by the *IETF* (Internet Engineering Task Force) that serves as a model for almost all publicly-used PKIs today. In this model, authentication is made by *certificate authorities* (CA) in a hierarchical tree structure. The root of the tree is the root CA, which certifies all sub-CAs. The lowest level of sub-CAs issue user certificates. The user certificates are trustworthy by certification that can be traced to the root CA.

The security of such a PKI depends on the trustworthiness of the CA certificates. To make certification practices clear to PKI customers, the PKI operator defines a *certification practice statement* (CPS) that defines the procedures for certificate management. This should ensure that the PKI only issues trustworthy certificates.

## 16.1.2 X.509 Certificates

An X.509 certificate is a data structure with several fixed fields and, optionally, additional extensions. The fixed fields mainly contain the name of the key owner,

the public key, and the data relating to the issuing CA (name and signature). For security reasons, a certificate should only have a limited period of validity, so a field is also provided for this date. The CA guarantees the validity of the certificate in the specified period. The CPS usually requires the PKI (the issuing CA) to create and distribute a new certificate before expiration.

The extensions can contain any additional information. An application is only required to be able to evaluate an extension if it is identified as *critical*. If an application does not recognize a critical extension, it must reject the certificate. Some extensions are only useful for a specific application, such as signature or encryption.

Таблица 16.1 shows the fields of a basic X.509 certificate in version 3.

***Таблица 16.1*** *X.509v3 Certificate*

| Field | Content |
|---|---|
| Version | The version of the certificate, for example, v3 |
| Serial Number | Unique certificate ID (an integer) |
| Signature | The ID of the algorithm used to sign the certificate |
| Issuer | Unique name (DN) of the issuing authority (CA) |
| Validity | Period of validity |
| Subject | Unique name (DN) of the owner |
| Subject Public Key Info | Public key of the owner and the ID of the algorithm |
| Issuer Unique ID | Unique ID of the issuing CA (optional) |
| Subject Unique ID | Unique ID of the owner (optional) |
| Extensions | Optional additional information, such as «KeyUsage» or «BasicConstraints» |

## 16.1.3 Blocking X.509 Certificates

If a certificate becomes untrustworthy before it has expired, it must be blocked immediately. This can become necessary if, for example, the private key has accidentally been made public. Blocking certificates is especially important if the private key belongs to a CA rather than a user certificate. In this case, all user certificates issued by the relevant CA must be blocked immediately. If a certificate is blocked, the PKI (the responsible CA) must make this information available to all those involved using a *certificate revocation list* (CRL).

These lists are supplied by the CA to public CRL distribution points (CDPs) at regular intervals. The CDP can optionally be named as an extension in the certificate, so a checker can fetch a current CRL for validation purposes. One way to do this is the *online certificate status protocol* (OCSP). The authenticity of the CRLs is ensured with the signature of the issuing CA. Таблица 16.2 shows the basic parts of a X.509 CRL.

***Таблица 16.2*** *X.509 Certificate Revocation List (CRL)*

| Field | Content |
|---|---|
| Version | The version of the CRL, such as v2 |
| Signature | The ID of the algorithm used to sign the CRL |
| Issuer | Unique name (DN) of the publisher of the CRL (usually the issuing CA) |
| This Update | Time of publication (date, time) of this CRL |
| Next Update | Time of publication (date, time) of the next CRL |
| List of revoked certificates | Every entry contains the serial number of the certificate, the time of revocation, and optional extensions (CRL entry extensions) |

| Field | Content |
| --- | --- |
| Extensions | Optional CRL extensions |

## 16.1.4 Repository for Certificates and CRLs

The certificates and CRLs for a CA must be made publicly accessible using a *repository*. Because the signature protects the certificates and CRLs from being forged, the repository itself does not need to be secured in a special way. Instead, it tries to grant the simplest and fastest access possible. For this reason, certificates are often provided on an LDAP or HTTP server. Find explanations about LDAP in Глава 4, *LDAP—A Directory Service* (стр. 39). Глава 30, *The Apache HTTP Server* (↑Reference) contains information about the HTTP server.

## 16.1.5 Proprietary PKI

YaST contains modules for the basic management of X.509 certificates. This mainly involves the creation of CAs, sub-CAs, and their certificates. The services of a PKI go far beyond simply creating and distributing certificates and CRLs. The operation of a PKI requires a well-conceived administrative infrastructure allowing continuous update of certificates and CRLs. This infrastructure is provided by commercial PKI products and can also be partly automated. YaST provides tools for creating and distributing CAs and certificates, but cannot currently offer this background infrastructure. To set up a small PKI, you can use the available YaST modules. However, you should use commercial products to set up an «official» or commercial PKI.

# 16.2 YaST Modules for CA Management

YaST provides two modules for basic CA management. The primary management tasks with these modules are explained here.

## 16.2.1 Creating a Root CA

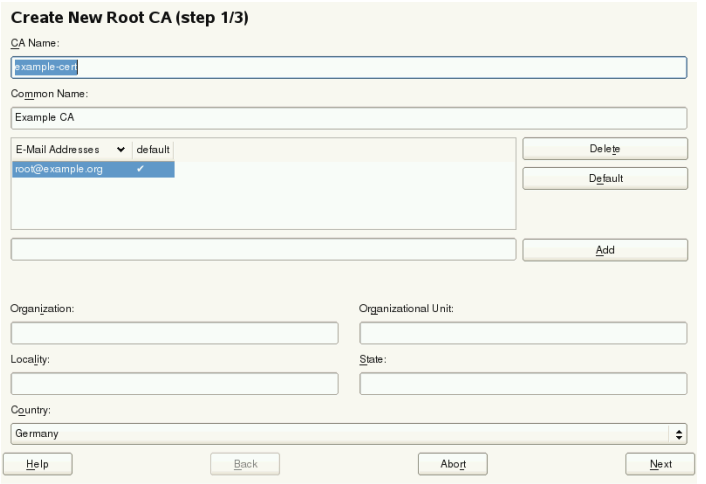
The first step when setting up a PKI is to create a root CA. Do the following:

1 Start YaST and go to *Security and Users* > *CA Management*.

2 Click *Create Root CA*.

3 Enter the basic data for the CA in the first dialog, shown in Рисунок 16.1. The text fields have the following meanings:

***Рисунок 16.1*** *YaST CA Module—Basic Data for a Root CA*




*CA Name*
: Enter the technical name of the CA. Directory names, among other things, are derived from this name, which is why only the characters listed in the help can be used. The technical name is also displayed in the overview when the module is started.

*Common Name*
: Enter the name for use in referring to the CA.

*E-Mail Addresses*
: Several e-mail addresses can be entered that can be seen by the CA user. This can be helpful for inquiries.

*Country*
Select the country where the CA is operated.

*Organization*, *Organizational Unit*, *Locality*, *State*
Optional values

Proceed with *Next*.

**4** Enter a password in the second dialog. This password is always required when using the CA—when creating a sub-CA or generating certificates. The text fields have the following meaning:

*Key Length*
*Key Length* contains a meaningful default and does not generally need to be changed unless an application cannot deal with this key length. The higher the number the more secure your password is.

*Valid Period (days)*
The *Valid Period* in the case of a CA defaults to 3650 days (roughly ten years). This long period makes sense because the replacement of a deleted CA involves an enormous administrative effort.

Clicking *Advanced Options* opens a dialog for setting different attributes from the X.509 extensions (Рисунок 16.4, «YaST CA Module—Extended Settings» (стр. 216)). These values have rational default settings and should only be changed if you are really sure of what you are doing. Proceed with *Next*.

**5** Review the summary. YaST displays the current settings for confirmation. Click *Create*. The root CA is created then appears in the overview.

---

**ПОДСКАЗКА**

In general, it is best not to allow user certificates to be issued by the root CA. It is better to create at least one sub-CA and create the user certificates from there. This has the advantage that the root CA can be kept isolated and secure, for example, on an isolated computer on secure premises. This makes it very difficult to attack the root CA.

---

## 16.2.2 Changing Password

If you need to change your password for your CA, proceed as follows:

**1** Start YaST and open the CA module.

**2** Select the required root CA and click *Enter CA*.

**3** Enter the password if you entered a CA the first time. YaST displays the CA key information in the *Description* tab (see Рисунок 16.2).

**4** Click *Advanced* and select *Change CA Password*. A dialog box opens.

**5** Enter the old and the new password.

**6** Finish with *OK*

## 16.2.3 Creating or Revoking a Sub-CA

A sub-CA is created in exactly the same way as a root CA.

---

**ЗАМЕЧАНИЕ**

The validity period for a sub-CA must be fully within the validity period of the «parent» CA. A sub-CA is always created after the «parent» CA, therefore, the default value leads to an error message. To avoid this, enter a permissible value for the period of validity.

---

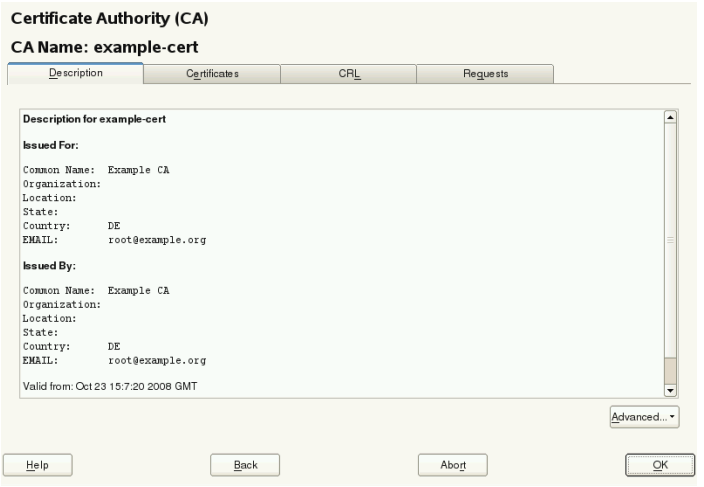
Do the following:

**1** Start YaST and open the CA module.

**2** Select the required root CA and click *Enter CA*.

**3** Enter the password if you are entering a CA for the first time. YaST displays the CA key information in the tab *Description* (see Рисунок 16.2).

***Рисунок 16.2*** *YaST CA Module—Using a CA*




**4** Click *Advanced* and select *Create SubCA*. This opens the same dialog as for creating a root CA.

**5** Proceed as described in Раздел 16.2.1, «Creating a Root CA» (стр. 210).

It is possible to use one password for all your CAs. Enable *Use CA Password as Certificate Password* to give your sub-CAs the same password as your root CA. This helps to reduce the amount of passwords for your CAs.

---

**ЗАМЕЧАНИЕ: Check your Valid Period**

Take into account that the valid period must be lower than the valid period in the root CA.

---

**6** Select the *Certificates* tab. Reset compromised or otherwise unwanted sub-CAs here, using *Revoke*. Revocation alone is not enough to deactivate a sub-CA. You must also publish revoked sub-CAs in a CRL. The creation of CRLs is described in Раздел 16.2.6, «Creating CRLs» (стр. 217).

**7** Finish with *OK*

# 16.2.4 Creating or Revoking User Certificates

Creating client and server certificates is very similar to creating CAs in Раздел 16.2.1, «Creating a Root CA» (стр. 210). The same principles apply here. In certificates intended for e-mail signature, the e-mail address of the sender (the private key owner) should be contained in the certificate to enable the e-mail program to assign the correct certificate. For certificate assignment during encryption, it is necessary for the e-mail address of the recipient (the public key owner) to be included in the certificate. In the case of server and client certificates, the hostname of the server must be entered in the *Common Name* field. The default validity period for certificates is 365 days.

To create client and server certificates, do the following:

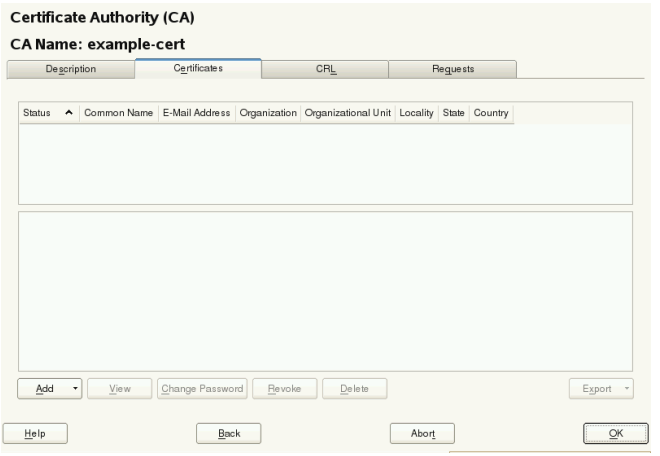
**1** Start YaST and open the CA module.

**2** Select the required root CA and click *Enter CA*.

**3** Enter the password if you are entering a CA for the first time. YaST displays the CA key information in the *Description* tab.

**4** Click *Certificates* (see Рисунок 16.3).

***Рисунок 16.3*** *Certificates of a CA*



5 Click *Add* > *Add Server Certificate* and create a server certificate.

6 Click *Add* > *Add Client Certificate* and create a client certificate. Do not forget to enter an e-mail address.

7 Finish with *OK*

To revoke compromised or otherwise unwanted certificates, do the following:

1 Start YaST and open the CA module.

2 Select the required root CA and click *Enter CA*.

3 Enter the password if you are entering a CA for the first time. YaST displays the CA key information in the *Description* tab.

4 Click *Certificates* (see Раздел 16.2.3, «Creating or Revoking a Sub-CA» (стр. 212).)

5 Select the certificate to revoke and click *Revoke*.

6 Choose a reason to revoke this certificate

7 Finish with *OK*.

**ЗАМЕЧАНИЕ**

Revocation alone is not enough to deactivate a certificate. Also publish revoked certificates in a CRL. Раздел 16.2.6, «Creating CRLs» (стр. 217) explains how to create CRLs. Revoked certificates can be completely removed after publication in a CRL with *Delete*.

## 16.2.5 Changing Default Values

The previous sections explained how to create sub-CAs, client certificates, and server certificates. Special settings are used in the extensions of the X.509 certificate. These settings have been given rational defaults for every certificate type and do not normally need to be changed. However, it may be that you have special requirements for these extensions. In this case, it may make sense to adjust the defaults. Otherwise, start from scratch every time you create a certificate.

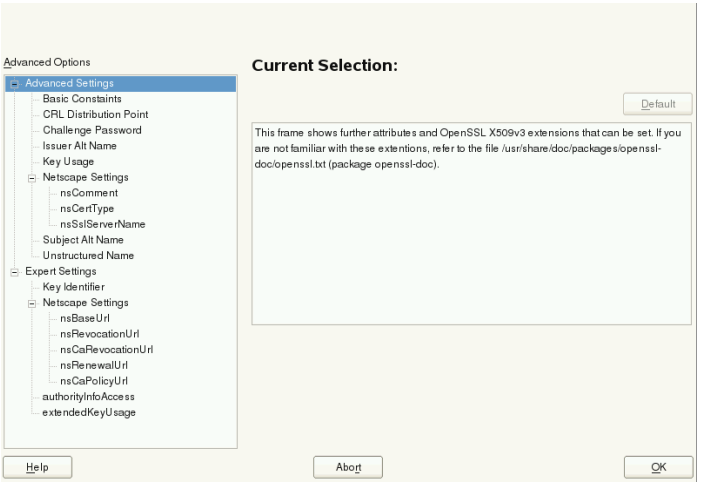
1 Start YaST and open the CA module.

2 Enter the required root CA, as described in Раздел 16.2.3, «Creating or Revoking a Sub-CA» (стр. 212).

3 Click *Advanced* > *Edit Defaults*.

4 Choose the type the settings to change. The dialog for changing the defaults, shown in Рисунок 16.4, «YaST CA Module—Extended Settings» (стр. 216), then opens.

***Рисунок 16.4*** *YaST CA Module—Extended Settings*




5 Change the associated value on the right side and set or delete the critical setting with *critical*.

6 Click *Next* to see a short summary.

7 Finish your changes with *Save*.

**ЗАМЕЧАНИЕ**

All changes to the defaults only affect objects created after this point. Already-existing CAs and certificates remain unchanged.

## 16.2.6 Creating CRLs

If compromised or otherwise unwanted certificates need to be excluded from further use, they must first be revoked. The procedure for this is explained in Раздел 16.2.3, «Creating or Revoking a Sub-CA» (стр. 212) (for sub-CAs) and Раздел 16.2.4, «Creating or Revoking User Certificates» (стр. 214) (for user certificates). After this, a CRL must be created and published with this information.

The system maintains only one CRL for each CA. To create or update this CRL, do the following:

1. Start YaST and open the CA module.
2. Enter the required CA, as described in Раздел 16.2.3, «Creating or Revoking a Sub-CA» (стр. 212).
3. Click *CRL*. The dialog that opens displays a summary of the last CRL of this CA.
4. Create a new CRL with *Generate CRL* if you have revoked new sub-CAs or certificates since its creation.
5. Specify the period of validity for the new CRL (default: 30 days).
6. Click *OK* to create and display the CRL. Afterwards, you must publish this CRL.

**ЗАМЕЧАНИЕ**

Applications that evaluate CRLs reject every certificate if the CRL is not available or has expired. As a PKI provider, it is your duty always to create and publish a new CRL before the current CRL expires (period of validity). YaST does not provide a function for automating this procedure.

## 16.2.7 Exporting CA Objects to LDAP

The executing computer should be configured with the YaST LDAP client for LDAP export. This provides LDAP server information at runtime that can be used when completing dialog fields. Otherwise (although export may be possible), all LDAP data must be entered manually. You must always enter several passwords (see Таблица 16.3, «Passwords during LDAP Export» (стр. 218)).

***Таблица 16.3*** *Passwords during LDAP Export*

| Password | Meaning |
|---|---|
| LDAP Password | Authorizes the user to make entries in the LDAP tree. |
| Certificate Password | Authorizes the user to export the certificate. |
| New Certificate Password | The PKCS12 format is used during LDAP export. This format forces the assignment of a new password for the exported certificate. |

Certificates, CAs, and CRLs can be exported to LDAP.

Exporting a CA to LDAP
: To export a CA, enter the CA as described in Раздел 16.2.3, «Creating or Revoking a Sub-CA» (стр. 212). Select *Extended* > *Export to LDAP* in the subsequent dialog, which opens the dialog for entering LDAP data. If your system has been configured with the YaST LDAP client, the fields are already partly completed. Otherwise, enter all the data manually. Entries are made in LDAP in a separate tree with the attribute «caCertificate».

Exporting a Certificate to LDAP
: Enter the CA containing the certificate to export then select *Certificates*. Select the required certificate from the certificate list in the upper part of the dialog and select *Export* > *Export to LDAP*. The LDAP data is entered here in the same way as for CAs. The certificate is saved with the corresponding user object in the LDAP tree with the attributes «userCertificate» (PEM format) and «userPKCS12» (PKCS12 format).

Exporting a CRL to LDAP
: Enter the CA containing the CRL to export and select *CRL*. If desired, create a new CRL and click *Export*. The dialog that opens displays the export parameters. You can export the CRL for this CA either once or in periodical time intervals. Activate the export by selecting *Export to LDAP* and enter the respective LDAP data. To do this at regular intervals, select the *Repeated Recreation and Export* radio button and change the interval, if appropriate.

## 16.2.8 Exporting CA Objects as a File

If you have set up a repository on the computer for administering CAs, you can use this option to create the CA objects directly as a file at the correct location. Different output formats are available, such as PEM, DER, and PKCS12. In the case of PEM, it is also possible to choose whether a certificate should be exported with or without key and whether the key should be encrypted. In the case of PKCS12, it is also possible to export the certification path.

Export a file in the same way for certificates, CAs as with LDAP, described in Раздел 16.2.7, «Exporting CA Objects to LDAP» (стр. 217), except you should select *Export as File* instead of *Export to LDAP*. This then takes you to a dialog for selecting the required output format and entering the password and filename. The certificate is stored at the required location after clicking *OK*.

For CRLs click *Export*, select *Export to file*, choose the export format (PEM or DER) and enter the path. Proceed with *OK* to save it to the respective location.

**ПОДСКАЗКА**

You can select any storage location in the file system. This option can also be used to save CA objects on a transport medium, such as a USB stick. The `/media` directory generally holds any type of drive except the hard drive of your system.

## 16.2.9 Importing Common Server Certificates

If you have exported a server certificate with YaST to your media on an isolated CA management computer, you can import this certificate on a server as a *common server certificate*. Do this during installation or at a later point with YaST.

**ЗАМЕЧАНИЕ**

You need one of the PKCS12 formats to import your certificate successfully.

The general server certificate is stored in `/etc/ssl/servercerts` and can be used there by any CA-supported service. When this certificate expires, it can easily

be replaced using the same mechanisms. To get things functioning with the replaced certificate, restart the participating services.

---

**ПОДСКАЗКА**

If you select *Import* here, you can select the source in the file system. This option can also be used to import certificates from a transport medium, such as a USB stick.

---

To import a common server certificate, do the following:

1. Start YaST and open *Common Server Certificate* under *Security and Users*
2. View the data for the current certificate in the description field after YaST has been started.
3. Select *Import* and the certificate file.
4. Enter the password and click *Next*. The certificate is imported then displayed in the description field.
5. Close YaST with *Finish*.

# Часть IV. Ограничение привилегий с Novell AppArmor

# 17 Introducing AppArmor

Many security vulnerabilities result from bugs in *trusted* programs. A trusted program runs with privileges that attackers would like to have. The program fails to keep that trust if there is a bug in the program that allows the attacker to acquire said privilege.

Novell® AppArmor is an application security solution designed specifically to apply privilege confinement to suspect programs. AppArmor allows the administrator to specify the domain of activities the program can perform by developing a security *profile* for that application (a listing of files that the program may access and the operations the program may perform). AppArmor secures applications by enforcing good application behavior without relying on attack signatures, so it can prevent attacks even if previously unknown vulnerabilities are being exploited.

Novell AppArmor consists of:

- A library of AppArmor profiles for common Linux* applications, describing what files the program needs to access.
- A library of AppArmor profile foundation classes (profile building blocks) needed for common application activities, such as DNS lookup and user authentication.
- A tool suite for developing and enhancing AppArmor profiles, so that you can change the existing profiles to suit your needs and create new profiles for your own local and custom applications.

- Several specially modified applications that are AppArmor enabled to provide enhanced security in the form of unique subprocess confinement (including Apache and Tomcat).
- The Novell AppArmor–loadable kernel module and associated control scripts to enforce AppArmor policies on your openSUSE® system.

# 17.1 Background Information on AppArmor Profiling

For more information about the science and security of Novell AppArmor, refer to the following papers:

*SubDomain: Parsimonious Server Security* by Crispin Cowan, Steve Beattie, Greg Kroah-Hartman, Calton Pu, Perry Wagle, and Virgil Gligor
: Describes the initial design and implementation of Novell AppArmor. Published in the proceedings of the USENIX LISA Conference, December 2000, New Orleans, LA. This paper is now out of date, describing syntax and features that are different from the current Novell AppArmor product. This paper should be used only for background, and not for technical documentation.

*Defcon Capture the Flag: Defending Vulnerable Code from Intense Attack* by Crispin Cowan, Seth Arnold, Steve Beattie, Chris Wright, and John Viega
: A good guide to strategic and tactical use of Novell AppArmor to solve severe security problems in a very short period of time. Published in the Proceedings of the DARPA Information Survivability Conference and Expo (DISCEX III), April 2003, Washington, DC.

*AppArmor for Geeks* by Seth Arnold
: This document tries to convey a better understanding of the technical details of AppArmor. It is available at http://en.opensuse.org/AppArmor_Geeks .

*AppArmor Technical Documentation* by Andreas Gruenbacher and Seth Arnold
: This document discusses the concept and design of AppArmor from a very technical point of view. It is available at http://forgeftp.novell.com//apparmor/LKML_Submission-June-07/techdoc.html .

# 18 Getting Started

Prepare a successful deployment of Novell AppArmor on your system by carefully considering the following items:

1. Determine the applications to profile. Read more on this in Раздел 18.3, «Choosing the Applications to Profile» (стр. 227).
2. Build the needed profiles as roughly outlined in Раздел 18.4, «Building and Modifying Profiles» (стр. 228). Check the results and adjust the profiles when necessary.
3. Keep track of what is happening on your system by running AppArmor reports and dealing with security events. Refer to Раздел 18.5, «Configuring Novell AppArmor Event Notification and Reports» (стр. 230).
4. Update your profiles whenever your environment changes or you need to react to security events logged by AppArmor's reporting tool. Refer to Раздел 18.6, «Updating Your Profiles» (стр. 231).

## 18.1 Installing Novell AppArmor

Novell AppArmor is installed and running on any installation of openSUSE® by default, regardless of what patterns are installed. The packages listed below are needed for a fully-functional instance of AppArmor

- `apparmor-docs`

- `apparmor-parser`
- `apparmor-profiles`
- `apparmor-utils`
- `audit`
- `libapparmor1`
- `perl-libapparmor`
- `yast2-apparmor`

# 18.2 Enabling and Disabling Novell AppArmor

Novell AppArmor is configured to run by default on any fresh installation of openSUSE. There are two ways of toggling the status of AppArmor:

Using YaST System Services (Runlevel)
: Disable or enable AppArmor by removing or adding its boot script to the sequence of scripts executed on system boot. Status changes are applied on reboot.

Using Novell AppArmor Control Panel
: Toggle the status of Novell AppArmor in a running system by switching it off or on using the YaST Novell AppArmor Control Panel. Changes made here are applied instantaneously. The Control Panel triggers a stop or start event for AppArmor and removes or adds its boot script in the system's boot sequence.

To disable AppArmor permanently (by removing it from the sequence of scripts executed on system boot) proceed as follows:

**1** Start YaST.

**2** Select *System* > *System Services (Runlevel)*.

**3** Select *Expert Mode*.

**4** Select `boot.apparmor` and click *Set/Reset* > *Disable the service*.

**5** Exit the YaST Runlevel tool with *Finish*.

AppArmor will not be initialized on reboot, and stays inactive until you reenable it. Reenabling a service using the YaST Runlevel tool is similar to disabling it.

Toggle the status of AppArmor in a running system by using the AppArmor Control Panel. These changes take effect as soon as you apply them and survive a reboot of the system. To toggle AppArmor's status, proceed as follows:

**1** Start YaST.

**2** Select *Novell AppArmor > AppArmor Control Panel*.

**3** Select *Enable AppArmor*. To disable AppArmor, uncheck this option.

**4** Exit the AppArmor Control Panel with *Done*.

# 18.3 Choosing the Applications to Profile

You only need to protect the programs that are exposed to attacks in your particular setup, so only use profiles for those applications you actually run. Use the following list to determine the most likely candidates:

Network Agents
Web Applications
Cron Jobs

To find out which processes are currently running with open network ports and might need a profile to confine them, run `aa-unconfined` as `root`.

***Пример 18.1*** *Output of aa-unconfined*

```
19848 /usr/sbin/cupsd not confined
19887 /usr/sbin/sshd not confined
19947 /usr/lib/postfix/master not confined
29205 /usr/sbin/sshd confined by '/usr/sbin/sshd (enforce)'
```

Each of the processes in the above example labeled `not confined` might need a custom profile to confine it. Those labeled `confined by` are already protected by AppArmor.

**ПОДСКАЗКА: For More Information**

For more information about choosing the the right applications to profile, refer to Раздел 19.2, «Determining Programs to Immunize» (стр. 236).

# 18.4 Building and Modifying Profiles

Novell AppArmor on openSUSE ships with a preconfigured set of profiles for the most important applications. In addition, you can use AppArmor to create your own profiles for any application you want.

There are two ways of managing profiles. One is to use the graphical front-end provided by the YaST Novell AppArmor modules and the other is to use the command line tools provided by the AppArmor suite itself. Both methods basically work the same way.

For each application, perform the following steps to create a profile:

**1** As `root`, let AppArmor create a rough outline of the application's profile by running `aa-genprof` *`programname`*

*or*

Outline the basic profile by running *YaST* > *Novell AppArmor* > *Add Profile Wizard* and specifying the complete path to the application you want to profile.

A basic profile is outlined and AppArmor is put into learning mode, which means that it logs any activity of the program you are executing, but does not yet restrict it.

**2** Run the full range of the application's actions to let AppArmor get a very specific picture of its activities.

**3** Let AppArmor analyze the log files generated in Шаг 2 (стр. 228) by typing S in aa-genprof.

*or*

Analyze the logs by clicking *Scan System Log for AppArmor Events* in the *Add Profile Wizard* and following the instructions given in the wizard until the profile is completed.

AppArmor scans the logs it recorded during the application's run and asks you to set the access rights for each event that was logged. Either set them for each file or use globbing.

4 Depending on the complexity of your application, it might be necessary to repeat Шаг 2 (стр. 228) and Шаг 3 (стр. 228). Confine the application, exercise it under the confined conditions, and process any new log events. To properly confine the full range of an application's capabilities, you might be required to repeat this procedure often.

5 Once all access permissions are set, your profile is set to enforce mode. The profile is applied and AppArmor restricts the application according to the profile just created.

If you started aa-genprof on an application that had an existing profile that was in complain mode, this profile remains in learning mode upon exit of this learning cycle. For more information about changing the mode of a profile, refer to «aa-complain—Entering Complain or Learning Mode» (стр. 299) and «aa-enforce —Entering Enforce Mode» (стр. 300).

Test your profile settings by performing every task you need with the application you just confined. Normally, the confined program runs smoothly and you do not notice AppArmor activities at all. However, if you notice certain misbehavior with your application, check the system logs and see if AppArmor is too tightly confining your application. Depending on the log mechanism used on your system, there are several places to look for AppArmor log entries:

```
/var/log/audit/audit.log
/var/log/messages
dmesg
```

To adjust the profile, analyze the log messages relating to this application again as described in Шаг 3 (стр. 228). Determine the access rights or restrictions when prompted.

**ПОДСКАЗКА: For More Information**

For more information about profile building and modification, refer to Глава 20, *Profile Components and Syntax* (стр. 243), Глава 22, *Building and Managing Profiles with YaST* (стр. 271), and Глава 23, *Building Profiles from the Command Line* (стр. 291).

# 18.5 Configuring Novell AppArmor Event Notification and Reports

Set up event notification in Novell AppArmor so you can review security events. Event Notification is an Novell AppArmor feature that informs a specified e-mail recipient when systemic Novell AppArmor activity occurs under the chosen severity level. This feature is currently available in the YaST interface.

To set up event notification in YaST, proceed as follows:

1. Make sure that a mail server is running on your system to deliver the event notifications.
2. Start YaST. Then select *Novell AppArmor* > *AppArmor Control Panel*. In *Security Event Notification*, select *Configure*.
3. For each record type (*Terse*, *Summary*, and *Verbose*), set a report frequency, enter the e-mail address that should receive the reports, and determine the severity of events to log. To include unknown events in the event reports, check *Include Unknown Severity Events*.

   **ЗАМЕЧАНИЕ: Selecting Events to Log**

   Unless you are familiar with AppArmor's event categorization, choose to be notified about events for all security levels.

4. Leave this dialog with *OK* > *Done* to apply your settings.

Using Novell AppArmor reports, you can read important Novell AppArmor security events reported in the log files without manually sifting through the cumbersome

messages only useful to the aa-logprof tool. You can decrease the size of the report by filtering by date range or program name.

To configure the AppArmor reports, proceed as follows:

1. Start YaST. Select *Novell AppArmor* > *AppArmor Reports*.
2. Select the type of report to examine or configure from *Executive Security Summary*, *Applications Audit*, and *Security Incident Report*.
3. Edit the report generation frequency, e-mail address, export format, and location of the reports by selecting *Edit* and providing the requested data.
4. To run a report of the selected type, click *Run Now*.
5. Browse through the archived reports of a given type by selecting *View Archive* and specifying the report type.

   *or*

   Delete unneeded reports or add new ones.

---

**ПОДСКАЗКА: For More Information**

For more information about configuring event notification in Novell AppArmor, refer to Раздел 26.2, «Configuring Security Event Notification» (стр. 332). Find more information about report configuration in Раздел 26.3, «Configuring Reports» (стр. 335).

---

# 18.6 Updating Your Profiles

Software and system configurations change over time. As a result, your profile setup for AppArmor might need some fine-tuning from time to time. AppArmor checks your system log for policy violations or other AppArmor events and lets you adjust your profile set accordingly. Any application behavior that is outside of any profile definition can also be addressed using the *Update Profile Wizard*.

To update your profile set, proceed as follows:

1. Start YaST and choose *Novell AppArmor* > *Update Profile Wizard*.

2 Adjust access or execute rights to any resource or for any executable that has been logged when prompted.

3 Leave YaST after you have answered all questions. Your changes are applied to the respective profiles.

---

**ПОДСКАЗКА: For More Information**

For more information about updating your profiles from the system logs, refer to Раздел 22.5, «Updating Profiles from Log Entries» (стр. 287).

---

# 19 Immunizing Programs

Effective hardening of a computer system requires minimizing the number of programs that mediate privilege, then securing the programs as much as possible. With Novell AppArmor, you only need to profile the programs that are exposed to attack in your environment, which drastically reduces the amount of work required to harden your computer. AppArmor profiles enforce policies to make sure that programs do what they are supposed to do, but nothing else.

Novell® AppArmor provides immunization technologies that protect applications from the inherent vulnerabilities they possess. After installing Novell AppArmor, setting up Novell AppArmor profiles, and rebooting the computer, your system becomes immunized because it begins to enforce the Novell AppArmor security policies. Protecting programs with Novell AppArmor is referred to as *immunizing*.

Administrators need only concern themselves with the applications that are vulnerable to attacks, and generate profiles for these. Hardening a system thus comes down to building and maintaining the AppArmor profile set and monitoring any policy violations or exceptions logged by AppArmor's reporting facility.

Users should not notice AppArmor at all. It runs «behind the scenes» and does not require any user interaction. Performance is not noticeably affected by AppArmor. If some activity of the application is not covered by an AppArmor profile or if some activity of the application is prevented by AppArmor, the administrator needs to adjust the profile of this application to cover this kind of behavior.

Novell AppArmor sets up a collection of default application profiles to protect standard Linux services. To protect other applications, use the Novell AppArmor tools to create profiles for the applications that you want protected. This chapter

introduces the philosophy of immunizing programs. Proceed to Глава 20, *Profile Components and Syntax* (стр. 243), Глава 22, *Building and Managing Profiles with YaST* (стр. 271), or Глава 23, *Building Profiles from the Command Line* (стр. 291) if you are ready to build and manage Novell AppArmor profiles.

Novell AppArmor provides streamlined access control for network services by specifying which files each program is allowed to read, write, and execute, and which type of network it is allowed to access. This ensures that each program does what it is supposed to do, and nothing else. Novell AppArmor quarantines programs to protect the rest of the system from being damaged by a compromised process.

Novell AppArmor is a host intrusion prevention or mandatory access control scheme. Previously, access control schemes were centered around users because they were built for large timeshare systems. Alternatively, modern network servers largely do not permit users to log in, but instead provide a variety of network services for users (such as Web, mail, file, and print servers). Novell AppArmor controls the access given to network services and other programs to prevent weaknesses from being exploited.

---

**ПОДСКАЗКА: Background Information for Novell AppArmor**

To get a more in-depth overview of AppArmor and the overall concept behind it, refer to Раздел 17.1, «Background Information on AppArmor Profiling» (стр. 224).

---

# 19.1 Introducing the AppArmor Framework

This section provides a very basic understanding of what is happening «behind the scenes» (and under the hood of the YaST interface) when you run AppArmor.

An AppArmor profile is a plain text file containing path entries and access permissions. See Раздел 20.1, «Breaking a Novell AppArmor Profile into Its Parts» (стр. 244) for a detailed reference profile. The directives contained in this text file are then enforced by the AppArmor routines to quarantine the process or program.

The following tools interact in the building and enforcement of AppArmor profiles and policies:

`aa-unconfined` / `unconfined`
: `aa-unconfined` detects any application running on your system that listens for network connections and is not protected by an AppArmor profile. Refer to «aa-unconfined—Identifying Unprotected Processes» (стр. 315) for detailed information about this tool.

`aa-autodep` / `autodep`
: `aa-autodep` creates a basic framework of a profile that needs to be fleshed out before it is put to use in production. The resulting profile is loaded and put into complain mode, reporting any behavior of the application that is not (yet) covered by AppArmor rules. Refer to «aa-autodep—Creating Approximate Profiles» (стр. 298) for detailed information about this tool.

`aa-genprof` / `genprof`
: `aa-genprof` generates a basic profile and asks you to refine this profile by executing the application and generating log events that need to be taken care of by AppArmor policies. You are guided through a series of questions to deal with the log events that have been triggered during the application's execution. After the profile has been generated, it is loaded and put into enforce mode. Refer to «aa-genprof—Generating Profiles» (стр. 301) for detailed information about this tool.

`aa-logprof` / `logprof`
: `aa-logprof` interactively scans and reviews the log entries generated by an application that is confined by an AppArmor profile in complain mode. It assists you in generating new entries in the profile concerned. Refer to «aa-logprof—Scanning the System Log» (стр. 309) for detailed information about this tool.

`aa-complain` / `complain`
: `aa-complain` toggles the mode of an AppArmor profile from enforce to complain. Exceptions to rules set in a profile are logged, but the profile is not enforced. Refer to «aa-complain—Entering Complain or Learning Mode» (стр. 299) for detailed information about this tool.

`aa-enforce` / `enforce`
: `aa-enforce` toggles the mode of an AppArmor profile from complain to enforce. Exceptions to rules set in a profile are logged, but not permitted—the profile is enforced. Refer to «aa-enforce—Entering Enforce Mode» (стр. 300) for detailed information about this tool.

Once a profile has been built and is loaded, there are two ways in which it can get processed:

`aa-complain` / `complain`
: In complain mode, violations of AppArmor profile rules, such as the profiled program accessing files not permitted by the profile, are detected. The violations are permitted, but also logged. To improve the profile, turn complain mode on, run the program through a suite of tests to generate log events that characterize the program's access needs, then postprocess the log with the AppArmor tools (YaST or aa-logprof) to transform log events into improved profiles.

`aa-enforce` / `enforce`
: In enforce mode, violations of AppArmor profile rules, such as the profiled program accessing files not permitted by the profile, are detected. The violations are logged and not permitted. The default is for enforce mode to be enabled. To log the violations only, but still permit them, use complain mode. Enforce toggles with complain mode.

# 19.2 Determining Programs to Immunize

Now that you have familiarized yourself with AppArmor, start selecting the applications for which to build profiles. Programs that need profiling are those that mediate privilege. The following programs have access to resources that the person using the program does not have, so they grant the privilege to the user when used:

cron Jobs
: Programs that are run periodically by cron. Such programs read input from a variety of sources and can run with special privileges, sometimes with as much as `root` privilege. For example, cron can run `/usr/sbin/logrotate` daily to rotate, compress, or even mail system logs. For instructions for finding these types of programs, refer to Раздел 19.3, «Immunizing cron Jobs» (стр. 237).

Web Applications
: Programs that can be invoked through a Web browser, including CGI Perl scripts, PHP pages, and more complex Web applications. For instructions for finding these types of programs, refer to Раздел 19.4.1, «Immunizing Web Applications» (стр. 239).

Network Agents
: Programs (servers and clients) that have open network ports. User clients, such as mail clients and Web browsers mediate privilege. These programs run

with the privilege to write to the user's home directory and they process input from potentially hostile remote sources, such as hostile Web sites and e-mailed malicious code. For instructions for finding these types of programs, refer to Раздел 19.4.2, «Immunizing Network Agents» (стр. 241).

Conversely, unprivileged programs do not need to be profiled. For instance, a shell script might invoke the `cp` program to copy a file. Because `cp` does not have its own profile, it inherits the profile of the parent shell script, so can copy any files that the parent shell script's profile can read and write.

# 19.3 Immunizing cron Jobs

To find programs that are run by cron, inspect your local cron configuration. Unfortunately, cron configuration is rather complex, so there are numerous files to inspect. Periodic cron jobs are run from these files:

```
/etc/crontab
/etc/cron.d/*
/etc/cron.daily/*
/etc/cron.hourly/*
/etc/cron.monthly/*
/etc/cron.weekly/*
```

For `root`'s cron jobs, edit the tasks with `crontab -e` and list `root`'s cron tasks with `crontab -l`. You must be `root` for these to work.

Once you find these programs, you can use the *Add Profile Wizard* to create profiles for them. Refer to Раздел 22.1, «Adding a Profile Using the Wizard» (стр. 273).

# 19.4 Immunizing Network Applications

An automated method for finding network server daemons that should be profiled is to use the `aa-unconfined` tool. You can also simply view a report of this information in the YaST module (refer to «Application Audit Report» (стр. 342) for instructions).

The `aa-unconfined` tool uses the command `netstat -nlp` to inspect your open ports from inside your computer, detect the programs associated with those

ports, and inspect the set of Novell AppArmor profiles that you have loaded. `aa-unconfined` then reports these programs along with the Novell AppArmor profile associated with each program, or reports «none» (if the program is not confined).

**ЗАМЕЧАНИЕ**

If you create a new profile, you must restart the program that has been profiled to have it be effectively confined by AppArmor.

Below is a sample `aa-unconfined` output:

```
2325 /sbin/portmap not confined
3702❶ /usr/sbin/sshd❷ confined
   by '/usr/sbin/sshd❸ (enforce)'
4040 /usr/sbin/ntpd confined by '/usr/sbin/ntpd (enforce)'
4373 /usr/lib/postfix/master confined by '/usr/lib/postfix/master
 (enforce)'
4505 /usr/sbin/httpd2-prefork confined by '/usr/sbin/httpd2-prefork
 (enforce)'
5274 /sbin/dhcpcd not confined
5592 /usr/bin/ssh not confined
7146 /usr/sbin/cupsd confined by '/usr/sbin/cupsd (complain)'
```

❶ The first portion is a number. This number is the process ID number (PID) of the listening program.

❷ The second portion is a string that represents the absolute path of the listening program

❸ The final portion indicates the profile confining the program, if any.

**ЗАМЕЧАНИЕ**

`aa-unconfined` requires `root` privileges and should not be run from a shell that is confined by an AppArmor profile.

`aa-unconfined` does not distinguish between one network interface and another, so it reports all unconfined processes, even those that might be listening to an internal LAN interface.

Finding user network client applications is dependent on your user preferences. The `aa-unconfined` tool detects and reports network ports opened by client applications, but only those client applications that are running at the time the `aa-unconfined` analysis is performed. This is a problem because network services

tend to be running all the time, while network client applications tend only to be running when the user is interested in them.

Applying Novell AppArmor profiles to user network client applications is also dependent on user preferences. Therefore, we leave the profiling of user network client applications as an exercise for the user.

To aggressively confine desktop applications, the `aa-unconfined` command supports a `paranoid` option, which reports all processes running and the corresponding AppArmor profiles that might or might not be associated with each process. The user can then decide whether each of these programs needs an AppArmor profile.

If you have new or modified profiles, you can submit them to the apparmor-general@forge.novell.com [`mailto:apparmor-general@forge.novell.com`] mailing list along with a use case for the application behavior that you exercised. The AppArmor team reviews and may submit the work into openSUSE. We cannot guarantee that every profile will be included, but we make a sincere effort to include as much as possible so that end users can contribute to the security profiles that ship in openSUSE.

Alternatively, use the AppArmor profile repository to make your profiles available to other users and to download profiles created by other AppArmor users and the AppArmor developers. Refer to Глава 21, *AppArmor Profile Repositories* (стр. 267) for more information on how to use the AppArmor profile repository.

## 19.4.1 Immunizing Web Applications

To find Web applications, investigate your Web server configuration. The Apache Web server is highly configurable and Web applications can be stored in many directories, depending on your local configuration. openSUSE, by default, stores Web applications in `/srv/www/cgi-bin/`. To the maximum extent possible, each Web application should have an Novell AppArmor profile.

Once you find these programs, you can use the AppArmor *Add Profile Wizard* to create profiles for them. Refer to Раздел 22.1, «Adding a Profile Using the Wizard» (стр. 273).

Because CGI programs are executed by the Apache Web server, the profile for Apache itself, `usr.sbin.httpd2-prefork` for Apache2 on openSUSE, must be modified to add execute permissions to each of these programs. For instance,

adding the line `/srv/www/cgi-bin/my_hit_counter.pl rpx` grants Apache permission to execute the Perl script `my_hit_counter.pl` and requires that there be a dedicated profile for `my_hit_counter.pl`. If `my_hit_counter.pl` does not have a dedicated profile associated with it, the rule should say `/srv/www/cgi-bin/my_hit_counter.pl rix` to cause `my_hit_counter.pl` to inherit the `usr.sbin.httpd2-prefork` profile.

Some users might find it inconvenient to specify execute permission for every CGI script that Apache might invoke. Instead, the administrator can grant controlled access to collections of CGI scripts. For instance, adding the line `/srv/www/cgi-bin/*.{pl,py,pyc} rix` allows Apache to execute all files in `/srv/www/cgi-bin/` ending in `.pl` (Perl scripts) and `.py` or `.pyc` (Python scripts). As above, the `ix` part of the rule causes Python scripts to inherit the Apache profile, which is appropriate if you do not want to write individual profiles for each Python script.

---

**ЗАМЕЧАНИЕ**

If you want the subprocess confinement module (`apache2-mod-apparmor`) functionality when Web applications handle Apache modules (`mod_perl` and `mod_php`), use the ChangeHat features when you add a profile in YaST or at the command line. To take advantage of the subprocess confinement, refer to Раздел 24.1, «Apache ChangeHat» (стр. 318).

---

Profiling Web applications that use `mod_perl` and `mod_php` requires slightly different handling. In this case, the «program» is a script interpreted directly by the module within the Apache process, so no exec happens. Instead, the Novell AppArmor version of Apache calls `change_hat()` using a subprofile (a «hat») corresponding to the name of the URI requested.

---

**ЗАМЕЧАНИЕ**

The name presented for the script to execute might not be the URI, depending on how Apache has been configured for where to look for module scripts. If you have configured your Apache to place scripts in a different place, the different names appear in log file when Novell AppArmor complains about access violations. See Глава 26, *Managing Profiled Applications* (стр. 331).

---

For `mod_perl` and `mod_php` scripts, this is the name of the Perl script or the PHP page requested. For example, adding this subprofile allows the `localtime.php` page to execute and access the local system time:

```
/usr/bin/httpd2-prefork {
  # ...
  ^/cgi-bin/localtime.php {
    /etc/localtime                  r,
    /srv/www/cgi-bin/localtime.php  r,
    /usr/lib/locale/**              r,
  }
}
```

If no subprofile has been defined, the Novell AppArmor version of Apache applies the `DEFAULT_URI` hat. This subprofile is basically sufficient to display an HTML Web page. The `DEFAULT_URI` hat that Novell AppArmor provides by default is the following:

```
^DEFAULT_URI {
    /usr/sbin/suexec2                   mixr,
    /var/log/apache2/**                 rwl,
    @{HOME}/public_html                 r,
    @{HOME}/public_html/**              r,
    /srv/www/htdocs                     r,
    /srv/www/htdocs/**                  r,
    /srv/www/icons/*.{gif,jpg,png}      r,
    /srv/www/vhosts                     r,
    /srv/www/vhosts/**                  r,
    /usr/share/apache2/**               r,
    /var/lib/php/sess_*                 rwl }
```

To use a single Novell AppArmor profile for all Web pages and CGI scripts served by Apache, a good approach is to edit the `DEFAULT_URI` subprofile.

## 19.4.2 Immunizing Network Agents

To find network server daemons and network clients (such as fetchmail, Firefox, Amarok or Banshee) that need to be profiled, you should inspect the open ports on your machine, consider the programs that are answering on those ports, and provide profiles for as many of those programs as possible. If you provide profiles for all programs with open network ports, an attacker cannot get to the file system on your machine without passing through a Novell AppArmor profile policy.

Scan your server for open network ports manually from outside the machine using a scanner (such as nmap), or from inside the machine using the `netstat --inet`

`-n -p` command. Then, inspect the machine to determine which programs are answering on the discovered open ports.

---

**ПОДСКАЗКА**

Refer to the man page of the `netstat` command for a detailed reference of all possible options.

---

# 20 Profile Components and Syntax

Building AppArmor profiles to confine an application is very straightforward and intuitive. AppArmor ships with several tools that assist in profile creation. It does not require you to do any programming or script handling. The only task that is required of the administrator is to determine a policy of strictest access and execute permissions for each application that needs to be hardened.

Updates or modifications to the application profiles are only required if the software configuration or the desired range of activities changes. AppArmor offers intuitive tools to handle profile updates and modifications.

You are ready to build Novell AppArmor profiles after you select the programs to profile. To do so, it is important to understand the components and syntax of profiles. AppArmor profiles contain several building blocks that help build simple and reusable profile code:

`#include` Files
: `#include` statements are used to pull in parts of other AppArmor profiles to simplify the structure of new profiles.

Abstractions
: Abstractions are `#include` statements grouped by common application tasks.

Program Chunks
: Program chunks are `#include` statements that contain chunks of profiles that are specific to program suites.

Capability Entries
: Capability entries are profile entries for any of the POSIX.1e Linux capabilities allowing a fine-grained control over what a confined process is allowed to do through system calls that require privileges.

Network Access Control Entries
: Network Access Control Entries mediate network access based on the address type and family.

Local Variable Definitions
: Local variables define shortcuts for paths.

File Access Control Entries
: File Access Control Entries specify the set of files an application can access.

rlimit Entries
: rlimit entries set and control an application's resource limits.

For help determining the programs to profile, refer to Раздел 19.2, «Determining Programs to Immunize» (стр. 236). To start building AppArmor profiles with YaST, proceed to Глава 22, *Building and Managing Profiles with YaST* (стр. 271). To build profiles using the AppArmor command line interface, proceed to Глава 23, *Building Profiles from the Command Line* (стр. 291).

# 20.1 Breaking a Novell AppArmor Profile into Its Parts

The easiest way of explaining what a profile consists of and how to create one is to show the details of a sample profile, in this case for a hypothetical application called `/usr/bin/foo`:

```
#include <tunables/global>❶

# a comment naming the application to confine
/usr/bin/foo❷
{❸
   #include <abstractions/base>❹

   capability setgid❺,
   network inet tcp❻,
```

```
  link /etc/sysconfig/foo -> /etc/foo.conf,❼
  /bin/mount             ux,
  /dev/{,u}❽random      r,
  /etc/ld.so.cache       r,
  /etc/foo/*             r,
  /lib/ld-*.so*          mr,
  /lib/lib*.so*          mr,
  /proc/[0-9]**          r,
  /usr/lib/**            mr,
  /tmp/❾                 r,
  /tmp/foo.pid           wr,
  /tmp/foo.*             lrw,
  /@{HOME}❿/.foo_file    rw,
  /@{HOME}/.foo_lock     kw,
  owner✂ /shared/foo/** rw,
  /usr/bin/foobar        cx,✂
  /bin/**                px -> bin_generic,✂


  # a comment about foo's local (children)profile for /usr/bin/foobar.

  profile /usr/bin/foobar✂ {
    /bin/bash            rmix,
    /bin/cat             rmix,
    /bin/more            rmix,
    /var/log/foobar*     rwl,
    /etc/foobar          r,
  }

 # foo's hat, bar.
  ^bar✂ {
   /lib/ld-*.so*         mr,
   /usr/bin/bar          px,
   /var/spool/*          rwl,
  }
}
```

❶ This loads a file containing variable definitions.

❷ The normalized path to the program that is confined.

❸ The curly braces ({ }) serve as a container for include statements, subprofiles, path entries, capability entries, and network entries.

❹ This directive pulls in components of AppArmor profiles to simplify profiles.

❺ Capability entry statements enable each of the 29 POSIX.1e draft capabilities.

❻ A directive determining the kind of network access allowed to the application. For details, refer to Раздел 20.5, «Network Access Control» (стр. 251).

❼ A link pair rule specifying the source and the target of a link. See Раздел 20.7.6, «Link Pair» (стр. 256) for more information.

❽ The curly braces ({}) make this rule apply to the path both with and without the content enclosed by the braces.

❾ A path entry specifying what areas of the file system the program can access. The first part of a path entry specifies the absolute path of a file (including regular expression globbing) and the second part indicates permissible access modes (for example `r` for read, `w` for write, and `x` for execute). A whitespace of any kind (spaces or tabs) can precede pathnames or separate the pathname from the access modes. Spaces between the access mode and the trailing comma are optional. Find a comprehensive overview of the available access modes in Раздел 20.7, «File Permission Access Modes» (стр. 254).

❿ This variable expands to a value that can be changed without changing the entire profile.

✂ An owner conditional rule, granting read and write permission on files owned by the user. Refer to Раздел 20.7.7, «Owner Conditional Rules» (стр. 256) for more information.

✂ This entry defines a transition to the local profile `/usr/bin/foobar`. Find a comprehensive overview of the available execute modes in Раздел 20.8, «Execute Modes» (стр. 257).

✂ A named profile transition to the profile bin_generic located in the global scope. See Раздел 20.8.7, «Named Profile Transitions» (стр. 260) for details.

✂ The local profile `/usr/bin/foobar` is defined in this section.

✂ This section references a «hat» subprofile of the application. For more details on AppArmor's ChangeHat feature, refer to Глава 24, *Profiling Your Web Applications Using ChangeHat* (стр. 317).

When a profile is created for a program, the program can access only the files, modes, and POSIX capabilities specified in the profile. These restrictions are in addition to the native Linux access controls.

**Example:** To gain the capability `CAP_CHOWN`, the program must have both access to `CAP_CHOWN` under conventional Linux access controls (typically, be a `root`-owned process) and have the capability `chown` in its profile. Similarly, to be able to write to the file `/foo/bar` the program must have both the correct user ID and mode bits set in the files attributes (see the `chmod` and `chown` man pages) and have `/foo/bar w` in its profile.

Attempts to violate Novell AppArmor rules are recorded in `/var/log/audit/audit.log` if the `audit` package is installed or otherwise in `/var/`

log/messages . In many cases, Novell AppArmor rules prevent an attack from working because necessary files are not accessible and, in all cases, Novell AppArmor confinement restricts the damage that the attacker can do to the set of files permitted by Novell AppArmor.

# 20.2 Profile Types

AppArmor knows four different types of profiles: standard profiles, unattached profiles, local profiles and hats. Standard and unattached profiles are stand-alone profiles, each stored in a file under /etc/apparmor.d/ . Local profiles and hats are children profiles embedded inside of a parent profile used to provide tighter or alternate confinement for a subtask of an application.

## 20.2.1 Standard Profiles

The default AppArmor profile is attached to a program by its name, so a profile name must match the path to the application it is to confine.

```
/usr/bin/foo {
...
}
```

This profile will be automatically used whenever an unconfined process executes /usr/bin/foo .

## 20.2.2 Unattached Profiles

Unattached profiles do not reside in the file system namespace and therefore are not automatically attached to an application. The name of an unattached profile is preceded by the keyword profile. You can freely choose a profile name, except for the following limitations: the name must not begin with a : or . character. If it contains a whitespace, it must be quoted. If the name begins with a /, the profile is considered to be a standard profile, so the following two profiles are identical:

```
profile /usr/bin/foo {
...
}
/usr/bin/foo {
...
```

```
}
```

Unattached profiles are never used automatically, nor can they be transitioned to through a `px` rule. They need to be attached to a program by either using a named profile transition (see Раздел 20.8.7, «Named Profile Transitions» (стр. 260)) or with the `change_profile` rule (see Раздел 20.2.5, «Change rules» (стр. 248)).

Unattached profiles are useful for specialized profiles for system utilities that generally should not be confined by a system wide profile (for example, `/bin/bash`). They can also be used to set up roles or to confine a user.

## 20.2.3 Local Profiles

Local profiles provide a convenient way to provide specialized confinement for utility programs launched by a confined application. They are specified just like standard profiles except they are embedded in a parent profile and begin with the `profile` keyword:

```
/parent/profile {
   ...
   profile local/profile {
      ...
   }
}
```

To transition to a local profile, either use a `cx` rule (see Раздел 20.8.2, «Discrete Local Profile Execute Mode (cx)» (стр. 258)) or a named profile transition (see Раздел 20.8.7, «Named Profile Transitions» (стр. 260)).

## 20.2.4 Hats

AppArmor "hats" are a local profiles with some additional restrictions and an implicit rule allowing for `change_hat` to be used to transition to them. Refer to Глава 24, *Profiling Your Web Applications Using ChangeHat* (стр. 317) for a detailed description.

## 20.2.5 Change rules

AppArmor provides `change_hat` and `change_profile` rules that control domain transitioning. `change_hat` are specified by defining hats in a profile,

while `change_profile` rules refer to another profile and start with the keyword `change_profile`:

```
change_profile /usr/bin/foobar,
```

Both `change_hat` and `change_profile` provide for an application directed profile transition, without having to launch a separate application. `change_profile` provides a generic one way transition between any of the loaded profiles. `change_hat` provides for a returnable parent child transition where an application can switch from the parent profile to the hat profile and if it provides the correct secret key return to the parent profile at a later time.

`change_profile` is best used in situations where an application goes through a trusted setup phase and then can lower its privilege level. Any resources mapped or opened during the start-up phase may still be accessible after the profile change, but the new profile will restrict the opening of new resources, and will even limit some of the resources opened before the switch. Specifically, memory resources will still be available while capability and file resources (as long as they are not memory mapped) can be limited.

`change_hat` is best used in situations where an application runs a virtual machine or an interpreter that does not provide direct access to the applications resources (e.g. Apache's `mod_php`). Since `change_hat` stores the return secret key in the application's memory the phase of reduced privilege should not have direct access to memory. It is also important that file access is properly separated, since the hat can restrict accesses to a file handle but does not close it. If an application does buffering and provides access to the open files with buffering, the accesses to these files may not be seen by the kernel and hence not restricted by the new profile.

---

**ВНИМАНИЕ: Safety of Domain Transitions**

The `change_hat` and `change_profile` domain transitions are less secure than a domain transition done through an exec because they do not affect a processes memory mappings, nor do they close resources that have already been opened.

---

# 20.3 `#include` Statements

`#include` statements are directives that pull in components of other Novell AppArmor profiles to simplify profiles. Include files retrieve access permissions for

programs. By using an include, you can give the program access to directory paths or files that are also required by other programs. Using includes can reduce the size of a profile.

By default, AppArmor adds `/etc/apparmor.d` to the path in the `#include` statement. AppArmor expects the include files to be located in `/etc/apparmor.d`. Unlike other profile statements (but similar to C programs), `#include` lines do not end with a comma.

To assist you in profiling your applications, Novell AppArmor provides three classes of `#includes`: abstractions, program chunks and tunables.

## 20.3.1 Abstractions

Abstractions are `#includes` that are grouped by common application tasks. These tasks include access to authentication mechanisms, access to name service routines, common graphics requirements, and system accounting. Files listed in these abstractions are specific to the named task. Programs that require one of these files usually require some of the other files listed in the abstraction file (depending on the local configuration as well as the specific requirements of the program). Find abstractions in `/etc/apparmor.d/abstractions`.

## 20.3.2 Program Chunks

The program-chunks directory (`/etc/apparmor.d/program-chunks`) contains some chunks of profiles that are specific to program suites and not generally useful outside of the suite, thus are never suggested for use in profiles by the profile wizards (aa-logprof and aa-genprof). Currently, program chunks are only available for the postfix program suite.

## 20.3.3 Tunables

The tunables directory (`/etc/apparmor.d/tunables`) contains global variable definitions. When used in a profile, these variables expand to a value that can be changed without changing the entire profile. Add all the tunables definitions that should be available to every profile to `/etc/apparmor.d/tunables/global`.

# 20.4 Capability Entries (POSIX.1e)

Capability statements are simply the word `capability` followed by the name of the POSIX.1e capability as defined in the `capabilities(7)` man page.

# 20.5 Network Access Control

AppArmor allows mediation of network access based on the address type and family. The following illustrates the network access rule syntax:

```
network [[<domain>❶][<type❷>][<protocol❸>]]
```

❶ Supported domains: `inet`, `ax25`, `ipx`, `appletalk`, `netrom`, `bridge`, `x25`, `inet6`, `rose`, `netbeui`, `security`, `key`, `packet`, `ash`, `econet`, `atmsvc`, `sna`, `irda`, `pppox`, `wanpipe`, `bluetooth`

❷ Supported types: `stream`, `dgram`, `seqpacket`, `rdm`, `raw`, `packet`

❸ Supported protocols: `tcp`, `udp`, `icmp`

The AppArmor tools support only family and type specification. The AppArmor module emits only `network` *`domain type`* in «access denied» messages. And only these are output by the profile generation tools, both YaST and command line.

The following examples illustrate possible network-related rules to be used in AppArmor profiles. Note that the syntax of the last two are not currently supported by the AppArmor tools.

```
network❶,
network inet❷,
network inet6❸,
network inet stream❹,
network inet tcp❺,
network tcp❻,
```

❶ Allow all networking. No restrictions applied with regards to domain, type, or protocol.

❷ Allow general use of IPv4 networking.

❸ Allow general use of IPv6 networking.

❹ Allow the use of IPv4 TCP networking.

❺ Allow the use of IPv4 TCP networking, paraphrasing the rule above.

❻ Allow the use of both IPv4 and IPv6 TCP networking.

# 20.6 Paths and Globbing

AppArmor explicitly distinguishes directory path names from file path names. Use a trailing / for any directory path that needs to be explicitly distinguished:

`/some/random/example/* r`
: Allow read access to files in the `/some/random/example` directory.

`/some/random/example/ r`
: Allow read access to the directory only.

`/some/**/ r`
: Give read access to any directories below `/some`.

`/some/random/example/** r`
: Give read access to files and directories under `/some/random/example` .

`/some/random/example/**[^/] r`
: Give read access to files under `/some/random/example` . Explicitly exclude directories (`[^/]`).

Globbing (or regular expression matching) is when you modify the directory path using wild cards to include a group of files or subdirectories. File resources can be specified with a globbing syntax similar to that used by popular shells, such as csh, Bash, and zsh.

| | |
|---|---|
| * | Substitutes for any number of any characters, except /.<br><br>Example: An arbitrary number of file path elements. |
| ** | Substitutes for any number of characters, including /. |

| | |
|---|---|
| | Example: An arbitrary number of path elements, including entire directories. |
| `?` | Substitutes for any single character, except `/`. |
| `[abc]` | Substitutes for the single character `a`, `b`, or `c`.<br><br>Example: a rule that matches `/home[01]/*/.plan` allows a program to access `.plan` files for users in both `/home0` and `/home1`. |
| `[a-c]` | Substitutes for the single character `a`, `b`, or `c`. |
| `{ab,cd}` | Expands to one rule to match `ab` and one rule to match `cd`.<br><br>Example: a rule that matches `/{usr,www}/pages/**` grants access to Web pages in both `/usr/pages` and `/www/pages` . |
| `[ ^a ]` | Substitutes for any character except `a`. |

## 20.6.1 Using Variables in Profiles

AppArmor allows to use variables holding paths in profiles. Use global variables to make your profiles portable and local variables to create shortcuts for paths.

A typical example of when global variables come in handy are network scenarios in which user home directories are mounted in different locations. Instead of rewriting paths to home directories in all affected profiles, you only need to change the value of a variable. Global variables are defined under `/etc/apparmor.d/tunables` and have to be made available via an `#include` statement. Find the variable definitions for this use case (`@{HOME}` and `@{HOMEDIRS}`) in the `/etc/apparmor.d/tunables/home` file.

Local variables are defined at the head of a profile. This is useful to provide the base of for a chrooted path, for example:

```
@{CHROOT_BASE}=/tmp/foo
/sbin/syslog-ng {
...
# chrooted applications
@{CHROOT_BASE}/var/lib/*/dev/log w,
@{CHROOT_BASE}/var/log/** w,
...
}
```

**ЗАМЕЧАНИЕ**

With the current AppArmor tools, variables can only be used when manually editing and maintaining a profile.

## 20.6.2 Alias rules

Alias rules provide an alternative way to manipulate profile path mappings to site specific layouts. They are an alternative form of path rewriting to using variables, and are done post variable resolution:

```
alias /home/ -> /mnt/users/
```

**ЗАМЕЧАНИЕ**

With the current AppArmor tools, alias rules can only be used when manually editing and maintaining a profile. Whats more, they are deactivated by disabled. Enable alias rules by editing `/etc/apparmor.d/tunables/alias`

# 20.7 File Permission Access Modes

File permission access modes consist of combinations of the following modes:

| | |
|---|---|
| `r` | Read mode |
| `w` | Write mode (mutually exclusive to `a`) |

| | |
|---|---|
| `a` | Append mode (mutually exclusive to `w`) |
| `k` | File locking mode |
| `l` | Link mode |
| `link` *`file -> target`* | Link pair rule (cannot be combined with other access modes) |

## 20.7.1 Read Mode (r)

Allows the program to have read access to the resource. Read access is required for shell scripts and other interpreted content and determines if an executing process can core dump.

## 20.7.2 Write Mode (w)

Allows the program to have write access to the resource. Files must have this permission if they are to be unlinked (removed).

## 20.7.3 Append Mode (a)

Allows a program to write to the end of a file. In contrast to the `w` mode, the append mode does not include the ability to overwrite data, to rename, or to remove a file. The append permission is typically used with applications who need to be able to write to log files, but which should not be able to manipulate any existing data in the log files. As the append permission is just a subset of the permissions associated with the write mode, the `w` and `a` permission flags cannot be used together and are mutually exclusive.

## 20.7.4 File Locking Mode (k)

The application can take file locks. Former versions of AppArmor allowed files to be locked if an application had access to them. By using a separate file locking mode, AppArmor makes sure locking is restricted only to those files which need

file locking and tightens security as locking can be used in several denial of service attack scenarios.

## 20.7.5 Link Mode (l)

The link mode mediates access to hard links. When a link is created, the target file must have the same access permissions as the link created (with the exception that the destination does not need link access).

## 20.7.6 Link Pair

The link mode grants permission to create links to arbitrary files, provided the link has a subset of the permissions granted by the target (subset permission test). By specifying origin and destination, the link pair rule provides greater control over how hard links are created. Link pair rules by default do not enforce the link subset permission test that the standard rules link permission requires. To force the rule to require the test the `subset` keyword is used. The following rules are equivalent:

```
/link    l,
link subset /link -> /**,
```

**ЗАМЕЧАНИЕ**

Currently link pair rules are not supported by YaST and the command line tools. Manually edit your profiles to use them. Updating such profiles using the tools is safe, because the link pair entries will not be touched.

## 20.7.7 Owner Conditional Rules

The file rules can be extended so that they can be conditional upon the the user being the owner of the file (the fsuid has to match the file's uid). For this purpose the `owner` keyword is prepended to the rule. Owner conditional rules accumulate just as regular file rules.

```
owner /home/*/** rw
```

When using file ownership conditions with link rules the ownership test is done against the target file so the user must own the file to be able to link to it.

**ЗАМЕЧАНИЕ: Precedence of Regular File Rules**

Owner conditional rules are considered a subset of regular file rules. If a regular file rule overlaps with an owner conditional file rule, the resultant permissions will be that of the regular file rule.

## 20.7.8 Deny Rules

Deny rules can be used to annotate or quiet known rejects. The profile generating tools will not ask about a known reject treated with a deny rule. Such a reject will also not show up in the audit logs when denied, keeping the log files lean. If this is not desired, prepend the deny entry with the keyword `audit`.

It is also possible to use deny rules in combination with allow rules. This allows you to specify a broad allow rule, and then subtract a few known files that should not be allowed. Deny rules can also be combined with owner rules, to deny files owned by the user. The following example allows read/write access to everything in a users directory except write access to the .ssh/ files:

```
deny /home/*/.ssh/** w,
/home/*/** rw,
```

The extensive use of deny rules is generally not encouraged, because it makes it much harder to understand what a profile does. However a judicious use of deny rules can simplify profiles. Therefore the tools only generate profiles denying specific files and will not make use of globbing in deny rules. Manually edit your profiles to add deny rules using globbing. Updating such profiles using the tools is safe, because the deny entries will not be touched.

# 20.8 Execute Modes

Execute modes, also named profile transitions, consist of the following modes:

| | |
|---|---|
| `px` | Discrete profile execute mode |
| `cx` | Discrete local profile execute mode |
| `ux` | Unconstrained execute mode |

| | |
|---|---|
| ix | Inherit execute mode |
| m | Allow PROT_EXEC with mmap(2) calls |

## 20.8.1 Discrete Profile Execute Mode (px)

This mode requires that a discrete security profile is defined for a resource executed at an AppArmor domain transition. If there is no profile defined, the access is denied.

**ВНИМАНИЕ: Using the Discrete Profile Execute Mode**

px does not scrub the environment of variables such as LD_PRELOAD. As a result, the calling domain may have an undue amount of influence over the called item.

Incompatible with Ux, ux, Px, and ix.

## 20.8.2 Discrete Local Profile Execute Mode (cx)

As px, but instead of searching the global profile set, cx only searches the local profiles of the current profile. This profile transition provides a way for an application to have alternate profiles for helper applications.

**ЗАМЕЧАНИЕ: Limitations of the Discrete Local Profile Execute Mode (cx)**

Currently, cx transitions are limited to top level profiles and can not be used in hats and children profiles. This restriction will be removed in the future.

Incompatible with Ux, ux, Px, px, Cx, and ix.

## 20.8.3 Unconstrained Execute Mode (ux)

Allows the program to execute the resource without any AppArmor profile applied to the executed resource. This mode is useful when a confined program needs to be

able to perform a privileged operation, such as rebooting the machine. By placing the privileged section in another executable and granting unconstrained execution rights, it is possible to bypass the mandatory constraints imposed on all confined processes. For more information about what is constrained, see the `apparmor(7)` man page.

---

**ВНИМАНИЕ: Using Unconstrained Execute Mode (ux)**

Use `ux` only in very special cases. It enables the designated child processes to be run without any AppArmor protection. `ux` does not scrub the environment of variables such as `LD_PRELOAD`. As a result, the calling domain may have an undue amount of influence over the called resource. Use this mode only if the child absolutely must be run unconfined and `LD_PRELOAD` must be used. Any profile using this mode provides negligible security. Use at your own risk.

---

This mode is incompatible with `Ux`, `px`, `Px`, and `ix`.

## 20.8.4 Clean Exec modes

The clean exec modes allow the named program to run in `px`, `cx` and `ux` mode, but AppArmor invokes the Linux kernel's `unsafe_exec` routines to scrub the environment, similar to setuid programs. The clean exec modes are specified with an uppercase letter: `Px`, `Cx` and `Ux`. See the man page of `ld.so(8)` for some information about setuid and setgid environment scrubbing.

## 20.8.5 Inherit Execute Mode (ix)

`ix` prevents the normal AppArmor domain transition on `execve(2)` when the profiled program executes the named program. Instead, the executed resource inherits the current profile.

This mode is useful when a confined program needs to call another confined program without gaining the permissions of the target's profile or losing the permissions of the current profile. There is no version to scrub the environment because `ix` executions do not change privileges.

Incompatible with `cx`, `ux`, and `px`. Implies `m`.

## 20.8.6 Allow Executable Mapping (m)

This mode allows a file to be mapped into memory using `mmap(2)`'s `PROT_EXEC` flag. This flag marks the pages executable. It is used on some architectures to provide non executable data pages, which can complicate exploit attempts. AppArmor uses this mode to limit which files a well-behaved program (or all programs on architectures that enforce non executable memory access controls) may use as libraries, to limit the effect of invalid `-L` flags given to `ld(1)` and `LD_PRELOAD`, `LD_LIBRARY_PATH`, given to `ld.so(8)`.

## 20.8.7 Named Profile Transitions

By default, the `px` and `cx` (and their clean exec variants, too) transition to a profile who's name matches the executable name. With named profile transitions, you can specify a profile to be transitioned to. This is useful if multiple binaries need to share a single profile, or if they need to use a different profile than their name would specify. Named profile transitions can be used in conjunction with `cx`, `Cx`, `px` and `Px`. Currently there is a limit of twelve named profile transitions per profile.

Named profile transitions use `->` to indicate the name of the profile that needs to be transitioned to:

```
/usr/bin/foo
{
  /bin/** px -> shared_profile,
  ...
  /usr/*bash cx -> local_profile,
  ...
  profile local_profile
  {
    ...
  }
}
```

---

**ЗАМЕЧАНИЕ: Difference Between Normal and Named Transitions**

When used with globbing, normal transitions provide a «one to many» relationship—`/bin/** px` will transition to `/bin/ping` , `/bin/cat` , etc, depending on the program being run.

Named transitions provide a «many to one» relationship—all programs that match the rule regardless of their name will transition to the specified profile.

Named profile transitions show up in the log as having the mode `Nx`. The name of the profile to be changed to is listed in the `name2` field.

## 20.8.8 Inheritance Fallback for Profile Transitions

The `px` and `cx` transitions specify a hard dependency (if the specified profile does not exist, the exec will fail). With the inheritance fallback, the execution will succeed but inherit the current profile. To specify inheritance fallback, `ix` is combined with `cx`, `Cx`, `px` and `Px` into the modes `cix`, `Cix`, `pix` and `Pix`. The fallback modes can be used with named profile transitions, too.

## 20.8.9 Variable Settings in Execution Modes

When choosing one of the Px, Cx or Ux execution modes, take into account that the following environment variables are removed from the environment before the child process inherits it. As a consequence, applications or processes relying on any of these variables do not work anymore if the profile applied to them carries Px, Cx or Ux flags:

- `GCONV_PATH`
- `GETCONF_DIR`
- `HOSTALIASES`
- `LD_AUDIT`
- `LD_DEBUG`
- `LD_DEBUG_OUTPUT`
- `LD_DYNAMIC_WEAK`
- `LD_LIBRARY_PATH`
- `LD_ORIGIN_PATH`

- LD_PRELOAD
- LD_PROFILE
- LD_SHOW_AUXV
- LD_USE_LOAD_BIAS
- LOCALDOMAIN
- LOCPATH
- MALLOC_TRACE
- NLSPATH
- RESOLV_HOST_CONF
- RES_OPTIONS
- TMPDIR
- TZDIR

# 20.9 Resource Limit Control

AppArmor provides the ability to set and control an application's resource limits (rlimits, also known as ulimits). By default AppArmor does not control applications rlimits, and it will only control those limits specified in the confining profile. For more information about resource limits, refer to the `setrlimit(2)`, `ulimit(1)`, or `ulimit(3)` man pages.

AppArmor leverages the system's rlimits and as such does not provide an additional auditing that would normally occur. It also cannot raise rlimits set by the system, AppArmor rlimits can only reduce an application's current resource limits.

The values will be inherited by the children of a process and will remain even if a new profile is transitioned to or the application becomes unconfined. So when an application transitions to a new profile, that profile has the ability to further reduce the applications rlimits.

AppArmor's rlimit rules will also provide mediation of setting an application's hard limits, should it try to raise them. The application will not be able to raise its hard limits any further than specified in the profile. The mediation of raising hard limits is not inherited as the set value is, so that once the application transitions to a new profile it is free to raise its limits as specified in the profile.

AppArmor's rlimit control does not affect an application's soft limits beyond ensuring that they are less than or equal to the application's hard limits.

AppArmor's hard limit rules have the general form of:

```
set rlimit resource <= value,
```

where *resource* and *value* are to be replaced with the following values:

`cpu`
: currently not supported

`fsize`, `data`, `stack`, `core`, `rss`, `as`, `memlock`, `msgqueue`
: a number in bytes, or a number with a suffix where the suffix can be K (kilobytes), M (megabytes), G (gigabytes), for example

```
rlimit data <= 100M,
```

`fsize`, `nofile`, `locks`, `sigpending`, `nproc`*, `rtprio`
: a number greater or equal to 0

`nice`
: a value between -20 and 19

*The nproc rlimit is handled different than all the other rlimits. Instead of indicating the standard process rlimit it controls the maximum number of processes that can be running under the profile at any given time. Once the limit is exceeded the creation of new processes under the profile will fail until the number of currently running processes is reduced.

---

**ЗАМЕЧАНИЕ**

Currently the tools can not be used to add rlimit rules to profiles. The only way to add rlimit controls to a profile is to manually edit the profile with a text editor. The tools will still work with profiles containing rlimit rules and will not remove them, so it is safe to use the tools to update profiles containing them.

---

# 20.10 Auditing Rules

AppArmor provides the ability to audit given rules so that when they are matched an audit message will appear in the audit log. To enable audit messages for a given rule, the `audit` keyword is prepended to the rule:

```
audit /etc/foo/*        rw,
```

If it is desirable to audit only a given permission the rule can be split into two rules. The following example will result in audit messages when files are opened for writing, but not when they are opened for just reading:

```
audit /etc/foo/*  w,
/etc/foo/*        r,
```

---

**ЗАМЕЧАНИЕ**

Audit messages are not generated for every read or write of a file but only when a file is opened for read or write.

---

Audit control can be combined with owner conditional file rules to provide auditing when users access files they own (at the moment it is not possible to audit files they don't own):

```
audit owner /home/*/.ssh/**       rw,
```

# 20.11 Setting Capabilities per Profile

Normally AppArmor only restricts existing native Linux controls and does not grant additional privileges. Therefore a program, having been granted write access to a file via its profile, would not be able to actually write to this file as long as the mode bits are set to read only.

The only exception to this strict rule is the `set capability` rule. This provides the ability to give non-root users administrative privileges, as defined in the `capabilities(7)` man page. Contrary to setting a program to setuid or using file system capabilities (that apply to single programs only), the set capability rule allows the user to apply capabilities to multiple programs running under a specific

profile (by using ix transitions). For security reasons, set capability rules will not be inherited (once a program leaves the profile, it loses the elevated privilege).

---

**ВНИМАНИЕ: Use set capabilities Rules with Extreme Caution**

Using the set capabilities rules allows to give processes `root` privileges. Therefore these rules should be used with extreme caution and only in exceptional cases.

---

To set a capability in a profile the keyword «set» is prepended to a capability rule. Setting a capability also implicitly adds a capability rule allowing that capability.

```
set capability cap_chown,
```

---

**ЗАМЕЧАНИЕ**

Currently the tools can not be used to add rlimit rules to profiles. The only way to add rlimit controls to a profile is to manually edit the profile with a text editor. The tools will still work with profiles containing rlimit rules and will not remove them, so it is safe to use the tools to update profiles containing them.

---

# 21 AppArmor Profile Repositories

AppArmor ships a set of profiles enabled by default and created by the AppArmor developers, and kept under the `/etc/apparmor.d` . In addition to these profiles, openSUSE ships profiles for individual applications together with the relevant application. These profiles are not enabled by default, and reside under another directory than the standard AppArmor profiles, `/etc/apparmor/profiles/extras` .

AppArmor also supports the use of an external profile repository. This repository is maintained by Novell and allows you to download profiles generated by Novell and other AppArmor users as well as uploading your own. Find the profile repository at `http://apparmor.opensuse.org` .

## 21.1 Using the Local Repository

The AppArmor tools (YaST and aa-genprof and aa-logprof) support the use of a local repository. Whenever you start to create a new profile from scratch, and there already is one inactive profile in your local repository, you are asked whether you would like to use the existing inactive one from `/etc/apparmor/profiles/extras` and whether you want to base your efforts on it. If you decide to use this profile, it gets copied over to the directory of profiles enabled by default (`/etc/apparmor.d` ) and loaded whenever AppArmor is started. Any further further adjustments will be done to the active profile under `/etc/apparmor.d` .

# 21.2 Using the External Repository

The external AppArmor profile repository at http://apparmor.opensuse.org serves two main purposes: Allowing users to either browse and download profiles created by other users and uploading their profiles to be able to easily use them on different machines. A valid login on the profile repository server is required for uploading profiles. Simply downloading profiles from the server does not require a login.

---

**ЗАМЕЧАНИЕ: Using the AppArmor Profile Repository**

When using the profile repository in your deployment, keep in mind that the profiles maintained in the repository are primarily targeted at profile developers and might probably need fine-tuning before they suit your particular needs. Please test the downloaded profiles extensively before deploying them to your live setup, and adjust them if necessary.

---

## 21.2.1 Setting up Profile Repository Support

Once properly configured, both the YaST and the command line tools support the use of an external profile repository. The initial configuration takes place when you start the YaST Add Profile Wizard, the Update Profile Wizard, aa-genprof, or aa-logprof to create or update a profile that already exists on the repository server:

1. Determine whether or not to use the profile repository.
2. Enable the repository for profile downloads.
3. Once you have created or modified a profile, determine whether the tools need to be able to upload your profile to the repository.

   If you choose to upload profiles to the repository, enter your credentials for the repository server.

The configuration of the repository is done by editing two configuration files, `/etc/apparmor/logprof.conf` and `/etc/apparmor/respository.conf` .

The /etc/apparmor/logprof.conf file contains a section called [repository]. distro determines the version of openSUSE used on your system for which the AppArmor tools need to search profiles on the server. url holds the server URL and preferred_user tells the AppArmor tools to prefer profiles created by the novell user. Those profiles were created, tested and approved by members of the SUSE development team.

```
...
[repository]
  distro         = opensuse10.3
  url            = http://apparmor.opensuse.org/backend/api
  preferred_user = novell
...
```

The /etc/apparmor/repository.conf file is created during the configuration process with the AppArmor tools. It contains your authentication data and specifies which actions to enable with regards to the profile repository. If you opt for profile download and do not want to be able to upload your own profiles enabled is set to yes while upload is set to no.

```
[repository]
   enabled = yes
   upload = yes
   user = tux
   pass = XXXXX
```

Once initially configured through the AppArmor tools, the configuration can only be changed manually.

## 21.2.2 Downloading a Profile

While creating a profile from scratch or updating an existing profile by processing reject messages in the log, the AppArmor tools search the repository for a matching profile. If the search is successful, the profile or the list of profiles is displayed and you can view them and choose the one that best matches your setup. As soon as you have chosen a profile, it gets copied to the local machine (to the /etc/apparmor .d directory) and activated. Alternatively, you can choose to ignore the profile on the repository and create your own one from scratch.

## 21.2.3 Uploading Your own Profile

After a profile has been created or updated, the AppArmor tools that a profile also present in the repository has been changed or that a new one has been created. If your system is configured to upload profiles to the repository, you are prompted to provide a ChangeLog to document your changes before the changes are uploaded to the server. These changes are only synched to the repository, but not to the creator of the original profile.

# 22 Building and Managing Profiles with YaST

YaST provides an easy way to build profiles and manage Novell® AppArmor. It provides two interfaces: a graphical one and a text-based one. The text-based interface consumes less resources and bandwidth, making it a better choice for remote administration, or for times when a local graphical environment is inconvenient. Although the interfaces have differing appearances, they offer the same functionality in similar ways. Another alternative is to use AppArmor commands, which can control AppArmor from a terminal window or through remote connections. The command line tools are described in Глава 23, *Building Profiles from the Command Line* (стр. 291).

Start YaST from the main menu and enter your `root` password when prompted for it. Alternatively, start YaST by opening a terminal window, logging in as `root`, and entering `yast2` for the graphical mode or `yast` for the text-based mode.

***Рисунок 22.1*** *YaST Controls for AppArmor*


The right frame shows the AppArmor options:

Add Profile Wizard
: For detailed steps, refer to Раздел 22.1, «Adding a Profile Using the Wizard» (стр. 273).

Manually Add Profile
: Add a Novell AppArmor profile for an application on your system without the help of the wizard. For detailed steps, refer to Раздел 22.2, «Manually Adding a Profile» (стр. 280).

Edit Profile
: Edits an existing Novell AppArmor profile on your system. For detailed steps, refer to Раздел 22.3, «Editing Profiles» (стр. 281).

Delete Profile
: Deletes an existing Novell AppArmor profile from your system. For detailed steps, refer to Раздел 22.4, «Deleting a Profile» (стр. 286).

Update Profile Wizard
: For detailed steps, refer to Раздел 22.5, «Updating Profiles from Log Entries» (стр. 287).

AppArmor Reports
: For detailed steps, refer to Раздел 26.3, «Configuring Reports» (стр. 335).

AppArmor Control Panel
: For detailed steps, refer to Раздел 22.6, «Managing Novell AppArmor and Security Event Status» (стр. 288).

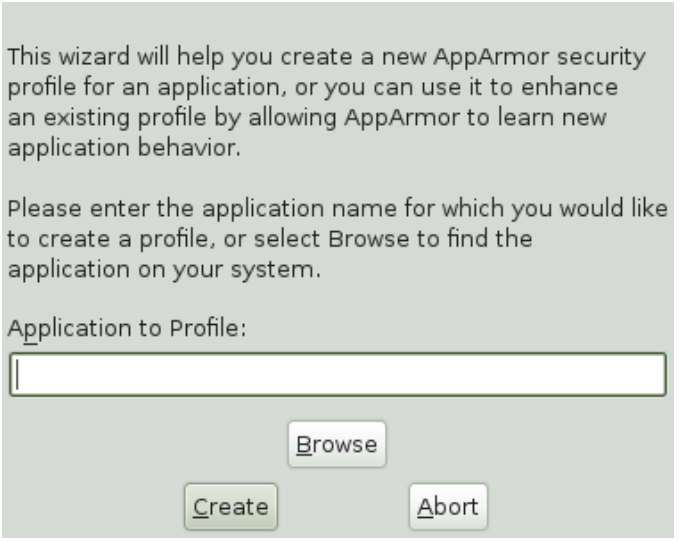
# 22.1 Adding a Profile Using the Wizard

*Add Profile Wizard* is designed to set up Novell AppArmor profiles using the AppArmor profiling tools, aa-genprof (generate profile) and aa-logprof (update profiles from learning mode log file). For more information about these tools, refer to Раздел 23.6.3, «Summary of Profiling Tools» (стр. 298).

1. Stop the application before profiling it to ensure that application start-up is included in the profile. To do this, make sure that the application or daemon is not running.

   For example, enter `rc`*`PROGRAM`* `stop` (or `/etc/init.d/`*`PROGRAM`* `stop`) in a terminal window while logged in as `root`, replacing *`PROGRAM`* with the name of the program to profile.

2. Start YaST and select *Novell AppArmor* > *Add Profile Wizard*.




3. Enter the name of the application or browse to the location of the program.

4. Click *Create*. This runs an AppArmor tool named aa-autodep, which performs a static analysis of the program to profile and loads an approximate profile into

the AppArmor module. For more information about aa-autodep, refer to «aa-autodep—Creating Approximate Profiles» (стр. 298).

Depending on whether the profile you are about to create already exists either in the local profile repository (see Раздел 21.1, «Using the Local Repository» (стр. 267)) or in the external profile repository (see Глава 21, *AppArmor Profile Repositories* (стр. 267)) or whether it does not exist yet, proceed with one of the following options:

- Determine whether you want to use or fine-tune an already existing profile from your local profile repository, as outlined in Шаг 5 (стр. 274).
- Determine whether you want to use or fine-tune an already existing profile from the external profile repository, as outlined in Шаг 6 (стр. 274).
- Create the profile from scratch and proceed with Шаг 7 (стр. 275) and beyond.

**5** If the profile already exists in the local profile repository under `/etc/apparmor/profiles/extra` , YaST informs you that there is an inactive profile which you can either use as a base for your own efforts or which you can just accept as is.

Alternatively, you can choose not to use the local version at all and start creating the profile from scratch. In any case, proceed with Шаг 7 (стр. 275).

**6** If the profile already exists in the external profile repository and this is the first time you tried to create a profile that already exists in the repository, configure your access to the server and determine how to use it:

**6a** Determine whether you want to enable access to the external repository or postpone this decision. In case you have selected *Enable Repository*, determine the access mode (download/upload) in a next step. In case you want to postpone the decision, select *Ask Me Later* and proceed directly to Шаг 7 (стр. 275).

**6b** Provide username and password for your account on the profile repository server and register at the server.

**6c** Select the profile to use and proceed to Шаг 7 (стр. 275).

7 Run the application to profile.

8 Perform as many of the application functions as possible, so that learning mode can log the files and directories to which the program requires access to function properly. Be sure to include restarting and stopping the program in the exercised functions. AppArmor needs to handle these events, as well as any other program function.

9 Click *Scan system log for AppArmor events* to parse the learning mode log files. This generates a series of questions that you must answer to guide the wizard in generating the security profile.

If requests to add hats appear, proceed to Глава 24, *Profiling Your Web Applications Using ChangeHat* (стр. 317).

The questions fall into two categories:

- A resource is requested by a profiled program that is not in the profile (see Рисунок 22.2, «Learning Mode Exception: Controlling Access to Specific Resources» (стр. 276)). Allow or deny access to a specific resource.

- A program is executed by the profiled program and the security domain transition has not been defined (see Рисунок 22.3, «Learning Mode Exception: Defining Execute Permissions for an Entry» (стр. 277)). Define execute permissions for an entry.

Each of these cases results in a series of questions that you must answer to add the resource to the profile or to add the program to the profile. For an example of each case, see Рисунок 22.2, «Learning Mode Exception: Controlling Access to Specific Resources» (стр. 276) and Рисунок 22.3, «Learning Mode Exception: Defining Execute Permissions for an Entry» (стр. 277). Subsequent steps describe your options in answering these questions.

**ЗАМЕЧАНИЕ: Varying Processing Options**

Depending on the type of entry processed, the available options vary.

***Рисунок 22.2*** *Learning Mode Exception: Controlling Access to Specific Resources*

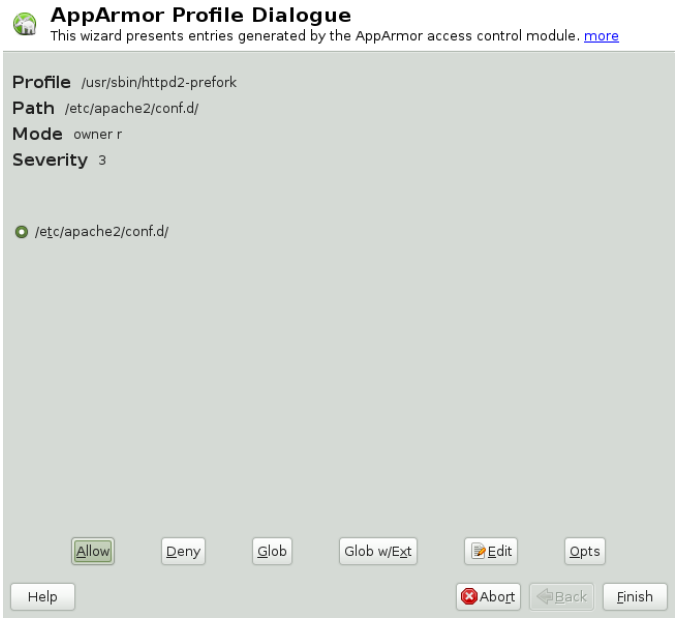
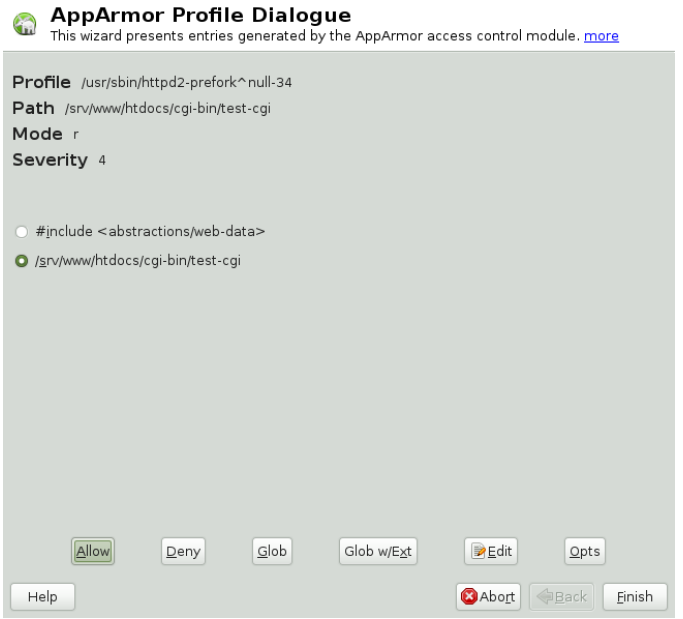


***Рисунок 22.3*** *Learning Mode Exception: Defining Execute Permissions for an Entry*




**10** The *Add Profile Wizard* begins suggesting directory path entries that have been accessed by the application profiled (as seen in Рисунок 22.2, «Learning Mode Exception: Controlling Access to Specific Resources» (стр. 276)) or requires you to define execute permissions for entries (as seen in Рисунок 22.3, «Learning Mode Exception: Defining Execute Permissions for an Entry» (стр. 277)).

- For Рисунок 22.2: Learning Mode Exception: Controlling Access to Specific Resources: Select the option that satisfies the request for access, which could be a suggested include, a particular globbed version of the path, or the actual pathname. Depending on the situation, these options are available:

  `#include`
  The section of a Novell AppArmor profile that refers to an include file. Include files give access permissions for programs. By using an include, you can give the program access to directory paths or files that are also

required by other programs. Using includes can reduce the size of a profile. It is good practice to select includes when suggested.

Globbed Version
: Accessed by clicking *Glob*. For information about globbing syntax, refer to Раздел 20.6, «Paths and Globbing» (стр. 252).

Actual Pathname
: Literal path that the program needs to access to run properly.

After selecting a directory path, process it as an entry to the Novell AppArmor profile by clicking *Allow* or *Deny*. If you are not satisfied with the directory path entry as it is displayed, you can also *Glob* or *Edit* it.

The following options are available to process the learning mode entries and build the profile:

Allow
: Grant the program access to the specified directory path entries. The *Add Profile Wizard* suggests file permission access. For more information about this, refer to Раздел 20.7, «File Permission Access Modes» (стр. 254).

Deny
: Click *Deny* to prevent the program from accessing the specified paths.

Glob
: Clicking this modifies the directory path (using wild cards) to include all files in the suggested directory. Double-clicking it grants access to all files and subdirectories beneath the one shown. For more information about globbing syntax, refer to Раздел 20.6, «Paths and Globbing» (стр. 252).

Glob w/Ext
: Modify the original directory path while retaining the filename extension. A single click causes `/etc/apache2/file.ext` to become `/etc/apache2/*.ext`, adding the wild card (asterisk) in place of the filename. This allows the program to access all files in the suggested directories that end with the `.ext` extension. When you double-click it, access is granted to all files with the particular extension and subdirectories beneath the one shown.

Edit
: Edit the highlighted line. The new edited line appears at the bottom of the list.

Abort
: Abort aa-logprof, losing all rule changes entered so far and leaving all profiles unmodified.

Finish
: Close aa-logprof, saving all rule changes entered so far and modifying all profiles.

Click *Allow* or *Deny* for each learning mode entry. These help build the Novell AppArmor profile.

---

**ЗАМЕЧАНИЕ**

The number of learning mode entries corresponds to the complexity of the application.

---

- For Рисунок 22.3: Learning Mode Exception: Defining Execute Permissions for an Entry: From the following options, select the one that satisfies the request for access. For detailed information about the options available, refer to Раздел 20.7, «File Permission Access Modes» (стр. 254).

  Inherit
  : Stay in the same security profile (parent's profile).

  Profile
  : Require a separate profile to exist for the executed program. When selecting this option, also select whether AppArmor should sanitize the environment when switching profiles by removing certain environment variables that can modify the execution behavior of the child process. Unless these variables are absolutely required to properly execute the child process, always choose the more secure, sanitized option.

  Unconfined
  : Execute the program without a security profile. When prompted, have AppArmor sanitize the environment to avoid adding security risks by inheriting certain environmental variables from the parent process.

**ВНИМАНИЕ: Risks of Running Unconfined**

Unless absolutely necessary, do not run unconfined. Choosing the *Unconfined* option executes the new program without any protection from AppArmor.

Deny
: Click *Deny* to prevent the program from accessing the specified paths.

Abort
: Abort aa-logprof, losing all rule changes entered so far, and leaving all profiles unmodified.

Finish
: Close aa-logprof, saving all rule changes entered so far, and modifying all profiles.

**11** Repeat the previous steps if you need to execute more functionality of the application.

When you are done, click *Finish*. Choose to apply your changes to the local profile set. If you have previously chosen to upload your profile to the external profile repository, provide a brief change log entry describing your work and upload the profile. If you had postponed the decision on whether to upload the profile or not, YaST asks you again and you can create an account the upload the profile now or not upload it at all.

As soon as you exit the *Profile Creation Wizard*, the profile is saved both locally and on the repository server, if you have chosen to upload it. The profile is then loaded into the AppArmor module.

# 22.2 Manually Adding a Profile

Novell AppArmor enables you to create a Novell AppArmor profile by manually adding entries into the profile. Select the application for which to create a profile then add entries.

**1** Start YaST and select *Novell AppArmor* > *Manually Add Profile*.

2 Browse your system to find the application for which to create a profile.

3 When you find the application, select it and click *Open*. A basic, empty profile appears in the *AppArmor Profile Dialog* window.

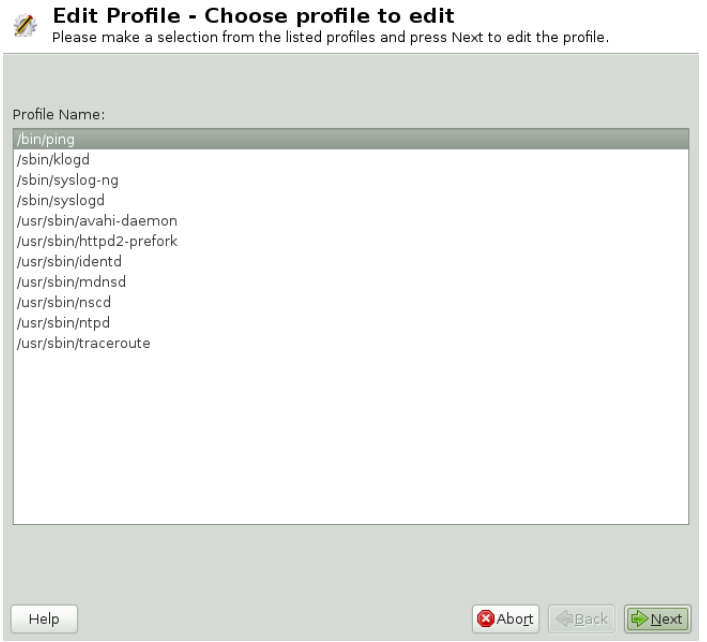
4 In *AppArmor Profile Dialog*, add, edit, or delete AppArmor profile entries by clicking the corresponding buttons and referring to Раздел 22.3.1, «Adding an Entry» (стр. 283), Раздел 22.3.2, «Editing an Entry» (стр. 286), or Раздел 22.3.3, «Deleting an Entry» (стр. 286).

5 When finished, click *Done*.

# 22.3 Editing Profiles

AppArmor enables you to edit Novell AppArmor profiles manually by adding, editing, or deleting entries. To edit a profile, proceed as follows:

1 Start YaST and select *Novell AppArmor* > *Edit Profile*.



2 From the list of profiled applications, select the profile to edit.

3 Click *Next*. The *AppArmor Profile Dialog* window displays the profile.


4 In the *AppArmor Profile Dialog* window, add, edit, or delete Novell AppArmor profile entries by clicking the corresponding buttons and referring to Раздел 22.3.1, «Adding an Entry» (стр. 283), Раздел 22.3.2, «Editing an Entry» (стр. 286), or Раздел 22.3.3, «Deleting an Entry» (стр. 286).

5 When you are finished, click *Done*.

6 In the pop-up that appears, click *Yes* to confirm your changes to the profile and reload the AppArmor profile set.

---

**ПОДСКАЗКА: Syntax Checking in AppArmor**

AppArmor contains a syntax check that notifies you of any syntax errors in profiles you are trying to process with the YaST AppArmor tools. If an error occurs, edit the profile manually as `root` and reload the profile set with `rcapparmor reload`.

---

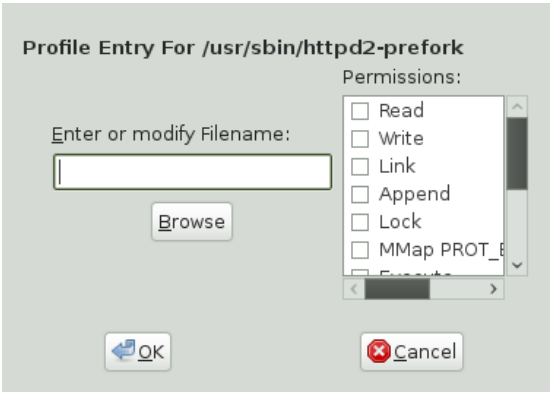
## 22.3.1 Adding an Entry

The *Add Entry* option can be found in Раздел 22.2, «Manually Adding a Profile» (стр. 280) or Раздел 22.3, «Editing Profiles» (стр. 281). When you select *Add Entry*, a list shows the types of entries you can add to the Novell AppArmor profile.

From the list, select one of the following:

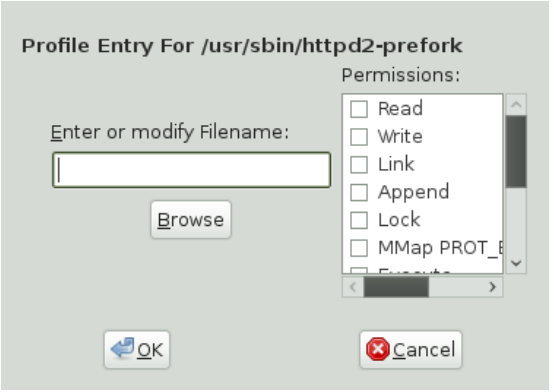
File
: In the pop-up window, specify the absolute path of a file, including the type of access permitted. When finished, click *OK*.

  You can use globbing if necessary. For globbing information, refer to Раздел 20.6, «Paths and Globbing» (стр. 252). For file access permission information, refer to Раздел 20.7, «File Permission Access Modes» (стр. 254).



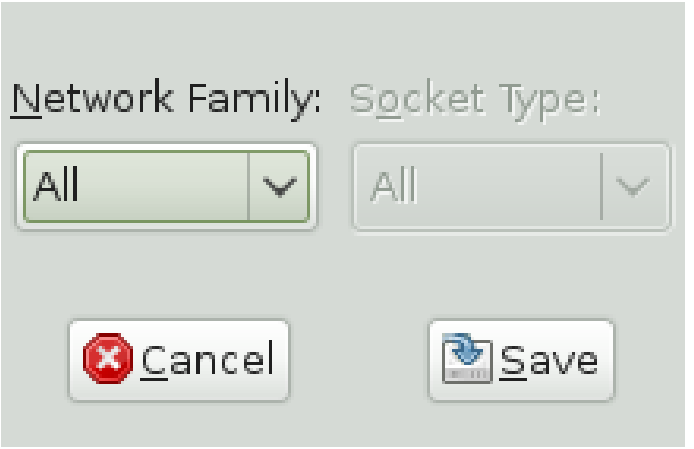

Directory
: In the pop-up window, specify the absolute path of a directory, including the type of access permitted. You can use globbing if necessary. When finished, click *OK*.

  For globbing information, refer to Раздел 20.6, «Paths and Globbing» (стр. 252). For file access permission information, refer to Раздел 20.7, «File Permission Access Modes» (стр. 254).



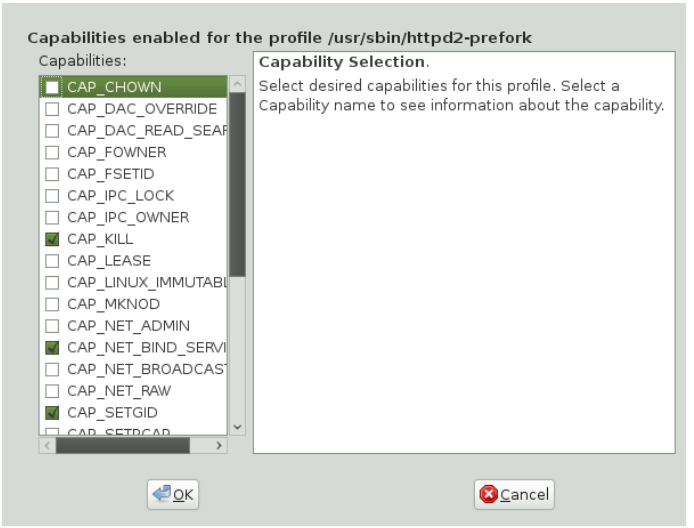

Network Rule

In the pop-up window, select the appropriate network family and the socket type. For more information, refer to Раздел 20.5, «Network Access Control» (стр. 251).



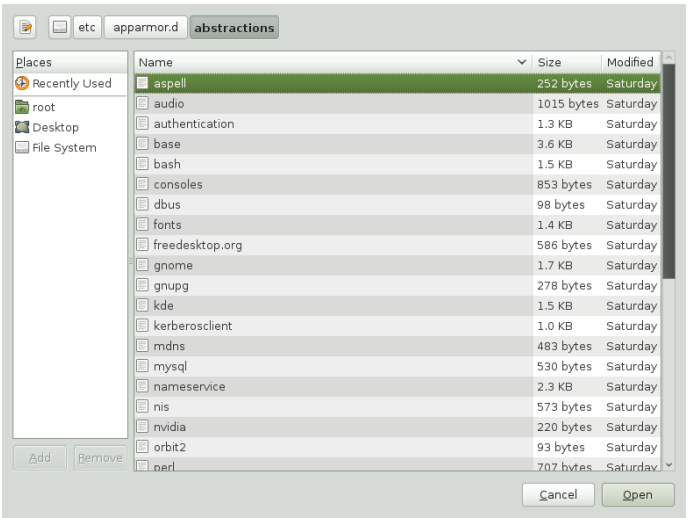

Capability

In the pop-up window, select the appropriate capabilities. These are statements that enable each of the 32 POSIX.1e capabilities. Refer to Раздел 20.4, «Capability Entries (POSIX.1e)» (стр. 251) for more information about capabilities. When finished making your selections, click *OK*.



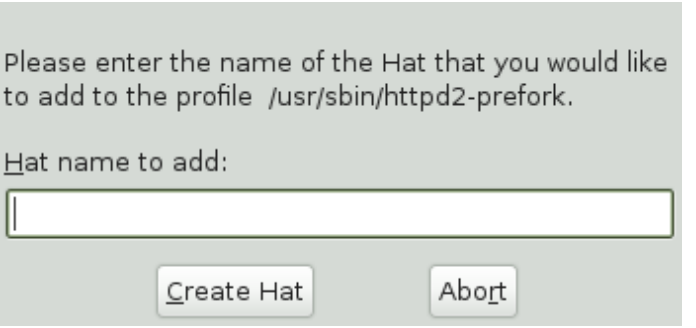

Include

In the pop-up window, browse to the files to use as includes. Includes are directives that pull in components of other Novell AppArmor profiles to simplify profiles. For more information, refer to Раздел 20.3, «`#include` Statements» (стр. 249).



Hat

In the pop-up window, specify the name of the subprofile (*hat*) to add to your current profile and click *Create Hat*. For more information, refer to Глава 24, *Profiling Your Web Applications Using ChangeHat* (стр. 317).




## 22.3.2 Editing an Entry

When you select *Edit Entry*, the file browser pop-up window opens. From here, edit the selected entry.

In the pop-up window, specify the absolute path of a file, including the type of access permitted. You can use globbing if necessary. When finished, click *OK*.

For globbing information, refer to Раздел 20.6, «Paths and Globbing» (стр. 252). For file access permission information, refer to Раздел 20.7, «File Permission Access Modes» (стр. 254).

## 22.3.3 Deleting an Entry

To delete an entry in a given profile, select *Delete Entry*. AppArmor removes the selected profile entry.

# 22.4 Deleting a Profile

AppArmor enables you to delete an AppArmor profile manually. Simply select the application for which to delete a profile then delete it as follows:

**1** Start YaST and select *Novell AppArmor* > *Delete Profile*.

2 Select the profile to delete.

3 Click *Next*.

4 In the pop-up that opens, click *Yes* to delete the profile and reload the AppArmor profile set.

# 22.5 Updating Profiles from Log Entries

The Novell AppArmor profile wizard uses aa-logprof, the tool that scans log files and enables you to update profiles. aa-logprof tracks messages from the Novell AppArmor module that represent exceptions for all profiles running on your system. These exceptions represent the behavior of the profiled application that is outside of the profile definition for the program. You can add the new behavior to the relevant profile by selecting the suggested profile entry.

---

**ПОДСКАЗКА: Support for the External Profile Repository**

Similar to the *Add Profile Wizard*, the *Update Profile Wizard* also supports profile exchange with the external repository server. For background information on the use of the external AppArmor profile repository, refer to Глава 21, *AppArmor Profile Repositories* (стр. 267). For details on how to configure access and access mode to the server, check the procedure described under Раздел 22.1, «Adding a Profile Using the Wizard» (стр. 273).

---

1 Start YaST and select *Novell AppArmor* > *Update Profile Wizard*.

Running *Update Profile Wizard* (aa-logprof) parses the learning mode log files. This generates a series of questions that you must answer to guide aa-logprof to generate the security profile. The exact procedure is the same as with creating a new profile. Refer to Шаг 9 (стр. 275) in Раздел 22.1, «Adding a Profile Using the Wizard» (стр. 273) for details.

2 When you are done, click *Finish*. In the following pop-up, click *Yes* to exit the *Add Profile Wizard*. The profile is saved and loaded into the Novell AppArmor module.

# 22.6 Managing Novell AppArmor and Security Event Status

You can change the status of AppArmor by enabling or disabling it. Enabling AppArmor protects your system from potential program exploitation. Disabling AppArmor, even if your profiles have been set up, removes protection from your system. You can determine how and when you are notified when system security events occur.

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**ЗАМЕЧАНИЕ**

For event notification to work, you must set up a mail server on your system that can send outgoing mail using the single mail transfer protocol (SMTP), such as postfix or exim.

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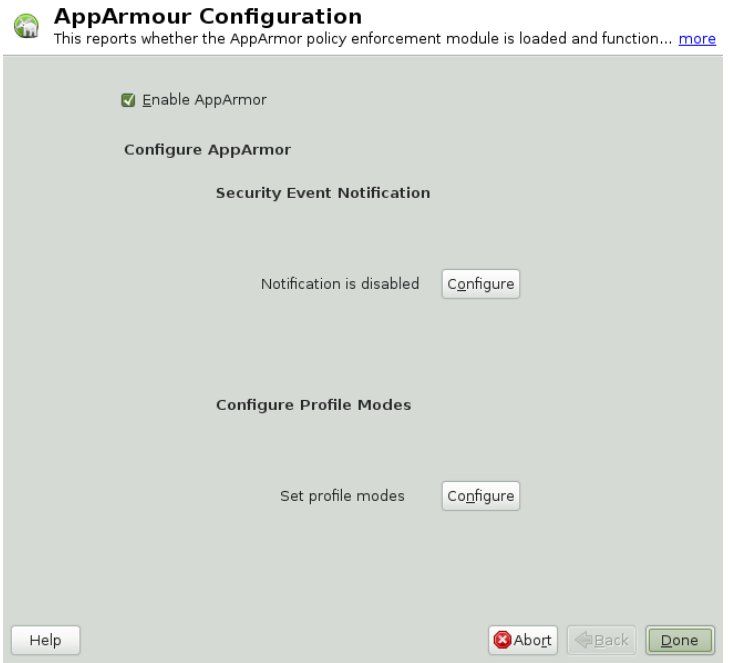
To configure event notification or change the status of AppArmor, start YaST and select *Novell AppArmor* > *Novell AppArmor Control Panel*.



From the *AppArmor Configuration* screen, determine whether Novell AppArmor and security event notification are running by looking for a status message that reads *enabled* or configure the mode of individual profiles.

To change the status of Novell AppArmor, continue as described in Раздел 22.6.1, «Changing Novell AppArmor Status» (стр. 289). To change the mode of individual profiles, continue as described in Раздел 22.6.2, «Changing the Mode of Individual Profiles» (стр. 289). To configure security event notification, continue as described in Раздел 26.2, «Configuring Security Event Notification» (стр. 332).

## 22.6.1 Changing Novell AppArmor Status

When you change the status of AppArmor, set it to enabled or disabled. When AppArmor is enabled, it is installed, running, and enforcing the AppArmor security policies.

1. Start YaST and select *Novell AppArmor* > *AppArmor Control Panel*.
2. Enable AppArmor by checking *Enable AppArmor* or disable AppArmor by deselecting it.
3. Click *Done* in the *AppArmor Configuration* window.
4. Click *File* > *Quit* in the YaST Control Center.

## 22.6.2 Changing the Mode of Individual Profiles

AppArmor can apply profiles in two different modes. In *complain* or *learning* mode, violations of AppArmor profile rules, such as the profiled program accessing files not permitted by the profile, are detected. The violations are permitted, but also logged. This mode is convenient for developing profiles and is used by the AppArmor tools for generating profiles. Loading a profile in *enforce* mode enforces the policy defined in the profile and reports policy violation attempts to syslogd.

The *Profile Modes* dialog allows you to view and edit the mode of currently loaded AppArmor profiles. This feature is useful for determining the status of your system during profile development. During the course of systemic profiling (see

Раздел 23.6.2, «Systemic Profiling» (стр. 296)), you can use this tool to adjust and monitor the scope of the profiles for which you are learning behavior.

To edit an application's profile mode, proceed as follows:

**1** Start YaST and select *Novell AppArmor* > *AppArmor Control Panel*.

**2** In the *Configure Profile Modes* section, select *Configure*.

**3** Select the profile for which to change the mode.

**4** Select *Toggle Mode* to set this profile to *complain* mode or to *enforce* mode.

**5** Apply your settings and leave YaST with *Done*.

To change the mode of all profiles, use *Set All to Enforce* or *Set All to Complain*.

---

**ПОДСКАЗКА: Listing the Profiles Available**

By default, only active profiles are listed (any profile that has a matching application installed on your system). To set up a profile before installing the respective application, click *Show All Profiles* and select the profile to configure from the list that appears.

---

# 23 Building Profiles from the Command Line

Novell® AppArmor provides the user the ability to use a command line interface rather than a graphical interface to manage and configure the system security. Track the status of Novell AppArmor and create, delete, or modify AppArmor profiles using the AppArmor command line tools.

**ПОДСКАЗКА: Background Information**

Before starting to manage your profiles using the AppArmor command line tools, check out the general introduction to AppArmor given in Глава 19, *Immunizing Programs* (стр. 233) and Глава 20, *Profile Components and Syntax* (стр. 243).

## 23.1 Checking the AppArmor Module Status

An AppArmor module can be in any one of three states:

Unloaded
: The AppArmor module is not loaded into the kernel.

Running
: The AppArmor module is loaded into the kernel and is enforcing AppArmor program policies.

Stopped
: The AppArmor module is loaded into the kernel, but no policies are enforced.

Detect the state of the AppArmor module by inspecting `/sys/kernel/security/apparmor/profiles`. If `cat /sys/kernel/security/apparmor/profiles` reports a list of profiles, AppArmor is running. If it is empty and returns nothing, AppArmor is stopped. If the file does not exist, AppArmor is unloaded.

Manage AppArmor through the script `rcapparmor`, which can perform the following operations:

`rcapparmor start`
: Behavior depends on the AppArmor module state. If it is unloaded, `start` loads the module and starts it, putting it in the running state. If it is stopped, `start` causes the module to rescan the AppArmor profiles usually found in `/etc/apparmor.d` and puts the module in the running state. If the module is already running, `start` reports a warning and takes no action.

`rcapparmor stop`
: Stops the AppArmor module if it is running by removing all profiles from kernel memory, effectively disabling all access controls, and putting the module into the stopped state. If the AppArmor module is unloaded or already stopped, `stop` tries to unload the profiles again, but nothing happens.

`rcapparmor restart`
: Causes the AppArmor module to rescan the profiles in `/etc/apparmor.d` without unconfining running processes. Freshly created profiles are enforced and recently deleted ones are removed from the `/etc/apparmor.d` directory.

`rcapparmor kill`
: Unconditionally removes the AppArmor module from the kernel. However, unloading modules from the Linux kernel is unsafe. This command is provided only for debugging and emergencies (when the module might need to be removed).

---

**ВНИМАНИЕ**

AppArmor is a powerful access control system and it is possible to lock yourself out of your own machine to the point where you must boot the machine from a rescue medium (such as the first medium of openSUSE) to regain control.

To prevent such a problem, always ensure that you have a running, unconfined, `root` login on the machine being configured when you restart the AppArmor module. If you damage your system to the point where logins are no longer possible (for example, by breaking the profile associated with the SSH daemon), you can repair the damage using your running `root` prompt then restarting the AppArmor module.

# 23.2 Building AppArmor Profiles

The AppArmor module profile definitions are stored in the `/etc/apparmor.d` directory as plain text files. For a detailed description of the syntax of these files, refer to Глава 20, *Profile Components and Syntax* (стр. 243).

All files in the `/etc/apparmor.d` directory are interpreted as profiles and are loaded as such. Renaming files in that directory is not an effective way of preventing profiles from being loaded. You must remove profiles from this directory to prevent them from being read and evaluated effectively.

You can use a text editor, such as vim, to access and make changes to these profiles. The following options contain detailed steps for building profiles:

Adding or Creating AppArmor Profiles
: Refer to Раздел 23.3, «Adding or Creating an AppArmor Profile» (стр. 293)

Editing AppArmor Profiles
: Refer to Раздел 23.4, «Editing an AppArmor Profile» (стр. 294)

Deleting AppArmor Profiles
: Refer to Раздел 23.5, «Deleting an AppArmor Profile» (стр. 294)

# 23.3 Adding or Creating an AppArmor Profile

To add or create an AppArmor profile for an application, you can use a systemic or stand-alone profiling method, depending on your needs. Learn more about these two approaches in Раздел 23.6, «Two Methods of Profiling» (стр. 294).

# 23.4 Editing an AppArmor Profile

The following steps describe the procedure for editing an AppArmor profile:

**1** If you are not currently logged in as `root`, enter `su` in a terminal window.

**2** Enter the `root` password when prompted.

**3** Go to the profile directory with `cd /etc/apparmor.d/`.

**4** Enter `ls` to view all profiles currently installed.

**5** Open the profile to edit in a text editor, such as vim.

**6** Make the necessary, changes then save the profile.

**7** Restart AppArmor by entering `rcapparmor restart` in a terminal window.

# 23.5 Deleting an AppArmor Profile

The following steps describe the procedure for deleting an AppArmor profile.

**1** If you are not currently logged in as `root`, enter `su` in a terminal window.

**2** Enter the `root` password when prompted.

**3** Go to the AppArmor directory with `cd /etc/apparmor.d/`.

**4** Enter `ls` to view all the AppArmor profiles that are currently installed.

**5** Delete the profile with `rm` *`profilename`*.

**6** Restart AppArmor by entering `rcapparmor restart` in a terminal window.

# 23.6 Two Methods of Profiling

Given the syntax for AppArmor profiles in Глава 20, *Profile Components and Syntax* (стр. 243), you could create profiles without using the tools. However, the effort

involved would be substantial. To avoid such a hassle, use the AppArmor tools to automate the creation and refinement of profiles.

There are two ways to approach AppArmor profile creation. Tools are available for both methods.

Stand-Alone Profiling
: A method suitable for profiling small applications that have a finite run time, such as user client applications like mail clients. For more information, refer to Раздел 23.6.1, «Stand-Alone Profiling» (стр. 295).

Systemic Profiling
: A method suitable for profiling large numbers of programs all at once and for profiling applications that may run for days, weeks, or continuously across reboots, such as network server applications like Web servers and mail servers. For more information, refer to Раздел 23.6.2, «Systemic Profiling» (стр. 296).

Automated profile development becomes more manageable with the AppArmor tools:

1. Decide which profiling method suits your needs.

2. Perform a static analysis. Run either aa-genprof or aa-autodep, depending on the profiling method chosen.

3. Enable dynamic learning. Activate learning mode for all profiled programs.

## 23.6.1 Stand-Alone Profiling

Stand-alone profile generation and improvement is managed by a program called aa-genprof. This method is easy because aa-genprof takes care of everything, but is limited because it requires aa-genprof to run for the entire duration of the test run of your program (you cannot reboot the machine while you are still developing your profile).

To use aa-genprof for the stand-alone method of profiling, refer to «aa-genprof—Generating Profiles» (стр. 301).

## 23.6.2 Systemic Profiling

This method is called *systemic profiling* because it updates all of the profiles on the system at once, rather than focusing on the one or few targeted by aa-genprof or stand-alone profiling. With systemic profiling, profile construction and improvement are somewhat less automated, but more flexible. This method is suitable for profiling long-running applications whose behavior continues after rebooting, or a large number of programs all at once.

Build an AppArmor profile for a group of applications as follows:

**1** Create profiles for the individual programs that make up your application.

Although this approach is systemic, AppArmor only monitors those programs with profiles and their children. To get AppArmor to consider a program, you must at least have aa-autodep create an approximate profile for it. To create this approximate profile, refer to «aa-autodep—Creating Approximate Profiles» (стр. 298).

**2** Put relevant profiles into learning or complain mode.

Activate learning or complain mode for all profiled programs by entering `aa-complain /etc/apparmor.d/*` in a terminal window while logged in as `root`. This functionality is also available through the YaST Profile Mode module, described in Раздел 22.6.2, «Changing the Mode of Individual Profiles» (стр. 289).

When in learning mode, access requests are not blocked, even if the profile dictates that they should be. This enables you to run through several tests (as shown in Шаг 3 (стр. 296)) and learn the access needs of the program so it runs properly. With this information, you can decide how secure to make the profile.

Refer to «aa-complain—Entering Complain or Learning Mode» (стр. 299) for more detailed instructions for using learning or complain mode.

**3** Exercise your application.

Run your application and exercise its functionality. How much to exercise the program is up to you, but you need the program to access each file representing its access needs. Because the execution is not being supervised by aa-genprof, this step can go on for days or weeks and can span complete system reboots.

4 Analyze the log.

In systemic profiling, run aa-logprof directly instead of letting aa-genprof run it (as in stand-alone profiling). The general form of aa-logprof is:

```
aa-logprof [ -d /path/to/profiles ] [ -f /path/to/logfile ]
```

Refer to «aa-logprof—Scanning the System Log» (стр. 309) for more information about using aa-logprof.

5 Repeat Шаг 3 (стр. 296) and Шаг 4 (стр. 297).

This generates optimum profiles. An iterative approach captures smaller data sets that can be trained and reloaded into the policy engine. Subsequent iterations generate fewer messages and run faster.

6 Edit the profiles.

You might want to review the profiles that have been generated. You can open and edit the profiles in `/etc/apparmor.d/` using vim.

7 Return to enforce mode.

This is when the system goes back to enforcing the rules of the profiles, not just logging information. This can be done manually by removing the `flags=(complain)` text from the profiles or automatically by using the `aa-enforce` command, which works identically to the `aa-complain` command, except it sets the profiles to enforce mode. This functionality is also available through the YaST Profile Mode module, described in Раздел 22.6.2, «Changing the Mode of Individual Profiles» (стр. 289).

To ensure that all profiles are taken out of complain mode and put into enforce mode, enter `aa-enforce /etc/apparmor.d/*`.

8 Rescan all profiles.

To have AppArmor rescan all of the profiles and change the enforcement mode in the kernel, enter `rcapparmor restart`.

# 23.6.3 Summary of Profiling Tools

All of the AppArmor profiling utilities are provided by the `apparmor-utils` RPM package and are stored in `/usr/sbin` . Each tool has a different purpose.

## aa-autodep—Creating Approximate Profiles

This creates an approximate profile for the program or application selected. You can generate approximate profiles for binary executables and interpreted script programs. The resulting profile is called «approximate» because it does not necessarily contain all of the profile entries that the program needs to be properly confined by AppArmor. The minimum aa-autodep approximate profile has, at minimum, a base include directive, which contains basic profile entries needed by most programs. For certain types of programs, aa-autodep generates a more expanded profile. The profile is generated by recursively calling `ldd(1)` on the executables listed on the command line.

To generate an approximate profile, use the aa-autodep program. The program argument can be either the simple name of the program, which aa-autodep finds by searching your shell's path variable, or it can be a fully qualified path. The program itself can be of any type (ELF binary, shell script, Perl script, etc.). aa-autodep generates an approximate profile to improve through the dynamic profiling that follows.

The resulting approximate profile is written to the `/etc/apparmor.d` directory using the AppArmor profile naming convention of naming the profile after the absolute path of the program, replacing the forward slash (`/`) characters in the path with period (`.`) characters. The general form of aa-autodep is to enter the following in a terminal window when logged in as `root`:

```
aa-autodep [ -d /path/to/profiles ] [program1 program2...]
```

If you do not enter the program name or names, you are prompted for them. *`/path/to/profiles`* overrides the default location of `/etc/apparmor.d` , should you keep profiles in a location other than the default.

To begin profiling, you must create profiles for each main executable service that is part of your application (anything that might start without being a child of another program that already has a profile). Finding all such programs depends on the application in question. Here are several strategies for finding such programs:

Directories

If all the programs to profile are in one directory and there are no other programs in that directory, the simple command `aa-autodep /path/to/your/programs/*` creates basic profiles for all programs in that directory.

ps command

You can run your application and use the standard Linux `ps` command to find all processes running. Then manually hunt down the location of these programs and run the `aa-autodep` for each one. If the programs are in your path, aa-autodep finds them for you. If they are not in your path, the standard Linux command `find` might be helpful in finding your programs. Execute `find / -name 'my_application' -print` to determine an application's path (*my_application* being an example application). You may use wild cards if appropriate.

## aa-complain—Entering Complain or Learning Mode

The complain or learning mode tool (aa-complain) detects violations of AppArmor profile rules, such as the profiled program accessing files not permitted by the profile. The violations are permitted, but also logged. To improve the profile, turn complain mode on, run the program through a suite of tests to generate log events that characterize the program's access needs, then postprocess the log with the AppArmor tools to transform log events into improved profiles.

Manually activating complain mode (using the command line) adds a flag to the top of the profile so that `/bin/foo` becomes `/bin/foo flags=(complain)`. To use complain mode, open a terminal window and enter one of the following lines as `root`:

- If the example program (*program1*) is in your path, use:

  ```
  aa-complain [program1 program2 ...]
  ```

- If the program is not in your path, specify the entire path as follows:

  ```
  aa-complain /sbin/program1
  ```

- If the profiles are not in `/etc/apparmor.d` , use the following to override the default location:

  ```
  aa-complain /path/to/profiles/ program1
  ```

- Specify the profile for *program1* as follows:

```
aa-complain /etc/apparmor.d/sbin.program1
```

Each of the above commands activates the complain mode for the profiles or programs listed. If the program name does not include its entire path, aa-complain searches `$PATH` for the program. For instance, `aa-complain /usr/sbin/*` finds profiles associated with all of the programs in `/usr/sbin` and puts them into complain mode. `aa-complain /etc/apparmor.d/*` puts all of the profiles in `/etc/apparmor.d` into complain mode.

---

**ПОДСКАЗКА: Toggling Profile Mode with YaST**

YaST offers a graphical front-end for toggling complain and enforce mode. See Раздел 22.6.2, «Changing the Mode of Individual Profiles» (стр. 289) for information.

---

## aa-enforce—Entering Enforce Mode

The enforce mode detects violations of AppArmor profile rules, such as the profiled program accessing files not permitted by the profile. The violations are logged and not permitted. The default is for enforce mode to be enabled. To log the violations only, but still permit them, use complain mode. Enforce toggles with complain mode.

Manually activating enforce mode (using the command line) adds a flag to the top of the profile so that `/bin/foo` becomes `/bin/foo flags=(enforce)`. To use enforce mode, open a terminal window and enter one of the following lines as `root`.

- If the example program (*program1*) is in your path, use:

```
aa-enforce [program1 program2 ...]
```

- If the program is not in your path, specify the entire path, as follows:

```
aa-enforce /sbin/program1
```

- If the profiles are not in */etc/apparmor.d*, use the following to override the default location:

```
aa-enforce /path/to/profiles/program1
```

- Specify the profile for *program1* as follows:

```
aa-enforce /etc/apparmor.d/sbin.program1
```

Each of the above commands activates the enforce mode for the profiles and programs listed.

If you do not enter the program or profile names, you are prompted to enter one. */path/to/profiles* overrides the default location of `/etc/apparmor.d` .

The argument can be either a list of programs or a list of profiles. If the program name does not include its entire path, aa-enforce searches `$PATH` for the program.

---

**ПОДСКАЗКА: Toggling Profile Mode with YaST**

YaST offers a graphical front-end for toggling complain and enforce mode. See Раздел 22.6.2, «Changing the Mode of Individual Profiles» (стр. 289) for information.

---

## aa-genprof—Generating Profiles

aa-genprof is AppArmor's profile generating utility. It runs aa-autodep on the specified program, creating an approximate profile (if a profile does not already exist for it), sets it to complain mode, reloads it into AppArmor, marks the log, and prompts the user to execute the program and exercise its functionality. Its syntax is as follows:

```
aa-genprof [ -d /path/to/profiles ]  program
```

To create a profile for the the Apache Web server program httpd2-prefork, do the following as `root`:

**1** Enter `rcapache2 stop`.

**2** Next, enter `aa-genprof httpd2-prefork`.

Now aa-genprof does the following:

1. Resolves the full path of httpd2-prefork using your shell's path variables. You can also specify a full path. On openSUSE, the default full path is `/usr/sbin/httpd2-prefork` .

2. Checks to see if there is an existing profile for httpd2-prefork. If there is one, it updates it. If not, it creates one using the aa-autodep as described in Раздел 23.6.3, «Summary of Profiling Tools» (стр. 298).

3. Puts the profile for this program into learning or complain mode so that profile violations are logged, but are permitted to proceed. A log event looks like this (see `/var/log/audit/audit.log` ):

```
type=APPARMOR_ALLOWED msg=audit(1189682639.184:20816):
 operation="file_mmap" requested_mask="::r" denied_mask="::r" fsuid=30
 name="/srv/www/htdocs/index.html" pid=27471 profile="null-complain-
profile"
```

If you are not running the audit daemon, the AppArmor events are logged to `/var/log/messages` :

```
Sep 13 13:20:30 K23 kernel: audit(1189682430.672:20810):
 operation="file_mmap" requested_mask="::r" denied_mask="::r" fsuid=30
 name="/srv/www/htdocs/phpsysinfo/templates/bulix/form.tpl" pid=30405
 profile="/usr/sbin/httpd2-prefork///phpsysinfo/"
```

They also can be viewed using the `dmesg` command:

```
audit(1189682430.672:20810): operation="file_mmap" requested_mask="::r"
 denied_mask="::r" fsuid=30 name="/srv/www/htdocs/phpsysinfo/templates/
bulix/form.tpl" pid=30405 profile="/usr/sbin/httpd2-prefork///
phpsysinfo/"
```

4. Marks the log with a beginning marker of log events to consider. For example:

```
Sep 13 17:48:52 figwit root: GenProf: e2ff78636296f16d0b5301209a04430d
```

**3** When prompted by the tool, run the application to profile in another terminal window and perform as many of the application functions as possible. Thus, the learning mode can log the files and directories to which the program requires access in order to function properly. For example, in a new terminal window, enter `rcapache2 start`.

**4** Select from the following options that are available in the aa-logprof terminal window after you have executed the program function:

- S runs aa-logprof on the system log from where it was marked when aa-genprof was started and reloads the profile. If system events exist in the log, AppArmor parses the learning mode log files. This generates a series of questions that you must answer to guide aa-genprof in generating the security profile.

- F exits the tool and returns to the main menu.

**ЗАМЕЧАНИЕ**

If requests to add hats appear, proceed to Глава 24, *Profiling Your Web Applications Using ChangeHat* (стр. 317).

**5** Answer two types of questions:

- A resource is requested by a profiled program that is not in the profile (see Пример 23.1, «Learning Mode Exception: Controlling Access to Specific Resources» (стр. 303)).
- A program is executed by the profiled program and the security domain transition has not been defined (see Пример 23.2, «Learning Mode Exception: Defining Execute Permissions for an Entry» (стр. 305)).

Each of these categories results in a series of questions that you must answer to add the resource or program to the profile. Пример 23.1, «Learning Mode Exception: Controlling Access to Specific Resources» (стр. 303) and Пример 23.2, «Learning Mode Exception: Defining Execute Permissions for an Entry» (стр. 305) provide examples of each one. Subsequent steps describe your options in answering these questions.

- Dealing with execute accesses is complex. You must decide how to proceed with this entry regarding which execute permission type to grant to this entry:

***Пример 23.1*** *Learning Mode Exception: Controlling Access to Specific Resources*

```
Reading log entries from /var/log/audit/audit.log.
Updating AppArmor profiles in /etc/apparmor.d.

Profile:  /usr/sbin/xinetd
Program:  xinetd
Execute:  /usr/lib/cups/daemon/cups-lpd
Severity: unknown

[(I)nherit] / (P)rofile / (U)nconfined / (D)eny / Abo(r)t / (F)inish
```

Inherit (ix)

The child inherits the parent's profile, running with the same access controls as the parent. This mode is useful when a confined program needs to call

another confined program without gaining the permissions of the target's profile or losing the permissions of the current profile. This mode is often used when the child program is a *helper application*, such as the `/usr/bin/mail` client using `less` as a pager or the Mozilla* Web browser using Adobe Acrobat* to display PDF files.

Profile (px)
: The child runs using its own profile, which must be loaded into the kernel. If the profile is not present, attempts to execute the child fail with permission denied. This is most useful if the parent program is invoking a global service, such as DNS lookups or sending mail with your system's MTA.

  Choose the *profile with clean exec* (Px) option to scrub the environment of environment variables that could modify execution behavior when passed to the child process.

Unconfined (ux)
: The child runs completely unconfined without any AppArmor profile applied to the executed resource.

  Choose the *unconfined with clean exec* (Ux) option to scrub the environment of environment variables that could modify execution behavior when passed to the child process. This option introduces a security vulnerability that could be used to exploit AppArmor. Only use it as a last resort.

mmap (m)
: This permission denotes that the program running under the profile can access the resource using the mmap system call with the flag `PROT_EXEC`. This means that the data mapped in it can be executed. You are prompted to include this permission if it is requested during a profiling run.

Deny
: Prevents the program from accessing the specified directory path entries. AppArmor then continues to the next event.

Abort
: Aborts aa-logprof, losing all rule changes entered so far and leaving all profiles unmodified.

Finish
: Closes aa-logprof, saving all rule changes entered so far and modifying all profiles.

- Пример 23.2, «Learning Mode Exception: Defining Execute Permissions for an Entry» (стр. 305) shows AppArmor suggesting directory path entries that have been accessed by the application being profiled. It might also require you to define execute permissions for entries.

***Пример 23.2*** *Learning Mode Exception: Defining Execute Permissions for an Entry*

```
Adding /bin/ps ix to profile.

Profile:  /usr/sbin/xinetd
Path:     /etc/hosts.allow
New Mode: r

 [1 - /etc/hosts.allow]

[(A)llow] / (D)eny / (N)ew / (G)lob / Glob w/(E)xt / Abo(r)t / (F)inish
```

AppArmor provides one or more paths or includes. By entering the option number, select the desired options then proceed to the next step.

---

**ЗАМЕЧАНИЕ**

All of these options are not always presented in the AppArmor menu.

---

`#include`
: This is the section of an AppArmor profile that refers to an include file, which procures access permissions for programs. By using an include, you can give the program access to directory paths or files that are also required by other programs. Using includes can reduce the size of a profile. It is good practice to select includes when suggested.

Globbed Version
: This is accessed by selecting *Glob* as described in the next step. For information about globbing syntax, refer to Раздел 20.6, «Paths and Globbing» (стр. 252).

Actual Path
: This is the literal path to which the program needs access so that it can run properly.

After you select the path or include, process it as an entry into the AppArmor profile by selecting *Allow* or *Deny*. If you are not satisfied with the directory path entry as it is displayed, you can also *Glob* it.

The following options are available to process the learning mode entries and build the profile:

Select Enter
: Allows access to the selected directory path.

Allow
: Allows access to the specified directory path entries. AppArmor suggests file permission access. For more information, refer to Раздел 20.7, «File Permission Access Modes» (стр. 254).

Deny
: Prevents the program from accessing the specified directory path entries. AppArmor then continues to the next event.

New
: Prompts you to enter your own rule for this event, allowing you to specify a regular expression. If the expression does not actually satisfy the event that prompted the question in the first place, AppArmor asks for confirmation and lets you reenter the expression.

Glob
: Select a specific path or create a general rule using wild cards that match a broader set of paths. To select any of the offered paths, enter the number that is printed in front of the path then decide how to proceed with the selected item.

  For more information about globbing syntax, refer to Раздел 20.6, «Paths and Globbing» (стр. 252).

Glob w/Ext
: This modifies the original directory path while retaining the filename extension. For example, `/etc/apache2/file.ext` becomes `/etc/apache2/*.ext`, adding the wild card (asterisk) in place of the filename. This allows the program to access all files in the suggested directory that end with the `.ext` extension.

Abort
: Aborts aa-logprof, losing all rule changes entered so far and leaving all profiles unmodified.

Finish
: Closes aa-logprof, saving all rule changes entered so far and modifying all profiles.

6 To view and edit your profile using vim, enter `vim /etc/apparmor.d/`*`profilename`* in a terminal window.

7 Restart AppArmor and reload the profile set including the newly created one using the `rcapparmor restart` command.

Like the graphical front-end for building AppArmor profiles, the YaST Add Profile Wizard, aa-genprof also supports the use of the local profile repository under `/etc/apparmor/profiles/extras` and the remote AppArmor profile repository.

To use a profile from the local repository, proceed as follows:

1 Start aa-genprof as described above.

If aa-genprof finds an inactive local profile, the following lines appear on your terminal window:

```
Profile: /usr/bin/opera

 [1 - Inactive local profile for /usr/bin/opera]

[(V)iew Profile] / (U)se Profile / (C)reate New Profile / Abo(r)t /
 (F)inish
```

2 If you want to just use this profile, hit U (*Use Profile*) and follow the profile generation procedure outlined above.

If you want to examine the profile before activating it, hit V (*View Profile*).

If you want to ignore the existing profile, hit C (*Create New Profile*) and follow the profile generation procedure outlined above to create the profile from scratch.

**3** Leave aa-genprof by hitting F (*Finish*) when you are done and save your changes.

To use the remote AppArmor profile repository with aa-genprof, proceed as follows:

**1** Start aa-genprof as described above.

If aa-genprof detects a suitable profile on the repository server, the following lines appear on your terminal window:

```
Repository: http://apparmor.opensuse.org/backend/api

Would you like to enable access to the profile repository?

(E)nable Repository / (D)isable Repository / Ask Me (L)ater
```

**2** Hit E (*Enable Repository*) to enable the repository.

**3** Determine whether you want to aa-genprof to upload any profiles to the repository server:

```
Would you like to upload newly created and changed profiles to
      the profile repository?

(Y)es / (N)o / Ask Me (L)ater
```

Hit Y (*Yes*), if you want to enable profile upload or select N (*No*), if you want aa-genprof to just pull profiles from the repository, but not to upload any.

**4** Create a new user on the profile repository server to be able to upload profiles. Provide username and password.

**5** Determine whether you want to use the profile downloaded from the server or whether you would just like to review it:

```
Profile: /usr/bin/opera

 [1 - novell]

[(V)iew Profile] / (U)se Profile / (C)reate New Profile / Abo(r)t /
 (F)inish
```

If you want to just use this profile, hit U (*Use Profile*) and follow the profile generation procedure outlined above.

If you want to examine the profile before activating it, hit V (*View Profile*).

If you want to ignore the existing profile, hit C (*Create New Profile*) and follow the profile generation procedure outlined above to create the profile from scratch.

6 Leave aa-genprof by hitting F (*Finish*) when you are done and save the profile.

If you opted for uploading your profile, provide a short change log and push it to the repository.

## aa-logprof—Scanning the System Log

aa-logprof is an interactive tool used to review the learning or complain-mode output found in the log entries in `/var/log/audit/audit.log` or `/var/log/messages` (if auditd is not running) and generate new entries in AppArmor security profiles.

When you run aa-logprof, it begins to scan the log files produced in learning or complain mode and, if there are new security events that are not covered by the existing profile set, it gives suggestions for modifying the profile. The learning or complain mode traces program behavior and enters it in the log. aa-logprof uses this information to observe program behavior.

If a confined program forks and executes another program, aa-logprof sees this and asks the user which execution mode should be used when launching the child process. The execution modes *ix*, *px*, *Px*, *ux*, and *Ux* are options for starting the child process. If a separate profile exists for the child process, the default selection is *px*. If one does not exist, the profile defaults to *ix*. Child processes with separate profiles have aa-autodep run on them and are loaded into AppArmor, if it is running.

When aa-logprof exits, profiles are updated with the changes. If the AppArmor module is running, the updated profiles are reloaded and, if any processes that generated security events are still running in the null-complain-profile, those processes are set to run under their proper profiles.

**ПОДСКАЗКА: Support for the External Profile Repository**

Similar to the aa-genprof, aa-logprof also supports profile exchange with the external repository server. For background information on the use of the external AppArmor profile repository, refer to Глава 21, *AppArmor Profile Repositories* (стр. 267). For details on how to configure access and access mode to the server, check the procedure described under «aa-genprof—Generating Profiles» (стр. 301).

To run aa-logprof, enter `aa-logprof` into a terminal window while logged in as `root`. The following options can be used for aa-logprof:

`aa-logprof -d` *`/path/to/profile/directory/`*
: Specifies the full path to the location of the profiles if the profiles are not located in the standard directory, `/etc/apparmor.d/` .

`aa-logprof -f` *`/path/to/logfile/`*
: Specifies the full path to the location of the log file if the log file is not located in the default directory, `/var/log/audit/audit.log` or `/var/log/messages` (if auditd is not running).

`aa-logprof -m "string marker in logfile"`
: Marks the starting point for aa-logprof to look in the system log. aa-logprof ignores all events in the system log before the specified mark. If the mark contains spaces, it must be surrounded by quotes to work correctly. For example:

```
aa-logprof -m"17:04:21"
```

or

```
logprof -m e2ff78636296f16d0b5301209a04430d
```

aa-logprof scans the log, asking you how to handle each logged event. Each question presents a numbered list of AppArmor rules that can be added by pressing the number of the item on the list.

By default, aa-logprof looks for profiles in `/etc/apparmor.d/` and scans the log in `/var/log/messages` . In many cases, running `aa-logprof` as `root` is enough to create the profile.

However, there might be times when you need to search archived log files, such as if the program exercise period exceeds the log rotation window (when the log file

is archived and a new log file is started). If this is the case, you can enter `zcat -f `ls -1tr /var/log/messages*` | aa-logprof -f -`.

## aa-logprof Example 1

The following is an example of how aa-logprof addresses httpd2-prefork accessing the file `/etc/group` . `[]` indicates the default option.

In this example, the access to `/etc/group` is part of httpd2-prefork accessing name services. The appropriate response is `1`, which includes a predefined set of AppArmor rules. Selecting `1` to `#include` the name service package resolves all of the future questions pertaining to DNS lookups and also makes the profile less brittle in that any changes to DNS configuration and the associated name service profile package can be made just once, rather than needing to revise many profiles.

```
Profile:  /usr/sbin/httpd2-prefork
Path:     /etc/group
New Mode: r

[1 - #include <abstractions/nameservice>]
 2 - /etc/group
[(A)llow] / (D)eny / (N)ew / (G)lob / Glob w/(E)xt / Abo(r)t / (F)inish
```

Select one of the following responses:

Select Enter
: Triggers the default action, which is, in this example, allowing access to the specified directory path entry.

Allow
: Allows access to the specified directory path entries. AppArmor suggests file permission access. For more information about this, refer to Раздел 20.7, «File Permission Access Modes» (стр. 254).

Deny
: Prevents the program from accessing the specified directory path entries. AppArmor then continues to the next event.

New
: Prompts you to enter your own rule for this event, allowing you to specify whatever form of regular expression you want. If the expression entered does not actually satisfy the event that prompted the question in the first place, AppArmor asks for confirmation and lets you reenter the expression.

Glob
: Select either a specific path or create a general rule using wild cards that matches on a broader set of paths. To select any of the offered paths, enter the number that is printed in front of the paths then decide how to proceed with the selected item.

  For more information about globbing syntax, refer to Раздел 20.6, «Paths and Globbing» (стр. 252).

Glob w/Ext
: This modifies the original directory path while retaining the filename extension. For example, `/etc/apache2/file.ext` becomes `/etc/apache2/*.ext`, adding the wild card (asterisk) in place of the filename. This allows the program to access all files in the suggested directory that end with the `.ext` extension.

Abort
: Aborts aa-logprof, losing all rule changes entered so far and leaving all profiles unmodified.

Finish
: Closes aa-logprof, saving all rule changes entered so far and modifying all profiles.

## aa-logprof Example 2

For example, when profiling vsftpd, see this question:

```
Profile:  /usr/sbin/vsftpd
Path:     /y2k.jpg
New Mode: r

[1 - /y2k.jpg]

(A)llow / [(D)eny] / (N)ew / (G)lob / Glob w/(E)xt / Abo(r)t / (F)inish
```

Several items of interest appear in this question. First, note that vsftpd is asking for a path entry at the top of the tree, even though vsftpd on openSUSE serves FTP files from `/srv/ftp` by default. This is because httpd2-prefork uses chroot and, for the portion of the code inside the chroot jail, AppArmor sees file accesses in terms of the chroot environment rather than the global absolute path.

The second item of interest is that you might want to grant FTP read access to all JPEG files in the directory, so you could use *Glob w/Ext* and use the suggested path

of `/*.jpg`. Doing so collapses all previous rules granting access to individual `.jpg` files and forestalls any future questions pertaining to access to `.jpg` files.

Finally, you might want to grant more general access to FTP files. If you select *Glob* in the last entry, aa-logprof replaces the suggested path of `/y2k.jpg` with `/*`. Alternatively, you might want to grant even more access to the entire directory tree, in which case you could use the *New* path option and enter `/**.jpg` (which would grant access to all `.jpg` files in the entire directory tree) or `/**` (which would grant access to all files in the directory tree).

These items deal with read accesses. Write accesses are similar, except that it is good policy to be more conservative in your use of regular expressions for write accesses. Dealing with execute accesses is more complex. Find an example in Пример 23.1, «Learning Mode Exception: Controlling Access to Specific Resources» (стр. 303).

In the following example, the `/usr/bin/mail` mail client is being profiled and aa-logprof has discovered that `/usr/bin/mail` executes `/usr/bin/less` as a helper application to «page» long mail messages. Consequently, it presents this prompt:

```
/usr/bin/nail -> /usr/bin/less
(I)nherit / (P)rofile / (U)nconfined / (D)eny
```

**ПОДСКАЗКА**

The actual executable file for `/usr/bin/mail` turns out to be `/usr/bin/nail`, which is not a typographical error.

The program `/usr/bin/less` appears to be a simple one for scrolling through text that is more than one screen long and that is in fact what `/usr/bin/mail` is using it for. However, less is actually a large and powerful program that makes use of many other helper applications, such as tar and rpm.

**ПОДСКАЗКА**

Run `less` on a tar file or an RPM file and it shows you the inventory of these containers.

You do not want to run `rpm` automatically when reading mail messages (that leads directly to a Microsoft* Outlook–style virus attack, because rpm has the power to install and modify system programs), so, in this case, the best choice is to use *Inherit*.

This results in the less program executed from this context running under the profile for `/usr/bin/mail` . This has two consequences:

- You need to add all of the basic file accesses for `/usr/bin/less` to the profile for `/usr/bin/mail` .
- You can avoid adding the helper applications, such as tar and rpm, to the `/usr/bin/mail` profile so that when `/usr/bin/mail` runs `/usr/bin/less` in this context, the less program is far less dangerous than it would be without AppArmor protection.

In other circumstances, you might instead want to use the *Profile* option. This has two effects on aa-logprof:

- The rule written into the profile uses px, which forces the transition to the child's own profile.
- aa-logprof constructs a profile for the child and starts building it, in the same way that it built the parent profile, by assigning events for the child process to the child's profile and asking the aa-logprof user questions.

If a confined program forks and executes another program, aa-logprof sees this and asks the user which execution mode should be used when launching the child process. The execution modes of inherit, profile, unconfined or an option to deny the execution are presented.

If a separate profile exists for the child process, the default selection is profile. If a profile does not exist, the default is inherit. The inherit option, or `ix`, is described in Раздел 20.7, «File Permission Access Modes» (стр. 254).

The profile option indicates that the child program should run in its own profile. A secondary question asks whether to sanitize the environment that the child program inherits from the parent. If you choose to sanitize the environment, this places the execution modifier `Px` in your AppArmor profile. If you select not to sanitize, `px` is placed in the profile and no environment sanitizing occurs. The default for the execution mode is `px` if you select profile execution mode.

The unconfined execution mode is not recommended and should only be used in cases where there is no other option to generate a profile for a program reliably. Selecting unconfined opens a warning dialog asking for confirmation of the choice. If you are sure and choose *Yes*, a second dialog ask whether to sanitize the

environment. Choosing *Yes* uses the execution mode `Ux` in your profile. Choosing *No* uses the execution mode `ux` for your profile. The default value selected is `Ux` for unconfined execution mode.

**ВАЖНО: Running Unconfined**

Choosing `ux` is very dangerous and provides no enforcement of policy (from a security perspective) of the resulting execution behavior of the child program.

## aa-unconfined—Identifying Unprotected Processes

The `aa-unconfined` command examines open network ports on your system, compares that to the set of profiles loaded on your system, and reports network services that do not have AppArmor profiles. It requires `root` privileges and that it not be confined by an AppArmor profile.

aa-unconfined must be run as `root` to retrieve the process executable link from the `/proc` file system. This program is susceptible to the following race conditions:

- An unlinked executable is mishandled
- A process that dies between `netstat(8)` and further checks is mishandled

**ЗАМЕЧАНИЕ**

This program lists processes using TCP and UDP only. In short, this program is unsuitable for forensics use and is provided only as an aid to profiling all network-accessible processes in the lab.

# 23.7 Important Filenames and Directories

The following list contains the most important files and directories used by the AppArmor framework. If you intend to manage and troubleshoot your profiles manually, make sure that you know about these files and directories:

`/sys/kernel/security/apparmor/profiles`
: Virtualized file representing the currently loaded set of profiles.

`/etc/apparmor/`
: Location of AppArmor configuration files.

`/etc/apparmor/profiles/extras/`
: A local repository of profiles shipped with AppArmor, but not enabled by default.

`/etc/apparmor.d/`
: Location of profiles, named with the convention of replacing the `/` in paths with `.` (not for the root `/`) so profiles are easier to manage. For example, the profile for the program `/usr/sbin/ntpd` is named `usr.sbin.ntpd` .

`/etc/apparmor.d/abstractions/`
: Location of abstractions.

`/etc/apparmor.d/program-chunks/`
: Location of program chunks.

`/proc/*/attr/current`
: Check this file to review the confinement status of a process and the profile that is used to confine the process. The `ps auxZ` command retrieves this information automatically.

# Profiling Your Web Applications Using ChangeHat

# 24

A Novell® AppArmor profile represents the security policy for an individual program instance or process. It applies to an executable program, but if a portion of the program needs different access permissions than other portions, the program can «change hats» to use a different security context, distinctive from the access of the main program. This is known as a *hat* or *subprofile*.

ChangeHat enables programs to change to or from a *hat* within a Novell AppArmor profile. It enables you to define security at a finer level than the process. This feature requires that each application be made «ChangeHat aware», meaning that it is modified to make a request to the Novell AppArmor module to switch security domains at arbitrary times during the application execution. Two examples for ChangeHat-aware applications are the Apache Web server and Tomcat.

A profile can have an arbitrary number of subprofiles, but there are only two levels: a subprofile cannot have further sub-subprofiles. A subprofile is written as a separate profile and named as the containing profile followed by the subprofile name, separated by a ^. Subprofiles must be stored in the same file as the parent profile.

Note that the security of hats is considerably weaker than that of full profiles. That is to say, if attackers can find just the right kind of bug in a program, they may be able to escape from a hat into the containing profile. This is because the security of hats is determined by a secret key handled by the containing process, and the code running in the hat must not have access to the key. Thus change_hat is most useful in conjunction with application servers, where a language interpreter (such as PERL, PHP, or Java) is isolating pieces of code such that they do not have direct access to the memory of the containing process.

The rest of this chapter describes using change_hat in conjunction with Apache, to contain web server components run using mod_perl and mod_php. Similar approaches can be used with any application server by providing an application module similar to the mod_apparmor described next in Раздел 24.2.2, «Location and Directory Directives» (стр. 325).

**ЗАМЕЧАНИЕ: For More Information**

For more information, see the `change_hat` man page.

# 24.1 Apache ChangeHat

Novell AppArmor provides a `mod_apparmor` module (package `apache2-mod_apparmor`) for the Apache program. This module makes the Apache Web server ChangeHat aware. Install it along with Apache.

When Apache is ChangeHat aware, it checks for the following customized Novell AppArmor security profiles in the order given for every URI request that it receives.

- URI-specific hat. For example, `^phpsysinfo/templates/classic/images/bar_left.gif`
- `DEFAULT_URI`
- `HANDLING_UNTRUSTED_INPUT`

**ЗАМЕЧАНИЕ: Apache Configuration**

If you install `apache2-mod_apparmor`, make sure the module gets loaded in Apache by executing the following command:

```
a2enmod apparmor
```

## 24.1.1 Managing ChangeHat-Aware Applications

As with most of the Novell AppArmor tools, you can use two methods for managing ChangeHat, YaST or the command line interface. Managing ChangeHat-aware

applications from the command line is much more flexible, but the process is also more complicated. Both methods allow you to manage the hats for your application and populate them with profile entries.

The following steps are a demonstration that adds hats to an Apache profile using YaST. In the *Add Profile Wizard*, the Novell AppArmor profiling utilities prompt you to create new hats for distinct URI requests. Choosing to create a new hat allows you to create individual profiles for each URI. You can create very tight rules for each request.

If the URI that is processed does not represent significant processing or otherwise does not represent a significant security risk, safely select *Use Default Hat* to process this URI in the default hat, which is the default security profile.

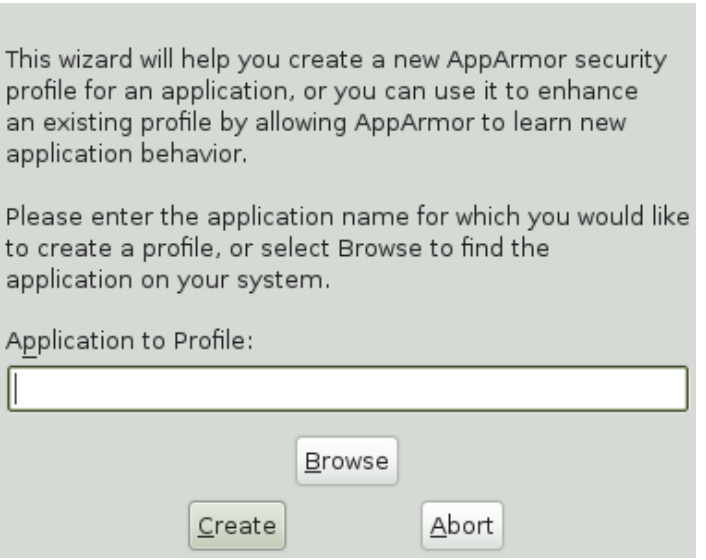
This example creates a new hat for the URI `phpsysinfo` and its subsequent accesses. Using the profiling utilities, delegate what to add to this new hat. The resulting hat becomes a tight-security container that encompasses all the processing on the server that occurs when the `phpsysinfo` URI is passed to the Apache Web server.

The URI runs the application phpsysinfo (refer to `http://phpsysinfo.sourceforge.net` for more information). The `phpsysinfo` package is assumed to be installed in `/srv/www/htdocs/phpsysinfo` in a clean (new) installation of openSUSE and AppArmor.

1. Once `phpsysinfo` is installed, you are ready to add hats to the Apache profile. From the Novell AppArmor GUI, select *Add Profile Wizard*.

2. In *Application to Profile*, enter `httpd2-prefork`.

3. Click *Create Profile*.




4 Restart Apache by entering `rcapache2 restart` in a terminal window.

Restart any program you are profiling at this point.

5 Open `http://localhost/phpsysinfo/` in a Web browser window. The browser window should display network usage and system information.

---

**ЗАМЕЧАНИЕ: Data Caching**

To ensure that this request is processed by the server and you do not review cached data in your browser, refresh the page. To do this, click the browser *Refresh* button to make sure that Apache processes the request for the `phpsysinfo` URI.

---

6 Click *Scan System Log for Entries to Add to Profiles*. Novell AppArmor launches the `aa-logprof` tool, which scans the information learned in the previous step. It begins to prompt you with profile questions.

7 `aa-logprof` first prompts with *Add Requested Hat* or *Use Default Hat* because it noticed that the `phpsysinfo` URI was accessed. Select *Add Requested Hat*.

8 Click *Allow*.

Choosing *Add Requested Hat* in the previous step creates a new hat in the profile and specifies that the results of subsequent questions about the script's actions are added to the newly created hat rather than the default hat for this application.

In the next screen, Novell AppArmor displays an external program that the script executed. You can specify that the program should run confined by the phpsysinfo hat (choose *Inherit*), confined by a separate profile (choose *Profile*), or that it should run unconfined or without any security profile (choose *Unconfined*). For the case of the *Profile* option, a new profile is created for the program if one does not already exist.

---

**ЗАМЕЧАНИЕ: Security Considerations**

Selecting *Unconfined* can create a significant security hole and should be done with caution.

---

**8a** Select *Inherit* for the `/bin/bash` path. This adds `/bin/bash` (accessed by Apache) to the phpsysinfo hat profile with the necessary permissions.

**8b** Click *Allow*.

**9** The remaining questions prompt you to generate new hats and add entries to your profile and its hats. The process of adding entries to profiles is covered in detail in the Раздел 22.1, «Adding a Profile Using the Wizard» (стр. 273).

When all profiling questions are answered, click *Finish* to save your changes and exit the wizard.

The following is an example phpsysinfo hat.

***Пример 24.1*** *Example phpsysinfo Hat*

```
/usr/sbin/httpd2-prefork {
  ...
  ^phpsysinfo {
    #include <abstractions/bash>
    #include <abstractions/nameservice>

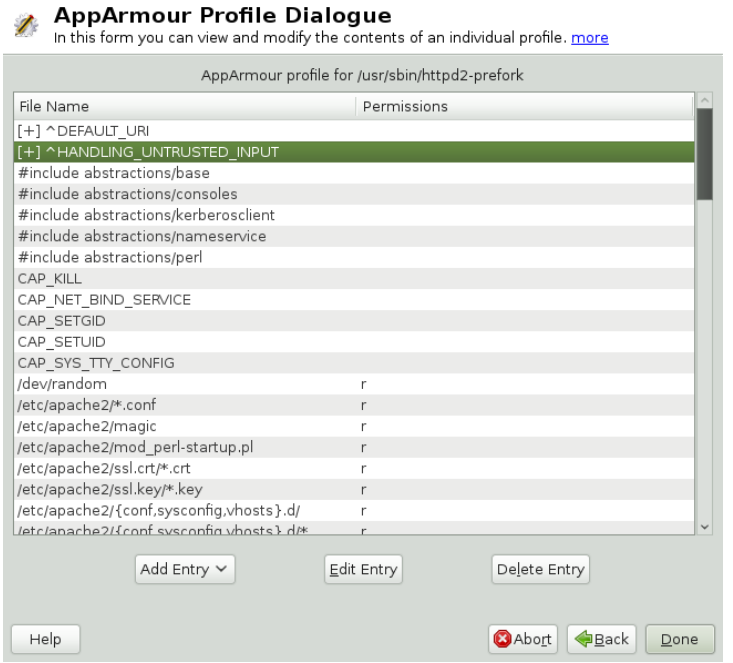
    /bin/basename                          ixr,
    /bin/bash                              ixr,
    /bin/df                                ixr,
    /bin/grep                              ixr,
    /bin/mount                             Ux,
    /bin/sed                               ixr,
    /dev/bus/usb/                          r,
    /dev/bus/usb/**                        r,
    /dev/null                              w,
    /dev/tty                               rw,
    /dev/urandom                           r,
    /etc/SuSE-release                      r,
    /etc/ld.so.cache                       r,
    /etc/lsb-release                       r,
    /etc/lsb-release.d/                    r,
    /lib/ld-2.6.1.so                       ixr,
    /proc/**                               r,
    /sbin/lspci                            ixr,
    /srv/www/htdocs/phpsysinfo/**          r,
    /sys/bus/pci/**                        r,
    /sys/bus/scsi/devices/                 r,
    /sys/devices/**                        r,
    /usr/bin/cut                           ixr,
    /usr/bin/getopt                        ixr,
    /usr/bin/head                          ixr,
    /usr/bin/lsb_release                   ixr,
    /usr/bin/lsscsi                        ixr,
    /usr/bin/tr                            ixr,
    /usr/bin/who                           ixr,
    /usr/lib/lib*so*                       mr,
    /usr/lib/locale/**                     r,
    /usr/sbin/lsusb                        ixr,
    /usr/share/locale/**                   r,
    /usr/share/pci.ids                     r,
    /usr/share/usb.ids                     r,
    /var/log/apache2/access_log            w,
    /var/run/utmp                          kr,
   }
}
```

**ЗАМЕЧАНИЕ: Hat and Parent Profile Relationship**

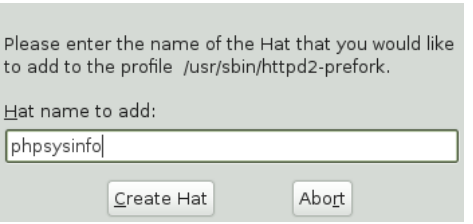
The profile `^phpsysinfo` is only valid in the context of a process running under the parent profile `httpd2-prefork` .

# 24.1.2 Adding Hats and Entries to Hats

When you use the *Edit Profile* dialog (for instructions, refer to Раздел 22.3, «Editing Profiles» (стр. 281)) or when you add a new profile using *Manually Add Profile* (for instructions, refer to Раздел 22.2, «Manually Adding a Profile» (стр. 280)), you are given the option of adding hats (subprofiles) to your Novell AppArmor profiles. Add a ChangeHat subprofile from the *AppArmor Profile Dialog* window as in the following.




1 From the *AppArmor Profile Dialog* window, click *Add Entry* then select *Hat*. The *Enter Hat Name* dialog box opens:



2 Enter the name of the hat to add to the Novell AppArmor profile. The name is the URI that, when accessed, receives the permissions set in the hat.

3 Click *Create Hat*. You are returned to the *AppArmor Profile Dialog* screen.

4 After adding the new hat, click *Done*.

---

**ЗАМЕЧАНИЕ: For More Information**

For an example of an Novell AppArmor profile, refer to Пример 24.1, «Example phpsysinfo Hat» (стр. 322).

---

# 24.2 Configuring Apache for mod_apparmor

Apache is configured by placing directives in plain text configuration files. The main configuration file is usually `httpd.conf` . When you compile Apache, you can indicate the location of this file. Directives can be placed in any of these configuration files to alter the way Apache behaves. When you make changes to the main configuration files, you need to start or restart Apache, so the changes are recognized.

## 24.2.1 Virtual Host Directives

Virtual host directives control whether requests that contain trailing pathname information following an actual filename (or that refer to a nonexistent file in an existing directory) are accepted or rejected. For Apache documentation on virtual host directives, refer to `http://httpd.apache.org/docs/2.2/mod/core.html#virtualhost` .

The ChangeHat-specific configuration keyword is `AADefaultHatName`. It is used similarly to `AAHatName`, for example, `AADefaultHatName My_Funky_Default_Hat`.

The configuration option is actually based on a server directive, which enables you to use the keyword outside of other options, setting it for the default server. Virtual

hosts are considered internally within Apache to be separate «servers,» so you can set a default hat name for the default server as well as one for each virtual host, if desired.

When a request comes in, the following steps reflect the sequence in which `mod_apparmor` attempts to apply hats.

1. A location or directory hat as specified by the `AAHatName` keyword

2. A hat named by the entire URI path

3. A default server hat as specified by the `AADefaultHatName` keyword

4. `DEFAULT_URI` (if none of those exist, it goes back to the «parent» Apache hat)

## 24.2.2 Location and Directory Directives

Location and directory directives specify hat names in the program configuration file so the program calls the hat regarding its security. For Apache, you can find documentation about the location and directory directives at http://httpd.apache.org/docs/2.2/sections.html .

The location directive example below specifies that, for a given location, `mod_apparmor` should use a specific hat:

```
<Location /foo/> AAHatName MY_HAT_NAME </Location>
```

This tries to use `MY_HAT_NAME` for any URI beginning with `/foo/` (`/foo/`, `/foo/bar` , `/foo/cgi/path/blah_blah/blah` , etc.).

The directory directive works similarly to the location directive, except it refers to a path in the file system as in the following example:

```
<Directory "/srv/www/www.immunix.com/docs">
  # Note lack of trailing slash
  AAHatName immunix.com
</Directory>
```

**Example:** The program phpsysinfo is used to illustrate a location directive in the following example. The tarball can be downloaded from http://phpsysinfo.sourceforge.net .

1 After downloading the tarball, install it into `/srv/www/htdocs/phpsysinfo .`

2 Create `/etc/apache2/conf.d/phpsysinfo.conf` and add the following text to it:

```
<Location "/phpsysinfo">
  AAHatName phpsysinfo
</Location>
```

The following hat should then work for phpsysinfo:

```
/usr/sbin/httpd2-prefork {
  ...
  ^phpsysinfo {
    #include <abstractions/bash>
    #include <abstractions/nameservice>

    /bin/basename                          ixr,
    /bin/bash                              ixr,
    /bin/df                                ixr,
    /bin/grep                              ixr,
    /bin/mount                             Ux,
    /bin/sed                               ixr,
    /dev/bus/usb/                          r,
    /dev/bus/usb/**                        r,
    /dev/null                              w,
    /dev/tty                               rw,
    /dev/urandom                           r,
    /etc/SuSE-release                      r,
    /etc/ld.so.cache                       r,
    /etc/lsb-release                       r,
    /etc/lsb-release.d/                    r,
    /lib/ld-2.6.1.so                       ixr,
    /proc/**                               r,
    /sbin/lspci                            ixr,
    /srv/www/htdocs/phpsysinfo/**          r,
    /sys/bus/pci/**                        r,
    /sys/bus/scsi/devices/                 r,
    /sys/devices/**                        r,
    /usr/bin/cut                           ixr,
    /usr/bin/getopt                        ixr,
    /usr/bin/head                          ixr,
    /usr/bin/lsb_release                   ixr,
    /usr/bin/lsscsi                        ixr,
    /usr/bin/tr                            ixr,
    /usr/bin/who                           ixr,
    /usr/lib/lib*so*                       mr,
    /usr/lib/locale/**                     r,
    /usr/sbin/lsusb                        ixr,
    /usr/share/locale/**                   r,
```

```
    /usr/share/pci.ids                    r,
    /usr/share/usb.ids                    r,
    /var/log/apache2/access_log           w,
    /var/run/utmp                         kr,
   }
}
```

3. Reload Novell AppArmor profiles by entering `rcapparmor restart` at a terminal window as `root`.

4. Restart Apache by entering `rcapache2 restart` at a terminal window as `root`.

5. Enter `http://hostname/phpsysinfo/` into a browser to receive the system information that phpsysinfo delivers.

6. Locate configuration errors by going to `/var/log/audit/audit.log` or running `dmesg` and looking for any rejections in the output.

# 25 Confining Users with pam_apparmor

An AppArmor profile applies to an executable program; if a portion of the program needs different access permissions than other portions need, the program can change hats via change_hat to a different role, also known as a subprofile. The pam_apparmor PAM module allows applications to confine authenticated users into subprofiles based on group names, user names, or a default profile. To accomplish this, pam_apparmor needs to be registered as a PAM session module.

The package pam_apparmor may not installed by default, you may need to install it using YaST or `zypper`. Details about how to set up and configure pam_apparmor can be found in `/usr/share/doc/packages/pam_apparmor/README` after the package has been installed. For details on PAM, refer to Глава 2, *Authentication with PAM* (стр. 17).

pam_apparmor allows you to set up role-based access control (RBAC). In conjunction with the set capabilities rules (see Раздел 20.11, «Setting Capabilities per Profile» (стр. 264) for more information), it allows you to map restricted admin profiles to users. A detailed HOWTO on setting up RBAC with AppArmor is available at `http://developer.novell.com/wiki/index.php/Apparmor_RBAC_in_version_2.3` .

# 26 Managing Profiled Applications

After creating profiles and immunizing your applications, openSUSE® becomes more efficient and better protected as long as you perform Novell® AppArmor profile maintenance (which involves analyzing log files, refining your profiles, backing up your set of profiles and keeping it up-to-date). You can deal with these issues before they become a problem by setting up event notification by e-mail, running periodic reports, updating profiles from system log entries by running the aa-logprof tool through YaST, and dealing with maintenance issues.

## 26.1 Monitoring Your Secured Applications

Applications that are confined by Novell AppArmor security profiles generate messages when applications execute in unexpected ways or outside of their specified profile. These messages can be monitored by event notification, periodic report generation, or integration into a third-party reporting mechanism.

For reporting and alerting, AppArmor uses a userspace daemon (`/usr/sbin/aa-eventd`). This daemon monitors log traffic, sends out notifications, and runs scheduled reports. It does not require any end user configuration and it is started automatically as part of the security event notification through the YaST AppArmor Control Panel or by the configuration of scheduled reports in the YaST AppArmor Reports module.

Apart from transparently enabling and disabling aa-eventd with the YaST modules, you can manually toggle its status with the `rcaaeventd` init script. The AppArmor event daemon is not required for proper functioning of the profiling process (such as enforcement or learning). It is just required for reporting.

Find more details on security event notification in Раздел 26.2, «Configuring Security Event Notification» (стр. 332) and on scheduled reports in Раздел 26.3, «Configuring Reports» (стр. 335).

If you prefer a simple way of being notified of any AppArmor reject events that does not require you to check your e-mails or any log files, use the AppArmor Desktop Monitor applet that integrates into the GNOME desktop. Refer to Раздел 26.4, «Configuring and Using the AppArmor Desktop Monitor Applet» (стр. 355) for details.

# 26.2 Configuring Security Event Notification

Security event notification is a Novell AppArmor feature that informs you when systemic Novell AppArmor activity occurs. Activate it by selecting a notification frequency (receiving daily notification, for example). Enter an e-mail address so you can be notified by e-mail when Novell AppArmor security events occur. Select one of the following notification types:

Terse
: Terse notification summarizes the total number of system events without providing details. For example:

```
jupiter.example.com has had 41 security events since Mon Sep 10 14:53:16
 2007.
```

Summary Notification
: Summary notification displays the logged Novell AppArmor security events and lists the number of individual occurrences, including the date of the last occurrence. For example:

```
AppArmor: PERMITTING access to capability 'setgid' (httpd2-prefork(6347)
 profile /usr/sbin/httpd2-prefork active /usr/sbin/httpd2-prefork) 2
 times, the latest at Sat Oct  9 16:05:54 2004.
```

Verbose Notification

Verbose notification displays unmodified, logged Novell AppArmor security events. It tells you every time an event occurs and writes a new line in the verbose log. These security events include the date and time the event occurred, when the application profile permits and rejects access, and the type of file permission access that is permitted or rejected. Verbose notification also reports several messages that the aa-logprof tool (see «aa-logprof—Scanning the System Log» (стр. 309)) uses to interpret profiles. For example:

```
type=APPARMOR_DENIED msg=audit(1189428793.218:2880):
      operation="file_permission" requested_mask="::w" denied_mask="::w"
 fsuid=1000 name="/var/log/apache2/error_log" pid=22969 profile="/usr/
sbin/httpd2-prefork"
```

**ЗАМЕЧАНИЕ**

You must set up a mail server that can send outgoing mail using the SMTP protocol (for example, postfix or exim) for event notification to work.

1 In the *Enable Security Event Notification* section of the *AppArmor Configuration* window, click *Configure*.

**2** In the *Security Event Notification* window, enable *Terse*, *Summary*, or *Verbose* event notification.

**2a** In each applicable notification type section, enter the e-mail addresses of those who should receive notification in the field provided. If notification is enabled, you must enter an e-mail address. Separate multiple e-mail addresses with commas.

**2b** For each notification type enabled, select the frequency of notification.

Select a notification frequency from the following options:

- Disabled
- 1 minute
- 5 minutes
- 10 minutes
- 15 minutes
- 30 minutes
- 1 hour
- 1 day
- 1 week

**2c** For each selected notification type, select the lowest severity level for which a notification should be sent. Security events are logged and the notifications are sent at the time indicated by the interval when events are equal to or greater than the selected severity level. If the interval is *1 day*, the notification is sent daily, if security events occur.

---

**ЗАМЕЧАНИЕ: Severity Levels**

Novell AppArmor sends out event messages for things that are in the severity database and above the level selected. Severity levels are numbered 1 through 10, with 10 being the most severe security incident. The `/etc/severity.db` file defines the

severity level of potential security events. The severity levels are determined by the importance of different security events, such as certain resources accessed or services denied.

3 Click *OK*.

4 Click *Done* in the *Novell AppArmor Configuration* window.

5 Click *File* > *Quit* in the YaST Control Center.

After configuring security event notification, read the reports and determine whether events require follow up. Follow up may include the procedures outlined in Раздел 26.5, «Reacting to Security Event Rejections» (стр. 355).

# 26.3 Configuring Reports

Novell AppArmor's reporting feature adds flexibility by enhancing the way users can view security event data. The reporting tool performs the following:

- Creates on-demand reports
- Exports reports
- Schedules periodic reports for archiving
- E-mails periodic reports
- Filters report data by date
- Filters report data by other options, such as program name

Using reports, you can read important Novell AppArmor security events reported in the log files without manually sifting through the messages only useful to the aa-logprof tool. Narrow down the size of the report by filtering by date range or program name. You can also export an `html` or `csv` file.

The following are the three types of reports available in Novell AppArmor:

Executive Security Summary
: A combined report, consisting of one or more security incident reports from one or more machines. This report can provide a single view of security events on

multiple machines. For more details, refer to «Executive Security Summary» (стр. 345).

Application Audit Report
: An auditing tool that reports which application servers are running and whether the applications are confined by AppArmor. Application servers are applications that accept incoming network connections. For more details, refer to «Application Audit Report» (стр. 342).

Security Incident Report
: A report that displays application security for a single host. It reports policy violations for locally confined applications during a specific time period. You can edit and customize this report or add new versions. For more details, refer to «Security Incident Report» (стр. 343).

To use the Novell AppArmor reporting features, proceed with the following steps:

1 Open *YaST* > *Novell AppArmor*.

2 In *Novell AppArmor*, click *AppArmor Reports*. The *AppArmor Security Event Reports* window appears. From the *Reports* window, select an option and proceed to the respective section for instructions:


View Archive

Displays all reports that have been run and stored in `/var/log/apparmor/reports-archived/`. Select the report you want to see in detail and click *View*. For *View Archive* instructions, proceed to Раздел 26.3.1, «Viewing Archived Reports» (стр. 338).

Run Now

Produces an instant version of the selected report type. If you select a security incident report, it can be further filtered in various ways. For *Run Now* instructions, proceed to Раздел 26.3.2, «Run Now: Running On-Demand Reports» (стр. 346).

Add

Creates a scheduled security incident report. For *Add* instructions, proceed to Раздел 26.3.3, «Adding New Reports» (стр. 348).

Edit

Edits a scheduled security incident report.

Delete
: Deletes a scheduled security incident report. All stock or canned reports cannot be deleted.

Back
: Returns you to the Novell AppArmor main screen.

Abort
: Returns you to the Novell AppArmor main screen.

Next
: Performs the same function as the *Run Now* button.

## 26.3.1 Viewing Archived Reports

*View Reports* enables you to specify the location of a collection of reports from one or more systems, including the ability to filter by date or names of programs accessed and display them all together in one report.

**1** From the *AppArmor Security Event Report* window, select *View Archive*.

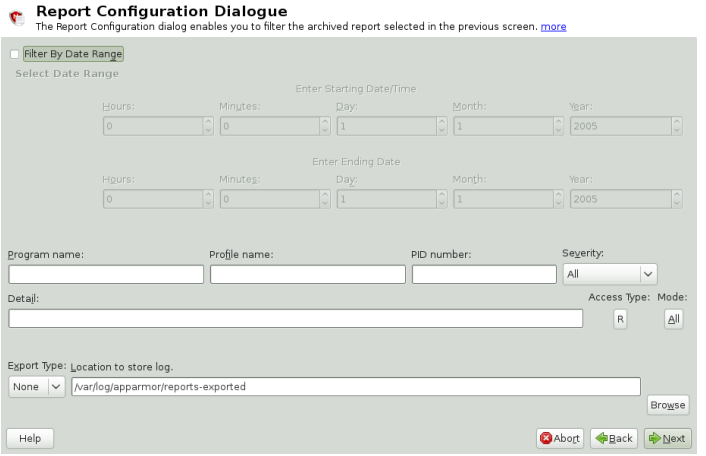

**2** Select the report type to view. Toggle between the different types: *SIR* (Security Incident Report), *App Aud* (Application Audit), and *ESS* (Executive Security Summary).

**3** You can alter the directory location of the archived reports in *Location of Archived Reports*. Select *Accept* to use the current directory or select *Browse* to find a new report location. The default directory is `/var/log/apparmor/reports-archived` .

**4** To view all the reports in the archive, select *View All*. To view a specific report, select a report file listed in the *Report* field then select *View*.

**5** For *Application Audit* and *Executive Security Summary* reports, proceed to IIIar 9 (стр. 341).

**6** The *Report Configuration Dialog* opens for *Security Incident* reports.




**7** The *Report Configuration* dialog enables you to filter the reports selected in the previous screen. Enter the desired filter details. The fields are:

Date Range
: To display reports for a certain time period, select *Filter By Date Range*. Enter the start and end dates that define the scope of the report.

Program Name
: When you enter a program name or pattern that matches the name of the binary executable of the program of interest, the report displays security events that have occurred for a specific program.

Profile Name
: When you enter the name of the profile, the report displays the security events that are generated for the specified profile. You can use this to see what is being confined by a specific profile.

PID Number
: *PID number* is a number that uniquely identifies one specific process or running program (this number is valid only during the lifetime of that process).

Severity
: Select the lowest severity level for security events to include in the report. The selected severity level (and above) are then included in the reports.

Detail
: A source to which the profile has denied access. This includes capabilities and files. You can use this field to report the resources to which profiles prevent access.

Access Type
: The access type describes what is actually happening with the security event. The options are `PERMITTING`, `REJECTING`, or `AUDITING`.

Mode
: The *Mode* is the permission that the profile grants to the program or process to which it is applied. The options are `all` (all modes without filtering), `r` (read), `w` (write), `l` (link),`x` (execute), and `m` (mmap).

Export Type
: Enables you to export a CSV (comma separated values) or HTML file. The CSV file separates pieces of data in the log entries with commas using a standard data format for importing into table-oriented applications. You can enter a path for your exported report by typing the full path in the field provided.

Location to Store Log
: Enables you to change the location at which to store the exported report. The default location is `/var/log/apparmor/reports-exported` . When you change this location, select *Accept*. Select *Browse* to browse the file system.

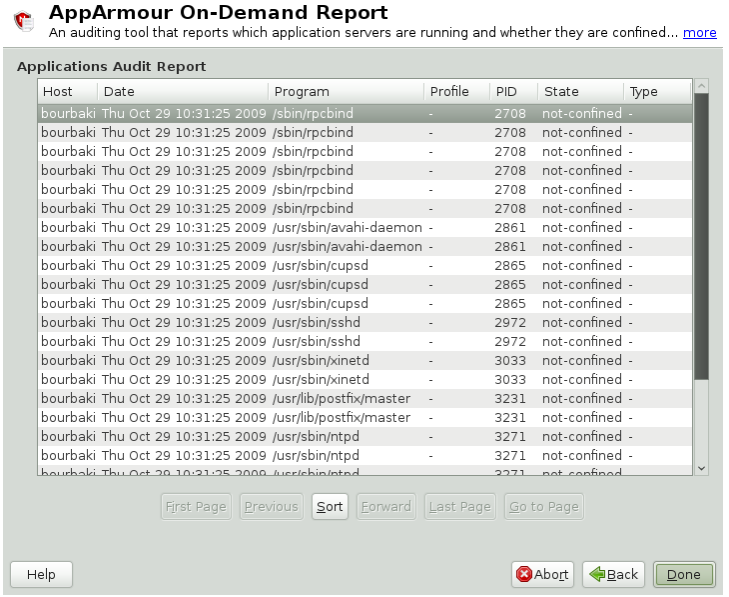
**8** To see the report, filtered as desired, select *Next*. One of the three reports displays.

**9** Refer to the following sections for detailed information about each type of report.

- For the application audit report, refer to «Application Audit Report» (стр. 342).
- For the security incident report, refer to «Security Incident Report» (стр. 343).
- For the executive summary report, refer to «Executive Security Summary» (стр. 345).

# Application Audit Report

An application audit report is an auditing tool that reports which application servers are running and whether they are confined by AppArmor.




The following fields are provided in an application audit report:

Host
: The machine protected by AppArmor for which the security events are reported.

Date
: The date during which security events occurred.

Program
: The name and path of the executing process.

Profile
: The absolute name of the security profile that is applied to the process.

PID
: A number that uniquely identifies one specific process or running program (this number is valid only during the lifetime of that process).

State
: This field reveals whether the program listed in the program field is confined. If it is not confined, consider creating a profile for it.

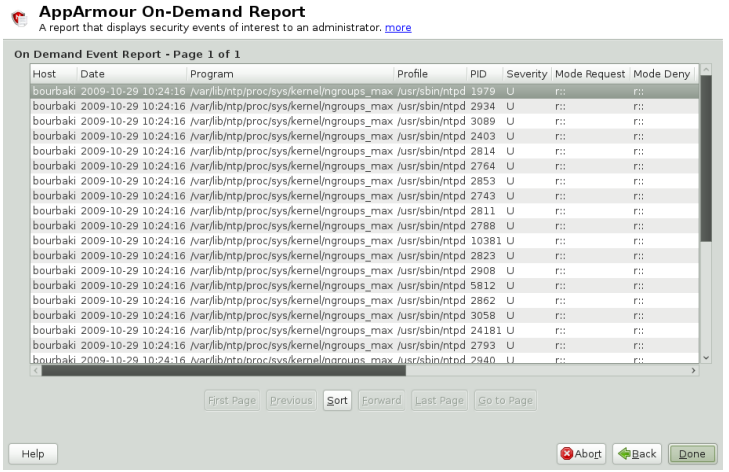
Type
: This field reveals the type of confinement the security event represents (either complain or enforce). If the application is not confined (state), no type of confinement is reported.

## Security Incident Report

A security incident report displays security events of interest to an administrator. The SIR reports policy violations for locally confined applications during a specified time period. It also reports policy exceptions and policy engine state changes. These two types of security events are defined as follows:

Policy Exceptions
: When an application requests a resource that is not defined within its profile, a security event is triggered. A report is generated that displays security events of interest to an administrator. The SIR reports policy violations for locally confined applications during a specified time period. The SIR reports policy exceptions and policy engine state changes.

Policy Engine State Changes
: Enforces policy for applications and maintains its own state, including when engines start or stop, when a policy is reloaded, and when global security feature are enabled or disabled.




The fields in the SIR report have the following meanings:

Host
: The machine protected by AppArmor for which the security events are reported.

Date
: The date during which security events occurred.

Program
: The name of the executing process.

Profile
: The absolute name of the security profile that is applied to the process.

PID
: A number that uniquely identifies one specific process or running program (this number is valid only during the lifetime of that process).

Severity
: Severity levels of events are reported from the severity database. The severity database defines the importance of potential security events and numbers them 1 through 10, 10 being the most severe security incident. The severity levels are determined by the threat or importance of different security events, such as certain resources accessed or services denied.

Mode
: The mode is the permission that the profile grants to the program or process to which it is applied. The options are `r` (read), `w` (write), `l` (link), and `x` (execute).

Detail
: A source to which the profile has denied access. This includes capabilities and files. You can use this field to report the resources to which the profile prevents access.

Access Type
: The access type describes what is actually happening with the security event. The options are `PERMITTING`, `REJECTING`, or `AUDITING`.

## Executive Security Summary

A combined report consisting of one or more high-level reports from one or more machines. This report can provide a single view of security events on multiple machines as long as each machine's data is copied to the report archive directory, which is `/var/log/apparmor/reports-archived` . One line of the ESS report represents a range of SIR reports.

The following fields are provided in an executive security summary:

Host
: The machine protected by AppArmor for which the security events are reported.

Start Date
: The first date in a range of dates during which security events are reported.

End Date
: The last date in a range of dates during which security events are reported.

Num Rejects
: In the date range given, the total number of security events that are rejected access attempts.

Num Events
: In the date range given, the total number of security events.

Ave. Sev
: This is the average of the severity levels reported in the date range given. Unknown severities are disregarded in this figure.

High Sev

This is the severity of the highest severity event reported in the date range given.

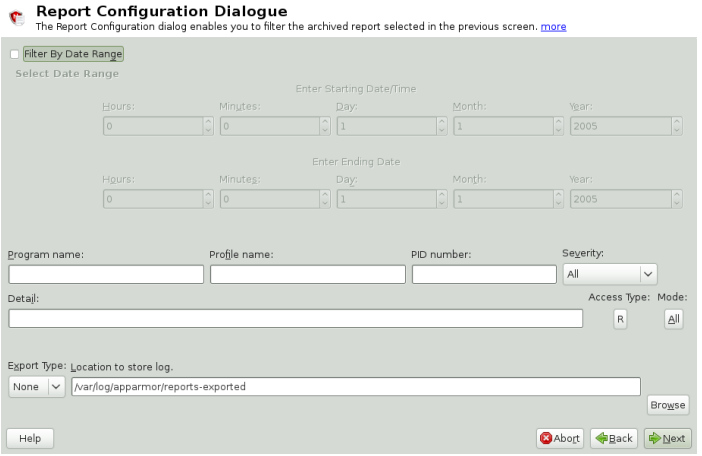
## 26.3.2 Run Now: Running On-Demand Reports

The *Run Now* report feature enables you to instantly extract report information from the Novell AppArmor event logs without waiting for scheduled events. If you need help navigating to the main report screen, see Раздел 26.3, «Configuring Reports» (стр. 335). Perform the following steps to run a report from the list of reports:

1. Select the report to run instantly from the list of reports in the *Schedule Reports* window.

2. Select *Run Now* or *Next*. The next screen is dependent on which report you selected in the previous step. As an example, select a security incident report.

3. The *Report Configuration Dialog* opens for security incident reports.




4. The *Report Configuration Dialog* enables you to filter the reports selected in the previous screen. Enter the desired filter details. The following filter options are available:

Date Range
: To limit reports to a certain time period, select *Filter By Date Range*. Enter the start and end dates that determine the scope of the report.

Program Name
: When you enter a program name or pattern that matches the name of the binary executable for the relevant program, the report displays security events that have occurred for that program only.

Profile Name
: When you enter the name of the profile, the report displays the security events that are generated for the specified profile. You can use this to see what is confined by a specific profile.

PID Number
: A number that uniquely identifies one specific process or running program (this number is valid only during the lifetime of that process).

Severity
: Select the lowest severity level for security events to include in the report. The selected severity level and above are included in the reports.

Detail
: A source to which the profile has denied access. This includes capabilities and files. You can use this field to report the resources to which profiles prevent access.

Access Type
: The access type describes the action being taken with the security event. The options are `PERMITTING`, `REJECTING`, or `AUDITING`.

Mode
: The mode is the permission that the profile grants to the program or process to which it is applied. The options are `r` (read), `w` (write), `l` (link), and `x` (execute).

Export Type
: Enables you to export a CSV (comma separated values) or HTML file. The CSV file separates pieces of data in the log entries with commas, using a

standard data format for importing into table-oriented applications. Enter a path for your exported report by typing in the full path in the field provided.

Location to Store Log
: Enables you to change the location that the exported report is stored. The default location is `/var/log/apparmor/reports-exported` . When you change this location, select *Accept*. Select *Browse* to browse the file system.

**5** To see the report, filtered as desired, select *Next*. One of the three reports displays.

Refer the following sections for detailed information about each type of report.

- For the application audit report, refer to «Application Audit Report» (стр. 342).
- For the security incident report, refer to «Security Incident Report» (стр. 343).
- For the executive summary report, refer to «Executive Security Summary» (стр. 345).

## 26.3.3 Adding New Reports

Adding new reports enables you to create a scheduled security incident report that displays Novell AppArmor security events according to your preset filters. When a report is set up in *Schedule Reports*, it periodically launches a report of Novell AppArmor security events that have occurred on the system.

You can configure a daily, weekly, monthly, or hourly report to run for a specified period. You can set the report to display rejections for certain severity levels or to filter by program name, profile name, severity level, or denied resources. This report can be exported to an HTML (Hypertext Markup Language) or CSV (Comma Separated Values) file format.

---

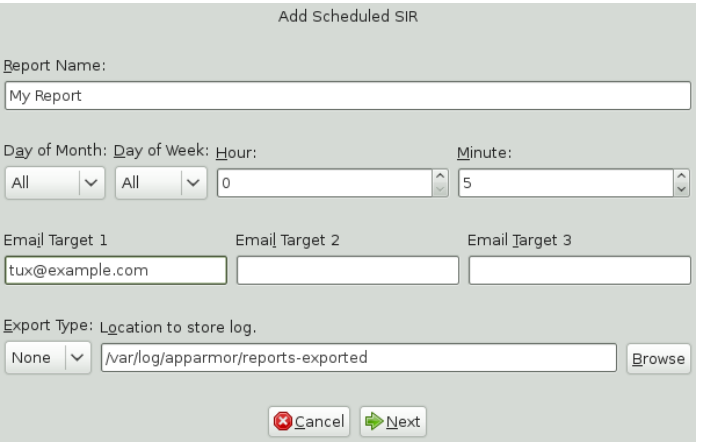
**ЗАМЕЧАНИЕ**

Return to the beginning of this section if you need help navigating to the main report screen (see Раздел 26.3, «Configuring Reports» (стр. 335)).

---

To add a new scheduled security incident report, proceed as follows:

**1** Click *Add* to create a new security incident report. The first page of *Add Scheduled SIR* opens.




**2** Fill in the fields with the following filtering information, as necessary:

Report Name
: Specify the name of the report. Use names that easily distinguish different reports.

Day of Month
: Select any day of the month to activate monthly filtering in reports. If you select `All`, monthly filtering is not performed.

Day of Week
: Select the day of the week on which to schedule weekly reports, if desired. If you select `ALL`, weekly filtering is not performed. If monthly reporting is selected, this field defaults to `ALL`.

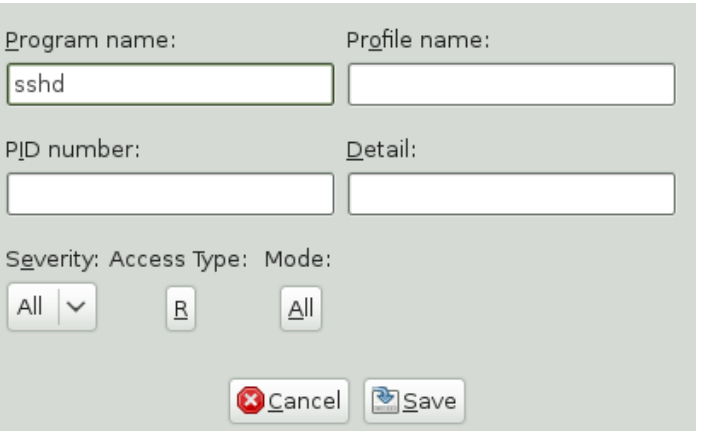
Hour and Minute
: Select the time. This specifies the hour and minute that you would like the reports to run. If you do not change the time, selected reports run at midnight. If neither month nor day of week are selected, the report runs daily at the specified time.

E-Mail Target
: You have the ability to send the scheduled security incident report via e-mail to up to three recipients. Just enter the e-mail addresses for those who require the security incident information.

Export Type
: This option enables you to export a CSV (comma separated values) or HTML file. The CSV file separates pieces of data in the log entries with commas using a standard data format for importing into table-oriented applications. Enter a path for your exported report by typing in the full path in the field provided.

Location to Store Log
: Enables you to change the location where the exported report is stored. The default location is `/var/log/apparmor/reports-exported` . When you change this location, select *Accept*. Select *Browse* to browse the file system.

**3** Click *Next* to proceed to the second page of *Add Scheduled SIR*.




**4** Fill in the fields with the following filtering information, as necessary:

Program Name
: You can specify a program name or pattern that matches the name of the binary executable for the program of interest. The report displays security events that have occurred for the specified program only.

Profile Name
: You can specify the name of the profile for which the report should display security events. You can use this to see what is being confined by a specific profile.

PID Number
: A number that uniquely identifies one specific process or running program (this number is valid only during the lifetime of that process).

Detail
: A source to which the profile has denied access. This includes capabilities and files. You can use this field to create a report of resources to which profiles prevent access.

Severity
: Select the lowest severity level of security events to include in the report. The selected severity level and above are included in the reports.

Access Type
: The access type describes the action being taken with the security event. The options are `PERMITTING`, `REJECTING`, or `AUDITING`.

Mode
: The mode is the permission that the profile grants to the program or process to which it is applied. The options are `r` (read), `w` (write), `l` (link), and `x` (execute).

**5** Click *Save* to save this report. Novell AppArmor returns to the *Scheduled Reports* main window where the newly scheduled report appears in the list of reports.

## 26.3.4 Editing Reports

From the AppArmor *Reports* screen, you can select and edit a report. The three pre-configured reports (*stock reports*) cannot be edited or deleted.

---

**ЗАМЕЧАНИЕ**

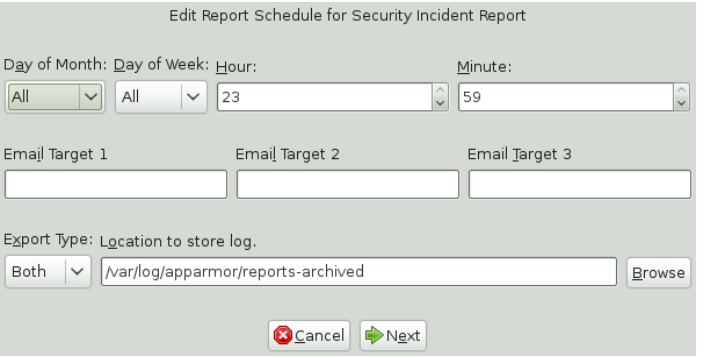
Return to the beginning of this section if you need help navigating to the main report screen (see Раздел 26.3, «Configuring Reports» (стр. 335)).

---

Perform the following steps to modify a report from the list of reports:

**1** From the list of reports in the *Schedule Reports* window, select the report to edit. This example assumes that you have selected a security incident report.

2 Click *Edit* to edit the security incident report. The first page of the *Edit Scheduled SIR* displays.




3 Modify the following filtering information, as necessary:

Day of Month
: Select any day of the month to activate monthly filtering in reports. If you select `All`, monthly filtering is not performed.

Day of Week
: Select the day of the week on which to schedule the weekly reports. If you select `All`, weekly filtering is not performed. If monthly reporting is selected, this defaults to `All`.

Hour and Minute
: Select the time. This specifies the hour and minute that you would like the reports to run. If you do not change the time, the selected report runs at midnight. If neither the day of the month nor day of the week is selected, the report runs daily at the specified time.

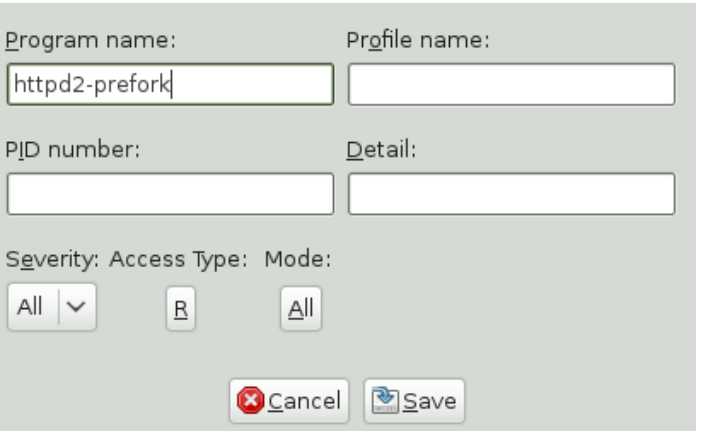
E-Mail Target
: You have the ability to send the scheduled security incident report via e-mail to up to three recipients. Just enter the e-mail addresses for those who require the security incident information.

Export Type
: This option enables you to export a CSV (comma separated values) or HTML file. The CSV file separates pieces of data in the log entries with commas, using a standard data format for importing into table-oriented applications.

Enter a path for your exported report by typing the full path in the field provided.

Location to Store Log
: Enables you to change the location where the exported report is stored. The default location is `/var/log/apparmor/reports-exported` . When you change this location, select *Accept*. Select *Browse* to browse the file system.

**4** Click *Next* to proceed to the next *Edit Scheduled SIR* page. The second page of *Edit Scheduled Reports* opens.




**5** Modify the fields with the following filtering information, as necessary:

Program Name
: You can specify a program name or pattern that matches the name of the binary executable for the program of interest. The report displays security events that have occurred for the specified program only.

Profile Name
: You can specify the name of the profile for which to display security events. You can use this to see what is being confined by a specific profile.

PID Number
: Process ID number is a number that uniquely identifies one specific process or running program (this number is valid only during the lifetime of that process).

Detail
: A source to which the profile has denied access. This includes capabilities and files. You can use this field to create a report of resources to which profiles prevent access.

Severity
: Select the lowest severity level for security events to include in the report. The selected severity level and above are included in the reports.

Access Type
: The access type describes the action being taken with the security event. The options are `PERMITTING`, `REJECTING`, or `AUDITING`.

Mode
: The mode is the permission that the profile grants to the program or process to which it is applied. The options are `r` (read), `w` (write), `l` (link), and `x` (execute).

6 Select *Save* to save the changes to this report. Novell AppArmor returns to the *Scheduled Reports* main window where the scheduled report appears in the list of reports.

## 26.3.5 Deleting Reports

*Delete a Report* enables you to permanently remove a report from the list of Novell AppArmor scheduled reports. To delete a report, follow these instructions:

1 To remove a report from the list of reports, highlight the report and click *Delete*.

2 From the confirmation pop-up, select *Cancel* if you do not want to delete the selected report. If you are sure you want to remove the report permanently from the list of reports, select *Delete*.

# 26.4 Configuring and Using the AppArmor Desktop Monitor Applet

The Linux audit framework contains a dispatcher that can send AppArmor events to any consumer application via dbus. The GNOME AppArmor Desktop Monitor applet is one example of an application that gathers AppArmor events via dbus. To configure audit to use the dbus dispatcher, just set the dispatcher in your audit configuration in `/etc/audit/auditd.conf` to `apparmor-dbus` and restart auditd:

```
dispatcher=/usr/bin/apparmor-dbus
```

Once the dbus dispatcher is configured correctly, add the AppArmor Desktop Monitor to the GNOME panel by right-clicking the panel and selecting *Add to Panel* > *AppArmor Desktop Monitor*. As soon as a `REJECT` event is logged, the applet's panel icon changes appearance and you can click the applet to see the number of reject events per confined application. To view the exact log messages, refer to the audit log under `/var/log/audit/audit.log`. React to any `REJECT` events as described in Раздел 26.5, «Reacting to Security Event Rejections» (стр. 355).

# 26.5 Reacting to Security Event Rejections

When you receive a security event rejection, examine the access violation and determine if that event indicated a threat or was part of normal application behavior. Application-specific knowledge is required to make the determination. If the rejected action is part of normal application behavior, run `aa-logprof` at the command line or the *Update Profile Wizard* in Novell AppArmor to update your profile.

If the rejected action is not part of normal application behavior, this access should be considered a possible intrusion attempt (that was prevented) and this notification should be passed to the person responsible for security within your organization.

# 26.6 Maintaining Your Security Profiles

In a production environment, you should plan on maintaining profiles for all of the deployed applications. The security policies are an integral part of your deployment. You should plan on taking steps to back up and restore security policy files, plan for software changes, and allow any needed modification of security policies that your environment dictates.

## 26.6.1 Backing Up Your Security Profiles

Backing up profiles might save you from having to reprofile all your programs after a disk crash. Also, if profiles are changed, you can easily restore previous settings by using the backed up files.

Back up profiles by copying the profile files to a specified directory.

1 You should first archive the files into one file. To do this, open a terminal window and enter the following as `root`:

```
tar zclpf profiles.tgz /etc/apparmor.d
```

The simplest method to ensure that your security policy files are regularly backed up is to include the directory `/etc/apparmor.d` in the list of directories that your backup system archives.

2 You can also use `scp` or a file manager like Konqueror or Nautilus to store the files on some kind of storage media, the network, or another computer.

## 26.6.2 Changing Your Security Profiles

Maintenance of security profiles includes changing them if you decide that your system requires more or less security for its applications. To change your profiles in Novell AppArmor, refer to Раздел 22.3, «Editing Profiles» (стр. 281).

## 26.6.3 Introducing New Software into Your Environment

When you add a new application version or patch to your system, you should always update the profile to fit your needs. You have several options, depending on your company's software deployment strategy. You can deploy your patches and upgrades into a test or production environment. The following explains how to do this with each method.

If you intend to deploy a patch or upgrade in a test environment, the best method for updating your profiles is one of the following:

- Run the profiling wizard by selecting *Add Profile Wizard* in YaST. This creates a new profile for the added or patched application. For step-by-step instructions, refer to Раздел 22.1, «Adding a Profile Using the Wizard» (стр. 273).

- Run aa-genprof by typing `aa-genprof` in a terminal while logged in as `root`. For detailed instructions, refer to «aa-genprof—Generating Profiles» (стр. 301).

If you intend to deploy a patch or upgrade directly into a production environment, the best method for updating your profiles is one of the following:

- Monitor the system frequently to determine if any new rejections should be added to the profile and update as needed using aa-logprof. For detailed instructions, refer to «aa-logprof—Scanning the System Log» (стр. 309).

- Run the YaST *Update Profile Wizard* to learn the new behavior (high security risk as all accesses are allowed and logged, not rejected). For step-by-step instructions, refer to Раздел 22.5, «Updating Profiles from Log Entries» (стр. 287).

# 27 Support

This chapter outlines maintenance-related tasks. Learn how to update Novell® AppArmor and get a list of available man pages providing basic help for using the command line tools provided by Novell AppArmor. Use the troubleshooting section to learn about some common problems encountered with Novell AppArmor and their solutions. Report defects or enhancement requests for Novell AppArmor following the instructions in this chapter.

## 27.1 Updating Novell AppArmor Online

Updates for Novell AppArmor packages are provided in the same way as any other update for openSUSE. Retrieve and apply them exactly like for any other package that ships as part of openSUSE.

## 27.2 Using the Man Pages

There are man pages available for your use. In a terminal, enter `man apparmor` to open the apparmor man page. Man pages are distributed in sections numbered 1 through 8. Each section is specific to a category of documentation:

***Таблица 27.1*** *Man Pages: Sections and Categories*

| Section | Category |
|---|---|
| 1 | User commands |
| 2 | System calls |
| 3 | Library functions |
| 4 | Device driver information |
| 5 | Configuration file formats |
| 6 | Games |
| 7 | High level concepts |
| 8 | Administrator commands |

The section numbers are used to distinguish man pages from each other. For example, `exit(2)` describes the exit system call, while `exit(3)` describes the exit C library function.

The Novell AppArmor man pages are:

- `unconfined(8)`
- `autodep(1)`
- `complain(1)`
- `enforce(1)`
- `genprof(1)`
- `logprof(1)`
- `change_hat(2)`
- `logprof.conf(5)`

- apparmor.conf(5)
- apparmor.d(5)
- apparmor.vim(5)
- apparmor(7)
- apparmor_parser(8)

# 27.3 For More Information

Find more information about the AppArmor product on the Novell AppArmor product page at Novell: http://www.novell.com/linux/security/apparmor// . Find the product documentation for Novell AppArmor, including this document, at http://www.novell.com/documentation/apparmor/ or in the installed system in /usr/share/doc/manual .

There are specific mailing lists for AppArmor that users can post to or join to communicate with developers.

apparmor-general@forge.novell.com [mailto:apparmor-general@forge.novell.com ]
: This is a mailing list for end users of AppArmor. It is a good place for questions about how to use AppArmor to protect your applications.

apparmor-dev@forge.novell.com [mailto:apparmor-dev@forge.novell.com ]
: This is a developer mailing list for AppArmor developers and community members. This list is for questions about development of core AppArmor features—the kernel module and the profiling tools. If you are interested in reviewing the code for AppArmor and contributing reviews or patches, this would be the list for you.

apparmor-announce@forge.novell.com [mailto:apparmor-announce@forge.novell.com ]
: This is a low traffic list announcing the availability of new releases or features.

# 27.4 Troubleshooting

This section lists the most common problems and error messages that may occur using Novell AppArmor.

## 27.4.1 How to React to odd Application Behavior?

If you notice odd application behavior or any other type of application problem, you should first check the reject messages in the log files to see if AppArmor is too closely constricting your application. To check reject messages, start *YaST > Novell AppArmor* and go to *AppArmor Reports*. Select *View Archive* and *App Aud* for the application audit report. You can filter dates and times to narrow down the specific periods when the unexpected application behavior occurred.

If you detect reject messages that indicate that your application or service is too closely restricted by AppArmor, update your profile to properly handle your use case of the application. Do this with the *Update Profile Profile Wizard* in YaST, as described in Раздел 22.5, «Updating Profiles from Log Entries» (стр. 287).

If you decide to run your application or service without AppArmor protection, remove the application's profile from `/etc/apparmor.d` or move it to another location.

## 27.4.2 My Profiles do not Seem to Work Anymore …

If you have been using previous versions of AppArmor and have updated your system (but kept your old set of profiles) you might notice some applications which seemed to work perfectly before you updated behaving strangely, or not working at all .

This version of AppArmor introduces a set of new features to the profile syntax and the AppArmor tools that might cause trouble with older versions of the AppArmor profiles. Those features are:

- File Locking

- Network Access Control
- The SYS_PTRACE Capability
- Directory Path Access

The current version of AppArmor mediates file locking and introduces a new permission mode (k) for this. Applications requesting file locking permission might misbehave or fail altogether if confined by older profiles which do not explicitly contain permissions to lock files. If you suspect this being the case, check the log file under /var/log/audit/audit.log for entries like the following:

```
type=APPARMOR_DENIED msg=audit(1188913493.299:9304): operation="file_lock"
 requested_mask="::k" denied_mask="::k" fsuid=1000 name="/home/
tux/.qt/.qtrc.lock" pid=25736 profile="/usr/bin/opera"
```

Update the profile using the YaST Update Profile Wizard or the aa-logprof command as outlined below.

The new network access control syntax based on the network family and type specification, described in Раздел 20.5, «Network Access Control» (стр. 251), might cause application misbehavior or even stop applications from working. If you notice a network-related application behaving strangely, check the log file under /var/log/audit/audit.log for entries like the following:

```
type=APPARMOR_DENIED msg=audit(1188894313.206:9123):
 operation="socket_create" family="inet" sock_type="raw" protocol=1
 pid=23810 profile="/bin/ping"
```

This log entry means that our example application, /bin/ping in this case, failed to get AppArmor's permission to open a network connection. This permission has to be explicitly stated to make sure that an application has network access. To update the profile to the new syntax, use the YaST Update Profile Wizard or the aa-logprof command as outlined below.

The current kernel requires the SYS_PTRACE capability, if a process tries to access files in /proc/*pid*/fd/* . New profiles need an entry for the file and the capability, where old profiles only needed the file entry. For example:

```
/proc/*/fd/**  rw,
```

in the old syntax would translate to the following rules in the new syntax:

```
capability SYS_PTRACE,
```

```
/proc/*/fd/**  rw,
```

To update the profile to the new syntax, use the YaST Update Profile Wizard or the `aa-logprof` command as outlined below.

With this version of AppArmor, a few changes have been made to the profile rule syntax to better distinguish directory from file access. Therefore, some rules matching both file and directory paths in the previous version might now just match a file path. This could lead to AppArmor not being able to access a crucial directory at all, and thus trigger misbehavior of your application and various log messages. The following examples highlight the most important changes to the path syntax.

Using the old syntax, the following rule would allow access to files and directories in `/proc/net` . It would allow directory access only to read the entries in the directory, but not give access to files or directories under the directory, e.g. `/proc/net/dir/foo` would be matched by the asterisk (*), but as `foo` is a file or directory under `dir`, it cannot be accessed.

```
/proc/net/*  r,
```

To get the same behavior using the new syntax, you need two rules instead of one. The first allows access to the file under `/proc/net` and the second allows access to directories under `/proc/net` . Directory access can only be used for listing the contents, not actually accessing files or directories underneath the directory.

```
/proc/net/*  r,
/proc/net/*/  r,
```

The following rule works similarly both under the old and the new syntax, and allows access to both files and directories under `/proc/net` :

```
/proc/net/**  r,
```

To distinguish file access from directory access using the above expression in the new syntax, use the following two rules. The first one only allows to recursively access directories under `/proc/net` while the second one explicitly allows for recursive file access only.

```
/proc/net/**/  r,
/proc/net/**[^/]  r,
```

The following rule works similarly both under the old and the new syntax and allows access to both files and directories beginning with `foo` under `/proc/net` :

```
/proc/net/foo**  r,
```

To distinguish file access from directory access in the new syntax and use the `**` globbing pattern, use the following two rules. The first one would have matched both files and directories in the old syntax, but only matches files in the new syntax due to the missing trailing slash. The second rule matched neither file nor directory in the old syntax, but matches directories only in the new syntax:

```
/proc/net/**foo  r,
/proc/net/**foo/  r,
```

The following rules illustrate how the use of the `?` globbing pattern has changed. In the old syntax, the first rule would have matched both files and directories (four characters, last character could be any but a slash). In the new syntax, it matches only files (trailing slash is missing). The second rule would match nothing in the old profile syntax, but matches directories only in the new syntax. The last rule matches explicitly matches a file called `bar` under `/proc/net/foo?` . Using the old syntax, this rule would have applied to both files and directories:

```
/proc/net/foo?  r,
/proc/net/foo?/  r,
/proc/net/foo?/bar  r,
```

To find and resolve issues related to syntax changes, take some time after the update to check the profiles you want to keep and proceed as follows for each application you kept the profile for:

1. Make sure that AppArmor is running and that the application's profile is loaded.

2. Start the YaST AppArmor Control Panel and put the application's profile into complain mode. Log entries are made for any actions violating the current profile, but the profile is not enforced and the application's behavior not restricted.

3. Run the application covering all the tasks you need this application to be able to perform.

4. Start the YaST Update Profile Wizard to update the application's profile according to the log entries generated while running the application.

5. Once the profile is updated, put it back into enforce mode via the YaST AppArmor Control Panel.

Using the AppArmor command line tools, you would proceed as follows:

1. Put the application's profile into complain mode:

```
aa-complain /path/to/application
```

2 Run the application.

3 Update the profile according to the log entries made while running the application:

```
aa-logprof /path/to/application
```

4 Put the resulting profile back into enforce mode:

```
aa-enforce /path/to/application
```

# 27.4.3 How to Confine KDE Applications with AppArmor?

Currently, it is not possible to confine KDE applications to the same extent as any other application, due to the way KDE manages its processes.

If you want to confine KDE applications, choose one of the following approaches, but note that none of them are really suited for a standard setup:

Create a Single Profile for the Entire KDE Desktop
: As all KDE processes are children of one parent process and AppArmor cannot distinguish an individual application's process from the rest, create one huge profile to confine the entire desktop all at once. This approach is only feasible if your setup is a very limited (kiosk-type) one. Maintaining such a profile for a standard KDE desktop (including all of its applications) would be close to impossible.

Modify KDE's process handling
: Using `KDE_EXEC_SLAVES=1` and `KDE_IS_PRELINKED=1` variables force KDE to manage its processes in a way that allows AppArmor to distinguish individual applications from each other and apply profiles to them. This approach might slow down your desktop considerably, as it turns off a crucial optimization for speed. Note that the above mentioned environment variables have to be set before KDM/XDM/GDM or startx are started. One way to achieve this would be to add them to `/etc/security/pam_env.conf` .

## 27.4.4 How to Resolve Issues with Apache?

Apache is not starting properly or it is not serving Web pages and you just installed a new module or made a configuration change. When you install additional Apache modules (like `apache2-mod_apparmor`) or make configuration changes to Apache, you should profile Apache again to catch any additional rules that need to be added to the profile.

## 27.4.5 Why are the Reports not Sent by E-Mail?

When the reporting feature generates an HTML or CSV file that exceeds the default size, the file is not sent. Mail servers have a default hard limit for e-mail size. This limitation can impede AppArmor's ability to send e-mails that are generated for reporting purposes. If your mail is not arriving, this could be why. Consider the mail size limits and check the archives if e-mails have not been received.

## 27.4.6 How to Exclude Certain Profiles from the List of Profiles Used?

AppArmor always loads and applies all profiles that are available in its profile directory (`/etc/apparmor.d/` ). If you decide not to apply a profile to a certain application, delete the appropriate profile or move it to another location where AppArmor would not check for it.

## 27.4.7 Can I Manage Profiles for Applications not Installed on my System?

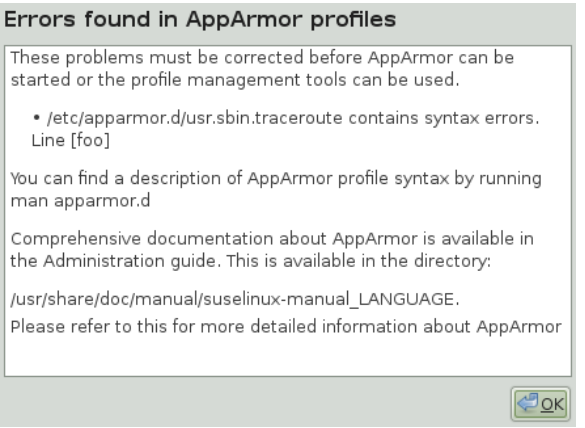
Managing profiles with AppArmor requires you to have access to the log of the system on which the application is running. So you do not need to run the application on your profile, build host as long as you have access to the machine that runs the application. You can run the application on one system, transfer the logs (`/var/log/audit.log` or, if `audit` is not installed, `/var/log/messages` ) to your profile build host and run `aa-logprof -f` *`path_to_logfile`*.

## 27.4.8 How to Spot and fix AppArmor Syntax Errors?

Manually editing Novell AppArmor profiles can introduce syntax errors. If you attempt to start or restart AppArmor with syntax errors in your profiles, error results are shown. This example shows the syntax of the entire parser error.

```
localhost:~ # rcapparmor start
Loading AppArmor profiles AppArmor parser error in /etc/apparmor.d/
usr.sbin.squid at line 410: syntax error, unexpected TOK_ID, expecting
 TOK_MODE
 Profile /etc/apparmor.d/usr.sbin.squid failed to load
```

Using the AppArmor YaST tools, a graphical error message indicates which profile contained the error and requests you to fix it.




To fix a syntax error, log in to a terminal window as `root`, open the profile, and correct the syntax. Reload the profile set with `rcapparmor reload`.

# 27.5 Reporting Bugs for AppArmor

The developers of AppArmor are eager to deliver products of the highest quality. Your feedback and your bug reports help us keep the quality high. Whenever you encounter a bug in AppArmor, file a bug report against this product:

1 Use your Web browser to go to https://bugzilla.novell.com/index.cgi .

2 Enter the account data of your Novell account and click *Login*

*or*

Create a new Novell account as follows:

**2a** Click *Create New Account* on the *Login to Continue* page.

**2b** Provide a username and password and additional address data and click *Create Login* to immediately proceed with the login creation.

*or*

Provide data on which other Novell accounts you maintain to sync all these to one account.

3 Check whether a problem similar to yours has already been reported by clicking *Search Reports*. Use a quick search against a given product and keyword or use the *Advanced Search*.

4 If your problem has already been reported, check this bug report and add extra information to it, if necessary.

5 If your problem has not been reported yet, select *New* from the top navigation bar and proceed to the *Enter Bug* page.

6 Select the product against which to file the bug. In your case, this would be your product's release. Click *Submit*.

7 Select the product version, component (AppArmor in this case), hardware platform, and severity.

8 Enter a brief headline describing your problem and add a more elaborate description including log files. You may create attachments to your bug report for screen shots, log files, or test cases.

9 Click *Submit* after you have entered all the details to send your report to the developers.

# 28 AppArmor Glossary

Apache
: Apache is a freely-available UNIX-based Web server. It is currently the most commonly used Web server on the Internet. Find more information about Apache at the Apache Web site at http://www.apache.org .

application firewalling
: Novell AppArmor contains applications and limits the actions they are permitted to take. It uses privilege confinement to prevent attackers from using malicious programs on the protected server and even using trusted applications in unintended ways.

attack signature
: Pattern in system or network activity that alerts of a possible virus or hacker attack. Intrusion detection systems might use attack signatures to distinguish between legitimate and potentially malicious activity.

  By not relying on attack signatures, Novell AppArmor provides "proactive" instead of "reactive" defense from attacks. This is better because there is no window of vulnerability where the attack signature must be defined for Novell AppArmor as it does for products using attack signatures to secure their networks.

GUI
: Graphical user interface. Refers to a software front-end meant to provide an attractive and easy-to-use interface between a computer user and application. Its elements include such things as windows, icons, buttons, cursors, and scroll bars.

globbing
: Filename substitution.

HIP
: Host intrusion prevention. Works with the operating system kernel to block abnormal application behavior in the expectation that the abnormal behavior represents an unknown attack. Blocks malicious packets on the host at the network level before they can «hurt» the application they target.

mandatory access control
: A means of restricting access to objects that is based on fixed security attributes assigned to users, files, and other objects. The controls are mandatory in the sense that they cannot be modified by users or their programs.

profile foundation classes
: Profile building blocks needed for common application activities, such as DNS lookup and user authentication.

RPM
: The RPM Package Manager. An open packaging system available for anyone to use. It works on Red Hat Linux, openSUSE, and other Linux and UNIX systems. It is capable of installing, uninstalling, verifying, querying, and updating computer software packages. See http://www.rpm.org/ for more information.

SSH
: Secure Shell. A service that allows you to access your server from a remote computer and issue text commands through a secure connection.

streamlined access control
: Novell AppArmor provides streamlined access control for network services by specifying which files each program is allowed to read, write, and execute. This ensures that each program does what it is supposed to do and nothing else.

URI
: Universal resource identifier. The generic term for all types of names and addresses that refer to objects on the World Wide Web. A URL is one kind of URI.

URL
: Uniform Resource Locator. The global address of documents and other resources on the World Wide Web.

The first part of the address indicates what protocol to use and the second part specifies the IP address or the domain name where the resource is located.

For example, in `http://www.novell.com`, http is the protocol to use.

vulnerabilities
: An aspect of a system or network that leaves it open to attack. Characteristics of computer systems that allow an individual to keep it from correctly operating or that allows unauthorized users to take control of the system. Design, administrative, or implementation weaknesses or flaws in hardware, firmware, or software. If exploited, a vulnerability could lead to an unacceptable impact in the form of unauthorized access to information or the disruption of critical processing.

A

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## Универсальная Общественная Лицензия GNU (GNU General Public License)

Версия 2, июнь 1991 г.



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Ниже следуют точные определения и условия для копирования, распространения и модификации.

## ОПРЕДЕЛЕНИЯ И УСЛОВИЯ ДЛЯ КОПИРОВАНИЯ, РАСПРОСТРАНЕНИЯ И МОДИФИКАЦИИ

**0.** Эта Лицензия применима к любой программе или другому произведению, содержащему уведомление, помещенное держателем авторских прав и сообщающее о том, что оно может распространяться при условиях, оговоренных в данной Универсальной Общественной Лицензии. В дальнейшем термин «Программа» относится к любой такой программе или произведению, а термин «произведение, основанное на Программе» означает Программу или любое произведение, содержащее Программу или ее часть, дословную, или модифицированную, и/или переведенную на другой язык. (Здесь и далее перевод включается без ограничений в понятие «модификация».) Каждый обладатель лицензии адресуется как «вы».

Виды деятельности, не являющиеся копированием, распространением или модификацией, не охватываются данной Лицензией; они лежат за пределами ее влияния. Использование Программы по ее функциональному назначению не ограничено, а выходные данные Программы охватываются этой Лицензией, только если их содержание является произведением, основанным на Программе (вне зависимости от того, были ли они получены в процессе использования Программы). Являются ли они таковыми, зависит от того, что именно делает Программа.

**1.** Вы можете копировать и распространять дословные копии исходного кода Программы по его получении на любом носителе, при условии что вы соответствующим образом помещаете на видном месте в каждой копии соответствующее уведомление об авторских правах и отказ от предоставления гарантий; оставляете нетронутыми все уведомления, относящиеся к данной Лицензии и к отсутствию каких-либо гарантий; и передаете всем другим получателям Программы копию данной Лицензии вместе с Программой.

Вы можете назначить плату за физический акт передачи копии и можете по своему усмотрению предоставлять гарантии за вознаграждение.

**2.** Вы можете изменять свою копию или копии Программы или любой ее части, создавая таким образом произведение, основанное на Программе, и копировать и распространять эти модификации или произведение в соответствии с Разделом 1, приведенным выше, при условии, что вы выполните все нижеследующие условия:

**a)** Вы обязаны снабдить модифицированные файлы заметными уведомлениями, содержащими указания на то, что вы изменили файлы, и дату каждого изменения.

**b)** Вы обязаны предоставить всем третьим лицам лицензию на бесплатное использование каждого произведения, которое вы распространяете или публикуете, целиком, и которое полностью или частично содержит Программу или какую-либо ее часть, на условиях, оговоренных в данной Лицензии.

**c)** Если модифицированная программа обычно читает команды в интерактивном режиме работы, вы должны сделать так, чтобы при запуске для работы в таком интерактивном режиме обычным для нее способом она печатала или выводила на экран объявление, содержащее соответствующее уведомление об авторских правах и уведомление о том, что гарантий нет (или, наоборот, сообщающее о том, что вы обеспечиваете гарантии), и что пользователи могут повторно распространять программу при этих условиях, и указывающее пользователю, как просмотреть копию данной Лицензии. (Исключение: если сама Программа работает в интерактивном режиме, но обычно не выводит подобных сообщений, то ваше произведение, основанное на Программе, не обязано выводить объявление.)

Эти требования применяются к модифицированному произведению в целом. Если известные части этого произведения не были основаны на Программе и могут обоснованно считаться независимыми и самостоятельными произведениями, то эта Лицензия и ее условия не распространяются на эти части, если вы распространяете их как отдельные произведения. Но если вы распространяете эти части как часть целого произведения, основанного на Программе, то вы обязаны делать это в соответствии с условиями данной Лицензии, распространяя права получателей лицензии на все произведение и, таким образом, на каждую часть, вне зависимости от того, кто ее написал.

Таким образом, содержание этого раздела не имеет цели претендовать на ваши права на произведение, написанное полностью вами, или оспаривать их; цель скорее в том, чтобы реализовать право управлять распространением производных или коллективных произведений, основанных на Программе.

Кроме того, простое нахождение другого произведения, не основанного на этой Программе, совместно с Программой (или с произведением, основанным на этой Программе) на одном носителе для постоянного хранения или распространяемом носителе не распространяет действие этой Лицензии на другое произведение.

**3.** Вы можете копировать и распространять Программу (или произведение, основанное на ней) согласно Разделу 2) в объектном коде или в выполнимом виде в соответствии с Разделами 1 и 2, приведенными выше, при условии, что вы также выполните одно из следующих требований:

**a)** Сопроводите ее полным соответствующим машиночитаемым исходным кодом, который должен распространяться в соответствии с Разделами 1 и 2, приведенными выше, на носителе, который обычно используется для обмена ПО; или,

**b)** Сопроводите ее письменным предложением, действительным по крайней мере в течение трех лет, предоставить любому третьему лицу за вознаграждение, не превышающее стоимость физического акта изготовления копии, полную машиночитаемую копию соответствующего исходного кода, подлежащую распространению в соответствии с Разделами 1 и 2, приведенными выше; или

**c)** Сопроводите ее информацией, полученной вами в качестве предложения распространить соответствующий исходный код. (Эта возможность допустима только для некоммерческого распространения, и только если вы получили программу в объектном коде или в исполняемом виде с предложением в соответствии с Пунктом b) выше.)

Исходный код для произведения означает его вид, предпочтительный для выполнения в нем модификаций. Для исполняемого произведения полный исходный код означает все исходные коды для всех модулей, которые он содержит, плюс любые связанные с произведением файлы определения интерфейса, плюс сценарии, используемые для управления компиляцией и установкой исполняемого произведения. Однако, в виде особого исключения распространяемый исходный код не обязан включать то, что обычно предоставляется (как в объектных, так и в исходных кодах) с основными компонентами (компилятор, ядро и так далее) операционной системы, под управлением которой работает исполняемое произведение, за исключением случая, когда сам компонент сопровождает исполняемое произведение.

Если распространение исполняемого произведения или объектного кода происходит путем предоставления доступа для копирования с обозначенного места, то предоставление доступа для копирования исходного кода с того же места считается распространением исходного кода, даже если третьи лица не принуждаются к копированию исходного кода вместе с объектным кодом.

**4.** Вы не можете копировать, изменять, повторно лицензировать, или распространять Программу никаким иным способом, кроме явно предусмотренных данной Лицензией. Любая попытка копировать, изменять или распространять Программу каким-либо другим способом или с измененной лицензией неправомерна и автоматически прекращает ваши права, данные вам этой Лицензией. Однако лицензии лиц, получивших от вас копии или права согласно данной Универсальной Общественной Лицензии, не прекращают своего действия, если эти лица полностью соблюдают условия.

**5.** Вы не обязаны соглашаться с этой Лицензией, так как вы не подписывали ее. Однако, ничто, кроме этой Лицензии, не дает вам право изменять или распространять эту Программу или основанные на ней произведения. Эти действия запрещены законом, если вы не принимаете к соблюдению эту Лицензию. А значит, изменяя или распространяя Программу (или произведение, основанное на Программе), вы изъявляете свое согласие с этой Лицензией и всеми ее условиями о копировании, распространении или модификации Программы или основанных на ней произведений.

**6.** Каждый раз, когда вы повторно распространяете Программу (или любое произведение, основанное на Программе), получатель этого произведения автоматически получает от первоначального выдавшего лицензию лица свою лицензию на копирование, распространение или модификацию Программы, обсуждаемую в этих определениях и условиях. Вы не можете налагать каких-либо дополнительных ограничений на осуществление получателем прав, предоставленных данным документом. Вы не несете ответственности за соблюдение третьими лицами условий этой Лицензии.

**7.** Если в результате судебного разбирательства, или обвинения в нарушении патента или по любой другой причине (не обязательно связанной с патентами), вам навязаны условия, противоречащие данной Лицензии (по постановлению суда, по соглашению или иным способом), это не освобождает вас от соблюдения Лицензии. Если вы не можете заниматься распространением так, чтобы одновременно удовлетворить требованиям и этой Лицензии, и всем другим требованиям, то вы не должны заниматься распространением Программы. Например, если патент не позволяет безвозмездное повторное распространение Программы всем, кто получил копии от вас непосредственно или через посредников, то единственным способом удовлетворить и патенту, и этой Лицензии будет ваш полный отказ от распространения Программы.

Если какая-либо часть этого раздела не имеет силы или не может быть исполнена при некоторых конкретных обстоятельствах, то подразумевается, что имеет силу остальная часть раздела, а при других обстоятельствах имеет силу весь Раздел.

Цель этого раздела — не побудить вас делать заявления о нарушениях прав на патент, или заявлять о других претензиях на право собственности или оспаривать правильность подобных претензий; единственная цель этого раздела — защита целостности системы распространения свободного ПО, которая реализуется использованием общественных лицензий. Многие люди внесли щедрый вклад в широкий спектр ПО, распространяемого по этой системе, полагаясь на ее согласованное применение; только автору принадлежит право решать, хочет ли он или она распространять ПО в этой системе или в какой-то другой, и получатель лицензии не может влиять на принятие этого решения.

Этот раздел предназначен для того, чтобы тщательно прояснить, что полагается следствием из остальной части данной Лицензии.

**8.** Если распространение и/или применение Программы ограничено в ряде стран либо патентами, либо авторскими правами на интерфейсы, первоначальный обладатель авторских прав, выпускающий Программу с этой Лицензией, может добавить явное ограничение на географическое распространение, исключив такие страны, так что распространение разрешается только в тех странах, которые не были исключены. В этом случае данная Лицензия включает в себя это ограничение, как если бы оно было написано в тексте данной Лицензии.

**9.** Фонд Свободного ПО может время от времени публиковать пересмотренные и/или новые версии Универсальной Общественной Лицензии. Такие новые версии будут сходны по духу с настоящей версией, но могут отличаться в деталях, направленных на новые проблемы или обстоятельства.

Каждой версии придается отличительный номер. Если в Программе указывается, что к ней относится некоторый номер версии данной Лицензии и «любая последующая версия», вы можете по выбору следовать определениям и условиям либо данной версии, либо любой последующей версии, опубликованной Фондом Свободного ПО. Если в Программе не указан номер версии данной Лицензии, вы можете выбрать любую версию, когда-либо опубликованную Фондом Свободного ПО.

**10.** Если вы хотите встроить части Программы в другие свободные программы с иными условиями распространения, напишите автору с просьбой о разрешении. Для ПО, которое охраняется авторскими правами Фонда Свободного ПО, напишите в Фонд Свободного ПО; мы иногда делаем такие исключения. Наше решение будет руководствоваться двумя целями: сохранения свободного статуса всех производных нашего свободного ПО и содействия совместному и повторному использованию ПО вообще.

*НИКАКИХ ГАРАНТИЙ*

**11.** ПОСКОЛЬКУ ПРОГРАММА ПРЕДОСТАВЛЯЕТСЯ БЕСПЛАТНО, НА ПРОГРАММУ НЕТ ГАРАНТИЙ В ТОЙ МЕРЕ, КАКАЯ ДОПУСТИМА ПРИМЕНИМЫМ ЗАКОНОМ. ЗА ИСКЛЮЧЕНИЕМ ТЕХ СЛУЧАЕВ, КОГДА ОБРАТНОЕ ЗАЯВЛЕНО В ПИСЬМЕННОЙ ФОРМЕ, ДЕРЖАТЕЛИ АВТОРСКИХ ПРАВ И/ИЛИ ДРУГИЕ СТОРОНЫ ПОСТАВЛЯЮТ ПРОГРАММУ “КАК

ОНА ЕСТЬ" БЕЗ КАКОГО-ЛИБО ВИДА ГАРАНТИЙ, ВЫРАЖЕННЫХ ЯВНО ИЛИ ПОДРАЗУМЕВАЕМЫХ, ВКЛЮЧАЯ, НО НЕ ОГРАНИЧИВАЯСЬ ИМИ, ПОДРАЗУМЕВАЕМЫЕ ГАРАНТИИ КОММЕРЧЕСКОЙ ЦЕННОСТИ И ПРИГОДНОСТИ ДЛЯ КОНКРЕТНОЙ ЦЕЛИ. ВЕСЬ РИСК В ОТНОШЕНИИ КАЧЕСТВА И ПРОИЗВОДИТЕЛЬНОСТИ ПРОГРАММЫ ОСТАЕТСЯ ПРИ ВАС. ЕСЛИ ПРОГРАММА ОКАЖЕТСЯ ДЕФЕКТНОЙ, ВЫ ПРИНИМАЕТЕ НА СЕБЯ СТОИМОСТЬ ВСЕГО НЕОБХОДИМОГО ОБСЛУЖИВАНИЯ, ВОССТАНОВЛЕНИЯ ИЛИ ИСПРАВЛЕНИЯ.

**12.** НИ В КОЕМ СЛУЧАЕ, ЕСЛИ НЕ ТРЕБУЕТСЯ СООТВЕТСТВУЮЩИМ ЗАКОНОМ, ИЛИ НЕ УСЛОВЛЕНО В ПИСЬМЕННОЙ ФОРМЕ, НИ ОДИН ДЕРЖАТЕЛЬ АВТОРСКИХ ПРАВ И НИ ОДНО ДРУГОЕ ЛИЦО, КОТОРОЕ МОЖЕТ ИЗМЕНЯТЬ И/ИЛИ ПОВТОРНО РАСПРОСТРАНЯТЬ ПРОГРАММУ, КАК БЫЛО РАЗРЕШЕНО ВЫШЕ, НЕ ОТВЕТСТВЕННЫ ПЕРЕД ВАМИ ЗА УБЫТКИ, ВКЛЮЧАЯ ЛЮБЫЕ ОБЩИЕ, СПЕЦИАЛЬНЫЕ, СЛУЧАЙНЫЕ ИЛИ ПОСЛЕДОВАВШИЕ УБЫТКИ, ПРОИСТЕКАЮЩИЕ ИЗ ИСПОЛЬЗОВАНИЯ ИЛИ НЕВОЗМОЖНОСТИ ИСПОЛЬЗОВАНИЯ ПРОГРАММЫ (ВКЛЮЧАЯ, НО НЕ ОГРАНИЧИВАЯСЬ ПОТЕРЕЙ ДАННЫХ, ИЛИ ДАННЫМИ, СТАВШИМИ НЕПРАВИЛЬНЫМИ, ИЛИ ПОТЕРЯМИ, ПОНЕСЕННЫМИ ИЗ-ЗА ВАС ИЛИ ТРЕТЬИХ ЛИЦ, ИЛИ ОТКАЗОМ ПРОГРАММЫ РАБОТАТЬ СОВМЕСТНО С ЛЮБЫМИ ДРУГИМИ ПРОГРАММАМИ), ДАЖЕ ЕСЛИ ТАКОЙ ДЕРЖАТЕЛЬ ИЛИ ДРУГОЕ ЛИЦО БЫЛИ ИЗВЕЩЕНЫ О ВОЗМОЖНОСТИ ТАКИХ УБЫТКОВ.

*КОНЕЦ ОПРЕДЕЛЕНИЙ И УСЛОВИЙ*

### Как применять эти условия к вашим новым программам

Если вы разрабатываете новую программу и хотите, чтобы она принесла максимально возможную пользу обществу, лучший способ достичь этого — включить ее в свободное ПО, которое каждый может повторно распространять и изменять согласно данным условиям.

Чтобы сделать это, добавьте в программу следующие уведомления. Надежнее всего будет добавить их в начало каждого исходного файла, чтобы наиболее эффективно передать сообщение об отсутствии гарантий; каждый файл должен содержать по меньшей мере строку, содержащую «знак охраны авторского права» и указание на то, где находится полное уведомление.

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одна строка, содержащая название программы и краткое описание того, что
она делает.
(C) наименование (имя) автора уууу


Это свободная программа; вы можете повторно распространять ее и/или
модифицировать ее в соответствии с Универсальной Общественной
Лицензией GNU, опубликованной Фондом Свободного ПО; либо версии 2,
либо (по вашему выбору) любой более поздней версии.


 Эта программа распространяется в надежде, что она будет полезной,
 но БЕЗ КАКИХ-ЛИБО ГАРАНТИЙ; даже без подразумеваемых гарантий
 КОММЕРЧЕСКОЙ ЦЕННОСТИ или ПРИГОДНОСТИ ДЛЯ КОНКРЕТНОЙ ЦЕЛИ. Для
 получения подробных сведений смотрите Универсальную Общественную
 Лицензию GNU.


 Вы должны были получить копию Универсальной Общественной Лицензии
 GNU вместе с этой программой; если нет, напишите по адресу: Free
 Software Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA
 02111-1307 USA
```

Добавьте также сведения о том, как связаться с вами по электронной и обычной почте.

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