

GNU SASL

Simple Authentication and Security Layer for the GNU system
for version 0.2.0, 7 November 2004

Simon Josefsson

This manual is last updated 7 November 2004 for version 0.2.0 of GNU SASL.

Copyright © 2002, 2003, 2004 Simon Josefsson.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation; with the Invariant Sections being “Commercial Support”, no Front-Cover Texts, and no Back-Cover Texts. A copy of the license is included in the section entitled “GNU Free Documentation License”.

Table of Contents

1	Introduction	1
1.1	Getting Started	1
1.2	Features	2
1.3	SASL Overview	2
1.4	Supported Platforms	3
1.5	Commercial Support	5
1.6	Downloading and Installing	5
1.7	Bug Reports	6
1.8	Contributing	6
2	Preparation	8
2.1	Header	8
2.2	Initialization	8
2.3	Version Check	10
2.4	Building the source	10
2.5	Autoconf tests	11
2.5.1	Autoconf test via ‘pkg-config’	11
2.5.2	Standalone Autoconf test using Libtool	11
3	Using the Library	13
3.1	Choosing a mechanism	17
3.2	Using a callback	18
4	Properties	20
5	Mechanisms	22
5.1	The EXTERNAL mechanism	22
5.2	The ANONYMOUS mechanism	22
5.3	The PLAIN mechanism	23
5.4	The LOGIN mechanism	23
5.5	The CRAM-MD5 mechanism	23
5.6	The DIGEST-MD5 mechanism	24
5.7	The NTLM mechanism	24
5.8	The SECURID mechanism	24
5.9	The GSSAPI mechanism	25
5.10	The KERBEROS_V5 mechanism	25
6	Global Functions	26
7	Callback Functions	28

8	Property Functions	30
9	Session Functions	32
10	Utilities	34
11	Error Handling	37
11.1	Error values	37
11.2	Error strings	40
12	Examples	41
12.1	Example 1	41
12.2	Example 2	43
12.3	Example 3	46
12.4	Example 4	49
13	Acknowledgements	53
14	Invoking gssasl	54
Appendix A	Protocol Clarifications	57
A.1	Server-side use of SASLPrep in CRAM-MD5	57
Appendix B	Old Functions	58
B.1	Obsolete callback function prototypes	70
Appendix C	Copying This Manual	76
C.1	GNU Free Documentation License	76
C.1.1	ADDENDUM: How to use this License for your documents	82
	Concept Index	83
	Function and Data Index	84

1 Introduction

GNU SASL is an implementation of the Simple Authentication and Security Layer framework and a few common SASL mechanisms. SASL is used by network servers (e.g., IMAP, SMTP) to request authentication from clients, and in clients to authenticate against servers.

GNU SASL contains 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, 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 utilize 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 support client and server mode, and the IMAP and SMTP protocols, fits in under 60kb on an Intel x86 platform, without any modifications to the code. (This figure was accurate as of version 0.0.13.)

The library is licensed under the GNU Lesser General Public License, and the command-line interface, self-tests and examples are licensed under the GNU General Public License.

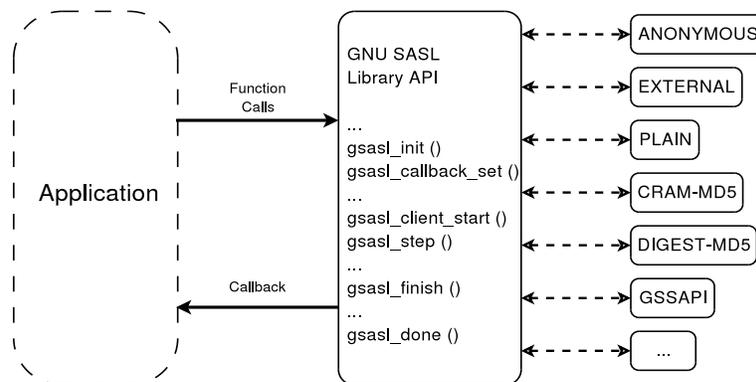


Illustration 1.1: Logical overview showing how applications use authentication mechanisms through an abstract interface.

1.1 Getting Started

This manual documents the GNU SASL Library programming interface. All functions and data types provided by the library are explained.

The reader is assumed to possess basic familiarity with SASL and network programming in C or C++.

This manual can be used in several ways. If read from the beginning to the end, it gives a good introduction into the library and how it can be 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.

1.2 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. The library can even be distributed under the GNU Lesser General Public License.

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 username 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.

Note that the library do 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.

1.3 SASL Overview

This section describes SASL from a protocol point of view.

The Simple Authentication and Security Layer (SASL) is a method for adding authentication support to connection-based protocols. A protocol includes a command for identifying and authenticating a user to a server and for optionally negotiating a security layer for subsequent protocol interactions.

The command has a required argument identifying a SASL mechanism. SASL mechanisms are named by strings, from 1 to 20 characters in length, consisting of upper-case letters, digits, hyphens, and/or underscores.

If a server supports the requested mechanism, it initiates an authentication protocol exchange. This consists of a series of server challenges and client responses that are specific to the requested mechanism. The challenges and responses are defined by the mechanisms as binary tokens of arbitrary length. The protocol's profile then specifies how these binary tokens are then encoded for transfer over the connection.

After receiving the authentication command or any client response, a server may issue a challenge, indicate failure, or indicate completion. The protocol's profile specifies how the server indicates which of the above it is doing.

After receiving a challenge, a client may issue a response or abort the exchange. The protocol's profile specifies how the client indicates which of the above it is doing.

During the authentication protocol exchange, the mechanism performs authentication, transmits an authorization identity (frequently known as a userid) from the client to server, and negotiates the use of a mechanism-specific security layer. If the use of a security layer is agreed upon, then the mechanism must also define or negotiate the maximum cipher-text buffer size that each side is able to receive.

The transmitted authorization identity may be different than the identity in the client's authentication credentials. This permits agents such as proxy servers to authenticate using their own credentials, yet request the access privileges of the identity for which they are proxying. With any mechanism, transmitting an authorization identity of the empty string directs the server to derive an authorization identity from the client's authentication credentials.

If use of a security layer is negotiated, it is applied to all subsequent data sent over the connection. The security layer takes effect immediately following the last response of the authentication exchange for data sent by the client and the completion indication for data sent by the server. Once the security layer is in effect, the protocol stream is processed by the security layer into buffers of cipher-text. Each buffer is transferred over the connection as a stream of octets prepended with a four octet field in network byte order that represents the length of the following buffer. The length of the cipher-text buffer must be no larger than the maximum size that was defined or negotiated by the other side.

1.4 Supported Platforms

GNU SASL has at some point in time been tested on the following platforms.

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.

1.5 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
Hagagatan 24
113 47 Stockholm
Sweden

E-mail: simon@josefsson.org

If your company provide support related to GNU SASL and would like to be mentioned here, contact the author (see [Section 1.7 \[Bug Reports\]](#), page 6).

1.6 Downloading and Installing

The package can be downloaded from several places, including:

<http://josefsson.org/gsas1/releases/>

The latest version is stored in a file, e.g., ‘`gsasl-0.2.0.tar.gz`’ where the ‘0.2.0’ 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 download, configure, build and install the package. You will need a few basic tools, such as ‘sh’, ‘make’ and ‘cc’.

```
$ wget -q http://josefsson.org/gsas1/releases/gsas1-0.2.0.tar.gz
$ tar xzf gsasl-0.2.0.tar.gz
$ cd gsasl-0.2.0/
$ ./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 do 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-anonymous
--disable-external
--disable-plain
--disable-login
--disable-securid
--disable-ntlm
--disable-cram-md5
--disable-digest-md5
--disable-gssapi
--disable-kerberos_v5
```

Disable individual mechanisms (see [Chapter 5 \[Mechanisms\]](#), page 22).

```
--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`.

1.7 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'`

1.8 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 1.7 \[Bug Reports\]](#), page 6). 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 12 \[Examples\]](#), page 41).

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 26). 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 *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 *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 Libgcrypt¹, 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. Example code to initialize secure memory in your code:

```

#include <gcrypt.h>
...
int
main (int argc, char *argv[])
{
    Gsasl_ctx *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;
    }
...

```

¹ Note that GNU SASL can also use Nettle for the Crypto backend. 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 application is not the biggest secure problem anyway). Note that the GNU SASL Library has not been audited to make sure it only ever 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 is actually used. So you may want to check that the version is okay right after program startup.

```
const char * gsas1_check_version (const char * req_version)      [Function]
    req_version: version string to compare with, or NULL
```

Check library version.

Return value: Check that the 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 compilers 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 ‘libgsasl’ library (for instance, the ‘-lidn’ option). The example shows how to link ‘foo.o’ with the ‘libgsasl’ 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 illustrate 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 >= 0.2.0,
[gsasl=yes],
[gsasl=no])
if test "$gsasl" != "yes" ; then
sal=no
AC_MSG_WARN([Cannot find GNU SASL, disabling])
else
gsasl=yes
AC_DEFINE(USE_GSASL, 1, [Define to 1 if you want GNU SASL.])
fi
fi
AC_MSG_CHECKING([if GNU SASL should be used])
AC_MSG_RESULT($gsasl)
```

2.5.2 Standalone Autoconf test using Libtool

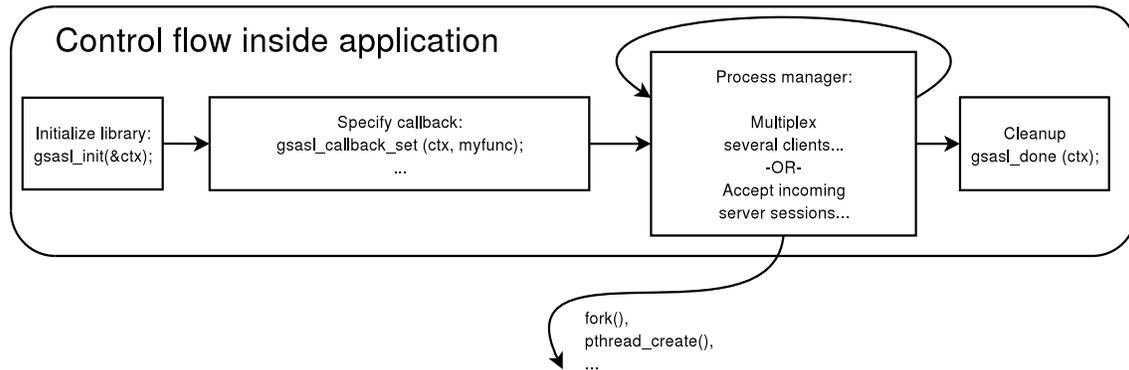
If your package uses Libtool(see [\[top\]](#), page [\[undefined\]](#)), you can use the normal Autoconf tests to find Libgsasl and rely on the Libtool dependency tracking to include the proper dependency libraries (e.g., Libidn). The following illustrate this scenario.

```
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 illustrate this.



The third step may look the most complex, but for a simple client it will actually not involve any code. If your application need to handle several concurrent clients, or if it is a server that need to serve many clients simultaneous, 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 username or passwords, 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 our `main` function in our client (see [Section 12.1 \[Example 1\], page 41](#)):

```

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.

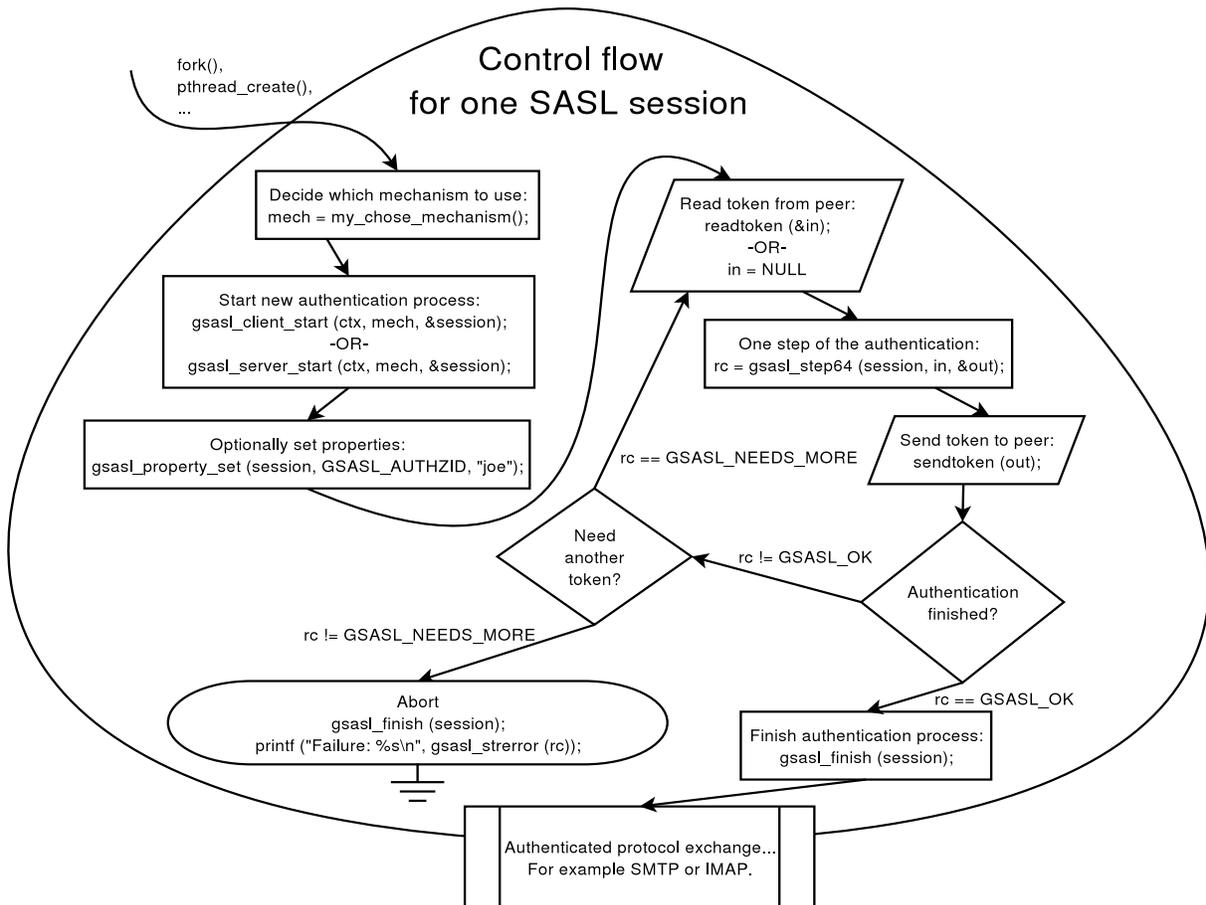
For a more complicated application, that have several clients running simultaneous, instead of simply calling `client`, it may have created new threads for each session, and call `client` within each thread. The library is thread safe.

An actual authentication session is more complicated than what we have seen so far. The steps that make up it are: 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 there is an error. The format of the data to transfer, 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 a buffer. You must send it to the server yourself, according to 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 (Gsasl *ctx)
{
    Gsasl_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 (ctx, 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 create a new session, store the username and password in the session handle, then call another function `client_authenticate` to handle the authentication loop, and end by cleaning up. Let’s continue with the implementation of `client_authenticate`.

```

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

    /* This loop mimic a protocol where the server get to send data
       first. */

    do
    {
        printf ("Input base64 encoded data from server:\n");
        fgets (buf, sizeof (buf) - 1, stdin);

        rc = gssasl_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, gssasl_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 need 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 12.2 \[Example 2\], page 43](#)) is used for application profiles where the server send data first. For some mechanisms, this may waste a roundtrip, because the server need input from the client to proceed. Therefore, today the recommended approach is to permit client to send data first (see [Section 12.1 \[Example 1\], page 41](#)). Which version you should use depend 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 `gssasl_step64` (and of course also `gssasl_step`) return two non-error return codes. `GSASL_OK` is used for success, indicating that the library consider 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 reply "OK" but these function has 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 conclude the authentication process, with no data, you should call `gssasl_step64` (or `gssasl_step`) specifying a zero-length token.

If the functions (`gssasl_step` and `gssasl_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 mechanism 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 26](#)) that will try to pick the “best” available mechanism from a list of mechanisms. Our simple interactive example client (see [Section 12.3 \[Example 3\], page 46](#)) include 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`, but rather let 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 mechanism that server support, separate by SPC:\n");
    fgets (mechlist, sizeof (mechlist) - 1, stdin);

    suggestion = gsasl_client_suggest_mechanism (ctx, mechlist);
    if (suggestion)
        printf ("Library suggest 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 of mechanism that server support, separate by SPC:
CRAM-MD5 DIGEST-MD5 GSSAPI FOO BAR
Library suggest use of 'GSSAPI'.
Enter mechanism to use:
CRAM-MD5
Input base64 encoded data from server:
Zm5vcnQ=
Output:
amFzIDkyY2U1NWE5MTM2ZTY4NzEyMTUyZTFjYmFmNjVkJjgk
```

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 only ever need an username and a password. But some mechanism require 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 abort the authentication process? Then your application have 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 need 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 abort, 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 12.4 \[Example 4\], page 49](#)) specify 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 See [Chapter 4 \[Properties\], page 20](#), 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

Properties with associated data:

- **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_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.

Abstract 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 query the user for a username and password. The server callback hand the username and password into any local policy deciding authentication system (such as ‘/etc/passwd’ via PAM).

Mechanism such as ‘CRAM-MD5’ and ‘DIGEST-MD5’ uses hashed passwords. The client callback behaviour is the same as for PLAIN. However, the server do 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 that TLS is used, since they also support anonymous modes.

In the client, this mechanism is always enabled, and 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 invoke the `GSASL_VALIDATE_EXTERNAL` callback 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, indicate 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 is provided.

In the first approach, the server side of the mechanism will invoke 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.

If the first approach fails (because, e.g., your callback return ‘`GSASL_NO_CALLBACK`’) the mechanism will continue to query the application for a password, via the `GSASL_PASSWORD` property. The password is then normalized using SASLprep and compared to the client credential.

Which approach to use? If the passwords in your user database are stored in a prepared form (using SASLprep), the first approach will be faster. If you do not have prepared passwords available, you must use the second approach, to make sure the password has been prepared properly.

5.4 The LOGIN mechanism

The LOGIN mechanism is a non-standard mechanism, and is similar to the PLAIN mechanism except that LOGIN lack 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 not used nor required, and that the server do not normalize the password using SASLprep.

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 transfer 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 do not support authorization identities; making the relationship between PLAIN and LOGIN similar to the relationship between DIGEST-MD5 and CRAM-MD5.

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 require the `GSASL_AUTHID` and `GSASL_PASSWORD` properties.

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

See [Section A.1 \[Server-side use of SASLPrep in CRAM-MD5\]](#), page 57, 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 the same cryptographic primitive as CRAM-MD5 (namely the challenge-response HMAC-MD5 system), 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 need access to (a possibly hashed) form of the correct password to verify the client response, which make it impossible to use, e.g., PAM on the server side.

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 will invoke the `GSASL_PASSWORD` callback, which may use the `GSASL_AUTHID` property to determine which users' password should be used. The server will then normalize the password, and compare the client response with a known correct computed response, and accept the user accordingly.

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

5.7 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 require the `GSASL_AUTHID` and `GSASL_PASSWORD` properties.

5.8 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 require 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 callbacks has 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.

5.9 The GSSAPI mechanism

GSS-API is a framework, similar to SASL, for authentication. The GSSAPI mechanism only support 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 require the `GSASL_AUTHID`, `GSASL_SERVICE`, and `GSASL_HOSTNAME` properties.

In the server, the mechanism require the `GSASL_SERVICE`, and `GSASL_HOSTNAME` properties, and will invoke the `GSASL_VALIDATE_GSSAPI` callback 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.

5.10 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), 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

`int gssasl_init (Gssasl ** ctx)` [Function]
ctx: pointer to libgssasl handle.

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

Return value: GSASL_OK iff successful, otherwise GSASL_MALLOC_ERROR.

`void gssasl_done (Gssasl * ctx)` [Function]
ctx: libgssasl handle.

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

`int gssasl_client_mechlist (Gssasl * ctx, char ** out)` [Function]
ctx: libgssasl handle.

out: newly allocated output character array.

Return a newly allocated string containing SASL names, separated by space, of mechanisms supported by the libgssasl 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.

`int gssasl_server_mechlist (Gssasl * ctx, char ** out)` [Function]
ctx: libgssasl handle.

out: newly allocated output character array.

Return a newly allocated string containing SASL names, separated by space, of mechanisms supported by the libgssasl 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.

`int gssasl_client_support_p (Gssasl * ctx, const char * name)` [Function]
ctx: libgssasl handle.

name: name of SASL mechanism.

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

`int gssasl_server_support_p (Gssasl * ctx, const char * name)` [Function]
ctx: libgssasl handle.

name: name of SASL mechanism.

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

```
const char * gssasl_client_suggest_mechanism (Gssasl * ctx,          [Function]  
      const char * mechlist)
```

ctx: libgssasl 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 libgssasl client which is present in the input string.

```
int gssasl_register (Gssasl * ctx, const Gssasl_mechanism * mech)    [Function]
```

ctx: pointer to libgssasl 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 to access to data from other parts of your application, there are hooks to store and retrieve application specific pointers. This avoid the use of global variables in your application, 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`.

```
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

```
int gsasl_callback (Gsasl * ctx, Gsasl_session * sctx, Gsasl_property      [Function]
                    prop)
```

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

```
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()`. It is normally used by the application to maintain state between the main program and the callback.

Since: 0.2.0

```
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()`. 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.

Since: 0.2.0

8 Property Functions

`void gsasl_property_set (Gsasl_session * sctx, Gsasl_property prop, [Function]
 const char * data)`

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

`void gsasl_property_set_raw (Gsasl_session * sctx, Gsasl_property [Function]
 prop, const char * data, size_t len)`

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

`const char * gsasl_property_fast (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*.

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

`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

`int gssasl_client_start (Gssasl * ctx, const char * mech,` [Function]

`Gssasl_session ** sctx)`

ctx: libgssasl 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 `gssasl_client_*`() function is called.

Return value: Returns `GSASL_OK` if successful, or error code.

`int gssasl_server_start (Gssasl * ctx, const char * mech,` [Function]

`Gssasl_session ** sctx)`

ctx: libgssasl 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 `gssasl_server_*`() function is called.

Return value: Returns `GSASL_OK` if successful, or error code.

`int gssasl_step (Gssasl_session * sctx, const char * input, size_t` [Function]

`input_len, char ** output, size_t * output_len)`

sctx: libgssasl 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.

`int gssasl_step64 (Gssasl_session * sctx, const char * b64input, char` [Function]

`** b64output)`

sctx: libgssasl 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.

`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.

`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.

`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.

10 Utilities

`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*, or NULL on error.

`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.

`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.

`int gssasl_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.

`int gssasl_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.

`int gssasl_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 *username\tpassword*. This function removes \r and \n at the end of lines before processing.

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.

`int gssasl_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.

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

11 Error Handling

Most functions in the GNU SASL Library are returning 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.

11.1 Error values

Errors are returned as an `int`. Except for the OK case an application should always use the constants instead of their numeric value. Applications are encouraged to use the constants even for OK as it improves readability. Possible values are:

`GSASL_OK` This value indicates success. The value of this error is guaranteed to always be 0 so you may use it in boolean constructs.

`GSASL_NEEDS_MORE`
SASL mechanisms 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 need 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_GCRYPT_ERROR`
Gcrypt error in SASL library

`GSASL_GSSAPI_RELEASE_BUFFER_ERROR`
GSSAPI library could not deallocate memory in `gss_release_buffer()` in SASL library. This is a serious internal error.

`GSASL_GSSAPI_IMPORT_NAME_ERROR`
GSSAPI library could not understand a peer name in `gss_import_name()` in SASL library. This may be due to incorrect user supplied data.

GSASL_GSSAPI_INIT_SEC_CONTEXT_ERROR

GSSAPI error in client while negotiating security context in `gss_init_sec_context()` 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 `gss_init_sec_context()` 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 `gss_unwrap()` in SASL library. This is most likely due to data corruption.

GSASL_GSSAPI_WRAP_ERROR

GSSAPI error while encrypting or encoding data in `gss_wrap()` 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_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_ANONYMOUS_CALLBACK
SASL mechanism needs `gsasl_server_callback_anonymous()` callback (application error)

GSASL_NEED_SERVER_EXTERNAL_CALLBACK
SASL mechanism needs `gsasl_server_callback_external()` 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 `gsasl_server_callback_retrieve()` callback (application error)

GSASL_MECHANISM_PARSE_ERROR
SASL mechanism could not parse input

GSASL_AUTHENTICATION_ERROR
Error authentication user

GSASL_CANNOT_GET_CTX
Cannot get internal library handle (library error)

GSASL_INTEGRITY_ERROR
Integrity error in application payload

<code>GSASL_NO_MORE_REALMS</code>	No more realms available (non-fatal)
<code>GSASL_NO_CLIENT_CODE</code>	Client-side functionality not available in library (application error)
<code>GSASL_NO_SERVER_CODE</code>	Server-side functionality not available in library (application error)
<code>GSASL_INVALID_HANDLE</code>	The provided library handle was invalid (application error)
<code>GSASL_NO_CALLBACK</code>	No callback specified by caller (application error).
<code>GSASL_NO_ANONYMOUS_TOKEN</code>	Authentication failed because the anonymous token was not provided.
<code>GSASL_NO_AUTHID</code>	Authentication failed because the authentication identity was not provided.
<code>GSASL_NO_AUTHZID</code>	Authentication failed because the authorization identity was not provided.
<code>GSASL_NO_PASSWORD</code>	Authentication failed because the password was not provided.
<code>GSASL_NO_PASSCODE</code>	Authentication failed because the passcode was not provided.
<code>GSASL_NO_PIN</code>	Authentication failed because the pin code was not provided.
<code>GSASL_NO_SERVICE</code>	Authentication failed because the service name was not provided.
<code>GSASL_NO_HOSTNAME</code>	Authentication failed because the host name was not provided.
<code>GSASL_UNICODE_NORMALIZATION_ERROR</code>	Failed to perform Unicode Normalization on string.

11.2 Error strings

`const char * gssasl_strerror (int err)` [Function]
err: libgssasl error code

Return value: Returns a pointer to a statically allocated string containing a description of the error with the error value *err*. This string can be used to output a diagnostic message to the user.

12 Examples

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

12.1 Example 1

```

/* client.c --- Example SASL client.
 * Copyright (C) 2004 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * GNU SASL 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 2 of the License, or
 * (at your option) any later version.
 *
 * GNU SASL 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 GNU SASL; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA
 */

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

#include <gsasl.h>

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

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

    do
    {
        /* Generate client output. */

```

```

    rc = gssasl_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);
    }
}
while (rc == GSASL_NEEDS_MORE);

printf ("\n");

if (rc != GSASL_OK)
{
    printf ("Authentication error (%d): %s\n", rc, gssasl_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 = "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 (ctx, 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. */
    gssasl_done (ctx);

    return 0;
}

```

12.2 Example 2

```

/* client-serverfirst.c --- Example SASL client, where server send data first.
 * Copyright (C) 2004 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * GNU SASL 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 2 of the License, or
 * (at your option) any later version.
 *
 * GNU SASL 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 GNU SASL; if not, write to the Free Software
* Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA
*
*/

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

#include <gsasl.h>

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

    /* This loop mimic a protocol where the server get to send data first. */

    do
    {
        printf ("Input base64 encoded data from server:\n");
        fgets (buf, sizeof (buf) - 1, stdin);

        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 (ctx, 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;
}

```

12.3 Example 3

```

/* client-mech.c --- Example SASL client, with a choice of mechanism to use.
 * Copyright (C) 2004 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * GNU SASL 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 2 of the License, or
 * (at your option) any later version.
 *
 * GNU SASL 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 GNU SASL; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA
 */

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

#include <gsasl.h>

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

    /* This loop mimic a protocol where the server get to send data first. */

```

```

do
{
    printf ("Input base64 encoded data from server:\n");
    fgets (buf, sizeof (buf) - 1, stdin);

    rc = gssasl_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, gssasl_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 (Gssasl *ctx)
{
    static char mech[GSASL_MAX_MECHANISM_SIZE + 1] = "";
    char meclist[BUFSIZ] = "";
    const char *suggestion;

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

    suggestion = gssasl_client_suggest_mechanism (ctx, meclist);
    if (suggestion)
        printf ("Library suggest 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 (Gssasl *ctx)
{
    Gssasl_session *session;
    const char *mech;
    int rc;

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

    /* 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 (ctx, 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;
}

```

12.4 Example 4

```

/* client-callback.c --- Example SASL client, with callback for user info.
 * Copyright (C) 2004 Simon Josefsson
 *
 * This file is part of GNU SASL.
 *
 * GNU SASL 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 2 of the License, or
 * (at your option) any later version.
 *
 * GNU SASL 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 GNU SASL; if not, write to the Free Software
 * Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA
 */

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

#include <gsasl.h>

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

    /* This loop mimic a protocol where the server get to send data first. */

    do

```

```

    {
        printf ("Input base64 encoded data from server:\n");
        fgets (buf, sizeof (buf) - 1, stdin);

        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 (ctx, session);

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

```

```
}

static int
callback (Gssasl * ctx, Gssasl_session * sctx, Gssasl_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';

            gssasl_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';

            gssasl_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[])
{
    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;
}

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

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

/* Cleanup. */
gssasl_done (ctx);

return 0;
}
```

13 Acknowledgements

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

Cryptographic functions for some SASL mechanisms uses Libgrypt 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.

This manual borrows text from the SASL specification.

14 Invoking gssasl

Name

GNU SASL (gssasl) – Command line interface to libgssasl.

Description

`gssasl` 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

`gssasl` recognizes these commands:

<code>-c, --client</code>	Act as client.
<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. <code>SERVICE</code> 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 28](#)) in the library. The default is the query the user on the terminal.

<code>-a, --authentication-id=STRING</code>	Identity of credential owner.
<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>-n, --anonymous-token=STRING</code>	Token for anonymous authentication, usually mail address (ANONYMOUS only).
<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=<auth auth-int auth-conf></code>	How application payload will be protected. "auth" means no protection, "auth-int" means integrity protection, "auth-conf" means integrity and confidentiality protection. Currently only used by DIGEST-MD5, where the default is "auth-conf".
<code>-r, --realm=STRING</code>	Realm (may be given more than once iff server). 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).
<code>-z, --authorization-id=STRING</code>	Identity to request service for.

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 contain clarification to various SASL specification that we felt were necessary to include, if for nothing else it may serve as a guide for other implementors that worry about the same issues.

A.1 Server-side use of SASLPrep in CRAM-MD5

The specification, as of draft-ietf-sasl-crammd5-02, 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).

In the server, GNU SASL apply SASLPrep to the password with the AllowUnassigned bit cleared.

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.

`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 `out=NULL`.

Return value: Returns GSASL_OK if successful, or error code.

Deprecated: Use `gsasl_client_mechlist()` instead.

`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 `out=NULL`.

Return value: Returns GSASL_OK if successful, or error code.

Deprecated: Use `gsasl_server_mechlist()` instead.

`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.

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

sctx: libgssasl 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 `gssasl_step()` instead.

`int gssasl_client_step_base64 (Gssasl_session * sctx, const char * [Function]
 b64input, char * b64output, size_t b64output_len)`

sctx: libgssasl 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 `gssasl_client_step()` that base64 decodes the input and base64 encodes the output.

Return value: See `gssasl_client_step()`.

Deprecated: Use `gssasl_step64()` instead.

`int gssasl_server_step_base64 (Gssasl_session * sctx, const char * [Function]
 b64input, char * b64output, size_t b64output_len)`

sctx: libgssasl 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 `gssasl_server_step()` that base64 decodes the input and base64 encodes the output.

Return value: See `gssasl_server_step()`.

Deprecated: Use `gssasl_step64()` instead.

`void gssasl_client_finish (Gssasl_session * sctx) [Function]`

sctx: libgssasl client handle.

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

Deprecated: Use `gssasl_finish()` instead.

`void gssasl_server_finish (Gssasl_session * sctx)` [Function]
sctx: libgssasl server handle.

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

Deprecated: Use `gssasl_finish()` instead.

`Gssasl * gssasl_client_ctx_get (Gssasl_session * sctx)` [Function]
sctx: libgssasl client handle

Return value: Returns the libgssasl handle given a libgssasl client handle.

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

`void gssasl_client_application_data_set (Gssasl_session * sctx, [Function]
 void * application_data)`
sctx: libgssasl client handle.

application_data: opaque pointer to application specific data.

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

Deprecated: Use `gssasl_callback_hook_set()` instead.

`void * gssasl_client_application_data_get (Gssasl_session * [Function]
sctx)`
sctx: libgssasl client handle.

Retrieve application specific data from libgssasl client handle. The application data is set using `gssasl_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 `gssasl_callback_hook_get()` instead.

`Gssasl * gssasl_server_ctx_get (Gssasl_session * sctx)` [Function]
sctx: libgssasl server handle

Return value: Returns the libgssasl handle given a libgssasl server handle.

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

`void gssasl_server_application_data_set (Gssasl_session * sctx, [Function]
 void * application_data)`
sctx: libgssasl server handle.

application_data: opaque pointer to application specific data.

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

Deprecated: Use `gssasl_callback_hook_set()` instead.

`void * gssasl_server_application_data_get (Gssasl_session * sctx)` [Function]

sctx: libgssasl server handle.

Retrieve application specific data from libgssasl server handle. The application data is set using `gssasl_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 `gssasl_callback_hook_get()` instead.

`int gssasl_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 GSSASL_OK iff successful.

Deprecated: Use `gssasl_random()` or `gssasl_nonce()` instead.

`Gssasl * gssasl_ctx_get (Gssasl_session * sctx)` [Function]

sctx: libgssasl session handle

Return value: Returns the libgssasl handle given a libgssasl session handle.

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

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

sctx: libgssasl 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 GSSASL_OK if encoding was successful, otherwise an error code.

Deprecated: Use `gssasl_encode()` instead.

Since: 0.2.0

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

sctx: libgssasl 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

```
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.

```
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.

```
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.

```
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.

```
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.

```
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()`.

```
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()`.

```
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()`.

```
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()`.

```
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()`.

```
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()`.

`void gssasl_client_callback_passcode_set (Gssasl * ctx, [Function]
 Gssasl_client_callback_passcode cb)`

ctx: libgssasl handle.

cb: callback function

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

`Gssasl_client_callback_passcode gssasl_client_callback_passcode_get (Gssasl * ctx) [Function]`

ctx: libgssasl handle.

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

`void gssasl_client_callback_pin_set (Gssasl * ctx, [Function]
 Gssasl_client_callback_pin cb)`

ctx: libgssasl 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 `gssasl_client_callback_pin_get()`.

`Gssasl_client_callback_pin gssasl_client_callback_pin_get [Function]
 (Gssasl * ctx)`

ctx: libgssasl handle.

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

`void gssasl_client_callback_service_set (Gssasl * ctx, [Function]
 Gssasl_client_callback_service cb)`

ctx: libgssasl 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 `gssasl_client_callback_service_get()`.

`Gssasl_client_callback_service gssasl_client_callback_service_get (Gssasl * ctx) [Function]`

ctx: libgssasl handle.

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

`void gssasl_client_callback_anonymous_set (Gssasl * ctx, [Function]
 Gssasl_client_callback_anonymous cb)`

ctx: libgssasl 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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

- `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()`.
- `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()`.
- `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()`.
- `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()`.
- `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()`.
- `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()`.
- `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()`.

`void gssasl_server_callback_digest_md5_set (Gssasl * ctx, [Function]
Gssasl_server_callback_digest_md5 cb)`

ctx: libgssasl 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 `gssasl_server_callback_digest_md5_get()`.

`Gssasl_server_callback_digest_md5 gssasl_server_callback_digest_md5_get (Gssasl * ctx) [Function]`

ctx: libgssasl handle.

Return value: Return the callback earlier set by calling `gssasl_server_callback_digest_md5_set()`.

`void gssasl_server_callback_external_set (Gssasl * ctx, [Function]
Gssasl_server_callback_external cb)`

ctx: libgssasl 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 `gssasl_server_callback_external_get()`.

`Gssasl_server_callback_external gssasl_server_callback_external_get (Gssasl * ctx) [Function]`

ctx: libgssasl handle.

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

`void gssasl_server_callback_anonymous_set (Gssasl * ctx, [Function]
Gssasl_server_callback_anonymous cb)`

ctx: libgssasl 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 `gssasl_server_callback_anonymous_get()`.

`Gssasl_server_callback_anonymous gssasl_server_callback_anonymous_get (Gssasl * ctx) [Function]`

ctx: libgssasl handle.

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

`void gssasl_server_callback_realm_set (Gssasl * ctx, [Function]
Gssasl_server_callback_realm cb)`

ctx: libgssasl 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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

`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()`.

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 * ctx, const char * token)` [Prototype]

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) (Gsasl_session_ctx * ctx, char * out, size_t * outlen)` [Prototype]

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 (*Gsasl_client_callback_service) (Gsasl_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 SERVICELEN, 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 (*Gsasl_server_callback_cram_md5) (Gsasl_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 (*Gsasl_server_callback_digest_md5) (Gsasl_session_ctx * [Prototype]
    ctx, 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 * [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 (*Gsasl_client_callback_password) (Gsasl_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 (*Gsasl_server_callback_retrieve) (Gsasl_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 (*Gsasl_server_callback_validate) (Gsasl_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 canonical 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 successful. GSASL_AUTHENTICATION_ERROR is a good failure if authentication failed, but any available return code may be used.

Appendix C Copying This Manual

C.1 GNU Free Documentation License

Version 1.2, November 2002

Copyright © 2000,2001,2002 Free Software Foundation, Inc.
59 Temple Place, Suite 330, Boston, MA 02111-1307, USA

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document *free* in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or non-commercially. Secondly, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of “copyleft”, which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The “Document”, below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as “you”. You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A “Modified Version” of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A “Secondary Section” is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document’s overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The “Invariant Sections” are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

The “Cover Texts” are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A “Transparent” copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not “Transparent” is called “Opaque”.

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The “Title Page” means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, “Title Page” means the text near the most prominent appearance of the work’s title, preceding the beginning of the body of the text.

A section “Entitled XYZ” means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as “Acknowledgements”, “Dedications”, “Endorsements”, or “History”.) To “Preserve the Title” of such a section when you modify the Document means that it remains a section “Entitled XYZ” according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

- A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any,

- be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.
- B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.
 - C. State on the Title page the name of the publisher of the Modified Version, as the publisher.
 - D. Preserve all the copyright notices of the Document.
 - E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
 - F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
 - G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
 - H. Include an unaltered copy of this License.
 - I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.
 - J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.
 - K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.
 - L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.
 - M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.
 - N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.
 - O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their

titles to the list of Invariant Sections in the Modified Version’s license notice. These titles must be distinct from any other section titles.

You may add a section Entitled “Endorsements”, provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled “History” in the various original documents, forming one section Entitled “History”; likewise combine any sections Entitled “Acknowledgements”, and any sections Entitled “Dedications”. You must delete all sections Entitled “Endorsements.”

6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an “aggregate” if the copyright resulting from the compilation is not used to limit the legal rights of the compilation’s users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document’s Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled “Acknowledgements”, “Dedications”, or “History”, the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See <http://www.gnu.org/copyleft/>.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License “or any later version” applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

C.1.1 ADDENDUM: How to use this License for your documents

To use this License in a document you have written, include a copy of the License in the document and put the following copyright and license notices just after the title page:

```
Copyright (C) year your name.  
Permission is granted to copy, distribute and/or modify this document  
under the terms of the GNU Free Documentation License, Version 1.2  
or any later version published by the Free Software Foundation;  
with no Invariant Sections, no Front-Cover Texts, and no Back-Cover  
Texts. A copy of the license is included in the section entitled ‘‘GNU  
Free Documentation License’’.
```

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the “with...Texts.” line with this:

```
with the Invariant Sections being list their titles, with  
the Front-Cover Texts being list, and with the Back-Cover Texts  
being list.
```

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.

Concept Index

A

AIX	4
Autoconf tests	11

C

Callbacks	28
command line	54
Compiling your application	10
Configure tests	11
Contributing	6

D

Debian	3
Deprecated functions	58
Download	5

E

Error Handling	37
Examples	41

F

FDL, GNU Free Documentation License	76
FreeBSD	4

H

Hacking	6
HP-UX	4

I

Installation	5
invoking <code>gsasl</code>	54
IRIX	4

M

Mandrake	4
----------------	---

Motorola Coldfire	4
-------------------------	---

N

NetBSD	4
--------------	---

O

Obsolete functions	58
OpenBSD	4

P

Properties	30
------------------	----

R

RedHat	4
RedHat Advanced Server	4
Reporting Bugs	6

S

SASL sessions	32
Solaris	4
SuSE	3
SuSE Linux	3

T

Tru64	3
-------------	---

U

uClibc	4
uClinux	4

W

Windows	4
---------------	---

Function and Data Index

(
(*Gsassl_client_callback_anonymous)	70
(*Gsassl_client_callback_authentication_id)	
.....	70
(*Gsassl_client_callback_authorization_id)	
.....	71
(*Gsassl_client_callback_passcode).....	73
(*Gsassl_client_callback_password).....	73
(*Gsassl_client_callback_service).....	71
(*Gsassl_server_callback_anonymous)	70
(*Gsassl_server_callback_cram_md5).....	72
(*Gsassl_server_callback_digest_md5)	72
(*Gsassl_server_callback_external).....	72
(*Gsassl_server_callback_gssapi)	72
(*Gsassl_server_callback_retrieve).....	73
(*Gsassl_server_callback_service).....	74
(*Gsassl_server_callback_validate).....	74, 75
G	
gsasl.....	54
gsasl_appinfo_get.....	62
gsasl_appinfo_set.....	62
gsasl_application_data_get	62
gsasl_application_data_set	62
gsasl_base64_decode.....	35
gsasl_base64_encode.....	35
gsasl_callback.....	28
gsasl_callback_hook_get	29
gsasl_callback_hook_set	28
gsasl_callback_set.....	28
gsasl_check_version.....	10
gsasl_client_application_data_get.....	60
gsasl_client_application_data_set.....	60
gsasl_client_callback_anonymous_get	65
gsasl_client_callback_anonymous_set	64
gsasl_client_callback_authentication_id_get	
.....	63
gsasl_client_callback_authentication_id_set	
.....	63
gsasl_client_callback_authorization_id_get	
.....	63
gsasl_client_callback_authorization_id_set	
.....	63
gsasl_client_callback_maxbuf_get.....	65
gsasl_client_callback_maxbuf_set.....	65
gsasl_client_callback_passcode_get	64
gsasl_client_callback_passcode_set	64
gsasl_client_callback_password_get	63
gsasl_client_callback_password_set	63
gsasl_client_callback_pin_get.....	64
gsasl_client_callback_pin_set.....	64
gsasl_client_callback_qop_get.....	65
gsasl_client_callback_qop_set.....	65
gsasl_client_callback_realm_get.....	66
gsasl_client_callback_realm_set.....	65
gsasl_client_callback_service_get.....	64
gsasl_client_callback_service_set.....	64
gsasl_client_ctx_get.....	60
gsasl_client_finish.....	59
gsasl_client_listmech	58
gsasl_client_mechlist	26
gsasl_client_start	32
gsasl_client_step.....	58
gsasl_client_step_base64	59
gsasl_client_suggest_mechanism.....	27
gsasl_client_support_p	26
gsasl_ctx_get	61
gsasl_decode	33
gsasl_decode_inline.....	61
gsasl_done	26
gsasl_encode	33
gsasl_encode_inline.....	61
gsasl_finish.....	33
gsasl_hmac_md5	36
gsasl_init	26
gsasl_md5	36
gsasl_md5pwd_get_password	35
gsasl_nonce	35
gsasl_property_fast.....	30
gsasl_property_get	30
gsasl_property_set	30
gsasl_property_set_raw	30
gsasl_random	36
gsasl_randomize	61
gsasl_register	27
gsasl_server_application_data_get.....	61
gsasl_server_application_data_set.....	60
gsasl_server_callback_anonymous_get	67
gsasl_server_callback_anonymous_set	67
gsasl_server_callback_cipher_get.....	69
gsasl_server_callback_cipher_set	68
gsasl_server_callback_cram_md5_get	66
gsasl_server_callback_cram_md5_set	66
gsasl_server_callback_digest_md5_get	67
gsasl_server_callback_digest_md5_set	67
gsasl_server_callback_external_get	67
gsasl_server_callback_external_set	67
gsasl_server_callback_gssapi_get.....	69
gsasl_server_callback_gssapi_set.....	69
gsasl_server_callback_maxbuf_get	68
gsasl_server_callback_maxbuf_set	68
gsasl_server_callback_qop_get.....	68
gsasl_server_callback_qop_set	68
gsasl_server_callback_realm_get.....	68
gsasl_server_callback_realm_set.....	67
gsasl_server_callback_retrieve_get	66
gsasl_server_callback_retrieve_set	66
gsasl_server_callback_secured_get.....	69

<code>gsasl_server_callback_secured_set</code>	69	<code>gsasl_server_step_base64</code>	59
<code>gsasl_server_callback_service_get</code>	70	<code>gsasl_server_suggest_mechanism</code>	62
<code>gsasl_server_callback_service_set</code>	69	<code>gsasl_server_support_p</code>	26
<code>gsasl_server_callback_validate_get</code>	66	<code>gsasl_step</code>	32
<code>gsasl_server_callback_validate_set</code>	66	<code>gsasl_step64</code>	32
<code>gsasl_server_ctx_get</code>	60	<code>gsasl_strerror</code>	40
<code>gsasl_server_finish</code>	60	<code>gsasl_stringprep_nfkc</code>	34
<code>gsasl_server_listmech</code>	58	<code>gsasl_stringprep_saslprep</code>	34
<code>gsasl_server_mechlist</code>	26	<code>gsasl_stringprep_trace</code>	34
<code>gsasl_server_start</code>	32		
<code>gsasl_server_step</code>	59		