

# GNU SASL

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Simple Authentication and Security Layer for the GNU system  
for version 1.3, 8 October 2009

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# 1 Introduction

This manual can be used in several ways. If read from the beginning to the end, it gives the reader an understanding of the SASL framework and the GNU SASL implementation, and how the GNU SASL library is used in an application. Forward references are included where necessary. Later on, the manual can be used as a reference manual to get just the information needed about any particular interface of the library. Experienced programmers might want to start looking at the examples at the end of the manual, and then only read up those parts of the interface which are unclear.

## 1.1 SASL Overview

SASL is a framework for application protocols, such as SMTP or IMAP, to add authentication support. For example, SASL is used to prove to the server who you are when you access an IMAP server to read your e-mail.

The SASL framework does not specify the technology used to perform the authentication, that is the responsibility for each SASL mechanism. Popular SASL mechanisms include CRAM-MD5 and GSSAPI (for Kerberos V5).

Typically a SASL negotiation works as follows. First the client requests authentication (possibly implicitly by connecting to the server). The server responds with a list of supported mechanisms. The client chose one of the mechanisms. The client and server then exchange data, one round-trip at a time, until authentication either succeeds or fails. After that, the client and server knows more about who is on the other end of the channel.

For example, in SMTP communication happens like this:

```
250-mail.example.com Hello pc.example.org [192.168.1.42], pleased to meet you
250-AUTH DIGEST-MD5 CRAM-MD5 LOGIN PLAIN
250 HELP
AUTH CRAM-MD5
334 PDK5MDgwNDEzMdUwNTUyMTE1NDQ5LjBAbG9jYWxob3N0Pg==
amFzIDBkZDRkODZkMDVjNjI4ODRkYzc3OTcwODE4ZGI5MGY3
235 2.0.0 OK Authenticated
```

Here the first three lines are sent by the server and contains the list of supported mechanisms (DIGEST-MD5, CRAM-MD5, etc). The next line is sent by the client to select the CRAM-MD5 mechanism. The server replies with a challenge, which is a message that can be generated by calling GNU SASL functions. The client replies with a response, which also is a message that can be generated by GNU SASL functions. Depending on the mechanism, there can be more than one round trip, so do not assume all authentication exchanges consists of one message from the server and one from the client. The server accepts the authentication. At that point it knows it is talking to a authenticated client, and the application protocol can continue.

Essentially, your application is responsible for implementing the framing protocol (e.g., SMTP or XMPP) according to the particular specifications. Your application uses GNU SASL to generate the authentication messages.

## 1.2 Implementation

GNU SASL is an implementation of the Simple Authentication and Security Layer framework and a few common SASL mechanisms.

GNU SASL consists of a library (`libgsasl`), a command line utility (`gsasl`) to access the library from the shell, and a manual. The library includes support for the framework (with authentication functions and application data privacy and integrity functions) and at least partial support for the CRAM-MD5, EXTERNAL, GSSAPI, ANONYMOUS, PLAIN, SECURID, DIGEST-MD5, SCRAM-SHA-1, LOGIN, and NTLM mechanisms.

The library is easily ported because it does not do network communication by itself, but rather leaves it up to the calling application. The library is flexible with regards to the authorization infrastructure used, as it utilizes a callback into the application to decide whether a user is authorized or not.

GNU SASL is developed for the GNU/Linux system, but runs on over 20 platforms including most major Unix platforms and Windows, and many kind of devices including iPAQ handhelds and S/390 mainframes.

GNU SASL is written in pure ANSI C89 to be portable to embedded and otherwise limited platforms. The entire library, with full support for ANONYMOUS, EXTERNAL, PLAIN, LOGIN and CRAM-MD5, and the front-end that supports client and server mode, and the IMAP and SMTP protocols, fits in under 80kb on an Intel x86 platform, without any modifications to the code. (This figure was accurate as of version 1.1.)

The design of the library and the intended interaction between applications and the library through the official API is illustrated below.

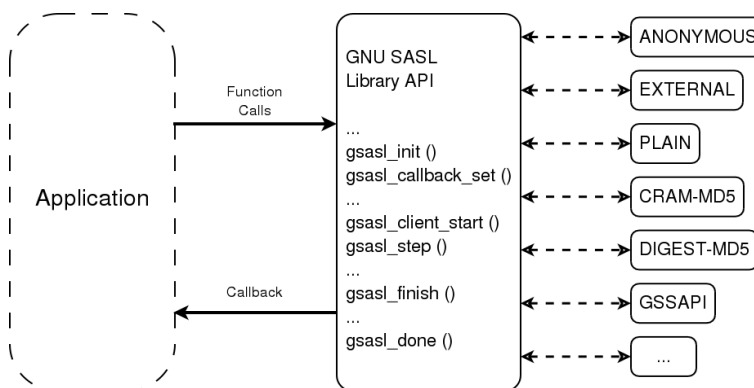


Illustration 1.1: Logical overview showing how applications use authentication mechanisms through an abstract interface.

## 1.3 Features

GNU SASL might have a couple of advantages over other libraries doing a similar job.

### It's Free Software

Anybody can use, modify, and redistribute it under the terms of the GNU General Public License version 3.0 or later. The library uses the GNU Lesser General Public License version 2.1 or later.

### It's thread-safe

No global variables are used and multiple library handles and session handles may be used in parallel.

It's internationalized

It handles non-ASCII usernames and passwords and user visible strings used in the library (error messages) can be translated into the users' language.

It's portable

It should work on all Unix like operating systems, including Windows. The library itself should be portable to any C89 system, not even POSIX is required.

It's small    The library has been rewritten with embedded platforms in mind. For example, no API consumes more than around 250 bytes of stack space.

Note that the library does not implement any policy to decide whether a certain user is “authenticated” or “authorized” or not. Rather, it uses a callback into the application to answer these questions.

## 1.4 Requirements

The GNU SASL library does not have any required external dependencies, but some optional features are enabled if you have a specific external library.

**LibNTLM**    The NTLM mechanism requires the library LibNTLM, <http://josefsson.org/libntlm/>.

**GSS-API**    The GSS-API mechanism requires a GSS-API library, such as GNU GSS (<http://www.gnu.org/software/gss/>), MIT Kerberos or Heimdal.

**LibIDN**    Processing of non-ASCII usernames and passwords requires the SASLprep implementation in LibIDN (<http://www.gnu.org/software/libidn/>). This is needed for full conformance with the latest SASL protocol drafts, but is optional in the library for improved portability.

**Libgcrypt**    The GNU SASL library ships with its own cryptographic implementation, but it can use the one in libgcrypt (<http://www.gnupg.org/>) instead, if it is available. This is typically useful for desktop machines which have libgcrypt installed.

The command-line interface to GNU SASL requires a POSIX or Windows platform for network connectivity. The command-line tool can make use of GnuTLS (<http://www.gnutls.org/>) to support the STARTTLS modes of IMAP and SMTP, but GnuTLS is not required.

Note that the library does not need a POSIX platform or network connectivity.

## 1.5 Supported Platforms

GNU SASL has at some point in time been tested on the following platforms. Daily online build reports are available at <http://autobuild.josefsson.org/gsas1/>.

### 1. Debian GNU/Linux 3.0 (Woody)

GCC 2.95.4 and GNU Make. This is the main development platform. `alphaev67-unknown-linux-gnu`, `alphaev6-unknown-linux-gnu`, `arm-unknown-linux-gnu`, `hppa-unknown-linux-gnu`, `hppa64-unknown-linux-gnu`, `i686-pc-linux-gnu`, `ia64-unknown-linux-gnu`, `m68k-unknown-linux-gnu`, `mips-unknown-linux-gnu`, `mipsel-unknown-linux-gnu`, `powerpc-unknown-linux-gnu`, `s390-ibm-linux-gnu`, `sparc-unknown-linux-gnu`.

2. Debian GNU/Linux 2.1  
GCC 2.95.1 and GNU Make. `armv4l-unknown-linux-gnu`.
3. Tru64 UNIX  
Tru64 UNIX C compiler and Tru64 Make. `alphaev67-dec-osf5.1`, `alphaev68-dec-osf5.1`.
4. SuSE Linux 7.1  
GCC 2.96 and GNU Make. `alphaev6-unknown-linux-gnu`, `alphaev67-unknown-linux-gnu`.
5. SuSE Linux 7.2a  
GCC 3.0 and GNU Make. `ia64-unknown-linux-gnu`.
6. RedHat Linux 7.2  
GCC 2.96 and GNU Make. `alphaev6-unknown-linux-gnu`, `alphaev67-unknown-linux-gnu`, `ia64-unknown-linux-gnu`.
7. RedHat Linux 8.0  
GCC 3.2 and GNU Make. `i686-pc-linux-gnu`.
8. RedHat Advanced Server 2.1  
GCC 2.96 and GNU Make. `i686-pc-linux-gnu`.
9. Slackware Linux 8.0.01  
GCC 2.95.3 and GNU Make. `i686-pc-linux-gnu`.
10. Mandrake Linux 9.0  
GCC 3.2 and GNU Make. `i686-pc-linux-gnu`.
11. IRIX 6.5  
MIPS C compiler, IRIX Make. `mips-sgi-irix6.5`.
12. AIX 4.3.2  
IBM C for AIX compiler, AIX Make. `rs6000-ibm-aix4.3.2.0`.
13. Microsoft Windows 2000 (Cygwin)  
GCC 3.2, GNU make. `i686-pc-cygwin`.
14. HP-UX 11  
HP-UX C compiler and HP Make. `ia64-hp-hpux11.22`, `hppa2.0w-hp-hpux11.11`.
15. SUN Solaris 2.8  
Sun WorkShop Compiler C 6.0 and SUN Make. `sparc-sun-solaris2.8`.
16. SUN Solaris 2.9  
Sun Forte Developer 7 C compiler and GNU Make. `sparc-sun-solaris2.9`.
17. NetBSD 1.6  
GCC 2.95.3 and GNU Make. `alpha-unknown-netbsd1.6`, `i386-unknown-netbsdelf1.6`.
18. OpenBSD 3.1 and 3.2  
GCC 2.95.3 and GNU Make. `alpha-unknown-openbsd3.1`, `i386-unknown-openbsd3.1`.



## 19. FreeBSD 4.7

GCC 2.95.4 and GNU Make. `alpha-unknown-freebsd4.7`, `i386-unknown-freebsd4.7`.

## 20. Cross compiled to uClinux/uClibc on Motorola Coldfire.

GCC 3.4 and GNU Make `m68k-uclinux-elf`.

If you port GNU SASL to a new platform, please report it to the author so this list can be updated.

## 1.6 Getting help

A mailing list where users may help each other exists, and you can reach it by sending e-mail to [help-gsas1@gnu.org](mailto:help-gsas1@gnu.org). Archives of the mailing list discussions, and an interface to manage subscriptions, is available through the World Wide Web at <http://lists.gnu.org/mailman/listinfo/help-gsas1>.

## 1.7 Commercial Support

Commercial support is available for users of GNU SASL. The kind of support that can be purchased may include:

- Implement new features. Such as a new SASL mechanism.
- Port GNU SASL to new platforms. This could include porting to an embedded platform that may need memory or size optimization.
- Integrating SASL as a security environment in your existing project.
- System design of components related to SASL.

If you are interested, please write to:

Simon Josefsson Datakonsult AB  
Hagagatan 24  
113 47 Stockholm  
Sweden

E-mail: [simon@josefsson.org](mailto:simon@josefsson.org)

If your company provides support related to GNU SASL and would like to be mentioned here, contact the author (see [Section 1.9 \[Bug Reports\]](#), page 7).

## 1.8 Downloading and Installing

The package can be downloaded from several places, including:

<ftp://ftp.gnu.org/pub/gnu/gsas1/>

The latest version is stored in a file, e.g., `gsas1-1.3.tar.gz` where the ‘1.3’ value is the highest version number in the directory.

The package is then extracted, configured and built like many other packages that use Autoconf. For detailed information on configuring and building it, refer to the ‘INSTALL’ file that is part of the distribution archive.

Here is an example terminal session that downloads, configures, builds and install the package. You will need a few basic tools, such as ‘sh’, ‘make’ and ‘cc’.

```

$ wget -q ftp://ftp.gnu.org/pub/gnu/gsas1/gsas1-1.3.tar.gz
$ tar xzf gsas1-1.3.tar.gz
$ cd gsas1-1.3/
$ ./configure
...
$ make
...
$ make install
...

```

After that gsasl should be properly installed and ready for use.

A few configure options may be relevant, summarized in the table.

`--disable-client`

`--disable-server`

If your target system require a minimal implementation, you may wish to disable the client or the server part of the code. This does not remove symbols from the library, so if you attempt to call an application that uses server functions in a library built with `--disable-server`, the function will return an error code.

`--disable-obsolete`

Remove backwards compatibility (see [Appendix B \[Old Functions\]](#), page 64). Use if you want to limit the size of the library.

`--disable-anonymous`

`--disable-external`

`--disable-plain`

`--disable-login`

`--disable-securid`

`--disable-ntlm`

`--disable-cram-md5`

`--disable-digest-md5`

`--disable-gssapi`

`--enable-kerberos_v5`

`--disable-scram-sha1`

Disable or enable individual mechanisms (see [Chapter 5 \[Mechanisms\]](#), page 24).

`--without-stringprep`

Disable internationalized string processing. Note that this will result in a SASL library that is only compatible with RFC 2222.

For the complete list, refer to the output from `configure --help`.

### 1.8.1 Installing under Windows

There are two ways to build GNU SASL on Windows: via MinGW or via Microsoft Visual Studio.

With MinGW, you can build a GNU SASL DLL and use it from other applications. After installing MinGW (<http://mingw.org/>) follow the generic installation instructions (see [Section 1.8 \[Downloading and Installing\]](#), page 5). The DLL is installed by default.

For information on how to use the DLL in other applications, see: <http://www.mingw.org/mingwfaq.shtml#faq-msvcdll>.

You can build GNU SASL as a native Visual Studio C++ project. This allows you to build the code for other platforms that VS supports, such as Windows Mobile. You need Visual Studio 2005 or later.

First download and unpack the archive as described in the generic installation instructions (see [Section 1.8 \[Downloading and Installing\]](#), page 5). Don't run `./configure`. Instead, start Visual Studio and open the project file `lib/win32/libgsasl.sln` inside the GNU SASL directory. You should be able to build the project using Build Project.

Output libraries will be written into the `lib/win32/lib` (or `lib/win32/lib/debug` for Debug versions) folder.

Warning! Unless you build GNU SASL linked with `libgcrypt`, GNU SASL uses the Windows function `CryptGenRandom` for generating cryptographic random data. The function is known to have some security weaknesses. See <http://eprint.iacr.org/2007/419> for more information. The code will attempt to use the Intel RND crypto provider if it is installed, see `lib/gl/gc-gnulib.c`.

## 1.9 Bug Reports

If you think you have found a bug in GNU SASL, please investigate it and report it.

- Please make sure that the bug is really in GNU SASL, and preferably also check that it hasn't already been fixed in the latest version.
- You have to send us a test case that makes it possible for us to reproduce the bug.
- You also have to explain what is wrong; if you get a crash, or if the results printed are not good and in that case, in what way. Make sure that the bug report includes all information you would need to fix this kind of bug for someone else.

Please make an effort to produce a self-contained report, with something definite that can be tested or debugged. Vague queries or piecemeal messages are difficult to act on and don't help the development effort.

If your bug report is good, we will do our best to help you to get a corrected version of the software; if the bug report is poor, we won't do anything about it (apart from asking you to send better bug reports).

If you think something in this manual is unclear, or downright incorrect, or if the language needs to be improved, please also send a note.

Send your bug report to:

`'bug-gsas1@gnu.org'`

## 1.10 Contributing

If you want to submit a patch for inclusion – from solve a typo you discovered, up to adding support for a new feature – you should submit it as a bug report (see [Section 1.9 \[Bug Reports\]](#), page 7). There are some things that you can do to increase the chances for it to be included in the official package.

Unless your patch is very small (say, under 10 lines) we require that you assign the copyright of your work to the Free Software Foundation. This is to protect the freedom

of the project. If you have not already signed papers, we will send you the necessary information when you submit your contribution.

For contributions that doesn't consist of actual programming code, the only guidelines are common sense. Use it.

For code contributions, a number of style guides will help you:

- Coding Style. Follow the GNU Standards document (see [\[top\]](#), page [\[undefined\]](#)).

If you normally code using another coding standard, there is no problem, but you should use 'indent' to reformat the code (see [\[top\]](#), page [\[undefined\]](#)) before submitting your work.

- Use the unified diff format 'diff -u'.
- Return errors. No reason whatsoever should abort the execution of the library. Even memory allocation errors, e.g. when `malloc` return `NULL`, should work although result in an error code.
- Design with thread safety in mind. Don't use global variables. Don't even write to per-handle global variables unless the documented behaviour of the function you write is to write to the per-handle global variable.
- Avoid using the C math library. It causes problems for embedded implementations, and in most situations it is very easy to avoid using it.
- Document your functions. Use comments before each function headers, that, if properly formatted, are extracted into Texinfo manuals and GTK-DOC web pages.
- Supply a ChangeLog and NEWS entries, where appropriate.

## 2 Preparation

To use GNU SASL, you have to perform some changes to your sources and the build system. The necessary changes are small and explained in the following sections. At the end of this chapter, it is described how the library is initialized, and how the requirements of the library are verified.

A faster way to find out how to adapt your application for use with GNU SASL may be to look at the examples at the end of this manual (see [Chapter 13 \[Examples\]](#), page 47).

### 2.1 Header

All interfaces (data types and functions) of the library are defined in the header file `gsasl.h`. You must include this in all programs using the library, either directly or through some other header file, like this:

```
#include <gsasl.h>
```

The name space is `gsasl_*` for function names, `Gsasl*` for data types and `GSASL_*` for other symbols. In addition the same name prefixes with one prepended underscore are reserved for internal use and should never be used by an application.

### 2.2 Initialization

The library must be initialized before it can be used. The library is initialized by calling `gsasl_init` (see [Chapter 6 \[Global Functions\]](#), page 29). The resources allocated by the initialization process can be released if the application no longer has a need to call ‘Libgsasl’ functions, this is done by calling `gsasl_done`. For example:

```
int
main (int argc, char *argv[])
{
    Gsasl *ctx = NULL;
    int rc;
    ...
    rc = gsasl_init (&ctx);
    if (rc != GSASL_OK)
    {
        printf ("SASL initialization failure (%d): %s\n",
                rc, gsasl_strerror (rc));
        return 1;
    }
    ...
}
```

In order to make error messages from `gsasl_strerror` be translated (see [Section “Top” in GNU Gettext](#)) the application must set the current locale using `setlocale` before calling `gsasl_init`. For example:

```
int
main (int argc, char *argv[])
{
    Gsasl *ctx = NULL;
```

```

    int rc;
...
    setlocale (LC_ALL, "");
...
    rc = gsasl_init (&ctx);
    if (rc != GSASL_OK)
    {
        printf (gettext ("SASL initialization failure (%d): %s\n"),
                rc, gsasl_strerror (rc));
        return 1;
    }
...

```

In order to take advantage of the secure memory features in Libgcrypt<sup>1</sup>, you need to initialize secure memory in your application, and for some platforms even make your application setuid root. See the Libgcrypt documentation for more information. Here is example code to initialize secure memory in your code:

```

#include <gcrypt.h>
...
int
main (int argc, char *argv[])
{
    Gsasl *ctx = NULL;
    int rc;
...
    /* Check version of libgcrypt. */
    if (!gcry_check_version (GCRYPT_VERSION))
        die ("version mismatch\n");

    /* Allocate a pool of 16k secure memory. This also drops privileges
       on some systems. */
    gcry_control (GCRYCTL_INIT_SECMEM, 16384, 0);

    /* Tell Libgcrypt that initialization has completed. */
    gcry_control (GCRYCTL_INITIALIZATION_FINISHED, 0);
...
    rc = gsasl_init (&ctx);
    if (rc != GSASL_OK)
    {
        printf ("SASL initialization failure (%d): %s\n",
                rc, gsasl_strerror (rc));
        return 1;
    }
...

```

---

<sup>1</sup> Note that GNU SASL normally use its own internal implementation of the cryptographic functions. Take care to verify that GNU SASL really use Libgcrypt, if this is what you want.

If you do not do this, keying material will not be allocated in secure memory (which, for most applications, is not the biggest secure problem anyway). Note that the GNU SASL Library has not been audited to make sure it stores passwords or keys in secure memory.

## 2.3 Version Check

It is often desirable to check that the version of the library used is indeed one which fits all requirements. Even with binary compatibility, new features may have been introduced but, due to problem with the dynamic linker, an old version may actually be used. So you may want to check that the version is okay right after program startup.

### `gsasl_check_version`

`const char * gsasl_check_version (const char * req_version)` [Function]  
*req\_version*: version string to compare with, or NULL.

Check GNU SASL Library version.

See `GSASL_VERSION` for a suitable `req_version` string.

This function is one of few in the library that can be used without a successful call to `gsasl_init()`.

**Return value:** Check that the version of the library is at minimum the one given as a string in `req_version` and return the actual version string of the library; return NULL if the condition is not met. If NULL is passed to this function no check is done and only the version string is returned.

The normal way to use the function is to put something similar to the following early in your main:

```
if (!gsasl_check_version (GSASL_VERSION))
{
    printf ("gsasl_check_version failed:\n"
           "Header file incompatible with shared library.\n");
    exit(1);
}
```

## 2.4 Building the source

If you want to compile a source file including the `'gsasl.h'` header file, you must make sure that the compiler can find it in the directory hierarchy. This is accomplished by adding the path to the directory in which the header file is located to the compilers include file search path (via the `'-I'` option).

However, the path to the include file is determined at the time the source is configured. To solve this problem, the library uses the external package `pkg-config` that knows the path to the include file and other configuration options. The options that need to be added to the compiler invocation at compile time are output by the `'--cflags'` option to `pkg-config libgsasl`. The following example shows how it can be used at the command line:

```
gcc -c foo.c 'pkg-config libgsasl --cflags'
```

Adding the output of `'pkg-config libgsasl --cflags'` to the compiler command line will ensure that the compiler can find the `'gsasl.h'` header file.

A similar problem occurs when linking the program with the library. Again, the compiler has to find the library files. For this to work, the path to the library files has to be added to the library search path (via the ‘-L’ option). For this, the option ‘--libs’ to `pkg-config libgsasl` can be used. For convenience, this option also outputs all other options that are required to link the program with the library (for instance, the ‘-lidn’ option). The example shows how to link ‘foo.o’ with the library to a program `foo`.

```
gcc -o foo foo.o `pkg-config libgsasl --libs`
```

Of course you can also combine both examples to a single command by specifying both options to `pkg-config`:

```
gcc -o foo foo.c `pkg-config libgsasl --cflags --libs`
```

## 2.5 Autoconf tests

If you work on a project that uses Autoconf (see [\[top\]](#), page [\[undefined\]](#)) to help find installed libraries, the suggestions in the previous section are not the entire story. There are a few methods to detect and incorporate the GNU SASL Library into your Autoconf based package. The preferred approach, is to use Libtool in your project, and use the normal Autoconf header file and library tests.

### 2.5.1 Autoconf test via ‘pkg-config’

If your audience is a typical GNU/Linux desktop, you can often assume they have the ‘pkg-config’ tool installed, in which you can use its Autoconf M4 macro to find and set up your package for use with Libgsasl. The following example illustrates this scenario.

```
AC_ARG_ENABLE(gsas1,
  AC_HELP_STRING([--disable-gsas1], [don't use GNU SASL]),
  gsasl=$enableval)
if test "$gsal" != "no" ; then
  PKG_CHECK_MODULES(GSASL, libgsasl >= 1.3,
    [gsasl=yes],
    [gsasl=no])
  if test "$gsasl" != "yes" ; then
    gsasl=no
    AC_MSG_WARN([Cannot find GNU SASL, disabling])
  else
    gsasl=yes
    AC_DEFINE(USE_GSASL, 1, [Define to 1 if you want GNU SASL.])
  fi
fi
AC_MSG_CHECKING([if GNU SASL should be used])
AC_MSG_RESULT($gsasl)
```

### 2.5.2 Standalone Autoconf test using Libtool

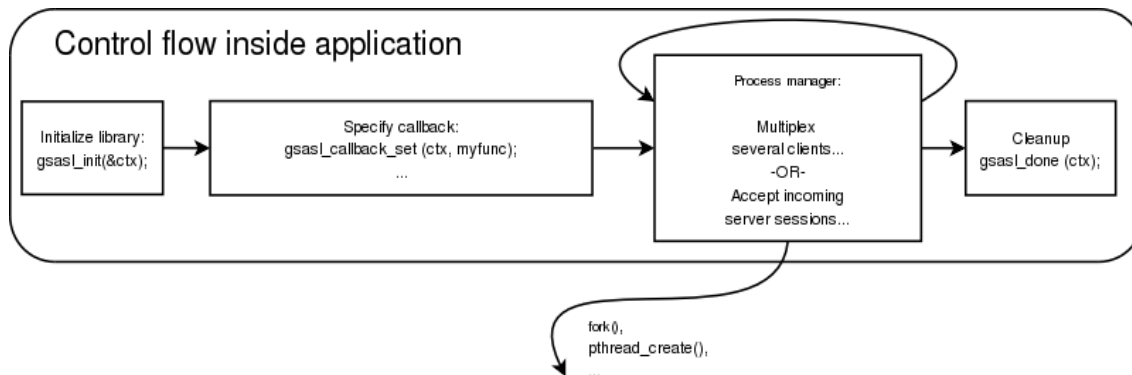
If your package uses Libtool (see [\[top\]](#), page [\[undefined\]](#)), you can use the normal Autoconf tests to find Libgsasl and rely on the Libtool dependency tracking to include the proper dependency libraries (e.g., Libidn). The following example illustrates this scenario.



```
AC_CHECK_HEADER(gsas1.h,
  AC_CHECK_LIB(gsas1, gsasl_check_version,
    [gsasl=yes AC_SUBST(GSASL_LIBS, -lgsasl)],
    gsasl=no),
  gsasl=no)
AC_ARG_ENABLE(gsas1,
  AC_HELP_STRING([--disable-gsas1], [don't use GNU SASL]),
  gsasl=$enableval)
if test "$gsasl" != "no" ; then
  AC_DEFINE(USE_SASL, 1, [Define to 1 if you want GNU SASL.])
else
  AC_MSG_WARN([Cannot find GNU SASL, disabling])
fi
AC_MSG_CHECKING([if GNU SASL should be used])
AC_MSG_RESULT($gsasl)
```

### 3 Using the Library

Your application's use of the library can be roughly modeled into the following steps: initialize the library, optionally specify the callback, perform the authentication, and finally clean up. The following image illustrates this.



The third step may look complex, but for a simple client it will actually not involve any code. If your application needs to handle several concurrent clients, or if it is a server that needs to serve many clients simultaneously, things do get a bit more complicated.

For illustration, we will write a simple client. Writing a server would be similar, the only difference is that, later on, instead of supplying a username and password, you need to decide whether someone should be allowed to log in or not. The code for what we have discussed so far make up the `main` function in our client (see [Section 13.1 \[Example 1\]](#), [page 47](#)):

```
int main (int argc, char *argv[])
{
    Gsasl *ctx = NULL;
    int rc;

    if ((rc = gsasl_init (&ctx)) != GSASL_OK)
    {
        printf ("Cannot initialize libgsasl (%d): %s",
                rc, gsasl_strerror (rc));
        return 1;
    }

    client (ctx);

    gsasl_done (ctx);

    return 0;
}
```

Here, the call to the function `client` correspond to the third step in the image above.

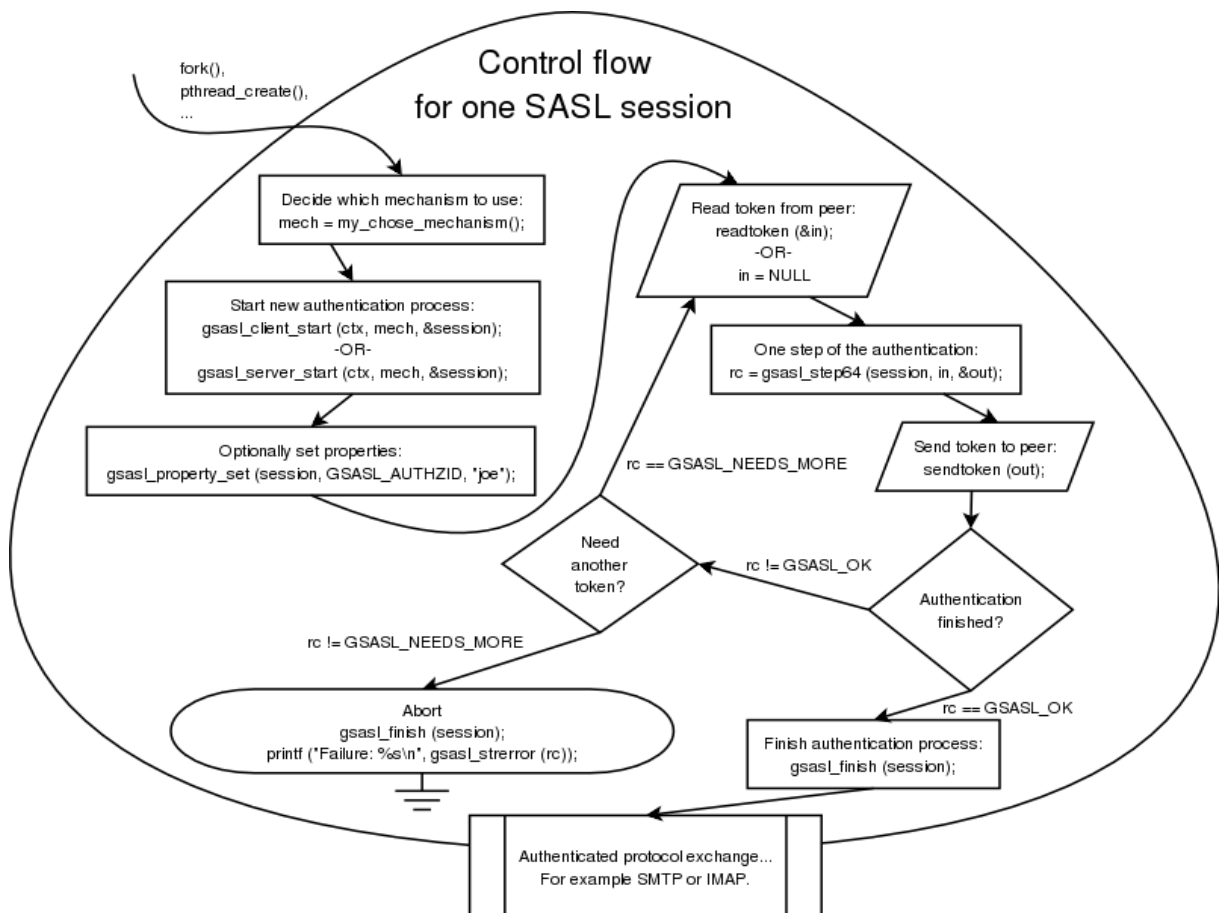
For a more complicated application, having several clients running simultaneous, instead of a simple call to `client`, it may have created new threads for each session, and call `client` within each thread. The library is thread safe.

An actual authentication session is more complicated than what we have seen so far. These are the steps: decide which mechanism to use, start the session, optionally specify the callback, optionally set any properties, perform the authentication loop, and clean up. Naturally, your application will start to talk its own protocol (e.g., SMTP or IMAP) after these steps have concluded.

The authentication loop is based on sending tokens (typically short messages encoded in base 64) back and forth between the client and server. It continues until authentication succeeds or an error occurs. The format of the data to be transferred, the number of iterations in the loop, and other details are specified by each mechanism. The goal of the library is to isolate your application from the details of all different mechanisms.

Note that the library does not send data to the server itself, but returns it in an buffer. You must send it to the server, following an application protocol profile. For example, the SASL application protocol profile for SMTP is described in RFC 2554.

The following image illustrates the steps we have been talking about.



We will now show the implementation of the `client` function used before.

```

void client (Gssasl *ctx)
{
    Gssasl_session *session;
    const char *mech = "PLAIN";
    int rc;

    /* Create new authentication session. */
    if ((rc = gssasl_client_start (ctx, mech, &session)) != GSASL_OK)
    {
        printf ("Cannot initialize client (%d): %s\n",
                rc, gssasl_strerror (rc));
        return;
    }

    /* Set username and password in session handle. This info will be
       lost when this session is deallocated below. */
    gssasl_property_set (session, GSASL_AUTHID, "jas");
    gssasl_property_set (session, GSASL_PASSWORD, "secret");

    /* Do it. */
    client_authenticate (session);

    /* Cleanup. */
    gssasl_finish (session);
}

```

This function is responsible for deciding which mechanism to use. In this case, the ‘PLAIN’ mechanism is hard coded, but you will see later how this can be made more flexible. The function creates a new session, then it stores the username and password in the session handle, then it calls another function `client_authenticate` to handle the authentication loop, and finally it cleans up up. Let’s continue with the implementation of `client_authenticate`.

```

void client_authenticate (Gssasl_session * session)
{
    char buf[BUFSIZ] = "";
    char *p;
    int rc;

    /* This loop mimics a protocol where the server sends data
       first. */

    do
    {
        printf ("Input base64 encoded data from server:\n");
        fgets (buf, sizeof (buf) - 1, stdin);
        if (buf[strlen (buf) - 1] == '\n')
            buf[strlen (buf) - 1] = '\0';
    }

```

```

    rc = gsasl_step64 (session, buf, &p);

    if (rc == GSASL_NEEDS_MORE || rc == GSASL_OK)
    {
        printf ("Output:\n%s\n", p);
        free (p);
    }
}
while (rc == GSASL_NEEDS_MORE);

printf ("\n");

if (rc != GSASL_OK)
{
    printf ("Authentication error (%d): %s\n",
           rc, gsasl_strerror (rc));
    return;
}

/* The client is done. Here you would typically check if the
   server let the client in. If not, you could try again. */

printf ("If server accepted us, we're done.\n");
}

```

This last function needs to be discussed in some detail. First, you should be aware that there are two versions of this function, that differ in a subtle way. The version above (see [Section 13.2 \[Example 2\], page 49](#)) is used for application profiles where the server sends data first. For some mechanisms, this may waste a roundtrip, because the server needs input from the client to proceed. Therefore, today the recommended approach is to permit client to send data first (see [Section 13.1 \[Example 1\], page 47](#)). Which version you should use depends on which application protocol you are implementing.

Further, you should realize that it is bad programming style to use a fixed size buffer. On GNU systems, you may use the `getline` functions instead of `fgets`. However, in practice, there are few mechanisms that use very large tokens. In typical configurations, the mechanism with the largest tokens (GSSAPI) can use at least 500 bytes. A fixed buffer size of 8192 bytes may thus be sufficient for now. But don't say I didn't warn you, when a future mechanism doesn't work in your application, because of a fixed size buffer.

The function `gsasl_step64` (and of course also `gasl_step`) returns two non-error return codes. `GSASL_OK` is used for success, indicating that the library considers the authentication finished. That may include a successful server authentication, depending on the mechanism. You must not let the client continue to the application protocol part unless you receive `GSASL_OK` from these functions. In particular, don't be fooled into believing authentication were successful if the server replies "OK" but these functions have failed with an error. The server may have been hacked, and could be tricking you into sending confidential data, without having successfully authenticated the server.

The non-error return code `GSASL_NEEDS_MORE` is used to signal to your application that you should send the output token to the peer, and wait for a new token, and do another iteration. If the server concludes the authentication process, with no data, you should call `gsasl_step64` (or `gsasl_step`) specifying a zero-length token.

If the functions (`gsasl_step` and `gsasl_step64`) return any non-error code, the content of the output buffer is undefined. Otherwise, it is the callers responsibility to deallocate the buffer, by calling `free`. Note that in some situations, where the buffer is empty, `NULL` is returned as the buffer value. You should treat this as an empty buffer.

### 3.1 Choosing a mechanism

Our earlier code was hard coded to use a specific mechanism. This is rarely a good idea. Instead, it is recommended to select the best mechanism available from the list of mechanisms supported by the server. Note that without TLS or similar, the list may have been maliciously altered, by an attacker. This means that you should abort if you cannot find any mechanism that exceeds your minimum security level. There is a function `gsasl_client_suggest_mechanism` (see [Chapter 6 \[Global Functions\], page 29](#)) that will try to pick the “best” available mechanism from a list of mechanisms. Our simple interactive example client (see [Section 13.3 \[Example 3\], page 52](#)) includes the following function to decide which mechanism to use. Note that the code doesn’t blindly use what is returned from `gsasl_client_suggest_mechanism`, rather it lets some logic (in this case the user, through an interactive query) decide which mechanism is acceptable.

```
const char *client_mechanism (Gsasl *ctx)
{
    static char mech[GSASL_MAX_MECHANISM_SIZE + 1] = "";
    char mechlist[BUFSIZ] = "";
    const char *suggestion;

    printf ("Enter list of server supported mechanisms, separate by SPC:\n");
    fgets (mechlist, sizeof (mechlist) - 1, stdin);

    suggestion = gsasl_client_suggest_mechanism (ctx, mechlist);
    if (suggestion)
        printf ("Library suggests use of '%s'.\n", suggestion);

    printf ("Enter mechanism to use:\n");
    fgets (mech, sizeof (mech) - 1, stdin);
    mech[strlen (mech) - 1] = '\0';

    return mech;
}
```

When running this example code, it might look like in the following output.

```
Enter list server supported mechanisms, separate by SPC:
CRAM-MD5 DIGEST-MD5 GSSAPI FOO BAR
Library suggests use of 'GSSAPI'.
Enter mechanism to use:
```

```

CRAM-MD5
Input base64 encoded data from server:
Zm5vcmlQ=
Output:
amFzIDkyY2U1NWE5MTM2ZTY4NzEyMTUyZTFjYmFmNjVkZjgx

```

If server accepted us, we're done.

## 3.2 Using a callback

Our earlier code specified the username and password before the authentication loop, as in:

```

gsasl_property_set (ctx, GSASL_AUTHID, "jas");
gsasl_property_set (ctx, GSASL_PASSWORD, "secret");

```

This may work for simple mechanisms, that need only a username and a password. But some mechanism requires more information, such as an authorization identity, a special PIN or passcode, a realm, a hostname, a service name, or an anonymous identifier. Querying the user for all that information, without knowing exactly which of it is really needed will result in a poor user interface. The user should not have to input private information, if it isn't required.

The approach is a bad idea for another reason. What if the server aborts the authentication process? Then your application has already queried the user for a username and password. It would be better if you only asked the user for this information, annoying to input, when it is known to be needed.

A better approach to this problem is to use a callback. Then the mechanism may query your application whenever it needs some information, like the username and password. It will only do this at the precise step in the authentication when the information is actually needed. Further, if the user aborts, e.g., a password prompt, the mechanism is directly informed of this (because it invoked the callback), and could recover somehow.

Our final example (see [Section 13.4 \[Example 4\], page 55](#)) specifies a callback function, inside `main` as below.

```

/* Set the callback handler for the library. */
gsasl_callback_set (ctx, callback);

```

The function itself is implemented as follows.

```

int callback (Gsasl * ctx, Gsasl_session * sctx, Gsasl_property prop)
{
    char buf[BUFSIZ] = "";
    int rc = GSASL_NO_CALLBACK;

    /* Get user info from user. */

    printf ("Callback invoked, for property %d.\n", prop);

    switch (prop)
    {
        case GSASL_PASSCODE:

```

```
    printf ("Enter passcode:\n");
    fgets (buf, sizeof (buf) - 1, stdin);
    buf[strlen (buf) - 1] = '\0';

    gsasl_property_set (sctx, GSASL_PASSCODE, buf);
    rc = GSASL_OK;
    break;

case GSASL_AUTHID:
    printf ("Enter username:\n");
    fgets (buf, sizeof (buf) - 1, stdin);
    buf[strlen (buf) - 1] = '\0';

    gsasl_property_set (sctx, GSASL_AUTHID, buf);
    rc = GSASL_OK;
    break;

default:
    printf ("Unknown property!  Don't worry.\n");
    break;
}

return rc;
}
```

Again, it is bad style to use a fixed size buffer. Mmm'kay.

Which properties you should handle is up to you. If you don't know how to respond to a certain property, simply return `GSASL_NO_CALLBACK`. The basic properties to support are authentication identity (`GSASL_AUTHID`), authorization identity (`GSASL_AUTHZID`), and password (`GSASL_PASSWORD`). See [Chapter 4 \[Properties\]](#), [page 21](#), for the list of all properties, and what your callback should (ideally) do for them, and which properties each mechanism require in order to work.



## 4 Properties

The library uses a concept called “properties” to request and pass data between the application and the individual authentication mechanisms. The application can set property values using the `gsasl_property_set` function. If a mechanism needs a property value the application has not yet provided, this is handled through a callback. The application provides a callback, using `gsasl_callback_set`, which will be invoked with a property parameter. The callback should set the property before returning, or fail. For more information, see See [Chapter 7 \[Callback Functions\]](#), page 31.

There are two kind of properties. The first, a “data property” is the simplest to understand because it normally refers to short strings. For example, the property called `GSASL_AUTHID` correspond to the username string, e.g., `simon`.

The latter properties, called “logical properties”, are used by the server to make a authentication decision, and is used as a way to get the application callback invoked. For example, the property `GSASL_VALIDATE_SIMPLE` is used by the server-side part of mechanisms like `PLAIN`. The purpose is to ask the server application to decide whether the user should be authenticated successfully or not. The callback typically look at other property fields, such as `GSASL_AUTHID` and `GSASL_PASSWORD`, and compare those values with external information (for example data stored in a database or on a LDAP server) and then return OK or not.

**Warning:** Don’t expect that all mechanisms invoke one of the logical properties in the server mode. For example, the `CRAM-MD5` and `SCRAM-SHA-1` mechanisms will use the data properties (i.e., username and password) provided by the application to internally decide whether to successfully authenticate the user. User authorization decisions needs to be made by the application outside of the SASL mechanism negotiation.

The logical properties are currently only used by servers, but data properties are used by both client and servers. It makes sense to think about the latter category as ‘**server properties**’ but the reverse is not valid nor useful.

The semantics associated with a data property is different when it is used in client context and in the server context. For example, in the client context, the application is expected to set the property `GSASL_AUTHID` to signal to the mechanism the username to use, but in the server context, the `GSASL_AUTHID` property is set by the mechanism and can be used by the application (in the callback) to find out what username the client provided.

Below is a list of all properties and an explanation for each. First is the list of data properties:

- `GSASL_AUTHID`  
The authentication identity.
- `GSASL_AUTHZID`  
The authorization identity.
- `GSASL_PASSWORD`  
The password of the authentication identity.
- `GSASL_ANONYMOUS_TOKEN`  
The anonymous token. This is typically the email address of the user.

- **GSASL\_SERVICE**  
The registered GSSAPI service name of the application service, e.g. “imap”. While the names are registered for GSSAPI, other mechanisms such as DIGEST-MD5 may also use this.
- **GSASL\_HOSTNAME**  
Should be the local host name of the machine.
- **GSASL\_GSSAPI\_DISPLAY\_NAME**  
Contain the GSSAPI “display name”, set by the server GSSAPI mechanism. Typically you retrieve this property in your callback, when invoked for **GSASL\_VALIDATE\_GSSAPI**.
- **GSASL\_REALM**  
The name of the authentication domain. This is used by several mechanisms, including DIGEST-MD5, GSS-API, KERBEROS\_V5 and NTLM.
- **GSASL\_PASSCODE**  
The SecurID passcode.
- **GSASL\_PIN**  
The SecurID personal identification number (PIN).
- **GSASL\_SUGGESTED\_PIN**  
A SecurID personal identification number (PIN) suggested by the server.
- **GSASL\_DIGEST\_MD5\_HASHED\_PASSWORD**  
For the DIGEST-MD5 mechanism, this is a hashed password. It is used in servers to avoid storing clear-text credentials.
- **GSASL\_QOPS**  
The DIGEST-MD5 server query for this property to get the set of quality of protection (QOP) values to advertise. The property holds strings with comma separated keywords denoting the set of qops to use, for example **qop-auth**, **qop-int**. Valid keywords are **qop-auth**, **qop-int**, and **qop-conf**.
- **GSASL\_QOP**  
The DIGEST-MD5 client query for this property to get the quality of protection (QOP) values to request. The property value is one of the keywords for **GSASL\_QOPS**. The client must chose one of the QOP values offered by the server (which may be inspected through the **GSASL\_QOPS** property).
- **GSASL\_SCRAM\_SALTED\_PASSWORD**  
The SCRAM-SHA-1 client requests this property from the application, and the value should be 40 character long hex-encoded string with the user’s hashed password. Note that the value is different for the same password for each value of the **GSASL\_SCRAM\_ITER** and **GSASL\_SCRAM\_ITER** properties. The property can be used to avoid storing a clear-text credential in the client. If the property is not available, the client will ask for the **GSASL\_PASSWORD** property instead.
- **GSASL\_SCRAM\_ITER**
- **GSASL\_SCRAM\_ITER**  
In the server, the application can set these properties to influence the hash iteration count and hash salt to use when deriving the password. The default hash iteration

count is 4096 and normally you should not need to use a lower setting. The salt should be a random string. In the client, the SCRAM-SHA-1 mechanism set these properties before asking for asking the application to provide a `GSASL_SCRAM_SALTED_PASSWORD` value.

Next follows a list of data properties used to trigger the callback, typically used in servers to validate client credentials:

- **GSASL\_VALIDATE\_SIMPLE**

You may retrieve `GSASL_AUTHID`, `GSASL_AUTHZID` and `GSASL_PASSWORD` and use them to make an authentication and authorization decision.

- **GSASL\_VALIDATE\_EXTERNAL**

Used by `EXTERNAL` mechanism on the server side to validate the client. The `GSASL_AUTHID` will contain the authorization identity of the client.

- **GSASL\_VALIDATE\_ANONYMOUS**

Used by `ANONYMOUS` mechanism on the server side to validate the client. The `GSASL_ANONYMOUS_TOKEN` will contain token that identity the client.

- **GSASL\_VALIDATE\_GSSAPI**

Used by the `GSSAPI` mechanism on the server side, to validate the client. You may retrieve the authorization identity from `GSASL_AUTHZID` and the GSS-API display name from `GSASL_GSSAPI_DISPLAY_NAME`.

- **GSASL\_VALIDATE\_SECURID**

Used by `SECURID` mechanism on the server side to validate client. The `GSASL_AUTHID`, `GSASL_AUTHZID`, `GSASL_PASSCODE`, and `GSASL_PIN` will be set. It can return `GSASL_SECURID_SERVER_NEED_ADDITIONAL_PASSCODE` to ask the client to supply another passcode, and `GSASL_SECURID_SERVER_NEED_NEW_PIN` to require the client to supply a new PIN code.

## 5 Mechanisms

Different SASL mechanisms have different requirements on the application using it. To handle these differences the library can use a callback function into your application in several different ways. Some mechanisms, such as ‘PLAIN’, are simple to explain and use. The client callback queries the user for a username and password. The server callback hands the username and password into any local policy deciding authentication system (such as ‘/etc/passwd’ via PAM).

Mechanism such as ‘CRAM-MD5’ and ‘SCRAM-SHA-1’ uses hashed passwords. The client callback behaviour is the same as for PLAIN. However, the server does not receive the plain text password over the network but rather a hash of it. Existing policy deciding systems like PAM cannot handle this, so the server callback for these mechanisms are more complicated.

Further, mechanisms like GSSAPI (Kerberos 5) assume a specific authentication system. In theory this means that the SASL library would not need to interact with the application, but rather call this specific authentication system directly. However, some callbacks are supported anyway, to modify the behaviour of how the specific authentication system is used (i.e., to handle “super-user” login as some other user).

Some mechanisms, like ‘EXTERNAL’ and ‘ANONYMOUS’ are entirely dependent on callbacks.

### 5.1 The EXTERNAL mechanism

The EXTERNAL mechanism is used to authenticate a user to a server based on out-of-band authentication. EXTERNAL is typically used over TLS authenticated channels. Note that in the server, you need to make sure that TLS actually authenticated the client successfully. It is normally not sufficient to use TLS, since it also supports anonymous modes.

In the client, this mechanism is always enabled, and it will send the `GSASL_AUTHZID` property as the authorization name to the server, if the property is set. If the property is not set, the empty authorization name is sent. You need not implement a callback.

In the server, this mechanism will request the `GSASL_VALIDATE_EXTERNAL` callback property to decide whether the client is authenticated and authorized to log in. Your callback can retrieve the `GSASL_AUTHZID` property to inspect the requested authorization name from the client.

### 5.2 The ANONYMOUS mechanism

The ANONYMOUS mechanism is used to “authenticate” clients to anonymous services; or rather, just indicate that the client wishes to use the service anonymously. The client sends a token, usually her email address, which serve the purpose of some trace information suitable for log files. The token is not permitted to be empty.

In the client, this mechanism is always enabled, and will send the `GSASL_ANONYMOUS_TOKEN` property as the trace information to the server.

In the server, this mechanism will invoke the `GSASL_VALIDATE_ANONYMOUS` callback to decide whether the client should be permitted to log in. Your callback can retrieve the `GSASL_ANONYMOUS_TOKEN` property to, for example, save it in a log file. The token is normally not used to decide whether the client should be permitted to log in or not.

### 5.3 The PLAIN mechanism

The PLAIN mechanism uses username and password to authenticate users. Two user names are relevant. The first, the authentication identity, indicates the credential holder, i.e., whom the provided password belongs to. The second, the authorization identity, is typically empty, to indicate that the user requests to log on to the server as herself. However, if the authorization identity is not empty, the server should decide whether the authenticated user may log on as the authorization identity. Normally, only “super-user” accounts such as ‘admin’ or similar should be allowed this.

In the client, this mechanism is always enabled, and require the `GSASL_AUTHID` and `GSASL_PASSWORD` properties. If set, `GSASL_AUTHZID` will also be used.

In the server, the mechanism is always enabled. Two approaches to authenticate and authorize the client are provided.

In the first approach, the server side of the mechanism will request the `GSASL_VALIDATE_SIMPLE` callback property to decide whether the client should be accepted or not. The callback may inspect the `GSASL_AUTHID`, `GSASL_AUTHZID`, and `GSASL_PASSWORD` properties. These property values will be normalized.

If the first approach fails (because, e.g., your callback returns ‘`GSASL_NO_CALLBACK`’ to signal that it does not implement `GSASL_VALIDATE_SIMPLE`) the mechanism will continue to query the application for a password, via the `GSASL_PASSWORD` property. Your callback may use the `GSASL_AUTHID` and `GSASL_AUTHZID` properties to select the proper password. The password is then normalized and compared to the client credential.

Which approach to use? If your database stores hashed passwords, you have no option, but must use the first approach. If passwords in your user database are stored in prepared (SASLprep) form, the first approach will be faster. If you do not have prepared passwords available, you can use the second approach to make sure the password is prepared properly before comparison.

### 5.4 The LOGIN mechanism

The LOGIN mechanism is a non-standard mechanism, and is similar to the PLAIN mechanism except that LOGIN lacks the support for authorization identities. Always use PLAIN instead of LOGIN in new applications.

The callback behaviour is the same as for PLAIN, except that `GSASL_AUTHZID` is neither used nor required, and that the server does not normalize the password using SASLprep.

See [Section A.2 \[Use of SASLprep in LOGIN\]](#), [page 63](#), for a proposed clarification of the interpretation of a hypothetical LOGIN specification.

### 5.5 The CRAM-MD5 mechanism

The CRAM-MD5 is a widely used, but officially deprecated (apparently in favor of DIGEST-MD5), challenge-response mechanism that transfers hashed passwords instead of clear text passwords. For insecure channels (e.g., when TLS is not used), it is safer than PLAIN. The CRAM-MD5 mechanism does not support authorization identities; making the relationship between CRAM-MD5 and DIGEST-MD5 similar to the relationship between LOGIN and PLAIN.

The disadvantage with hashed passwords is that the server cannot use normal authentication infrastructures such as PAM, because the server must have access to the correct password in order to validate an authentication attempt.

In the client, this mechanism is always enabled, and it requires the `GSASL_AUTHID` and `GSASL_PASSWORD` properties.

In the server, the mechanism will require the `GSASL_PASSWORD` callback property, which may use the `GSASL_AUTHID` property to determine which users' password should be used. The `GSASL_AUTHID` will be in normalized form. The server will then normalize the returned password, and compare the client response with the computed correct response, and accept the user accordingly.

See [Section A.1 \[Use of SASLprep in CRAM-MD5\]](#), page 63, for a clarification on the interpretation of the CRAM-MD5 specification that this implementation rely on.

## 5.6 The DIGEST-MD5 mechanism

The DIGEST-MD5 mechanism is based on repeated hashing using MD5, which after the MD5 break may be argued to be weaker than HMAC-MD5, but supports more features. For example, authorization identities and data integrity and privacy protection are supported. Like CRAM-MD5, only a hashed password is transferred. Consequently, DIGEST-MD5 needs access to the correct password (although it may be hashed, another improvement compared to CRAM-MD5) to verify the client response. Alas, this makes it impossible to use, e.g., PAM on the server side.

In the client, this mechanism is always enabled, and it requires the `GSASL_AUTHID`, `GSASL_PASSWORD`, `GSASL_SERVICE`, and `GSASL_HOSTNAME` properties. If set, `GSASL_AUTHZID` and `GSASL_REALM` will also be used.

In the server, the mechanism will first request the `GSASL_DIGEST_MD5_HASHED_PASSWORD` callback property to get the user's hashed password. If the callback doesn't supply a hashed password, the `GSASL_PASSWORD` callback property will be requested. Both callbacks may use the `GSASL_AUTHID`, `GSASL_AUTHZID` and `GSASL_REALM` properties to determine which users' password should be used. The server will then compare the client response with a computed correct response, and accept the user accordingly.

The server uses the `GSASL_QOPS` callback to get the set of quality of protection values to use. By default, it advertises support for authentication (`qop-auth`) only. You can use the callback, for example, to make the server advertise support for authentication with integrity layers.

The client uses the `GSASL_QOP` callback to get the quality of protection value to request. The client must choose one of the QOP values offered by the server (which may be inspected through the `GSASL_QOPS` property). If the client does not return a value, `qop-auth` is used by default.

## 5.7 The SCRAM-SHA-1 mechanism

The SCRAM-SHA-1 mechanism is designed to provide (almost) the same capabilities as CRAM-MD5 and DIGEST-MD5 but use modern cryptographic techniques such as HMAC-SHA-1 and PKCS#5 PBKDF2. SCRAM-SHA-1 supports authorization identities. Like

CRAM-MD5 and DIGEST-MD5, only a hashed password is transferred. Consequently, SCRAM-SHA-1 needs access to the correct password to verify the client response.

In the client, this mechanism is always enabled, and it requires the `GSASL_AUTHID` property, and either `GSASL_PASSWORD` or `GSASL_SCRAM_SALTED_PASSWORD`. If set, `GSASL_AUTHZID` will be used by the client. To be able to return the proper `GSASL_SCRAM_SALTED_PASSWORD` value, the client needs to check the `GSASL_SCRAM_ITER` and `GSASL_SCRAM_SALT` values which are available when the `GSASL_SCRAM_SALTED_PASSWORD` property is queried for.

In the server, the mechanism will require the `GSASL_PASSWORD` callback property, which may use the `GSASL_AUTHID` property to determine which users' password should be used. The `GSASL_AUTHID` will be in normalized form. The server will then normalize the returned password, and compare the client response with the computed correct response, and accept the user accordingly. The server may also set the `GSASL_SCRAM_ITER` and `GSASL_SCRAM_SALT` properties to influence the values to be used by clients to derive a key from a password.

Currently channel bindings are not supported, so there is no support for SCRAM-SHA-1-PLUS.

## 5.8 The NTLM mechanism

The NTLM is a non-standard mechanism. Do not use it in new applications, and do not expect it to be secure. Currently only the client side is supported.

In the client, this mechanism is always enabled, and it requires the `GSASL_AUTHID` and `GSASL_PASSWORD` properties. It will set the 'domain' field in the NTLM request to the value of `GSASL_REALM`. Some servers reportedly need non-empty but arbitrary values in that field.

## 5.9 The SECURID mechanism

The SECURID mechanism uses authentication and authorization identity together with a passcode from a hardware token to authenticate users.

In the client, this mechanism is always enabled, and it requires the `GSASL_AUTHID` and `GSASL_PASSCODE` properties. If set, `GSASL_AUTHZID` will also be used. If the server requests it, the `GSASL_PIN` property is also required, and its callback may inspect the `GSASL_SUGGESTED_PIN` property to discover a server-provided PIN to use.

In the server, this mechanism will invoke the `GSASL_VALIDATE_SECURID` callback. The callback may inspect the `GSASL_AUTHID`, `GSASL_AUTHZID`, and `GSASL_PASSCODE` properties. The callback can return `GSASL_SECURID_SERVER_NEED_ADDITIONAL_PASSCODE` to ask for another additional passcode from the client. The callback can return `GSASL_SECURID_SERVER_NEED_NEW_PIN` to ask for a new PIN code from the client, in which case it may also set the `GSASL_SUGGESTED_PIN` property to indicate a recommended new PIN. If the callback is invoked again, after having returned `GSASL_SECURID_SERVER_NEED_NEW_PIN`, it may also inspect the `GSASL_PIN` property, in addition to the other properties, to find out the client selected PIN code.



## 5.10 The GSSAPI mechanism

GSS-API is a framework, similar to SASL, for authentication. The GSSAPI mechanism only supports the Kerberos 5 GSS-API mechanism, though. (A new SASL mechanism to support non-Kerberos 5 GSS-API mechanisms may be supported in the future.)

In the client, the mechanism is enabled only if the user has acquired credentials (i.e., a ticket granting ticket), and it requires the `GSASL_AUTHID`, `GSASL_SERVICE`, and `GSASL_HOSTNAME` properties.

In the server, the mechanism requires the `GSASL_SERVICE` and `GSASL_HOSTNAME` properties, and it will invoke the `GSASL_VALIDATE_GSSAPI` callback property in order to validate the user. The callback may inspect the `GSASL_AUTHZID` and `GSASL_GSSAPI_DISPLAY_NAME` properties to decide whether to authorize the user. Note that authentication is performed by the GSS-API library.

XXX: explain more about quality of service, maximum buffer size, etc.

## 5.11 The KERBEROS\_V5 mechanism

The `KERBEROS_V5` is an experimental mechanism, the protocol specification is available on the GNU SASL homepage. It can operate in three modes, non-infrastructure mode, infrastructure mode and proxied infrastructure mode. Currently only non-infrastructure mode is supported.

In the non-infrastructure mode, it works as a superset of most features provided by `PLAIN`, `CRAM-MD5`, `DIGEST-MD5` and `GSSAPI` while at the same time building on what is believed to be proven technology (the RFC 1510 network security system). In the non-infrastructure mode, the client must specify (via callbacks) the name of the user, and optionally the server name and realm. The server must be able to retrieve passwords given the name of the user.

In the infrastructure mode (proxied or otherwise), it allows clients and servers to authenticate via SASL in an RFC 1510 environment, using a trusted third party, a “Key Distribution Central”. In the normal mode, clients acquire tickets out of band and then invokes a one roundtrip `AP-REQ` and `AP-REP` exchange. In the proxied mode, which can be used by clients without IP addresses or without connectivity to the KDC (e.g., when the KDC is IPv4 and the client is IPV6-only), the client uses the server to proxy ticket requests and finishes with the `AP-REQ/AP-REP` exchange. In infrastructure mode (proxied or otherwise), neither the client nor server need to implement any callbacks (this will likely change later, to allow a server to authorize users, similar to the GSSAPI callback).

XXX: update when implementation has matured



## 6 Global Functions

### gsasl\_init

**int** gsasl\_init (*Gsasl \*\* ctx*) [Function]

*ctx*: pointer to libgsasl handle.

This function initializes libgsasl. The handle pointed to by *ctx* is valid for use with other libgsasl functions iff this function is successful. It also registers all builtin SASL mechanisms, using `gsasl_register()`.

**Return value:** GSASL\_OK iff successful, otherwise GSASL\_MALLOC\_ERROR.

### gsasl\_done

**void** gsasl\_done (*Gsasl \* ctx*) [Function]

*ctx*: libgsasl handle.

This function destroys a libgsasl handle. The handle must not be used with other libgsasl functions after this call.

### gsasl\_client\_mechlist

**int** gsasl\_client\_mechlist (*Gsasl \* ctx*, *char \*\* out*) [Function]

*ctx*: libgsasl handle.

*out*: newly allocated output character array.

Return a newly allocated string containing SASL names, separated by space, of mechanisms supported by the libgsasl client. *out* is allocated by this function, and it is the responsibility of caller to deallocate it.

**Return value:** Returns GSASL\_OK if successful, or error code.

### gsasl\_server\_mechlist

**int** gsasl\_server\_mechlist (*Gsasl \* ctx*, *char \*\* out*) [Function]

*ctx*: libgsasl handle.

*out*: newly allocated output character array.

Return a newly allocated string containing SASL names, separated by space, of mechanisms supported by the libgsasl server. *out* is allocated by this function, and it is the responsibility of caller to deallocate it.

**Return value:** Returns GSASL\_OK if successful, or error code.

### gsasl\_client\_support\_p

**int** gsasl\_client\_support\_p (*Gsasl \* ctx*, *const char \* name*) [Function]

*ctx*: libgsasl handle.

*name*: name of SASL mechanism.

Decide whether there is client-side support for a specified mechanism.

**Return value:** Returns 1 if the libgsasl client supports the named mechanism, otherwise 0.

### gsasl\_server\_support\_p

**int** gsasl\_server\_support\_p (*Gsasl* \* *ctx*, *const char* \* *name*) [Function]

*ctx*: libgsasl handle.

*name*: name of SASL mechanism.

Decide whether there is server-side support for a specified mechanism.

**Return value:** Returns 1 if the libgsasl server supports the named mechanism, otherwise 0.

### gsasl\_client\_suggest\_mechanism

**const char \*** gsasl\_client\_suggest\_mechanism (*Gsasl* \* *ctx*, [Function]  
*const char* \* *mechlist*)

*ctx*: libgsasl handle.

*mechlist*: input character array with SASL mechanism names, separated by invalid characters (e.g. SPC).

Given a list of mechanisms, suggest which to use.

**Return value:** Returns name of "best" SASL mechanism supported by the libgsasl client which is present in the input string, or NULL if no supported mechanism is found.

### gsasl\_register

**int** gsasl\_register (*Gsasl* \* *ctx*, *const Gsasl\_mechanism* \* *mech*) [Function]

*ctx*: pointer to libgsasl handle.

*mech*: plugin structure with information about plugin.

This function initialize given mechanism, and if successful, add it to the list of plugins that is used by the library.

**Return value:** GSASL\_OK iff successful, otherwise GSASL\_MALLOC\_ERROR.

**Since:** 0.2.0

## 7 Callback Functions

The callback is used by mechanisms to retrieve information, such as username and password, from the application. In a server, the callback is used to decide whether a user is permitted to log in or not. You tell the library of your callback function by calling `gsasl_callback_set`.

Since your callback may need access to data from other parts of your application, there are hooks to store and retrieve application specific pointers. This avoids the use of global variables, which wouldn't be thread safe. You store a pointer to some information (opaque from the point of view of the library) by calling `gsasl_callback_hook_set` and can later retrieve this data in your callback by calling `gsasl_callback_hook_get`.

### `gsasl_callback_set`

**void** `gsasl_callback_set` (*Gsasl \* ctx*, *Gsasl\_callback\_function cb*) [Function]

*ctx*: handle received from `gsasl_init()`.

*cb*: pointer to function implemented by application.

Store the pointer to the application provided callback in the library handle. The callback will be used, via `gsasl_callback()`, by mechanisms to discover various parameters (such as username and passwords). The callback function will be called with a `Gsasl_property` value indicating the requested behaviour. For example, for `GSASL_ANONYMOUS_TOKEN`, the function is expected to invoke `gsasl_property_set(CTX, GSASL_ANONYMOUS_TOKEN, "token")` where "token" is the anonymous token the application wishes the SASL mechanism to use. See the manual for the meaning of all parameters.

**Since:** 0.2.0

### `gsasl_callback`

**int** `gsasl_callback` (*Gsasl \* ctx*, *Gsasl\_session \* sctx*, *Gsasl\_property prop*) [Function]

*ctx*: handle received from `gsasl_init()`, may be NULL to derive it from *sctx*.

*sctx*: session handle.

*prop*: enumerated value of `Gsasl_property` type.

Invoke the application callback. The *prop* value indicate what the callback is expected to do. For example, for `GSASL_ANONYMOUS_TOKEN`, the function is expected to invoke `gsasl_property_set(SCTX, GSASL_ANONYMOUS_TOKEN, "token")` where "token" is the anonymous token the application wishes the SASL mechanism to use. See the manual for the meaning of all parameters.

Note that if no callback has been set by the application, but the obsolete callback interface has been used, this function will translate the old callback interface into the new. This interface should be sufficient to invoke all callbacks, both new and old.

**Return value:** Returns whatever the application callback return, or `GSASL_NO_CALLBACK` if no application was known.

**Since:** 0.2.0

### **gsasl\_callback\_hook\_set**

**void gsasl\_callback\_hook\_set** (*Gsasl \* ctx*, *void \* hook*) [Function]

*ctx*: libgsasl handle.

*hook*: opaque pointer to application specific data.

Store application specific data in the libgsasl handle.

The application data can be later (for instance, inside a callback) be retrieved by calling **gsasl\_callback\_hook\_get()**. This is normally used by the application to maintain a global state between the main program and callbacks.

**Since:** 0.2.0

### **gsasl\_callback\_hook\_get**

**void \* gsasl\_callback\_hook\_get** (*Gsasl \* ctx*) [Function]

*ctx*: libgsasl handle.

Retrieve application specific data from libgsasl handle.

The application data is set using **gsasl\_callback\_hook\_set()**. This is normally used by the application to maintain a global state between the main program and callbacks.

**Return value:** Returns the application specific data, or NULL.

**Since:** 0.2.0

### **gsasl\_session\_hook\_set**

**void gsasl\_session\_hook\_set** (*Gsasl\_session \* sctx*, *void \* hook*) [Function]

*sctx*: libgsasl session handle.

*hook*: opaque pointer to application specific data.

Store application specific data in the libgsasl session handle.

The application data can be later (for instance, inside a callback) be retrieved by calling **gsasl\_session\_hook\_get()**. This is normally used by the application to maintain a per-session state between the main program and callbacks.

**Since:** 0.2.14

### **gsasl\_session\_hook\_get**

**void \* gsasl\_session\_hook\_get** (*Gsasl\_session \* sctx*) [Function]

*sctx*: libgsasl session handle.

Retrieve application specific data from libgsasl session handle.

The application data is set using **gsasl\_callback\_hook\_set()**. This is normally used by the application to maintain a per-session state between the main program and callbacks.

**Return value:** Returns the application specific data, or NULL.

**Since:** 0.2.14

## 8 Property Functions

### gsasl\_property\_set

**void gsasl\_property\_set** (*Gsasl\_session* \* *sctx*, *Gsasl\_property* *prop*, *const char* \* *data*) [Function]

*sctx*: session handle.

*prop*: enumerated value of *Gsasl\_property* type, indicating the type of data in *data*.

*data*: zero terminated character string to store.

Make a copy of *data* and store it in the session handle for the indicated property *prop*.

You can immediately deallocate *data* after calling this function, without affecting the data stored in the session handle.

**Since:** 0.2.0

### gsasl\_property\_set\_raw

**void gsasl\_property\_set\_raw** (*Gsasl\_session* \* *sctx*, *Gsasl\_property* *prop*, *const char* \* *data*, *size\_t* *len*) [Function]

*sctx*: session handle.

*prop*: enumerated value of *Gsasl\_property* type, indicating the type of data in *data*.

*data*: character string to store.

*len*: length of character string to store.

Make a copy of *len* sized *data* and store a zero terminated version of it in the session handle for the indicated property *prop*.

You can immediately deallocate *data* after calling this function, without affecting the data stored in the session handle.

Except for the length indicator, this function is identical to *gsasl\_property\_set*.

**Since:** 0.2.0

### gsasl\_property\_fast

**const char \*** *gsasl\_property\_fast* (*Gsasl\_session* \* *sctx*, *Gsasl\_property* *prop*) [Function]

*sctx*: session handle.

*prop*: enumerated value of *Gsasl\_property* type, indicating the type of data in *data*.

Retrieve the data stored in the session handle for given property *prop*.

The pointer is to live data, and must not be deallocated or modified in any way.

This function will not invoke the application callback.

**Return value:** Return property value, if known, or NULL if no value known.

**Since:** 0.2.0

## gsasl\_property\_get

`const char * gsasl_property_get (Gsasl_session * sctx, [Function]  
                                  Gsasl_property prop)`

*sctx*: session handle.

*prop*: enumerated value of Gsasl\_property type, indicating the type of data in **data**.

Retrieve the data stored in the session handle for given property **prop**, possibly invoking the application callback to get the value.

The pointer is to live data, and must not be deallocated or modified in any way.

This function will invoke the application callback, using `gsasl_callback()`, when a property value is not known.

If no value is known, and no callback is specified or if the callback fail to return data, and if any obsolete callback functions has been set by the application, this function will try to call these obsolete callbacks, and store the returned data as the corresponding property. This behaviour of this function will be removed when the obsolete callback interfaces are removed.

**Return value:** Return data for property, or NULL if no value known.

**Since:** 0.2.0

## 9 Session Functions

### gsasl\_client\_start

```
int gsasl_client_start (Gsasl * ctx, const char * mech,           [Function]
                      Gsasl_session ** sctx)
```

*ctx*: libgsasl handle.

*mech*: name of SASL mechanism.

*sctx*: pointer to client handle.

This functions initiates a client SASL authentication. This function must be called before any other `gsasl_client_*`() function is called.

**Return value:** Returns GSASL\_OK if successful, or error code.

### gsasl\_server\_start

```
int gsasl_server_start (Gsasl * ctx, const char * mech,         [Function]
                      Gsasl_session ** sctx)
```

*ctx*: libgsasl handle.

*mech*: name of SASL mechanism.

*sctx*: pointer to server handle.

This functions initiates a server SASL authentication. This function must be called before any other `gsasl_server_*`() function is called.

**Return value:** Returns GSASL\_OK if successful, or error code.

### gsasl\_step

```
int gsasl_step (Gsasl_session * sctx, const char * input, size_t  [Function]
               input_len, char ** output, size_t * output_len)
```

*sctx*: libgsasl session handle.

*input*: input byte array.

*input\_len*: size of input byte array.

*output*: newly allocated output byte array.

*output\_len*: pointer to output variable with size of output byte array.

Perform one step of SASL authentication. This reads data from the other end (from `input` and `input_len`), processes it (potentially invoking callbacks to the application), and writes data to server (into newly allocated variable `output` and `output_len` that indicate the length of `output`).

The contents of the `output` buffer is unspecified if this functions returns anything other than GSASL\_OK or GSASL\_NEEDS\_MORE. If this function return GSASL\_OK or GSASL\_NEEDS\_MORE, however, the `output` buffer is allocated by this function, and it is the responsibility of caller to deallocate it by calling `free (output)`.

**Return value:** Returns GSASL\_OK if authenticated terminated successfully, GSASL\_NEEDS\_MORE if more data is needed, or error code.

## gsasl\_step64

```
int gsasl_step64 (Gsasl_session * sctx, const char * b64input, char ** b64output) [Function]
```

*sctx*: libgsasl client handle.

*b64input*: input base64 encoded byte array.

*b64output*: newly allocated output base64 encoded byte array.

This is a simple wrapper around `gsasl_step()` that base64 decodes the input and base64 encodes the output.

The contents of the `b64output` buffer is unspecified if this functions returns anything other than `GSASL_OK` or `GSASL_NEEDS_MORE`. If this function return `GSASL_OK` or `GSASL_NEEDS_MORE`, however, the `b64output` buffer is allocated by this function, and it is the responsibility of caller to deallocate it by calling `free(b64output)`.

**Return value:** Returns `GSASL_OK` if authenticated terminated successfully, `GSASL_NEEDS_MORE` if more data is needed, or error code.

## gsasl\_finish

```
void gsasl_finish (Gsasl_session * sctx) [Function]
```

*sctx*: libgsasl session handle.

Destroy a libgsasl client or server handle. The handle must not be used with other libgsasl functions after this call.

## gsasl\_encode

```
int gsasl_encode (Gsasl_session * sctx, const char * input, size_t input_len, char ** output, size_t * output_len) [Function]
```

*sctx*: libgsasl session handle.

*input*: input byte array.

*input\_len*: size of input byte array.

*output*: newly allocated output byte array.

*output\_len*: size of output byte array.

Encode data according to negotiated SASL mechanism. This might mean that data is integrity or privacy protected.

The `output` buffer is allocated by this function, and it is the responsibility of caller to deallocate it by calling `free(output)`.

**Return value:** Returns `GSASL_OK` if encoding was successful, otherwise an error code.

## gsasl\_decode

```
int gsasl_decode (Gsasl_session * sctx, const char * input, size_t input_len, char ** output, size_t * output_len) [Function]
```

*sctx*: libgsasl session handle.

*input*: input byte array.

*input\_len*: size of input byte array.



*output*: newly allocated output byte array.

*output\_len*: size of output byte array.

Decode data according to negotiated SASL mechanism. This might mean that data is integrity or privacy protected.

The *output* buffer is allocated by this function, and it is the responsibility of caller to deallocate it by calling `free(output)`.

**Return value:** Returns `GSASL_OK` if encoding was successful, otherwise an error code.

## **gsasl\_mechanism\_name**

`const char * gsasl_mechanism_name (Gsasl_session * sctx)` [Function]

*sctx*: libgsasl session handle.

This function returns the name of the SASL mechanism used in the session.

**Return value:** Returns a zero terminated character array with the name of the SASL mechanism, or `NULL` if not known.

**Since:** 0.2.28

## 10 Utilities

### gsasl\_saslprep

**int** **gsasl\_saslprep** (*const char \* in*, *Gsasl\_saslprep\_flags flags*, *char \*\* out*, *int \* stringprepc*) [Function]

*in*: a UTF-8 encoded string.

*flags*: any SASLprep flag, e.g., GSASL\_ALLOW\_UNASSIGNED.

*out*: on exit, contains newly allocated output string.

*stringprepc*: if non-NULL, will hold precise stringprep return code.

Prepare string using SASLprep. On success, the *out* variable must be deallocated by the caller.

**Return value:** Returns GSASL\_OK on success, or GSASL\_SASLPREP\_ERROR on error.

**Since:** 0.2.3

### gsasl\_base64\_to

**int** **gsasl\_base64\_to** (*const char \* in*, *size\_t inlen*, *char \*\* out*, *size\_t \* outlen*) [Function]

*in*: input byte array

*inlen*: size of input byte array

*out*: pointer to newly allocated output byte array

*outlen*: pointer to size of newly allocated output byte array

Encode data as base64. The string is zero terminated, and *outlen* holds the length excluding the terminating zero. The *out* buffer must be deallocated by the caller.

**Return value:** Returns GSASL\_OK on success, or GSASL\_MALLOC\_ERROR if input was too large or memory allocation fail.

**Since:** 0.2.2

### gsasl\_base64\_from

**int** **gsasl\_base64\_from** (*const char \* in*, *size\_t inlen*, *char \*\* out*, *size\_t \* outlen*) [Function]

*in*: input byte array

*inlen*: size of input byte array

*out*: pointer to newly allocated output byte array

*outlen*: pointer to size of newly allocated output byte array

Decode Base64 data. The *out* buffer must be deallocated by the caller.

**Return value:** Returns GSASL\_OK on success, GSASL\_BASE64\_ERROR if input was invalid, and GSASL\_MALLOC\_ERROR on memory allocation errors.

**Since:** 0.2.2

## gsasl\_simple\_getpass

```
int gsasl_simple_getpass (const char * filename, const char * username, char ** key)
```

[Function]

*filename*: filename of file containing passwords.

*username*: username string.

*key*: newly allocated output character array.

Retrieve password for user from specified file. The buffer *key* contain the password if this function is successful. The caller is responsible for deallocating it.

The file should be on the UoW "MD5 Based Authentication" format, which means it is in text format with comments denoted by # first on the line, with user entries looking as "usernameTABpassword". This function removes CR and LF at the end of lines before processing. TAB, CR, and LF denote ASCII values 9, 13, and 10, respectively.

**Return value:** Return GSASL\_OK if output buffer contains the password, GSASL\_AUTHENTICATION\_ERROR if the user could not be found, or other error code.

## gsasl\_nonce

```
int gsasl_nonce (char * data, size_t datalen)
```

[Function]

*data*: output array to be filled with unpredictable random data.

*datalen*: size of output array.

Store unpredictable data of given size in the provided buffer.

**Return value:** Returns GSASL\_OK iff successful.

## gsasl\_random

```
int gsasl_random (char * data, size_t datalen)
```

[Function]

*data*: output array to be filled with strong random data.

*datalen*: size of output array.

Store cryptographically strong random data of given size in the provided buffer.

**Return value:** Returns GSASL\_OK iff successful.

## gsasl\_md5

```
int gsasl_md5 (const char * in, size_t inlen, char * out[16])
```

[Function]

*in*: input character array of data to hash.

*inlen*: length of input character array of data to hash.

Compute hash of data using MD5. The *out* buffer must be deallocated by the caller.

**Return value:** Returns GSASL\_OK iff successful.

### gsasl\_hmac\_md5

`int gsasl_hmac_md5 (const char * key, size_t keylen, const char * in, [Function]  
size_t inlen, char * outhash[16])`

*key*: input character array with key to use.

*keylen*: length of input character array with key to use.

*in*: input character array of data to hash.

*inlen*: length of input character array of data to hash.

Compute keyed checksum of data using HMAC-MD5. The *outhash* buffer must be deallocated by the caller.

**Return value:** Returns GSASL\_OK iff successful.

### gsasl\_sha1

`int gsasl_sha1 (const char * in, size_t inlen, char * out[20]) [Function]`

*in*: input character array of data to hash.

*inlen*: length of input character array of data to hash.

Compute hash of data using SHA1. The *out* buffer must be deallocated by the caller.

**Return value:** Returns GSASL\_OK iff successful.

**Since:** 1.3

### gsasl\_hmac\_sha1

`int gsasl_hmac_sha1 (const char * key, size_t keylen, const char * [Function]  
in, size_t inlen, char * outhash[20])`

*key*: input character array with key to use.

*keylen*: length of input character array with key to use.

*in*: input character array of data to hash.

*inlen*: length of input character array of data to hash.

Compute keyed checksum of data using HMAC-SHA1. The *outhash* buffer must be deallocated by the caller.

**Return value:** Returns GSASL\_OK iff successful.

**Since:** 1.3

## 11 Memory Handling

### gsasl\_free

`void gsasl_free (void * ptr)` [Function]  
*ptr*: memory pointer

Invoke `free(ptr)` to de-allocate memory pointer. Typically used on strings allocated by other libgsasl functions.

This is useful on Windows where libgsasl is linked to one CRT and the application is linked to another CRT. Then `malloc/free` will not use the same heap. This happens if you build libgsasl using mingw32 and the application with Visual Studio.

**Since:** 0.2.19

## 12 Error Handling

Most functions in the GNU SASL Library return an error if they fail. For this reason, the application should always catch the error condition and take appropriate measures, for example by releasing the resources and passing the error up to the caller, or by displaying a descriptive message to the user and cancelling the operation.

Some error values do not indicate a system error or an error in the operation, but the result of an operation that failed properly.

### 12.1 Error values

Errors are returned as `int` values.

The value of the symbol `GSASL_OK` is guaranteed to always be 0, and all other error codes are guaranteed to be non-0, so you may use that information to build boolean expressions involving return codes. Otherwise, an application should not depend on the particular value for error codes, and are encouraged to use the constants even for `GSASL_OK` to improve readability. Possible values are:

`GSASL_OK`    Libgsasl success

`GSASL_NEEDS_MORE`  
SASL mechanism needs more data

`GSASL_UNKNOWN_MECHANISM`  
Unknown SASL mechanism

`GSASL_MECHANISM_CALLED_TOO_MANY_TIMES`  
SASL mechanism called too many times

`GSASL_TOO_SMALL_BUFFER`  
SASL function needs larger buffer (internal error)

`GSASL_FOPEN_ERROR`  
Could not open file in SASL library

`GSASL_FCLOSE_ERROR`  
Could not close file in SASL library

`GSASL_MALLOC_ERROR`  
Memory allocation error in SASL library

`GSASL_BASE64_ERROR`  
Base 64 coding error in SASL library

`GSASL_CRYPTO_ERROR`  
Low-level crypto error in SASL library

`GSASL_NEED_CLIENT_ANONYMOUS_CALLBACK`  
SASL mechanism needs `gsasl_client_callback_anonymous()` callback (application error)

`GSASL_NEED_CLIENT_PASSWORD_CALLBACK`  
SASL mechanism needs `gsasl_client_callback_password()` callback (application error)

**GSASL\_NEED\_CLIENT\_PASSCODE\_CALLBACK**  
SASL mechanism needs `gsasl_client_callback_passcode()` callback (application error)

**GSASL\_NEED\_CLIENT\_PIN\_CALLBACK**  
SASL mechanism needs `gsasl_client_callback_pin()` callback (application error)

**GSASL\_NEED\_CLIENT\_AUTHORIZATION\_ID\_CALLBACK**  
SASL mechanism needs `gsasl_client_callback_authorization_id()` callback (application error)

**GSASL\_NEED\_CLIENT\_AUTHENTICATION\_ID\_CALLBACK**  
SASL mechanism needs `gsasl_client_callback_authentication_id()` callback (application error)

**GSASL\_NEED\_CLIENT\_SERVICE\_CALLBACK**  
SASL mechanism needs `gsasl_client_callback_service()` callback (application error)

**GSASL\_NEED\_SERVER\_VALIDATE\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_validate()` callback (application error)

**GSASL\_NEED\_SERVER\_CRAM\_MD5\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_cram_md5()` callback (application error)

**GSASL\_NEED\_SERVER\_DIGEST\_MD5\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_digest_md5()` callback (application error)

**GSASL\_NEED\_SERVER\_EXTERNAL\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_external()` callback (application error)

**GSASL\_NEED\_SERVER\_ANONYMOUS\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_anonymous()` callback (application error)

**GSASL\_NEED\_SERVER\_REALM\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_realm()` callback (application error)

**GSASL\_NEED\_SERVER\_SECURID\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_securid()` callback (application error)

**GSASL\_NEED\_SERVER\_SERVICE\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_service()` callback (application error)

**GSASL\_NEED\_SERVER\_GSSAPI\_CALLBACK**  
SASL mechanism needs `gsasl_server_callback_gssapi()` callback (application error)

|                                       |   |
|---------------------------------------|---|
| GSASL_NEED_SERVER_RETRIEVE_CALLBACK   | SASL mechanism needs <code>gsasl_server_callback_retrieve()</code> callback (application error)   |
| GSASL_UNICODE_NORMALIZATION_ERROR     | Failed to perform Unicode Normalization on string.  |
| GSASL_SASLPREP_ERROR                  | Could not prepare internationalized (non-ASCII) string.   |
| GSASL_MECHANISM_PARSE_ERROR           | SASL mechanism could not parse input  |
| GSASL_AUTHENTICATION_ERROR            | Error authenticating user   |
| GSASL_CANNOT_GET_CTX                  | Cannot get internal library handle (library error)  |
| GSASL_INTEGRITY_ERROR                 | Integrity error in application payload  |
| GSASL_NO_MORE_REALMS                  | No more realms available (non-fatal)  |
| GSASL_NO_CLIENT_CODE                  | Client-side functionality not available in library (application error)  |
| GSASL_NO_SERVER_CODE                  | Server-side functionality not available in library (application error)  |
| GSASL_GSSAPI_RELEASE_BUFFER_ERROR     | GSSAPI library could not deallocate memory in <code>gss_release_buffer()</code> in SASL library. This is a serious internal error.  |
| GSASL_GSSAPI_IMPORT_NAME_ERROR        | GSSAPI library could not understand a peer name in <code>gss_import_name()</code> in SASL library. This is most likely due to incorrect service and/or hostnames.                             |
| GSASL_GSSAPI_INIT_SEC_CONTEXT_ERROR   | GSSAPI error in client while negotiating security context in <code>gss_init_sec_context()</code> in SASL library. This is most likely due insufficient credentials or malicious interactions. |
| GSASL_GSSAPI_ACCEPT_SEC_CONTEXT_ERROR | GSSAPI error in server while negotiating security context in <code>gss_init_sec_context()</code> in SASL library. This is most likely due insufficient credentials or malicious interactions. |
| GSASL_GSSAPI_UNWRAP_ERROR             | GSSAPI error while decrypting or decoding data in <code>gss_unwrap()</code> in SASL library. This is most likely due to data corruption.  |
| GSASL_GSSAPI_WRAP_ERROR               | GSSAPI error while encrypting or encoding data in <code>gss_wrap()</code> in SASL library.  |



**GSASL\_GSSAPI\_ACQUIRE\_CRED\_ERROR**

GSSAPI error acquiring credentials in `gss_acquire_cred()` in SASL library. This is most likely due to not having the proper Kerberos key available in `/etc/krb5.keytab` on the server.

**GSASL\_GSSAPI\_DISPLAY\_NAME\_ERROR**

GSSAPI error creating a display name denoting the client in `gss_display_name()` in SASL library. This is probably because the client supplied bad data.

**GSASL\_GSSAPI\_UNSUPPORTED\_PROTECTION\_ERROR**

Other entity requested integrity or confidentiality protection in GSSAPI mechanism but this is currently not implemented.

**GSASL\_KERBEROS\_V5\_INIT\_ERROR**

Kerberos V5 initialization failure.

**GSASL\_KERBEROS\_V5\_INTERNAL\_ERROR**

Kerberos V5 internal error.

**GSASL\_SECURID\_SERVER\_NEED\_ADDITIONAL\_PASSCODE**

SecurID needs additional passcode.

**GSASL\_SECURID\_SERVER\_NEED\_NEW\_PIN**

SecurID needs new pin.

**GSASL\_INVALID\_HANDLE**

The provided library handle was invalid (application error)

**GSASL\_NO\_CALLBACK**

No callback specified by caller (application error).

**GSASL\_NO\_ANONYMOUS\_TOKEN**

Authentication failed because the anonymous token was not provided.

**GSASL\_NO\_AUTHID**

Authentication failed because the authentication identity was not provided.

**GSASL\_NO\_AUTHZID**

Authentication failed because the authorization identity was not provided.

**GSASL\_NO\_PASSWORD**

Authentication failed because the password was not provided.

**GSASL\_NO\_PASSCODE**

Authentication failed because the passcode was not provided.

**GSASL\_NO\_PIN**

Authentication failed because the pin code was not provided.

**GSASL\_NO\_SERVICE**

Authentication failed because the service name was not provided.

**GSASL\_NO\_HOSTNAME**

Authentication failed because the host name was not provided.

## 12.2 Error strings

### `gsasl_strerror`

`const char * gsasl_strerror (int err)` [Function]

*err*: libgsasl error code

Convert return code to human readable string explanation of the reason for the particular error code.

This string can be used to output a diagnostic message to the user.

This function is one of few in the library that can be used without a successful call to `gsasl_init()`.

**Return value:** Returns a pointer to a statically allocated string containing an explanation of the error code *err*.

### `gsasl_strerror_name`

`const char * gsasl_strerror_name (int err)` [Function]

*err*: libgsasl error code

Convert return code to human readable string representing the error code symbol itself. For example, `gsasl_strerror_name(GSASL_OK)` returns the string "GSASL\_OK".

This string can be used to output a diagnostic message to the user.

This function is one of few in the library that can be used without a successful call to `gsasl_init()`.

**Return value:** Returns a pointer to a statically allocated string containing a string version of the error code *err*, or NULL if the error code is not known.

**Since:** 0.2.29

## 13 Examples

This chapter contains example code which illustrates how the GNU SASL Library can be used when writing your own application.

### 13.1 Example 1

```

/* client.c --- Example SASL client.
 * Copyright (C) 2004, 2005, 2007, 2009 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * This program is free software: you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program. If not, see <http://www.gnu.org/licenses/>.
 */

#include <stdarg.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#include <gsasl.h>

static void
client_authenticate (Gsasl_session * session)
{
    char buf[BUFSIZ] = "";
    char *p;
    int rc;

    /* This loop mimics a protocol where the client send data first. */

    do
    {
        /* Generate client output. */
        rc = gsasl_step64 (session, buf, &p);
    }

```

```

    if (rc == GSASL_NEEDS_MORE || rc == GSASL_OK)
    {
        /* If successful, print it. */
        printf ("Output:\n%s\n", p);
        free (p);
    }

    if (rc == GSASL_NEEDS_MORE)
    {
        /* If the client need more data from server, get it here. */
        printf ("Input base64 encoded data from server:\n");
        fgets (buf, sizeof (buf) - 1, stdin);
        if (buf[strlen (buf) - 1] == '\n')
            buf[strlen (buf) - 1] = '\0';
    }
}

while (rc == GSASL_NEEDS_MORE);

printf ("\n");

if (rc != GSASL_OK)
{
    printf ("Authentication error (%d): %s\n", rc, gsasl_strerror (rc));
    return;
}

/* The client is done.    Here you would typically check if the server
   let the client in.    If not, you could try again. */

printf ("If server accepted us, we're done.\n");
}

static void
client (Gsasl * ctx)
{
    Gsasl_session *session;
    const char *mech = "PLAIN";
    int rc;

    /* Create new authentication session. */
    if ((rc = gsasl_client_start (ctx, mech, &session)) != GSASL_OK)
    {
        printf ("Cannot initialize client (%d): %s\n", rc, gsasl_strerror (rc));
        return;
    }
}

```

```

/* Set username and password in session handle.    This info will be
   lost when this session is deallocated below.    */
gsasl_property_set (session, GSASL_AUTHID, "jas");
gsasl_property_set (session, GSASL_PASSWORD, "secret");

/* Do it.  */
client_authenticate (session);

/* Cleanup.  */
gsasl_finish (session);
}

int
main (int argc, char *argv[])
{
    Gsasl *ctx = NULL;
    int rc;

    /* Initialize library.  */
    if ((rc = gsasl_init (&ctx)) != GSASL_OK)
    {
        printf ("Cannot initialize libgsasl (%d):  %s", rc, gsasl_strerror (rc));
        return 1;
    }

    /* Do it.  */
    client (ctx);

    /* Cleanup.  */
    gsasl_done (ctx);

    return 0;
}

```

## 13.2 Example 2

```

/* client-serverfirst.c --- Example SASL client, where server send data first.
 * Copyright (C) 2004, 2005, 2007, 2009 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * This program is free software:  you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,

```

```

* but WITHOUT ANY WARRANTY; without even the implied warranty of
* MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
* GNU General Public License for more details.
*
* You should have received a copy of the GNU General Public License
* along with this program. If not, see <http://www.gnu.org/licenses/>.
*
*/

#include <stdarg.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#include <gsasl.h>

static void
client_authenticate (Gsasl_session * session)
{
    char buf[BUFSIZ] = "";
    char *p;
    int rc;

    /* This loop mimics a protocol where the server send data first. */

    do
    {
        printf ("Input base64 encoded data from server:\n");
        fgets (buf, sizeof (buf) - 1, stdin);
        if (buf[strlen (buf) - 1] == '\n')
            buf[strlen (buf) - 1] = '\0';

        rc = gsasl_step64 (session, buf, &p);

        if (rc == GSASL_NEEDS_MORE || rc == GSASL_OK)
        {
            printf ("Output:\n%s\n", p);
            free (p);
        }
    }
    while (rc == GSASL_NEEDS_MORE);

    printf ("\n");

    if (rc != GSASL_OK)
    {
        printf ("Authentication error (%d): %s\n", rc, gsasl_strerror (rc));
    }
}

```

```

        return;
    }

    /* The client is done.    Here you would typically check if the server
       let the client in.    If not, you could try again.    */

    printf ("If server accepted us, we're done.\n");
}

static void
client (Gssasl * ctx)
{
    Gssasl_session *session;
    const char *mech = "CRAM-MD5";
    int rc;

    /* Create new authentication session.    */
    if ((rc = gssasl_client_start (ctx, mech, &session)) != GSASL_OK)
    {
        printf ("Cannot initialize client (%d):  %s\n", rc, gssasl_strerror (rc));
        return;
    }

    /* Set username and password in session handle.    This info will be
       lost when this session is deallocated below.    */
    gssasl_property_set (session, GSASL_AUTHID, "jas");
    gssasl_property_set (session, GSASL_PASSWORD, "secret");

    /* Do it.    */
    client_authenticate (session);

    /* Cleanup.    */
    gssasl_finish (session);
}

int
main (int argc, char *argv[])
{
    Gssasl *ctx = NULL;
    int rc;

    /* Initialize library.    */
    if ((rc = gssasl_init (&ctx)) != GSASL_OK)
    {
        printf ("Cannot initialize libgssasl (%d):  %s", rc, gssasl_strerror (rc));
        return 1;
    }
}

```

```

/* Do it. */
client (ctx);

/* Cleanup. */
gsasl_done (ctx);

return 0;
}

```

### 13.3 Example 3

```

/* client-mech.c --- Example SASL client, with a choice of mechanism to use.
 * Copyright (C) 2004, 2005, 2007, 2009 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * This program is free software: you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program. If not, see <http://www.gnu.org/licenses/>.
 */

#include <stdarg.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#include <gsasl.h>

static void
client_authenticate (Gsasl_session * session)
{
    char buf[BUFSIZ] = "";
    char *p;
    int rc;

    /* This loop mimics a protocol where the server send data first. */

```



```

do
{
    printf ("Input base64 encoded data from server:\n");
    fgets (buf, sizeof (buf) - 1, stdin);
    if (buf[strlen (buf) - 1] == '\n')
        buf[strlen (buf) - 1] = '\0';

    rc = gsasl_step64 (session, buf, &p);

    if (rc == GSASL_NEEDS_MORE || rc == GSASL_OK)
    {
        printf ("Output:\n%s\n", p);
        free (p);
    }
}
while (rc == GSASL_NEEDS_MORE);

printf ("\n");

if (rc != GSASL_OK)
{
    printf ("Authentication error (%d):  %s\n", rc, gsasl_strerror (rc));
    return;
}

/* The client is done.    Here you would typically check if the server
   let the client in.    If not, you could try again.  */

printf ("If server accepted us, we're done.\n");
}

static const char *
client_mechanism (Gsas1 * ctx)
{
    static char mech[GSASL_MAX_MECHANISM_SIZE + 1] = "";
    char meclist[BUFSIZ] = "";
    const char *suggestion;

    printf ("Enter list of server supported mechanisms, separate by SPC:\n");
    fgets (meclist, sizeof (meclist) - 1, stdin);

    suggestion = gsasl_client_suggest_mechanism (ctx, meclist);
    if (suggestion)
        printf ("Library suggests use of '%s'.\n", suggestion);

    printf ("Enter mechanism to use:\n");

```

```

    fgets (mech, sizeof (mech) - 1, stdin);
    mech[strlen (mech) - 1] = '\0';

    return mech;
}

static void
client (Gsas1 * ctx)
{
    Gsas1_session *session;
    const char *mech;
    int rc;

    /* Find out which mechanism to use. */
    mech = client_mechanism (ctx);

    /* Create new authentication session. */
    if ((rc = gsasl_client_start (ctx, mech, &session)) != GSASL_OK)
    {
        printf ("Cannot initialize client (%d): %s\n", rc, gsasl_strerror (rc));
        return;
    }

    /* Set username and password in session handle.    This info will be
       lost when this session is deallocated below.    */
    gsasl_property_set (session, GSASL_AUTHID, "jas");
    gsasl_property_set (session, GSASL_PASSWORD, "secret");

    /* Do it. */
    client_authenticate (session);

    /* Cleanup. */
    gsasl_finish (session);
}

int
main (int argc, char *argv[])
{
    Gsas1 *ctx = NULL;
    int rc;

    /* Initialize library. */
    if ((rc = gsasl_init (&ctx)) != GSASL_OK)
    {
        printf ("Cannot initialize libgsasl (%d): %s", rc, gsasl_strerror (rc));
        return 1;
    }
}

```

```

/* Do it. */
client (ctx);

/* Cleanup. */
gsasl_done (ctx);

return 0;
}

```

## 13.4 Example 4

```

/* client-callback.c --- Example SASL client, with callback for user info.
 * Copyright (C) 2004, 2005, 2007, 2009 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * This program is free software: you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation, either version 3 of the License, or
 * (at your option) any later version.
 *
 * This program is distributed in the hope that it will be useful,
 * but WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
 * GNU General Public License for more details.
 *
 * You should have received a copy of the GNU General Public License
 * along with this program. If not, see <http://www.gnu.org/licenses/>.
 */

#include <stdarg.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#include <gsasl.h>

static void
client_authenticate (Gsasl_session * session)
{
    char buf[BUFSIZ] = "";
    char *p;
    int rc;

    /* This loop mimics a protocol where the server send data first. */

```

```

do
{
    printf ("Input base64 encoded data from server:\n");
    fgets (buf, sizeof (buf) - 1, stdin);
    if (buf[strlen (buf) - 1] == '\n')
        buf[strlen (buf) - 1] = '\0';

    rc = gsasl_step64 (session, buf, &p);

    if (rc == GSASL_NEEDS_MORE || rc == GSASL_OK)
    {
        printf ("Output:\n%s\n", p);
        free (p);
    }
}
while (rc == GSASL_NEEDS_MORE);

printf ("\n");

if (rc != GSASL_OK)
{
    printf ("Authentication error (%d):  %s\n", rc, gsasl_strerror (rc));
    return;
}

/* The client is done.    Here you would typically check if the server
   let the client in.    If not, you could try again.  */

printf ("If server accepted us, we're done.\n");
}

static void
client (Gsasl * ctx)
{
    Gsasl_session *session;
    const char *mech = "SECURID";
    int rc;

    /* Create new authentication session.  */
    if ((rc = gsasl_client_start (ctx, mech, &session)) != GSASL_OK)
    {
        printf ("Cannot initialize client (%d):  %s\n", rc, gsasl_strerror (rc));
        return;
    }

    /* Do it.  */

```

```

    client_authenticate (session);

    /* Cleanup. */
    gsasl_finish (session);
}

static int
callback (Gsasl * ctx, Gsasl_session * sctx, Gsasl_property prop)
{
    char buf[BUFSIZ] = "";
    int rc = GSASL_NO_CALLBACK;

    /* Get user info from user. */

    printf ("Callback invoked, for property %d.\n", prop);

    switch (prop)
    {
        case GSASL_PASSCODE:
            printf ("Enter passcode:\n");
            fgets (buf, sizeof (buf) - 1, stdin);
            buf[strlen (buf) - 1] = '\0';

            gsasl_property_set (sctx, GSASL_PASSCODE, buf);
            rc = GSASL_OK;
            break;

        case GSASL_AUTHID:
            printf ("Enter username:\n");
            fgets (buf, sizeof (buf) - 1, stdin);
            buf[strlen (buf) - 1] = '\0';

            gsasl_property_set (sctx, GSASL_AUTHID, buf);
            rc = GSASL_OK;
            break;

        default:
            printf ("Unknown property!    Don't worry.\n");
            break;
    }

    return rc;
}

int
main (int argc, char *argv[])
{

```

```
Gsasl *ctx = NULL;
int rc;

/* Initialize library. */
if ((rc = gsasl_init (&ctx)) != GSASL_OK)
{
    printf ("Cannot initialize libgsasl (%d): %s", rc, gsasl_strerror (rc));
    return 1;
}

/* Set the callback handler for the library. */
gsasl_callback_set (ctx, callback);

/* Do it. */
client (ctx);

/* Cleanup. */
gsasl_done (ctx);

return 0;
}
```

## 14 Acknowledgements

The makefiles, manuals, etc borrowed much from Libgcrypt written by Werner Koch.

Cryptographic functions for some SASL mechanisms uses Libgcrypt by Werner Koch et al. The NTLM mechanism uses Libntlm by Grant Edwards et al, using code from Samba written by Andrew Tridgell, and now maintained by Simon Josefsson. The KERBEROS\_V5 mechanism uses Shishi by Simon Josefsson. The GSSAPI mechanism uses a GSS-API implementation, such as GSSLib by Simon Josefsson.

Gnulib is used to simplify portability.

This manual borrows text from the SASL specification.

## 15 Invoking gsasl

### Name

GNU SASL (gsasl) – Command line interface to libgsasl.

### Description

`gsasl` is the main program of GNU SASL.

This section only lists the commands and options available.

Mandatory or optional arguments to long options are also mandatory or optional for any corresponding short options.

### Commands

`gsasl` recognizes these commands:

|                                  |   |
|----------------------------------|---|
| <code>-c, --client</code>        | Act as client (the default).  |
| <code>--client-mechanisms</code> | Write name of supported client mechanisms separated by space to stdout. |
| <code>-s, --server</code>        | Act as server.  |
| <code>--server-mechanisms</code> | Write name of supported server mechanisms separated by space to stdout. |

### Network Options

Normally the SASL negotiation is performed on the terminal, with reading from stdin and writing to stdout. It is also possible to perform the negotiation with a server over a TCP network connection.

|   |  |
|---|--|
| <code>--connect=HOSTNAME[:SERVICE]</code> | Connect to TCP server and negotiate on stream instead of stdin/stdout. SERVICE is the protocol service, or an integer denoting the port, and defaults to 143 (imap) if not specified. Also sets the <code>--hostname</code> default. |
|---|--|



## Miscellaneous Options:

These parameters affect overall behaviour.

|                                     |   |
|-------------------------------------|---|
| <code>-d, --application-data</code> | After authentication, read data from stdin and run it through the mechanism's security layer and print it base64 encoded to stdout. The default is to terminate after authentication. |
| <code>--imap</code>                 | Use a IMAP-like logon procedure (client only). Also sets the <code>--service</code> default to "imap".  |
| <code>-m, --mechanism=STRING</code> | Mechanism to use.   |
| <code>--no-client-first</code>      | Disallow client to send data first (client only).   |

## SASL Mechanism Options

These options modify the behaviour of the callbacks (see [Chapter 7 \[Callback Functions\]](#), [page 31](#)) in the library. The default is to query the user on the terminal.

|  |   |
|--|---|
| <code>-n, --anonymous-token=STRING</code>                                  | Token for anonymous authentication, usually mail address (ANONYMOUS only).  |
| <code>-a, --authentication-id=STRING</code>                                | Identity of credential owner.   |
| <code>-z, --authorization-id=STRING</code>                                 | Identity to request service for.  |
| <code>--disable-cleartext-validate</code>                                  | Disable cleartext validate hook, forcing server to prompt for password.   |
| <code>--enable-cram-md5-validate</code>                                    | Validate CRAM-MD5 challenge and response interactively.   |
| <code>--hostname=STRING</code>   | Set the name of the server with the requested service.  |
| <code>-p, --password=STRING</code>   | Password for authentication (insecure for non-testing purposes).  |
| <code>--passcode=NUMBER</code>   | Passcode for authentication (SECURID only).   |
| <code>--quality-of-protection=&lt;qop-auth   qop-int   qop-conf&gt;</code> | How application payload will be protected. "qop-auth" means no protection, "qop-int" means integrity protection, "qop-conf" means confidentiality. Currently only used by DIGEST-MD5, where the default is "qop-int". |
| <code>-r, --realm=STRING</code>  | Realm. Defaults to hostname.  |
| <code>--service=STRING</code>  | Set the requested service name (should be a registered GSSAPI host based service name).   |
| <code>--service-name=STRING</code>   | Set the generic server name in case of a replicated server (DIGEST-MD5 only).   |
| <code>-x, --maxbuf=NUMBER</code>   | Indicate maximum buffer size (DIGEST-MD5 only).   |

## STARTTLS options

|                                    |   |
|------------------------------------|---|
| <code>--starttls</code>            | Force use of STARTTLS. The default is to use STARTTLS when available. (default=off)   |
| <code>--no-starttls</code>         | Unconditionally disable STARTTLS. (default=off)   |
| <code>--x509-ca-file=FILE</code>   | File containing one or more X.509 Certificate Authorities certificates in PEM format, used to verify the certificate received from the server. If not specified, no verification of the remote server certificate will be done. |
| <code>--x509-cert-file=FILE</code> | File containing client X.509 certificate in PEM format. Used together with <code>--x509-key-file</code> to specify the certificate/key pair.  |
| <code>--x509-key-file=FILE</code>  | Private key for the client X.509 certificate in PEM format. Used together with <code>--x509-key-file</code> to specify the certificate/key pair.  |
| <code>--priority</code>            | Cipher priority string.   |

## Other Options

These are some standard parameters.

|                                    |                                      |
|------------------------------------|--------------------------------------|
| <code>-q, --quiet, --silent</code> | Don't produce any diagnostic output. |
| <code>-v, --verbose</code>         | Produce verbose output.              |
| <code>-?, --help</code>            | Give this help list                  |
| <code>--usage</code>               | Give a short usage message           |
| <code>-V, --version</code>         | Print program version                |

## Appendix A Protocol Clarifications

This appendix contains clarifications to various SASL specification that we felt were necessary to include, if for nothing else it may serve as a guide for other implementers that worry about the same issues.

### A.1 Use of SASLprep in CRAM-MD5

The specification, as of ‘draft-ietf-sasl-crammd5-04.txt’, is silent on whether a SASL server implementation applying SASLprep on a password received from an external, non-SASL specific database (i.e., the passwords are not stored in SASLprep form in the database), should set or clear the AllowUnassigned bit. The motivation for the AU-bit in StringPrep/SASLprep is for stored vs query strings. It could be argued that in this situation the server can treat the external password either as a stored string (from a database) or as a query (the server uses the string as a query into the fixed HMAC-MD5 hash).

The specification is also unclear on whether clients should set or clear the AllowUnassigned flag.

In the server, GNU SASL applies SASLprep to the password with the AllowUnassigned bit cleared.

### A.2 Use of SASLprep in LOGIN

The non-standard mechanism LOGIN presumably does not support non-ASCII. We suggest that the client should send unprepared UTF-8 and that the server apply SASLprep with the AllowUnassigned bit cleared on the received username and password.

## Appendix B Old Functions

As GNU SASL is still under heavy development, some API functions have been found to be less useful. Those old API functions will be supported during a transition period. Refer to the NEWS file to find out since when a function has been deprecated.

### gsasl\_client\_listmech

```
int gsasl_client_listmech (Gsasl * ctx, char * out, size_t * outlen) [Function]
```

*ctx*: libgsasl handle.

*out*: output character array.

*outlen*: input maximum size of output character array, on output contains actual length of output array.

Write SASL names, separated by space, of mechanisms supported by the libgsasl client to the output array. To find out how large the output array must be, call this function with a NULL *out* parameter.

**Return value:** Returns GSASL\_OK if successful, or error code.

**Deprecated:** Use `gsasl_client_mechlist()` instead.

### gsasl\_server\_listmech

```
int gsasl_server_listmech (Gsasl * ctx, char * out, size_t * outlen) [Function]
```

*ctx*: libgsasl handle.

*out*: output character array.

*outlen*: input maximum size of output character array, on output contains actual length of output array.

Write SASL names, separated by space, of mechanisms supported by the libgsasl server to the output array. To find out how large the output array must be, call this function with a NULL *out* parameter.

**Return value:** Returns GSASL\_OK if successful, or error code.

**Deprecated:** Use `gsasl_server_mechlist()` instead.

### gsasl\_client\_step

```
int gsasl_client_step (Gsasl_session * sctx, const char * input, size_t input_len, char * output, size_t * output_len) [Function]
```

*sctx*: libgsasl client handle.

*input*: input byte array.

*input\_len*: size of input byte array.

*output*: output byte array.

*output\_len*: size of output byte array.

Perform one step of SASL authentication in client. This reads data from server (specified with `input` and `input_len`), processes it (potentially invoking callbacks to the application), and writes data to server (into variables `output` and `output_len`).

The contents of the output buffer is unspecified if this functions returns anything other than `GSASL_NEEDS_MORE`.

**Return value:** Returns `GSASL_OK` if authenticated terminated successfully, `GSASL_NEEDS_MORE` if more data is needed, or error code.

**Deprecated:** Use `gsasl_step()` instead.

## `gsasl_server_step`

```
int gsasl_server_step (Gsasl_session * sctx, const char * input,           [Function]
                      size_t input_len, char * output, size_t * output_len)
```

*sctx*: libgsasl server handle.

*input*: input byte array.

*input\_len*: size of input byte array.

*output*: output byte array.

*output\_len*: size of output byte array.

Perform one step of SASL authentication in server. This reads data from client (specified with `input` and `input_len`), processes it (potentially invoking callbacks to the application), and writes data to client (into variables `output` and `output_len`).

The contents of the output buffer is unspecified if this functions returns anything other than `GSASL_NEEDS_MORE`.

**Return value:** Returns `GSASL_OK` if authenticated terminated successfully, `GSASL_NEEDS_MORE` if more data is needed, or error code.

**Deprecated:** Use `gsasl_step()` instead.

## `gsasl_client_step_base64`

```
int gsasl_client_step_base64 (Gsasl_session * sctx, const char *         [Function]
                             b64input, char * b64output, size_t b64output_len)
```

*sctx*: libgsasl client handle.

*b64input*: input base64 encoded byte array.

*b64output*: output base64 encoded byte array.

*b64output\_len*: size of output base64 encoded byte array.

This is a simple wrapper around `gsasl_client_step()` that base64 decodes the input and base64 encodes the output.

**Return value:** See `gsasl_client_step()`.

**Deprecated:** Use `gsasl_step64()` instead.

**gsasl\_server\_step\_base64**

**int** **gsasl\_server\_step\_base64** (*Gsasl\_session* \* **sctx**, *const char* \* **b64input**, *char* \* **b64output**, *size\_t* **b64output\_len**) [Function]

**sctx**: libgsasl server handle.

**b64input**: input base64 encoded byte array.

**b64output**: output base64 encoded byte array.

**b64output\_len**: size of output base64 encoded byte array.

This is a simple wrapper around **gsasl\_server\_step()** that base64 decodes the input and base64 encodes the output.

**Return value**: See **gsasl\_server\_step()**.

**Deprecated**: Use **gsasl\_step64()** instead.

**gsasl\_client\_finish**

**void** **gsasl\_client\_finish** (*Gsasl\_session* \* **sctx**) [Function]

**sctx**: libgsasl client handle.

Destroy a libgsasl client handle. The handle must not be used with other libgsasl functions after this call.

**Deprecated**: Use **gsasl\_finish()** instead.

**gsasl\_server\_finish**

**void** **gsasl\_server\_finish** (*Gsasl\_session* \* **sctx**) [Function]

**sctx**: libgsasl server handle.

Destroy a libgsasl server handle. The handle must not be used with other libgsasl functions after this call.

**Deprecated**: Use **gsasl\_finish()** instead.

**gsasl\_client\_ctx\_get**

*Gsasl* \* **gsasl\_client\_ctx\_get** (*Gsasl\_session* \* **sctx**) [Function]

**sctx**: libgsasl client handle

**Return value**: Returns the libgsasl handle given a libgsasl client handle.

**Deprecated**: This function is not useful with the new 0.2.0 API.

**gsasl\_client\_application\_data\_set**

**void** **gsasl\_client\_application\_data\_set** (*Gsasl\_session* \* **sctx**, *void* \* **application\_data**) [Function]

**sctx**: libgsasl client handle.

**application\_data**: opaque pointer to application specific data.

Store application specific data in the libgsasl client handle. The application data can be later (for instance, inside a callback) be retrieved by calling **gsasl\_client\_application\_data\_get()**. It is normally used by the application to maintain state between the main program and the callback.

**Deprecated:** Use `gsasl_callback_hook_set()` or `gsasl_session_hook_set()` instead.

### **gsasl\_client\_application\_data\_get**

`void * gsasl_client_application_data_get (Gsasl_session * sctx)` [Function]

*sctx*: libgsasl client handle.

Retrieve application specific data from libgsasl client handle. The application data is set using `gsasl_client_application_data_set()`. It is normally used by the application to maintain state between the main program and the callback.

**Return value:** Returns the application specific data, or NULL.

**Deprecated:** Use `gsasl_callback_hook_get()` or `gsasl_session_hook_get()` instead.

### **gsasl\_server\_ctx\_get**

`Gsasl * gsasl_server_ctx_get (Gsasl_session * sctx)` [Function]

*sctx*: libgsasl server handle

**Return value:** Returns the libgsasl handle given a libgsasl server handle.

**Deprecated:** This function is not useful with the new 0.2.0 API.

### **gsasl\_server\_application\_data\_set**

`void gsasl_server_application_data_set (Gsasl_session * sctx, void * application_data)` [Function]

*sctx*: libgsasl server handle.

*application\_data*: opaque pointer to application specific data.

Store application specific data in the libgsasl server handle. The application data can be later (for instance, inside a callback) be retrieved by calling `gsasl_server_application_data_get()`. It is normally used by the application to maintain state between the main program and the callback.

**Deprecated:** Use `gsasl_callback_hook_set()` or `gsasl_session_hook_set()` instead.

### **gsasl\_server\_application\_data\_get**

`void * gsasl_server_application_data_get (Gsasl_session * sctx)` [Function]

*sctx*: libgsasl server handle.

Retrieve application specific data from libgsasl server handle. The application data is set using `gsasl_server_application_data_set()`. It is normally used by the application to maintain state between the main program and the callback.

**Return value:** Returns the application specific data, or NULL.

**Deprecated:** Use `gsasl_callback_hook_get()` or `gsasl_session_hook_get()` instead.

## gsasl\_randomize

`int gsasl_randomize (int strong, char * data, size_t datalen)` [Function]

*strong*: 0 iff operation should not block, non-0 for very strong randomness.

*data*: output array to be filled with random data.

*datalen*: size of output array.

Store cryptographically random data of given size in the provided buffer.

**Return value:** Returns GSASL\_OK iff successful.

**Deprecated:** Use `gsasl_random()` or `gsasl_nonce()` instead.

## gsasl\_ctx\_get

`Gsasl * gsasl_ctx_get (Gsasl_session * sctx)` [Function]

*sctx*: libgsasl session handle

**Return value:** Returns the libgsasl handle given a libgsasl session handle.

**Deprecated:** This function is not useful with the new 0.2.0 API.

## gsasl\_encode\_inline

`int gsasl_encode_inline (Gsasl_session * sctx, const char * input, size_t input_len, char * output, size_t * output_len)` [Function]

*sctx*: libgsasl session handle.

*input*: input byte array.

*input\_len*: size of input byte array.

*output*: output byte array.

*output\_len*: size of output byte array.

Encode data according to negotiated SASL mechanism. This might mean that data is integrity or privacy protected.

**Return value:** Returns GSASL\_OK if encoding was successful, otherwise an error code.

**Deprecated:** Use `gsasl_encode()` instead.

**Since:** 0.2.0

## gsasl\_decode\_inline

`int gsasl_decode_inline (Gsasl_session * sctx, const char * input, size_t input_len, char * output, size_t * output_len)` [Function]

*sctx*: libgsasl session handle.

*input*: input byte array.

*input\_len*: size of input byte array.

*output*: output byte array.

*output\_len*: size of output byte array.

Decode data according to negotiated SASL mechanism. This might mean that data is integrity or privacy protected.

**Return value:** Returns GSASL\_OK if encoding was successful, otherwise an error code.



**Deprecated:** Use `gsasl_decode()` instead.

**Since:** 0.2.0

## `gsasl_application_data_set`

`void gsasl_application_data_set (Gsasl * ctx, void * appdata)` [Function]

*ctx*: libgsasl handle.

*appdata*: opaque pointer to application specific data.

Store application specific data in the libgsasl handle. The application data can be later (for instance, inside a callback) be retrieved by calling `gsasl_application_data_get()`. It is normally used by the application to maintain state between the main program and the callback.

**Deprecated:** Use `gsasl_callback_hook_set()` instead.

## `gsasl_application_data_get`

`void * gsasl_application_data_get (Gsasl * ctx)` [Function]

*ctx*: libgsasl handle.

Retrieve application specific data from libgsasl handle. The application data is set using `gsasl_application_data_set()`. It is normally used by the application to maintain state between the main program and the callback.

**Return value:** Returns the application specific data, or NULL.

**Deprecated:** Use `gsasl_callback_hook_get()` instead.

## `gsasl_appinfo_set`

`void gsasl_appinfo_set (Gsasl_session * sctx, void * appdata)` [Function]

*sctx*: libgsasl session handle.

*appdata*: opaque pointer to application specific data.

Store application specific data in the libgsasl session handle. The application data can be later (for instance, inside a callback) be retrieved by calling `gsasl_appinfo_get()`. It is normally used by the application to maintain state between the main program and the callback.

**Deprecated:** Use `gsasl_callback_hook_set()` instead.

## `gsasl_appinfo_get`

`void * gsasl_appinfo_get (Gsasl_session * sctx)` [Function]

*sctx*: libgsasl session handle.

Retrieve application specific data from libgsasl session handle. The application data is set using `gsasl_appinfo_set()`. It is normally used by the application to maintain state between the main program and the callback.

**Return value:** Returns the application specific data, or NULL.

**Deprecated:** Use `gsasl_callback_hook_get()` instead.

### gsasl\_server\_suggest\_mechanism

```
const char * gsasl_server_suggest_mechanism (Gsasl * ctx,      [Function]
      const char * mechlist)
```

*ctx*: libgsasl handle.

*mechlist*: input character array with SASL mechanism names, separated by invalid characters (e.g. SPC).

**Return value:** Returns name of "best" SASL mechanism supported by the libgsasl server which is present in the input string.

**Deprecated:** This function was never useful, since it is the client that chose which mechanism to use.

### gsasl\_client\_callback\_authentication\_id\_set

```
void gsasl_client_callback_authentication_id_set (Gsasl *      [Function]
      ctx, Gsasl_client_callback_authentication_id cb)
```

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to set the authentication identity. The function can be later retrieved using `gsasl_client_callback_authentication_id_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### gsasl\_client\_callback\_authentication\_id\_get

```
Gsasl_client_callback_authentication_id      [Function]
      gsasl_client_callback_authentication_id_get (Gsasl * ctx)
```

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_authentication_id_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### gsasl\_client\_callback\_authorization\_id\_set

```
void gsasl_client_callback_authorization_id_set (Gsasl * ctx,  [Function]
      Gsasl_client_callback_authorization_id cb)
```

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to set the authorization identity. The function can be later retrieved using `gsasl_client_callback_authorization_id_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_authorization_id_get`

`Gsasl_client_callback_authorization_id` [Function]  
`gsasl_client_callback_authorization_id_get (Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_authorization_id_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_password_set`

`void gsasl_client_callback_password_set (Gsasl * ctx,` [Function]  
`Gsasl_client_callback_password cb)`

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to set the password. The function can be later retrieved using `gsasl_client_callback_password_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_password_get`

`Gsasl_client_callback_password` [Function]  
`gsasl_client_callback_password_get (Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_password_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_passcode_set`

`void gsasl_client_callback_passcode_set (Gsasl * ctx,` [Function]  
`Gsasl_client_callback_passcode cb)`

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to set the passcode. The function can be later retrieved using `gsasl_client_callback_passcode_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_passcode_get`

`Gsasl_client_callback_passcode` [Function]

`gsasl_client_callback_passcode_get (Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_passcode_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_pin_set`

`void gsasl_client_callback_pin_set (Gsasl * ctx,` [Function]

`Gsasl_client_callback_pin cb)`

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to chose a new pin, possibly suggested by the server, for the SECURID mechanism. This is not normally invoked, but only when the server requests it. The function can be later retrieved using `gsasl_client_callback_pin_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_pin_get`

`Gsasl_client_callback_pin gsasl_client_callback_pin_get` [Function]

`(Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_pin_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_service_set`

`void gsasl_client_callback_service_set (Gsasl * ctx,` [Function]

`Gsasl_client_callback_service cb)`

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to set the name of the service. The service buffer should be a registered GSSAPI host-based service name, hostname the name of the server. Servicename is used by DIGEST-MD5 and should be the name of generic server in case of a replicated service. The function can be later retrieved using `gsasl_client_callback_service_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## `gsasl_client_callback_service_get`

`Gsasl_client_callback_service` [Function]  
`gsasl_client_callback_service_get (Gsasl * ctx)`  
 ctx: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_service_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## `gsasl_client_callback_anonymous_set`

`void gsasl_client_callback_anonymous_set (Gsasl * ctx,` [Function]  
`Gsasl_client_callback_anonymous cb)`  
 ctx: libgsasl handle.  
 cb: callback function

Specify the callback function to use in the client to set the anonymous token, which usually is the users email address. The function can be later retrieved using `gsasl_client_callback_anonymous_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## `gsasl_client_callback_anonymous_get`

`Gsasl_client_callback_anonymous` [Function]  
`gsasl_client_callback_anonymous_get (Gsasl * ctx)`  
 ctx: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_anonymous_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_client\_callback\_qop\_set

```
void gsasl_client_callback_qop_set (Gsasl * ctx, [Function]
    Gsasl_client_callback_qop cb)
```

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to determine the qop to use after looking at what the server offered. The function can be later retrieved using `gsasl_client_callback_qop_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_client\_callback\_qop\_get

```
Gsasl_client_callback_qop gsasl_client_callback_qop_get [Function]
    (Gsasl * ctx)
```

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_qop_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_client\_callback\_maxbuf\_set

```
void gsasl_client_callback_maxbuf_set (Gsasl * ctx, [Function]
    Gsasl_client_callback_maxbuf cb)
```

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to inform the server of the largest buffer the client is able to receive when using the DIGEST-MD5 "auth-int" or "auth-conf" Quality of Protection (qop). If this directive is missing, the default value 65536 will be assumed. The function can be later retrieved using `gsasl_client_callback_maxbuf_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_client\_callback\_maxbuf\_get

```
Gsasl_client_callback_maxbuf [Function]
    gsasl_client_callback_maxbuf_get (Gsasl * ctx)
```

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_maxbuf_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_realm_set`

```
void gsasl_client_callback_realm_set (Gsasl * ctx, [Function]
                                     Gsasl_client_callback_realm cb)
```

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the client to know which realm it belongs to. The realm is used by the server to determine which username and password to use. The function can be later retrieved using `gsasl_client_callback_realm_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_client_callback_realm_get`

```
Gsasl_client_callback_realm [Function]
gsasl_client_callback_realm_get (Gsasl * ctx)
```

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_client_callback_realm_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_server_callback_validate_set`

```
void gsasl_server_callback_validate_set (Gsasl * ctx, [Function]
                                         Gsasl_server_callback_validate cb)
```

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server for deciding if user is authenticated using authentication identity, authorization identity and password. The function can be later retrieved using `gsasl_server_callback_validate_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_server_callback_validate_get`

```
Gsasl_server_callback_validate [Function]
gsasl_server_callback_validate_get (Gsasl * ctx)
```

*ctx*: libgsasl handle.



**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_validate_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_server_callback_retrieve_set`

```
void gsasl_server_callback_retrieve_set (Gsasl * ctx,           [Function]
                                         Gsasl_server_callback_retrieve cb)
ctx: libgsasl handle.
```

*cb*: callback function

Specify the callback function to use in the server for deciding if user is authenticated using authentication identity, authorization identity and password. The function can be later retrieved using `gsasl_server_callback_retrieve_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_server_callback_retrieve_get`

```
Gsasl_server_callback_retrieve           [Function]
gsasl_server_callback_retrieve_get (Gsasl * ctx)
ctx: libgsasl handle.
```

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_retrieve_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_server_callback_cram_md5_set`

```
void gsasl_server_callback_cram_md5_set (Gsasl * ctx,           [Function]
                                         Gsasl_server_callback_cram_md5 cb)
ctx: libgsasl handle.
```

*cb*: callback function

Specify the callback function to use in the server for deciding if user is authenticated using CRAM-MD5 challenge and response. The function can be later retrieved using `gsasl_server_callback_cram_md5_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.



## gsasl\_server\_callback\_cram\_md5\_get

Gsasl\_server\_callback\_cram\_md5 [Function]

gsasl\_server\_callback\_cram\_md5\_get (*Gsasl* \* *ctx*)

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_cram_md5_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_digest\_md5\_set

void gsasl\_server\_callback\_digest\_md5\_set (*Gsasl* \* *ctx*, [Function]

*Gsasl\_server\_callback\_digest\_md5* *cb*)

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server for retrieving the secret hash of the username, realm and password for use in the DIGEST-MD5 mechanism. The function can be later retrieved using `gsasl_server_callback_digest_md5_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_digest\_md5\_get

Gsasl\_server\_callback\_digest\_md5 [Function]

gsasl\_server\_callback\_digest\_md5\_get (*Gsasl* \* *ctx*)

*ctx*: libgsasl handle.

**Return value:** Return the callback earlier set by calling `gsasl_server_callback_digest_md5_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_external\_set

void gsasl\_server\_callback\_external\_set (*Gsasl* \* *ctx*, [Function]

*Gsasl\_server\_callback\_external* *cb*)

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server for deciding if user is authenticated out of band. The function can be later retrieved using `gsasl_server_callback_external_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_external\_get

Gsasl\_server\_callback\_external [Function]

gsasl\_server\_callback\_external\_get (*Gsasl \* ctx*)

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_external_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_anonymous\_set

void gsasl\_server\_callback\_anonymous\_set (*Gsasl \* ctx*, [Function]

*Gsasl\_server\_callback\_anonymous cb*)

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server for deciding if user is permitted anonymous access. The function can be later retrieved using `gsasl_server_callback_anonymous_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_anonymous\_get

Gsasl\_server\_callback\_anonymous [Function]

gsasl\_server\_callback\_anonymous\_get (*Gsasl \* ctx*)

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_anonymous_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_realm\_set

void gsasl\_server\_callback\_realm\_set (*Gsasl \* ctx*, [Function]

*Gsasl\_server\_callback\_realm cb*)

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server to know which realm it serves. The realm is used by the user to determine which username and password to use. The function can be later retrieved using `gsasl_server_callback_realm_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_realm\_get

Gsasl\_server\_callback\_realm [Function]

gsasl\_server\_callback\_realm\_get (*Gsasl* \* *ctx*)

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_realm_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_qop\_set

void gsasl\_server\_callback\_qop\_set (*Gsasl* \* *ctx*, [Function]

*Gsasl\_server\_callback\_qop* *cb*)

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server to know which quality of protection it accepts. The quality of protection eventually used is selected by the client though. It is currently used by the DIGEST-MD5 mechanism. The function can be later retrieved using `gsasl_server_callback_qop_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_qop\_get

Gsasl\_server\_callback\_qop gsasl\_server\_callback\_qop\_get [Function]

(*Gsasl* \* *ctx*)

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_qop_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_maxbuf\_set

void gsasl\_server\_callback\_maxbuf\_set (*Gsasl* \* *ctx*, [Function]

*Gsasl\_server\_callback\_maxbuf* *cb*)

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server to inform the client of the largest buffer the server is able to receive when using the DIGEST-MD5 "auth-int" or "auth-conf" Quality of Protection (qop). If this directive is missing, the default value 65536 will be assumed. The function can be later retrieved using `gsasl_server_callback_maxbuf_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## `gsasl_server_callback_maxbuf_get`

`Gsasl_server_callback_maxbuf` [Function]

`gsasl_server_callback_maxbuf_get (Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_maxbuf_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## `gsasl_server_callback_cipher_set`

`void gsasl_server_callback_cipher_set (Gsasl * ctx,` [Function]

`Gsasl_server_callback_cipher cb)`

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server to inform the client of the cipher suites supported. The DES and 3DES ciphers must be supported for interoperability. It is currently used by the DIGEST-MD5 mechanism. The function can be later retrieved using `gsasl_server_callback_cipher_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## `gsasl_server_callback_cipher_get`

`Gsasl_server_callback_cipher` [Function]

`gsasl_server_callback_cipher_get (Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_cipher_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## `gsasl_server_callback_securid_set`

`void gsasl_server_callback_securid_set (Gsasl * ctx,` [Function]

`Gsasl_server_callback_securid cb)`

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server for validating a user via the SECURID mechanism. The function should return GSASL\_OK if user authenticated successfully, GSASL\_SECURID\_SERVER\_NEED\_ADDITIONAL\_PASSCODE if it wants another passcode, GSASL\_SECURID\_SERVER\_NEED\_NEW\_PIN if it wants a PIN change, or an error. When (and only when) GSASL\_SECURID\_SERVER\_NEED\_NEW\_PIN is returned, suggestpin can be populated with a PIN code the server suggests, and suggestpinlen set to the length of the PIN. The function can be later retrieved using `gsasl_server_callback_securid_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_securid\_get

Gsasl\_server\_callback\_securid [Function]

`gsasl_server_callback_securid_get (Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_securid_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_gssapi\_set

void gsasl\_server\_callback\_gssapi\_set (Gsasl \* ctx, [Function]

`Gsasl_server_callback_gssapi cb)`

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server for checking if a GSSAPI user is authorized for username (by, e.g., calling `krb5_userok()`). The function should return GSASL\_OK if the user should be permitted access, or an error code such as GSASL\_AUTHENTICATION\_ERROR on failure. The function can be later retrieved using `gsasl_server_callback_gssapi_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

## gsasl\_server\_callback\_gssapi\_get

Gsasl\_server\_callback\_gssapi [Function]

`gsasl_server_callback_gssapi_get (Gsasl * ctx)`

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_gssapi_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_server_callback_service_set`

```
void gsasl_server_callback_service_set (Gsasl * ctx,           [Function]
                                       Gsasl_server_callback_service cb)
```

*ctx*: libgsasl handle.

*cb*: callback function

Specify the callback function to use in the server to set the name of the service. The service buffer should be a registered GSSAPI host-based service name, hostname the name of the server. The function can be later retrieved using `gsasl_server_callback_service_get()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_server_callback_service_get`

```
Gsasl_server_callback_service          [Function]
    gsasl_server_callback_service_get (Gsasl * ctx)
```

*ctx*: libgsasl handle.

**Return value:** Returns the callback earlier set by calling `gsasl_server_callback_service_set()`.

**Deprecated:** This function is part of the old callback interface. The new interface uses `gsasl_callback_set()` to set the application callback, and uses `gsasl_callback()` or `gsasl_property_get()` to invoke the callback for certain properties.

### `gsasl_stringprep_nfkc`

```
char * gsasl_stringprep_nfkc (const char * in, ssize_t len)  [Function]
```

*in*: a UTF-8 encoded string.

*len*: length of *str*, in bytes, or -1 if *str* is nul-terminated.

Converts a string into canonical form, standardizing such issues as whether a character with an accent is represented as a base character and combining accent or as a single precomposed character.

The normalization mode is NFKC (ALL COMPOSE). It standardizes differences that do not affect the text content, such as the above-mentioned accent representation. It standardizes the "compatibility" characters in Unicode, such as SUPERSCRIPT THREE to the standard forms (in this case DIGIT THREE). Formatting information may be lost but for most text operations such characters should be considered the same. It returns a result with composed forms rather than a maximally decomposed form.

**Return value:** Return a newly allocated string, that is the NFKC normalized form of *str*, o NULL on error.

**Deprecated:** No replacement functionality in GNU SASL, use GNU Libidn instead. Note that in SASL, you most likely want to use SASLprep and not bare NFKC, see `gsasl_saslprep()`.

### `gsasl_stringprep_saslprep`

`char * gsasl_stringprep_saslprep (const char * in, int * stringprep_rc)` [Function]

*in*: input ASCII or UTF-8 string with data to prepare according to SASLprep.

*stringprep\_rc*: pointer to output variable with stringprep error code, or NULL to indicate that you don't care about it.

Process a Unicode string for comparison, according to the "SASLprep" stringprep profile. This function is intended to be used by Simple Authentication and Security Layer (SASL) mechanisms (such as PLAIN, CRAM-MD5, and DIGEST-MD5) as well as other protocols exchanging user names and/or passwords.

**Return value:** Return a newly allocated string that is the "SASLprep" processed form of the input string, or NULL on error, in which case `stringprep_rc` contain the stringprep library error code.

**Deprecated:** Use `gsasl_saslprep()` instead.

### `gsasl_stringprep_trace`

`char * gsasl_stringprep_trace (const char * in, int * stringprep_rc)` [Function]

*in*: input ASCII or UTF-8 string with data to prepare according to "trace".

*stringprep\_rc*: pointer to output variable with stringprep error code, or NULL to indicate that you don't care about it.

Process a Unicode string for use as trace information, according to the "trace" stringprep profile. The profile is designed for use with the SASL ANONYMOUS Mechanism.

**Return value:** Return a newly allocated string that is the "trace" processed form of the input string, or NULL on error, in which case `stringprep_rc` contain the stringprep library error code.

**Deprecated:** No replacement functionality in GNU SASL, use GNU Libidn instead.

### `gsasl_md5pwd_get_password`

`int gsasl_md5pwd_get_password (const char * filename, const char * username, char * key, size_t * keylen)` [Function]

*filename*: filename of file containing passwords.

*username*: username string.

*key*: output character array.

*keylen*: input maximum size of output character array, on output contains actual length of output array.

Retrieve password for user from specified file. To find out how large the output array must be, call this function with `out=NULL`.



The file should be on the UoW "MD5 Based Authentication" format, which means it is in text format with comments denoted by # first on the line, with user entries looking as "usernameTABpassword". This function removes CR and LF at the end of lines before processing. TAB, CR, and LF denote ASCII values 9, 13, and 10, respectively.

**Return value:** Return GSASL\_OK if output buffer contains the password, GSASL\_AUTHENTICATION\_ERROR if the user could not be found, or other error code.

**Deprecated:** Use `gsasl_simple_getpass()` instead.

## gsasl\_base64\_encode

`int gsasl_base64_encode (char const * src, size_t srclength, char * target, size_t targsize)` [Function]

*src*: input byte array

*srclength*: size of input byte array

*target*: output byte array

*targsize*: size of output byte array

Encode data as base64. Converts characters, three at a time, starting at *src* into four base64 characters in the *target* area until the entire input buffer is encoded.

**Return value:** Returns the number of data bytes stored at the *target*, or -1 on error.

**Deprecated:** Use `gsasl_base64_to()` instead.

## gsasl\_base64\_decode

`int gsasl_base64_decode (char const * src, char * target, size_t targsize)` [Function]

*src*: input byte array

*target*: output byte array

*targsize*: size of output byte array

Decode Base64 data. Skips all whitespace anywhere. Converts characters, four at a time, starting at (or after) *src* from Base64 numbers into three 8 bit bytes in the *target* area.

**Return value:** Returns the number of data bytes stored at the *target*, or -1 on error.

**Deprecated:** Use `gsasl_base64_from()` instead.

## B.1 Obsolete callback function prototypes

`int (*Gsasl_client_callback_anonymous) (Gsasl_session_ctx * ctx, char * out, size_t * outlen)` [Prototype]

*ctx*: libgsasl handle.

*out*: output array with client token.

*outlen*: on input the maximum size of the output array, on output contains the actual size of the output array.



Type of callback function the application implements. It should populate the output array with some input from the user and set the output array length, and return `GSASL_OK`, or fail with an error code.

If `OUT` is `NULL`, the function should only populate the output length field with the length, and return `GSASL_OK`. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gsasl_server_callback_anonymous) (Gsasl_session_ctx *      [Prototype]
    ctx, const char * token)
```

*ctx*: libgsasl handle.

*ctx*: output array with client token.

*ctx*: on input the maximum size of the output array, on output contains the actual size of the output array. If `OUT` is

Type of callback function the application implements. It should return `GSASL_OK` if user should be permitted anonymous access, otherwise `GSASL_AUTHENTICATION_ERROR`.

```
int (*Gsasl_client_callback_authentication_id)                  [Prototype]
    (Gsasl_session_ctx * ctx, char * out, size_t * outlen)
```

*ctx*: libgsasl handle.

*out*: output array with authentication identity.

*outlen*: on input the maximum size of the output array, on output contains the actual size of the output array.

Type of callback function the application implements. It should populate the output array with authentication identity of user and set the output array length, and return `GSASL_OK`, or fail with an error code. The authentication identity must be encoded in UTF-8, but need not be normalized in any way.

If `OUT` is `NULL`, the function should only populate the output length field with the length, and return `GSASL_OK`. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gsasl_client_callback_authorization_id)                  [Prototype]
    (Gsasl_session_ctx * ctx, char * out, size_t * outlen)
```

*ctx*: libgsasl handle.

*out*: output array with authorization identity.

*outlen*: on input the maximum size of the output array, on output contains the actual size of the output array.

Type of callback function the application implements. It should populate the output array with authorization identity of user and set the output array length, and return `GSASL_OK`, or fail with an error code. The authorization identity must be encoded in UTF-8, but need not be normalized in any way.

If `OUT` is `NULL`, the function should only populate the output length field with the length, and return `GSASL_OK`. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gssasl_client_callback_service) (Gssasl_session_ctx * ctx,      [Prototype]
    char * service, size_t * servicelen, char * hostname, size_t *
    hostnamelen, char * servicename, size_t * servicenamelen)
```

*ctx*: libgsasl handle.

*service*: output array with name of service.

*servicelen*: on input the maximum size of the service output array, on output contains the actual size of the service output array.

*hostname*: output array with hostname of server.

*hostnamelen*: on input the maximum size of the hostname output array, on output contains the actual size of the hostname output array.

*servicename*: output array with generic name of server in case of replication (DIGEST-MD5 only).

*servicenamelen*: on input the maximum size of the servicename output array, on output contains the actual size of the servicename output array.

Type of callback function the application implements. It should retrieve the service (which should be a registered GSSAPI host based service name, such as “imap”) on the server, hostname of server (usually canonical DNS hostname) and optionally generic service name of server in case of replication (e.g. “mail.example.org” when the hostname is “mx42.example.org”, see the RFC 2831 for more information). It should return GSASL\_OK, or an error such as GSASL\_AUTHENTICATION\_ERROR if it fails.

If SERVICE, HOSTNAME or SERVICENAME is NULL, the function should only populate SERVICELLEN, HOSTNAMELEN or SERVICENAMELEN with the output length of the respective field, and return GSASL\_OK. This usage may be used by the caller to allocate the proper buffer size. Furthermore, SERVICENAMELEN may also be NULL, indicating that the mechanism is not interested in this field.

```
int (*Gssasl_server_callback_cram_md5) (Gssasl_session_ctx * ctx,      [Prototype]
    char * username, char * challenge, char * response)
```

*ctx*: libgsasl handle.

*username*: input array with username.

*challenge*: input array with CRAM-MD5 challenge.

*response*: input array with CRAM-MD5 response.

Type of callback function the application implements. It should return GSASL\_OK if and only if the validation of the provided credential was succesful. GSASL\_AUTHENTICATION\_ERROR is a good failure if authentication failed, but any available return code may be used.

```
int (*Gssasl_server_callback_digest_md5) (Gssasl_session_ctx * ctx,      [Prototype]
    char * username, char * realm, char * secrethash)
```

*ctx*: libgsasl handle.

*username*: input array with authentication identity of user.

*realm*: input array with realm of user.

*secrethash*: output array that should contain hash of username, realm and password as described for the DIGEST-MD5 mechanism.

Type of callback function the application implements. It should retrieve the secret hash for the given user in given realm and return GSASL\_OK, or an error such as GSASL\_AUTHENTICATION\_ERROR if it fails. The secrethash buffer is guaranteed to have size for the fixed length MD5 hash.

```
int (*Gsasl_server_callback_external) (Gsasl_session_ctx * ctx, [Prototype]
    ctx)
```

*ctx*: libgsasl handle.

Type of callback function the application implements. It should return GSASL\_OK if user is authenticated by out of band means, otherwise GSASL\_AUTHENTICATION\_ERROR.

```
int (*Gsasl_server_callback_gssapi) (Gsasl_session_ctx * ctx, [Prototype]
    char * clientname, char * authentication_id)
```

*ctx*: libgsasl handle.

*clientname*: input array with GSSAPI client name.

*authentication\_id*: input array with authentication identity.

Type of callback function the application implements. It should return GSASL\_OK if and only if the GSSAPI user is authorized to log on as the given authentication\_id. GSASL\_AUTHENTICATION\_ERROR is a good failure if authentication failed, but any available return code may be used. This callback is usually implemented in the application as a call to krb5\_kuserok(), such as:

```
int
callback_gssapi (Gsasl_session_ctx *ctx,
    char *clientname,
    char *authentication_id)
{
    int rc = GSASL_AUTHENTICATION_ERROR;

    krb5_principal p;
    krb5_context kcontext;

    krb5_init_context (&kcontext);

    if (krb5_parse_name (kcontext, clientname, &p) != 0)
        return -1;
    if (krb5_kuserok (kcontext, p, authentication_id))
        rc = GSASL_OK;
    krb5_free_principal (kcontext, p);

    return rc;
}
```

```
int (*Gsasl_client_callback_passcode) (Gsasl_session_ctx * ctx, [Prototype]
    char * out, size_t * outlen)
```

*ctx*: libgsasl handle.

*out*: output array with passcode.

*outlen*: on input the maximum size of the output array, on output contains the actual size of the output array.

Type of callback function the application implements. It should populate the output array with passcode of user and set the output array length, and return `GSASL_OK`, or fail with an error code.

If `OUT` is `NULL`, the function should only populate the output length field with the length, and return `GSASL_OK`. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gsassl_client_callback_password) (Gsassl_session_ctx * ctx,    [Prototype]
    char * out, size_t * outlen)
```

*ctx*: libgsasl handle.

*out*: output array with password.

*outlen*: on input the maximum size of the output array, on output contains the actual size of the output array.

Type of callback function the application implements. It should populate the output array with password of user and set the output array length, and return `GSASL_OK`, or fail with an error code. The password must be encoded in UTF-8, but need not be normalized in any way.

If `OUT` is `NULL`, the function should only populate the output length field with the length, and return `GSASL_OK`. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gsassl_server_callback_retrieve) (Gsassl_session_ctx * ctx,    [Prototype]
    char * authentication_id, char * authorization_id, char * realm, char
    * key, size_t * keylen)
```

*ctx*: libgsasl handle.

*authentication\_id*: input array with authentication identity.

*authorization\_id*: input array with authorization identity, or `NULL`.

*realm*: input array with realm of user, or `NULL`.

*key*: output array with key for authentication identity.

*keylen*: on input the maximum size of the key output array, on output contains the actual size of the key output array.

Type of callback function the application implements. It should retrieve the password for the indicated user and return `GSASL_OK`, or an error code such as `GSASL_AUTHENTICATION_ERROR`. The key must be encoded in UTF-8, but need not be normalized in any way.

If `KEY` is `NULL`, the function should only populate the `KEYLEN` output length field with the length, and return `GSASL_OK`. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gsassl_server_callback_validate) (Gsassl_session_ctx * ctx,    [Prototype]
    char * authentication_id, char * authorization_id, char * passcode,
    char * pin, char * suggestpin, size_t * suggestpinlen)
```

*ctx*: libgsasl handle.

*authorization\_id*: input array with authorization identity.

*authentication\_id*: input array with authentication identity.

*passcode*: input array with passcode.

*pin*: input array with new pin (this may be NULL).

*suggestpin*: output array with new suggested PIN.

*suggestpinlen*: on input the maximum size of the output array, on output contains the actual size of the output array.

Type of callback function the application implements. It should return GSASL\_OK if and only if the validation of the provided credential was succesful. GSASL\_AUTHENTICATION\_ERROR is a good failure if authentication failed, but any available return code may be used.

Two SECURID specific error codes also exists. The function can return GSASL\_SECURID\_SERVER\_NEED\_ADDITIONAL\_PASSCODE to request that the client generate a new passcode. It can also return GSASL\_SECURID\_SERVER\_NEED\_NEW\_PIN to request that the client generate a new PIN. If the server wishes to suggest a new PIN it can populate the SUGGESTPIN field.

If SUGGESTPIN is NULL, the function should only populate the output length field with the length, and return GSASL\_OK. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gsasl_server_callback_service) (Gsasl_session_ctx * ctx, [Prototype]
    char * service, size_t * servicelen, char * hostname, size_t *
    hostnamelen)
```

*ctx*: libgsasl handle.

*service*: output array with name of service.

*servicelen*: on input the maximum size of the service output array, on output contains the actual size of the service output array.

*hostname*: output array with hostname of server.

*hostnamelen*: on input the maximum size of the hostname output array, on output contains the actual size of the hostname output array.

Type of callback function the application implements. It should retrieve the service (which should be a registered GSSAPI host based service name, such as “imap”) the server provides and hostname of server (usually canoncial DNS hostname). It should return GSASL\_OK, or an error such as GSASL\_AUTHENTICATION\_ERROR if it fails.

If SERVICE or HOSTNAME is NULL, the function should only populate SERVICELEN or HOSTNAMELEN with the output length of the respective field, and return GSASL\_OK. This usage may be used by the caller to allocate the proper buffer size.

```
int (*Gsasl_server_callback_validate) (Gsasl_session_ctx * ctx, [Prototype]
    char * authorization_id, char * authentication_id, char * password)
```

*ctx*: libgsasl handle.

*authorization\_id*: input array with authorization identity.

*authentication\_id*: input array with authentication identity.

*password*: input array with password.

Type of callback function the application implements. It should return GSASL\_OK if and only if the validation of the provided credential was succesful. GSASL\_AUTHENTICATION\_ERROR is a good failure if authentication failed, but any available return code may be used.

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In other cases, permission to use a particular library in non-free programs enables a greater number of people to use a large body of free software. For example, permission to



use the GNU C Library in non-free programs enables many more people to use the whole GNU operating system, as well as its variant, the GNU/Linux operating system.

Although the Lesser General Public License is Less protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

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A "library" means a collection of software functions and/or data prepared so as to be conveniently linked with application programs (which use some of those functions and data) to form executables.

The "Library", below, refers to any such software library or work which has been distributed under these terms. A "work based on the Library" means either the Library or any derivative work under copyright law: that is to say, a work containing the Library or a portion of it, either verbatim or with modifications and/or translated straightforwardly into another language. (Hereinafter, translation is included without limitation in the term "modification".)

"Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

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2. You may modify your copy or copies of the Library or any portion of it, thus forming a work based on the Library, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:



- a. The modified work must itself be a software library.
- b. You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.
- c. You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.
- d. If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

- 3. You may opt to apply the terms of the ordinary GNU General Public License instead of this License to a given copy of the Library. To do this, you must alter all the notices that refer to this License, so that they refer to the ordinary GNU General Public License, version 2, instead of to this License. (If a newer version than version 2 of the ordinary GNU General Public License has appeared, then you can specify that version instead if you wish.) Do not make any other change in these notices.

Once this change is made in a given copy, it is irreversible for that copy, so the ordinary GNU General Public License applies to all subsequent copies and derivative works made from that copy.

This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

- 4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code,

which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a “work that uses the Library”. Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a “work that uses the Library” with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a “work that uses the library”. The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a “work that uses the Library” uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a “work that uses the Library” with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer’s own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

- a. Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable “work that uses the Library”, as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions

files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

- b. Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.
- c. Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.
- d. If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.
- e. Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the “work that uses the Library” must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:
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To apply these terms, attach the following notices to the library. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the “copyright” line and a pointer to where the full notice is found.

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Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301,
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You should also get your employer (if you work as a programmer) or your school, if any, to sign a “copyright disclaimer” for the library, if necessary. Here is a sample; alter the names:

```
Yoyodyne, Inc., hereby disclaims all copyright interest in the library
‘Frob’ (a library for tweaking knobs) written by James Random Hacker.
```

```
signature of Ty Coon, 1 April 1990
Ty Coon, President of Vice
```

That’s all there is to it!

## C.3 GNU General Public License

Version 3, 29 June 2007

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Some devices are designed to deny users access to install or run modified versions of the software inside them, although the manufacturer can do so. This is fundamentally incompatible with the aim of protecting users' freedom to change the software. The systematic pattern of such abuse occurs in the area of products for individuals to use, which is precisely where it is most unacceptable. Therefore, we have designed this version of the GPL to prohibit the practice for those products. If such problems arise substantially in other domains, we stand ready to extend this provision to those domains in future versions of the GPL, as needed to protect the freedom of users.

Finally, every program is threatened constantly by software patents. States should not allow patents to restrict development and use of software on general-purpose computers, but in those that do, we wish to avoid the special danger that patents applied to a free program could make it effectively proprietary. To prevent this, the GPL assures that patents cannot be used to render the program non-free.

The precise terms and conditions for copying, distribution and modification follow.

## TERMS AND CONDITIONS

### 0. Definitions.

“This License” refers to version 3 of the GNU General Public License.

“Copyright” also means copyright-like laws that apply to other kinds of works, such as semiconductor masks.



“The Program” refers to any copyrightable work licensed under this License. Each licensee is addressed as “you”. “Licensees” and “recipients” may be individuals or organizations.

To “modify” a work means to copy from or adapt all or part of the work in a fashion requiring copyright permission, other than the making of an exact copy. The resulting work is called a “modified version” of the earlier work or a work “based on” the earlier work.

A “covered work” means either the unmodified Program or a work based on the Program.

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To “convey” a work means any kind of propagation that enables other parties to make or receive copies. Mere interaction with a user through a computer network, with no transfer of a copy, is not conveying.

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#### 1. Source Code.

The “source code” for a work means the preferred form of the work for making modifications to it. “Object code” means any non-source form of a work.

A “Standard Interface” means an interface that either is an official standard defined by a recognized standards body, or, in the case of interfaces specified for a particular programming language, one that is widely used among developers working in that language.

The “System Libraries” of an executable work include anything, other than the work as a whole, that (a) is included in the normal form of packaging a Major Component, but which is not part of that Major Component, and (b) serves only to enable use of the work with that Major Component, or to implement a Standard Interface for which an implementation is available to the public in source code form. A “Major Component”, in this context, means a major essential component (kernel, window system, and so on) of the specific operating system (if any) on which the executable work runs, or a compiler used to produce the work, or an object code interpreter used to run it.

The “Corresponding Source” for a work in object code form means all the source code needed to generate, install, and (for an executable work) run the object code and to modify the work, including scripts to control those activities. However, it does not include the work’s System Libraries, or general-purpose tools or generally available free programs which are used unmodified in performing those activities but which are not part of the work. For example, Corresponding Source includes interface definition



files associated with source files for the work, and the source code for shared libraries and dynamically linked subprograms that the work is specifically designed to require, such as by intimate data communication or control flow between those subprograms and other parts of the work.

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- c. You must license the entire work, as a whole, under this License to anyone who comes into possession of a copy. This License will therefore apply, along with any applicable section 7 additional terms, to the whole of the work, and all its parts, regardless of how they are packaged. This License gives no permission to license the work in any other way, but it does not invalidate such permission if you have separately received it.
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A compilation of a covered work with other separate and independent works, which are not by their nature extensions of the covered work, and which are not combined with it such as to form a larger program, in or on a volume of a storage or distribution medium, is called an “aggregate” if the compilation and its resulting copyright are not used to limit the access or legal rights of the compilation’s users beyond what the individual works permit. Inclusion of a covered work in an aggregate does not cause this License to apply to the other parts of the aggregate.

#### 6. Conveying Non-Source Forms.

You may convey a covered work in object code form under the terms of sections 4 and 5, provided that you also convey the machine-readable Corresponding Source under the terms of this License, in one of these ways:

- a. Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by the Corresponding Source fixed on a durable physical medium customarily used for software interchange.
- b. Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by a written offer, valid for at least three years and valid for as long as you offer spare parts or customer support for that product model, to give anyone who possesses the object code either (1) a copy of the Corresponding Source for all the software in the product that is covered by this License, on a durable physical medium customarily used for software interchange, for a price no more than your reasonable cost of physically performing this conveying of source, or (2) access to copy the Corresponding Source from a network server at no charge.
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- d. Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.
- e. Convey the object code using peer-to-peer transmission, provided you inform other peers where the object code and Corresponding Source of the work are being offered to the general public at no charge under subsection 6d.

A separable portion of the object code, whose source code is excluded from the Corresponding Source as a System Library, need not be included in conveying the object code work.

A “User Product” is either (1) a “consumer product”, which means any tangible personal property which is normally used for personal, family, or household purposes, or (2) anything designed or sold for incorporation into a dwelling. In determining whether a product is a consumer product, doubtful cases shall be resolved in favor of coverage. For a particular product received by a particular user, “normally used” refers to a typical or common use of that class of product, regardless of the status of the particular user or of the way in which the particular user actually uses, or expects or is expected to use, the product. A product is a consumer product regardless of whether the product has substantial commercial, industrial or non-consumer uses, unless such uses represent the only significant mode of use of the product.

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materially and adversely affects the operation of the network or violates the rules and protocols for communication across the network.

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