Generic Security Service

for version 0.0.2, 28 June 2003

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1 Introduction

GSS is an implementation of the Generic Security Service Application Program Interface (GSS-API). GSS-API is used by network servers (e.g., IMAP, SMTP) to provide security security services, e.g., authenticate clients against servers. GSS consists of a library and a manual.

GSS 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.

GSS is licensed under the GNU Public License.

1.1 Getting Started

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

The reader is assumed to possess basic familiarity with GSS-API and network programming in C or C++. For general GSS-API information, and some programming examples, there is a guide available online at `http://docs.sun.com/db/doc/816-1331`.

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

GSS 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.

It's thread-safe
: No global variables are used and multiple library handles and session handles may be used in parallell.

It's internationalized
: It handles non-ASCII names and user visible strings used in the library (e.g., error messages) can be translated into the users' language.

It's portable
: It should work on all Unix like operating systems, including Windows.

1.3 Supported Platforms

GSS 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. NetBSD 1.6

    GCC 2.95.3 and GNU Make. `alpha-unknown-netbsd1.6`, `i386-unknown-netbsdelf1.6`.

17. OpenBSD 3.1 and 3.2

    GCC 2.95.3 and GNU Make. `alpha-unknown-openbsd3.1`, `i386-unknown-openbsd3.1`.

18. FreeBSD 4.7

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

If you use GSS on, or port GSS to, a new platform please report it to the author.

1.4 Bug Reports

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

- Please make sure that the bug is really in GSS, 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-gss@josefsson.org`'

2 Preparation

To use GSS, 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 GSS may be to look at the examples at the end of this manual.

2.1 Header

All standard interfaces (data types and functions) of the official GSS API are defined in the header file '`gss/api.h`'. The file is taken verbatim from the RFC (after correcting a few typos) where it is known as '`gssapi.h`'. However, to be able to co-exist gracefully with other GSS-API implementation, the name '`gssapi.h`' was changed.

The header file '`gss.h`' includes '`gss/api.h`', add a few non-standard extensions (by including '`gss/ext.h`'), takes care of including header files related to all supported mechanisms (e.g., '`gss/krb5.h`') and finally add C++ namespace protection of all definitions. Therefore, including '`gss.h`' in your project is recommended over '`gss/api.h`'. If using '`gss.h`' instead of '`gss/api.h`' causes problems, it should be regarded a bug.

You must include either file in all programs using the library, either directly or through some other header file, like this:

```
#include <gss.h>
```

The name space of GSS is `gss_*` for function names, `gss_*` for data types and `GSS_*` 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.

Each supported GSS mechanism may want to expose mechanism specific functionality, and can do so through one or more header files under the '`gss/`' directory. The Kerberos 5 mechanism uses the file '`gss/krb5.h`', but again, it is included (with C++ namespace fixes) from '`gss.h`'.

2.2 Initialization

GSS does not need to be initialized before it can be used.

In order to take advantage of the internationalisation features in GSS, e.g. translated error messages, the application must set the current locale using `setlocale()` before calling, e.g., `gss_display_status()`. This is typically done in `main()` as in the following example.

```
#include <gss.h>
#include <locale.h>
...
  setlocale (LC_ALL, "");
```

2.3 Version Check

It is often desirable to check that the version of GSS 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. The function is called `gss_check_version()` and is described formally in See Chapter 4 [Extended GSS API], page 32.

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

```
#include <gss.h>
...
  if (!gss_check_version (GSS_VERSION))
    {
      printf ("gss_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 that includes the '`gss.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, GSS 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 gss`. The following example shows how it can be used at the command line:

```
gcc -c foo.c `pkg-config gss --cflags`
```

Adding the output of '`pkg-config gss --cflags`' to the compilers command line will ensure that the compiler can find the '`gss.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 gss` can be used. For convenience, this option also outputs all other options that are required to link the program with the GSS libarary (for instance, the '`-lshishi`' option). The example shows how to link '`foo.o`' with GSS into a program `foo`.

```
gcc -o foo foo.o `pkg-config gss --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 gss --cflags --libs`
```

2.5 Out of Memory handling

The GSS API does not have a standard error code for the out of memory error condition. Instead of adding a non-standard error code, this library has chosen to adopt a different strategy. Out of memory handling happens in rare situations, but performing the out of memory error handling after almost all API function invocations pollute your source code and might make it harder to spot more serious problems. The strategy chosen improve code readability and robustness.

For most applications, aborting the application with an error message when the out of memory situation occur is the best that can be wished for. This is how the library behaves by default.

However, we realize that some applications may not want to have the GSS library abort execution in any situation. The GSS library support a hook to let the application regain control and perform its own cleanups when an out of memory situation has occured. The application can define a function (having a `void` prototype, i.e., no return value and no parameters) and set the library variable `xalloc_fail_func` to that function. The variable should be declared as follows.

```
extern void (*xalloc_fail_func) (void);
```

The GSS library will invoke this function if an out of memory error occurs. Note that after this the GSS library is in an undefined state, so you must unload or restart the application to continue call GSS library functions. The hook is only intended to allow the application to log the situation in a special way. Of course, care must be taken to not allocate more memory, as that will likely also fail.

3 Standard GSS API

3.1 Error Handling

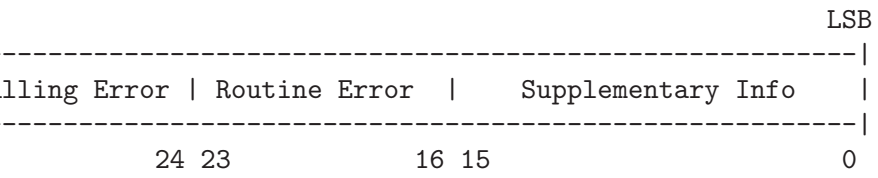
Every GSS-API routine returns two distinct values to report status information to the caller: GSS status codes and Mechanism status codes.

3.1.1 GSS status codes

GSS-API routines return GSS status codes as their OM_uint32 function value. These codes indicate errors that are independent of the underlying mechanism(s) used to provide the security service. The errors that can be indicated via a GSS status code are either generic API routine errors (errors that are defined in the GSS-API specification) or calling errors (errors that are specific to these language bindings).

A GSS status code can indicate a single fatal generic API error from the routine and a single calling error. In addition, supplementary status information may be indicated via the setting of bits in the supplementary info field of a GSS status code.

These errors are encoded into the 32-bit GSS status code as follows:



Hence if a GSS-API routine returns a GSS status code whose upper 16 bits contain a non-zero value, the call failed. If the calling error field is non-zero, the invoking application's call of the routine was erroneous. Calling errors are defined in table 3-1. If the routine error field is non-zero, the routine failed for one of the routine- specific reasons listed below in table 3-2. Whether or not the upper 16 bits indicate a failure or a success, the routine may indicate additional information by setting bits in the supplementary info field of the status code. The meaning of individual bits is listed below in table 3-3.

Table 3-1 Calling Errors

Name	Value in field	Meaning
GSS_S_CALL_INACCESSIBLE_READ	1	A required input parameter could not be read
GSS_S_CALL_INACCESSIBLE_WRITE	2	A required output parameter could not be written.
GSS_S_CALL_BAD_STRUCTURE	3	A parameter was malformed

Table 3-2 Routine Errors

Name	Value in field	Meaning
GSS_S_BAD_MECH	1	An unsupported mechanism

		was requested
GSS_S_BAD_NAME	2	An invalid name was supplied
GSS_S_BAD_NAMETYPE	3	A supplied name was of an unsupported type
GSS_S_BAD_BINDINGS	4	Incorrect channel bindings were supplied
GSS_S_BAD_STATUS	5	An invalid status code was supplied
GSS_S_BAD_MIC GSS_S_BAD_SIG	6	A token had an invalid MIC
GSS_S_NO_CRED	7	No credentials were supplied, or the credentials were unavailable or inaccessible.
GSS_S_NO_CONTEXT	8	No context has been established
GSS_S_DEFECTIVE_TOKEN	9	A token was invalid
GSS_S_DEFECTIVE_CREDENTIAL	10	A credential was invalid
GSS_S_CREDENTIALS_EXPIRED	11	The referenced credentials have expired
GSS_S_CONTEXT_EXPIRED	12	The context has expired
GSS_S_FAILURE	13	Miscellaneous failure (see text)
GSS_S_BAD_QOP	14	The quality-of-protection requested could not be provided
GSS_S_UNAUTHORIZED	15	The operation is forbidden by local security policy
GSS_S_UNAVAILABLE	16	The operation or option is unavailable
GSS_S_DUPLICATE_ELEMENT	17	The requested credential element already exists
GSS_S_NAME_NOT_MN	18	The provided name was not a mechanism name

Table 3-3 Supplementary Status Bits

Name	Bit Number	Meaning
GSS_S_CONTINUE_NEEDED	0 (LSB)	Returned only by gss_init_sec_context or gss_accept_sec_context. The routine must be called again to complete its function. See routine documentation for detailed description

GSS_S_DUPLICATE_TOKEN	1	The token was a duplicate of an earlier token
GSS_S_OLD_TOKEN	2	The token's validity period has expired
GSS_S_UNSEQ_TOKEN	3	A later token has already been processed
GSS_S_GAP_TOKEN	4	An expected per-message token was not received

The routine documentation also uses the name GSS_S_COMPLETE, which is a zero value, to indicate an absence of any API errors or supplementary information bits.

All GSS_S_xxx symbols equate to complete OM_uint32 status codes, rather than to bitfield values. For example, the actual value of the symbol GSS_S_BAD_NAMETYPE (value 3 in the routine error field) is 3<<16. The macros GSS_CALLING_ERROR(), GSS_ROUTINE_ERROR() and GSS_SUPPLEMENTARY_INFO() are provided, each of which takes a GSS status code and removes all but the relevant field. For example, the value obtained by applying GSS_ROUTINE_ERROR to a status code removes the calling errors and supplementary info fields, leaving only the routine errors field. The values delivered by these macros may be directly compared with a GSS_S_xxx symbol of the appropriate type. The macro GSS_ERROR() is also provided, which when applied to a GSS status code returns a non-zero value if the status code indicated a calling or routine error, and a zero value otherwise. All macros defined by GSS-API evaluate their argument(s) exactly once.

A GSS-API implementation may choose to signal calling errors in a platform-specific manner instead of, or in addition to the routine value; routine errors and supplementary info should be returned via major status values only.

The GSS major status code GSS_S_FAILURE is used to indicate that the underlying mechanism detected an error for which no specific GSS status code is defined. The mechanism-specific status code will provide more details about the error.

3.1.2 Mechanism-specific status codes

GSS-API routines return a minor_status parameter, which is used to indicate specialized errors from the underlying security mechanism. This parameter may contain a single mechanism-specific error, indicated by a OM_uint32 value.

The minor_status parameter will always be set by a GSS-API routine, even if it returns a calling error or one of the generic API errors indicated above as fatal, although most other output parameters may remain unset in such cases. However, output parameters that are expected to return pointers to storage allocated by a routine must always be set by the routine, even in the event of an error, although in such cases the GSS-API routine may elect to set the returned parameter value to NULL to indicate that no storage was actually allocated. Any length field associated with such pointers (as in a gss_buffer_desc structure) should also be set to zero in such cases.

3.2 Credential Management

Table 2-1 GSS-API Credential-management Routines

Routine	Section	Function
gss_acquire_cred	5.2	Assume a global identity; Obtain a GSS-API credential handle for pre-existing credentials.
gss_add_cred	5.3	Construct credentials incrementally
gss_inquire_cred	5.21	Obtain information about a credential
gss_inquire_cred_by_mech	5.22	Obtain per-mechanism information about a credential.
gss_release_cred	5.27	Discard a credential handle.

OM_uint32 **gss_release_cred** (OM_uint32 * *minor_status*, gss_cred_id_t * *cred_handle*) [Function]

minor_status: Mechanism specific status code.

cred_handle: Optional opaque handle identifying credential to be released. If GSS_C_NO_CREDENTIAL is supplied, the routine will complete successfully, but will do nothing.

Informs GSS-API that the specified credential handle is no longer required by the application, and frees associated resources. Implementations are encouraged to set the cred_handle to GSS_C_NO_CREDENTIAL on successful completion of this call.

Returns GSS_S_COMPLETE for successful completion, and GSS_S_NO_CRED for credentials could not be accessed.

3.3 Context-Level Routines

Table 2-2 GSS-API Context-Level Routines

Routine	Section	Function
gss_init_sec_context	5.19	Initiate a security context with a peer application
gss_accept_sec_context	5.1	Accept a security context initiated by a peer application
gss_delete_sec_context	5.9	Discard a security context
gss_process_context_token	5.25	Process a token on a security context from a peer application
gss_context_time	5.7	Determine for how long a context will remain valid
gss_inquire_context	5.20	Obtain information about a security context
gss_wrap_size_limit	5.34	Determine token-size limit for gss_wrap on a context

OM_uint32 **gss_init_sec_context** (OM_uint32 * *minor_status*, const gss_cred_id_t *initiator_cred_handle*, gss_ctx_id_t * *context_handle*, const gss_name_t *target_name*, const gss_OID *mech_type*, OM_uint32 *req_flags*, OM_uint32 *time_req*, const gss_channel_bindings_t *input_chan_bindings*, const gss_buffer_t *input_token*, gss_OID * *actual_mech_type*, gss_buffer_t *output_token*, OM_uint32 * *ret_flags*, OM_uint32 * *time_rec*) [Function]

minor_status: Mechanism specific status code.

initiator_cred_handle: Optional handle for credentials claimed. Supply GSS_C_NO_CREDENTIAL to act as a default initiator principal. If no default initiator is defined, the function will return GSS_S_NO_CRED.

context_handle: Context handle for new context. Supply GSS_C_NO_CONTEXT for first call; use value returned by first call in continuation calls. Resources associated with this context-handle must be released by the application after use with a call to `gss_delete_sec_context()`.

target_name: Name of target.

mech_type: Optional object ID of desired mechanism. Supply GSS_C_NO_OID to obtain an implementation specific default

req_flags: Contains various independent flags, each of which requests that the context support a specific service option. Symbolic names are provided for each flag, and the symbolic names corresponding to the required flags should be logically-ORed together to form the bit-mask value. See below for details.

time_req: Optional Desired number of seconds for which context should remain valid. Supply 0 to request a default validity period.

input_chan_bindings: Optional Application-specified bindings. Allows application to securely bind channel identification information to the security context. Specify GSS_C_NO_CHANNEL_BINDINGS if channel bindings are not used.

input_token: Optional (see text) Token received from peer application. Supply GSS_C_NO_BUFFER, or a pointer to a buffer containing the value GSS_C_EMPTY_BUFFER on initial call.

actual_mech_type: Optional actual mechanism used. The OID returned via this parameter will be a pointer to static storage that should be treated as read-only; In particular the application should not attempt to free it. Specify NULL if not required.

output_token: Token to be sent to peer application. If the length field of the returned buffer is zero, no token need be sent to the peer application. Storage associated with this buffer must be freed by the application after use with a call to `gss_release_buffer()`.

ret_flags: Optional various independent flags, each of which indicates that the context supports a specific service option. Specify NULL if not required. Symbolic names are provided for each flag, and the symbolic names corresponding to the required flags

should be logically-ANDed with the ret_flags value to test whether a given option is supported by the context. See below for details.

time_rec: Optional number of seconds for which the context will remain valid. If the implementation does not support context expiration, the value GSS_C_INDEFINITE will be returned. Specify NULL if not required.

Initiates the establishment of a security context between the application and a remote peer. Initially, the input_token parameter should be specified either as GSS_C_NO_BUFFER, or as a pointer to a gss_buffer_desc object whose length field contains the value zero. The routine may return a output_token which should be transferred to the peer application, where the peer application will present it to gss_accept_sec_context. If no token need be sent, gss_init_sec_context will indicate this by setting the length field of the output_token argument to zero. To complete the context establishment, one or more reply tokens may be required from the peer application; if so, gss_init_sec_context will return a status containing the supplementary information bit GSS_S_CONTINUE_NEEDED. In this case, gss_init_sec_context should be called again when the reply token is received from the peer application, passing the reply token to gss_init_sec_context via the input_token parameters.

Portable applications should be constructed to use the token length and return status to determine whether a token needs to be sent or waited for. Thus a typical portable caller should always invoke

```
int context_established = 0;
gss_ctx_id_t context_hdl = GSS_C_NO_CONTEXT;
       ...
input_token->length = 0;

while (!context_established) {
  maj_stat = gss_init_sec_context(&min_stat,
                                  cred_hdl,
                                  &context_hdl,
                                  target_name,
                                  desired_mech,
                                  desired_services,
                                  desired_time,
                                  input_bindings,
                                  input_token,
                                  &actual_mech,
                                  output_token,
                                  &actual_services,
                                  &actual_time);
  if (GSS_ERROR(maj_stat)) {
    report_error(maj_stat, min_stat);
  };

  if (output_token->length != 0) {
    send_token_to_peer(output_token);
```

```
        gss_release_buffer(&min_stat, output_token)
      };
      if (GSS_ERROR(maj_stat)) {

        if (context_hdl != GSS_C_NO_CONTEXT)
          gss_delete_sec_context(&min_stat,
                                 &context_hdl,
                                 GSS_C_NO_BUFFER);
        break;
      };

      if (maj_stat & GSS_S_CONTINUE_NEEDED) {
        receive_token_from_peer(input_token);
      } else {
        context_established = 1;
      };
    };
```

Whenever the routine returns a major status that includes the value GSS_S_CONTINUE_NEEDED, the context is not fully established and the following restrictions apply to the output parameters:

- The value returned via the time_rec parameter is undefined Unless the accompanying ret_flags parameter contains the bit GSS_C_PROT_READY_FLAG, indicating that per-message services may be applied in advance of a successful completion status, the value returned via the actual_mech_type parameter is undefined until the routine returns a major status value of GSS_S_COMPLETE.
- The values of the GSS_C_DELEG_FLAG, GSS_C_MUTUAL_FLAG, GSS_C_REPLAY_FLAG, GSS_C_SEQUENCE_FLAG, GSS_C_CONF_FLAG, GSS_C_INTEG_FLAG and GSS_C_ANON_FLAG bits returned via the ret_flags parameter should contain the values that the implementation expects would be valid if context establishment were to succeed. In particular, if the application has requested a service such as delegation or anonymous authentication via the req_flags argument, and such a service is unavailable from the underlying mechanism, gss_init_sec_context should generate a token that will not provide the service, and indicate via the ret_flags argument that the service will not be supported. The application may choose to abort the context establishment by calling gss_delete_sec_context (if it cannot continue in the absence of the service), or it may choose to transmit the token and continue context establishment (if the service was merely desired but not mandatory).
- The values of the GSS_C_PROT_READY_FLAG and GSS_C_TRANS_FLAG bits within ret_flags should indicate the actual state at the time gss_init_sec_context returns, whether or not the context is fully established.
- GSS-API implementations that support per-message protection are encouraged to set the GSS_C_PROT_READY_FLAG in the final ret_flags returned to a caller (i.e. when accompanied by a GSS_S_COMPLETE status code). However, applications should not rely on this behavior as the flag was not defined in Version 1 of the GSS-API. Instead, applications should determine what per-message

services are available after a successful context establishment according to the GSS_C_INTEG_FLAG and GSS_C_CONF_FLAG values.

- All other bits within the ret_flags argument should be set to zero.

If the initial call of gss_init_sec_context() fails, the implementation should not create a context object, and should leave the value of the context_handle parameter set to GSS_C_NO_CONTEXT to indicate this. In the event of a failure on a subsequent call, the implementation is permitted to delete the "half-built" security context (in which case it should set the context_handle parameter to GSS_C_NO_CONTEXT), but the preferred behavior is to leave the security context untouched for the application to delete (using gss_delete_sec_context).

During context establishment, the informational status bits GSS_S_OLD_TOKEN and GSS_S_DUPLICATE_TOKEN indicate fatal errors, and GSS-API mechanisms should always return them in association with a routine error of GSS_S_FAILURE. This requirement for pairing did not exist in version 1 of the GSS-API specification, so applications that wish to run over version 1 implementations must special-case these codes.

The `req_flags` values:

`GSS_C_DELEG_FLAG`
: True - Delegate credentials to remote peer. False - Don't delegate.

`GSS_C_MUTUAL_FLAG`
: True - Request that remote peer authenticate itself. False - Authenticate self to remote peer only.

`GSS_C_REPLAY_FLAG`
: True - Enable replay detection for messages protected with gss_wrap or gss_get_mic. False - Don't attempt to detect replayed messages.

`GSS_C_SEQUENCE_FLAG`
: True - Enable detection of out-of-sequence protected messages. False - Don't attempt to detect out-of-sequence messages.

`GSS_C_CONF_FLAG`
: True - Request that confidentiality service be made available (via gss_wrap). False - No per-message confidentiality service is required.

`GSS_C_INTEG_FLAG`
: True - Request that integrity service be made available (via gss_wrap or gss_get_mic). False - No per-message integrity service is required.

`GSS_C_ANON_FLAG`
: True - Do not reveal the initiator's identity to the acceptor. False - Authenticate normally.

The `ret_flags` values:

`GSS_C_DELEG_FLAG`
: True - Credentials were delegated to the remote peer. False - No credentials were delegated.

`GSS_C_MUTUAL_FLAG`
: True - The remote peer has authenticated itself. False - Remote peer has not authenticated itself.

`GSS_C_REPLAY_FLAG`
: True - replay of protected messages will be detected. False - replayed messages will not be detected.

`GSS_C_SEQUENCE_FLAG`
: True - out-of-sequence protected messages will be detected. False - out-of-sequence messages will not be detected.

`GSS_C_CONF_FLAG`
: True - Confidentiality service may be invoked by calling gss_wrap routine. False - No confidentiality service (via gss_wrap) available. gss_wrap will provide message encapsulation, data-origin authentication and integrity services only.

`GSS_C_INTEG_FLAG`
: True - Integrity service may be invoked by calling either gss_get_mic or gss_wrap routines. False - Per-message integrity service unavailable.

`GSS_C_ANON_FLAG`
: True - The initiator's identity has not been revealed, and will not be revealed if any emitted token is passed to the acceptor. False - The initiator's identity has been or will be authenticated normally.

`GSS_C_PROT_READY_FLAG`
: True - Protection services (as specified by the states of the GSS_C_CONF_FLAG and GSS_C_INTEG_FLAG) are available for use if the accompanying major status return value is either GSS_S_COMPLETE or GSS_S_CONTINUE_NEEDED. False - Protection services (as specified by the states of the GSS_C_CONF_FLAG and GSS_C_INTEG_FLAG) are available only if the accompanying major status return value is GSS_S_COMPLETE.

`GSS_C_TRANS_FLAG`
: True - The resultant security context may be transferred to other processes via a call to `gss_export_sec_context()`. False - The security context is not transferable.

All other bits should be set to zero.

Valid return values and their meaning:

`GSS_S_COMPLETE`: Successful completion.

`GSS_S_CONTINUE_NEEDED`: Indicates that a token from the peer application is required to complete the context, and that gss_init_sec_context must be called again with that token.

`GSS_S_DEFECTIVE_TOKEN`: Indicates that consistency checks performed on the input_token failed.

`GSS_S_DEFECTIVE_CREDENTIAL`: Indicates that consistency checks performed on the credential failed.

`GSS_S_NO_CRED`: The supplied credentials were not valid for context initiation, or the credential handle did not reference any credentials.

`GSS_S_CREDENTIALS_EXPIRED`: The referenced credentials have expired.

`GSS_S_BAD_BINDINGS`: The input_token contains different channel bindings to those specified via the input_chan_bindings parameter.

`GSS_S_BAD_SIG`: The input_token contains an invalid MIC, or a MIC that could not be verified.

`GSS_S_OLD_TOKEN`: The input_token was too old. This is a fatal error during context establishment.

`GSS_S_DUPLICATE_TOKEN`: The input_token is valid, but is a duplicate of a token already processed. This is a fatal error during context establishment.

`GSS_S_NO_CONTEXT`: Indicates that the supplied context handle did not refer to a valid context.

`GSS_S_BAD_NAMETYPE`: The provided target_name parameter contained an invalid or unsupported type of name.

`GSS_S_BAD_NAME`: The provided target_name parameter was ill-formed.

`GSS_S_BAD_MECH`: The specified mechanism is not supported by the provided credential, or is unrecognized by the implementation.

`OM_uint32` **gss_accept_sec_context** (`OM_uint32 *`*`minor_status`*`,` `gss_ctx_id_t *`*`context_handle`*`,` `const gss_cred_id_t` *`acceptor_cred_handle`*`,` `const gss_buffer_t` *`input_token_buffer`*`,` `const gss_channel_bindings_t` *`input_chan_bindings`*`,` `const gss_name_t *`*`src_name`*`,` `gss_OID *`*`mech_type`*`,` `gss_buffer_t` *`output_token`*`,` `OM_uint32 *`*`ret_flags`*`,` `OM_uint32 *`*`time_rec`*`,` `gss_cred_id_t *`*`delegated_cred_handle`*`)` [Function]

minor_status: Integer, modify Mechanism specific status code.

context_handle: gss_ctx_id_t, read/modify context handle for new context. Supply GSS_C_NO_CONTEXT for first call; use value returned in subsequent calls. Once gss_accept_sec_context() has returned a value via this parameter, resources have been assigned to the corresponding context, and must be freed by the application after use with a call to gss_delete_sec_context().

acceptor_cred_handle: gss_cred_id_t, read Credential handle claimed by context acceptor. Specify GSS_C_NO_CREDENTIAL to accept the context as a default principal. If GSS_C_NO_CREDENTIAL is specified, but no default acceptor principal is defined, GSS_S_NO_CRED will be returned.

input_token_buffer: buffer, opaque, read token obtained from remote application.

input_chan_bindings: channel bindings, read, optional Application- specified bindings. Allows application to securely bind channel identification information to the security context. If channel bindings are not used, specify GSS_C_NO_CHANNEL_BINDINGS.

src_name: gss_name_t, modify, optional Authenticated name of context initiator. After use, this name should be deallocated by passing it to gss_release_name(). If not required, specify NULL.

mech_type: Object ID, modify, optional Security mechanism used. The returned OID value will be a pointer into static storage, and should be treated as read-only by the caller (in particular, it does not need to be freed). If not required, specify NULL.

output_token: buffer, opaque, modify Token to be passed to peer application. If the length field of the returned token buffer is 0, then no token need be passed to the peer application. If a non- zero length field is returned, the associated storage must be freed after use by the application with a call to gss_release_buffer().

ret_flags: bit-mask, modify, optional Contains various independent flags, each of which indicates that the context supports a specific service option. If not needed, specify NULL. Symbolic names are provided for each flag, and the symbolic names corresponding to the required flags should be logically-ANDed with the ret_flags value to test whether a given option is supported by the context. See below for the values.

time_rec: Integer, modify, optional number of seconds for which the context will remain valid. Specify NULL if not required.

delegated_cred_handle: gss_cred_id_t, modify, optional credential handle for credentials received from context initiator. Only valid if deleg_flag in ret_flags is true, in which case an explicit credential handle (i.e. not GSS_C_NO_CREDENTIAL) will be returned; if deleg_flag is false, gss_accept_context() will set this parameter to GSS_C_NO_CREDENTIAL. If a credential handle is returned, the associated resources must be released by the application after use with a call to gss_release_cred(). Specify NULL if not required.

Allows a remotely initiated security context between the application and a remote peer to be established. The routine may return a output_token which should be transferred to the peer application, where the peer application will present it to gss_init_sec_context. If no token need be sent, gss_accept_sec_context will indicate this by setting the length field of the output_token argument to zero. To complete the context establishment, one or more reply tokens may be required from the peer application; if so, gss_accept_sec_context will return a status flag of GSS_S_CONTINUE_NEEDED, in which case it should be called again when the reply token is received from the peer application, passing the token to gss_accept_sec_context via the input_token parameters.

Portable applications should be constructed to use the token length and return status to determine whether a token needs to be sent or waited for. Thus a typical portable caller should always invoke gss_accept_sec_context within a loop:

```
gss_ctx_id_t context_hdl = GSS_C_NO_CONTEXT;

do {
  receive_token_from_peer(input_token);
  maj_stat = gss_accept_sec_context(&min_stat,
                                    &context_hdl,
                                    cred_hdl,
                                    input_token,
                                    input_bindings,
                                    &client_name,
                                    &mech_type,
```

```
                                        output_token,
                                        &ret_flags,
                                        &time_rec,
                                        &deleg_cred);
          if (GSS_ERROR(maj_stat)) {
            report_error(maj_stat, min_stat);
          };
          if (output_token->length != 0) {
            send_token_to_peer(output_token);

            gss_release_buffer(&min_stat, output_token);
          };
          if (GSS_ERROR(maj_stat)) {
            if (context_hdl != GSS_C_NO_CONTEXT)
              gss_delete_sec_context(&min_stat,
                                     &context_hdl,
                                     GSS_C_NO_BUFFER);
            break;
          };
        } while (maj_stat & GSS_S_CONTINUE_NEEDED);
```

Whenever the routine returns a major status that includes the value GSS_S_CONTINUE_NEEDED, the context is not fully established and the following restrictions apply to the output parameters:

The value returned via the time_rec parameter is undefined Unless the accompanying ret_flags parameter contains the bit GSS_C_PROT_READY_FLAG, indicating that per-message services may be applied in advance of a successful completion status, the value returned via the mech_type parameter may be undefined until the routine returns a major status value of GSS_S_COMPLETE.

The values of the GSS_C_DELEG_FLAG, GSS_C_MUTUAL_FLAG,GSS_C_REPLAY_FLAG, GSS_C_SEQUENCE_FLAG, GSS_C_CONF_FLAG,GSS_C_INTEG_FLAG and GSS_C_ANON_FLAG bits returned via the ret_flags parameter should contain the values that the implementation expects would be valid if context establishment were to succeed.

The values of the GSS_C_PROT_READY_FLAG and GSS_C_TRANS_FLAG bits within ret_flags should indicate the actual state at the time gss_accept_sec_context returns, whether or not the context is fully established.

Although this requires that GSS-API implementations set the GSS_C_PROT_READY_FLAG in the final ret_flags returned to a caller (i.e. when accompanied by a GSS_S_COMPLETE status code), applications should not rely on this behavior as the flag was not defined in Version 1 of the GSS-API. Instead, applications should be prepared to use per-message services after a successful context establishment, according to the GSS_C_INTEG_FLAG and GSS_C_CONF_FLAG values.

All other bits within the ret_flags argument should be set to zero. While the routine returns GSS_S_CONTINUE_NEEDED, the values returned via the ret_flags argument indicate the services that the implementation expects to be available from the established context.

If the initial call of gss_accept_sec_context() fails, the implementation should not create a context object, and should leave the value of the context_handle parameter set to GSS_C_NO_CONTEXT to indicate this. In the event of a failure on a subsequent call, the implementation is permitted to delete the "half-built" security context (in which case it should set the context_handle parameter to GSS_C_NO_CONTEXT), but the preferred behavior is to leave the security context (and the context_handle parameter) untouched for the application to delete (using gss_delete_sec_context).

During context establishment, the informational status bits GSS_S_OLD_TOKEN and GSS_S_DUPLICATE_TOKEN indicate fatal errors, and GSS-API mechanisms should always return them in association with a routine error of GSS_S_FAILURE. This requirement for pairing did not exist in version 1 of the GSS-API specification, so applications that wish to run over version 1 implementations must special-case these codes.

The `ret_flags` flag values:

`GSS_C_DELEG_FLAG`
: True - Delegated credentials are available via the delegated_cred_handle parameter. False - No credentials were delegated.

`GSS_C_MUTUAL_FLAG`
: True - Remote peer asked for mutual authentication. False - Remote peer did not ask for mutual authentication.

`GSS_C_REPLAY_FLAG`
: True - replay of protected messages will be detected. False - replayed messages will not be detected.

`GSS_C_SEQUENCE_FLAG`
: True - out-of-sequence protected messages will be detected. False - out-of-sequence messages will not be detected.

`GSS_C_CONF_FLAG`
: True - Confidentiality service may be invoked by calling the gss_wrap routine. False - No confidentiality service (via gss_wrap) available. gss_wrap will provide message encapsulation, data-origin authentication and integrity services only.

`GSS_C_INTEG_FLAG`
: True - Integrity service may be invoked by calling either gss_get_mic or gss_wrap routines. False - Per-message integrity service unavailable.

`GSS_C_ANON_FLAG`
: True - The initiator does not wish to be authenticated; the src_name parameter (if requested) contains an anonymous internal name. False - The initiator has been authenticated normally.

`GSS_C_PROT_READY_FLAG`
: True - Protection services (as specified by the states of the GSS_C_CONF_FLAG and GSS_C_INTEG_FLAG) are available if the accompanying major status return value is either GSS_S_COMPLETE or GSS_S_CONTINUE_NEEDED. False - Protection services (as specified

by the states of the GSS_C_CONF_FLAG and GSS_C_INTEG_FLAG) are available only if the accompanying major status return value is GSS_S_COMPLETE.

`GSS_C_TRANS_FLAG`
: True - The resultant security context may be transferred to other processes via a call to gss_export_sec_context(). False - The security context is not transferable.

All other bits should be set to zero.

Return values:

`GSS_S_CONTINUE_NEEDED`: Indicates that a token from the peer application is required to complete the context, and that gss_accept_sec_context must be called again with that token.

`GSS_S_DEFECTIVE_TOKEN`: Indicates that consistency checks performed on the input_token failed.

`GSS_S_DEFECTIVE_CREDENTIAL`: Indicates that consistency checks performed on the credential failed.

`GSS_S_NO_CRED`: The supplied credentials were not valid for context acceptance, or the credential handle did not reference any credentials.

`GSS_S_CREDENTIALS_EXPIRED`: The referenced credentials have expired.

`GSS_S_BAD_BINDINGS`: The input_token contains different channel bindings to those specified via the input_chan_bindings parameter.

`GSS_S_NO_CONTEXT`: Indicates that the supplied context handle did not refer to a valid context.

`GSS_S_BAD_SIG`: The input_token contains an invalid MIC.

`GSS_S_OLD_TOKEN`: The input_token was too old. This is a fatal error during context establishment.

`GSS_S_DUPLICATE_TOKEN`: The input_token is valid, but is a duplicate of a token already processed. This is a fatal error during context establishment.

`GSS_S_BAD_MECH`: The received token specified a mechanism that is not supported by the implementation or the provided credential.

`OM_uint32` **gss_delete_sec_context** (`OM_uint32 *` *`minor_status`*`,` [Function]
`gss_ctx_id_t *` *`context_handle`*`, gss_buffer_t` *`output_token`*`)`

minor_status: Mechanism specific status code.

context_handle: Context handle identifying context to delete. After deleting the context, the GSS-API will set this context handle to GSS_C_NO_CONTEXT.

output_token: Optional token to be sent to remote application to instruct it to also delete the context. It is recommended that applications specify GSS_C_NO_BUFFER for this parameter, requesting local deletion only. If a buffer parameter is provided by the application, the mechanism may return a token in it; mechanisms that implement only local deletion should set the length field of this token to zero to indicate to the application that no token is to be sent to the peer.

Delete a security context. `gss_delete_sec_context()` will delete the local data structures associated with the specified security context, and may generate an output_token, which when passed to the peer `gss_process_context_token()` will instruct it to do likewise. If no token is required by the mechanism, the GSS-API should set the length field of the output_token (if provided) to zero. No further security services may be obtained using the context specified by context_handle.

In addition to deleting established security contexts, `gss_delete_sec_context()` must also be able to delete "half-built" security contexts resulting from an incomplete sequence of `gss_init_sec_context()`/`gss_accept_sec_context()` calls.

The output_token parameter is retained for compatibility with version 1 of the GSS-API. It is recommended that both peer applications invoke `gss_delete_sec_context()` passing the value GSS_C_NO_BUFFER for the output_token parameter, indicating that no token is required, and that `gss_delete_sec_context()` should simply delete local context data structures. If the application does pass a valid buffer to `gss_delete_sec_context()`, mechanisms are encouraged to return a zero-length token, indicating that no peer action is necessary, and that no token should be transferred by the application.

Returns GSS_S_COMPLETE for successful completion, and GSS_S_NO_CONTEXT if no valid context was supplied.

3.4 Per-Message Routines

Table 2-3 GSS-API Per-message Routines

Routine	Section	Function
gss_get_mic	5.15	Calculate a cryptographic message integrity code (MIC) for a message; integrity service
gss_verify_mic	5.32	Check a MIC against a message; verify integrity of a received message
gss_wrap	5.33	Attach a MIC to a message, and optionally encrypt the message content; confidentiality service
gss_unwrap	5.31	Verify a message with attached MIC, and decrypt message content if necessary.

`OM_uint32` **gss_wrap** (`OM_uint32 *` *minor_status*, `const` `gss_ctx_id_t` *context_handle*, `int` *conf_req_flag*, `gss_qop_t` *qop_req*, `const gss_buffer_t` *input_message_buffer*, `int *` *conf_state*, `gss_buffer_t` *output_message_buffer*) [Function]

minor_status: Mechanism specific status code.

context_handle: Identifies the context on which the message will be sent

conf_req_flag: Whether confidentiality is requested.

qop_req: Specifies required quality of protection. A mechanism-specific default may be requested by setting qop_req to GSS_C_QOP_DEFAULT. If an unsupported protection strength is requested, gss_wrap will return a major_status of GSS_S_BAD_QOP.

input_message_buffer: Message to be protected.

conf_state: Optional output variable indicating if confidentiality services have been applied.

output_message_buffer: Buffer to receive protected message. Storage associated with this message must be freed by the application after use with a call to `gss_release_buffer()`.

Attaches a cryptographic MIC and optionally encrypts the specified input_message. The output_message contains both the MIC and the message. The qop_req parameter allows a choice between several cryptographic algorithms, if supported by the chosen mechanism.

Since some application-level protocols may wish to use tokens emitted by `gss_wrap()` to provide "secure framing", implementations must support the wrapping of zero-length messages.

Returns

GSS_S_COMPLETE Successful completion

GSS_S_CONTEXT_EXPIRED The context has already expired

GSS_S_NO_CONTEXT The context_handle parameter did not identify a valid context

GSS_S_BAD_QOP The specified QOP is not supported by the mechanism.

`OM_uint32` **gss_unwrap** (`OM_uint32 *` *minor_status*`, const gss_ctx_id_t` *context_handle*`, const gss_buffer_t` *input_message_buffer*`, gss_buffer_t` *output_message_buffer*`, int *` *conf_state*`, gss_qop_t *` *qop_state*`)` [Function]

minor_status: Mechanism specific status code.

context_handle: Identifies the context on which the message arrived

input_message_buffer: input protected message

output_message_buffer: Buffer to receive unwrapped message. Storage associated with this buffer must be freed by the application after use use with a call to `gss_release_buffer()`.

conf_state: optional output variable indicating if confidentiality protection was used.

qop_state: optional output variable indicating quality of protection.

Converts a message previously protected by gss_wrap back to a usable form, verifying the embedded MIC. The conf_state parameter indicates whether the message was encrypted; the qop_state parameter indicates the strength of protection that was used to provide the confidentiality and integrity services.

Since some application-level protocols may wish to use tokens emitted by `gss_wrap()` to provide "secure framing", implementations must support the wrapping and unwrapping of zero-length messages.

Returns:

GSS_S_COMPLETE Successful completion

GSS_S_DEFECTIVE_TOKEN The token failed consistency checks

GSS_S_BAD_SIG The MIC was incorrect

GSS_S_DUPLICATE_TOKEN The token was valid, and contained a correct MIC for the message, but it had already been processed

GSS_S_OLD_TOKEN The token was valid, and contained a correct MIC for the message, but it is too old to check for duplication.

GSS_S_UNSEQ_TOKEN The token was valid, and contained a correct MIC for the message, but has been verified out of sequence; a later token has already been received.

GSS_S_GAP_TOKEN The token was valid, and contained a correct MIC for the message, but has been verified out of sequence; an earlier expected token has not yet been received.

GSS_S_CONTEXT_EXPIRED The context has already expired

GSS_S_NO_CONTEXT The context_handle parameter did not identify a valid context

3.5 Name Manipulation

Table 2-4 GSS-API Name manipulation Routines

Routine	Section	Function
gss_import_name	5.16	Convert a contiguous string name to internal-form
gss_display_name	5.10	Convert internal-form name to text
gss_compare_name	5.6	Compare two internal-form names
gss_release_name	5.28	Discard an internal-form name
gss_inquire_names_for_mech	5.24	List the name-types supported by the specified mechanism
gss_inquire_mechs_for_name	5.23	List mechanisms that support the specified name-type
gss_canonicalize_name	5.5	Convert an internal name to an MN
gss_export_name	5.13	Convert an MN to export form
gss_duplicate_name	5.12	Create a copy of an internal name

`OM_uint32` **gss_import_name** (`OM_uint32 *` *minor_status*, `const gss_buffer_t` *input_name_buffer*, `const gss_OID` *input_name_type*, `gss_name_t *` *output_name*) [Function]

minor_status: Mechanism specific status code

input_name_buffer: buffer containing contiguous string name to convert

input_name_type: Optional Object ID specifying type of printable name. Applications may specify either GSS_C_NO_OID to use a mechanism-specific default printable syntax, or an OID recognized by the GSS-API implementation to name a specific namespace.

output_name: returned name in internal form. Storage associated with this name must be freed by the application after use with a call to `gss_release_name()`.

Convert a contiguous string name to internal form. In general, the internal name returned (via the <output_name> parameter) will not be an MN; the exception to this is if the <input_name_type> indicates that the contiguous string provided via the <input_name_buffer> parameter is of type GSS_C_NT_EXPORT_NAME, in which case the returned internal name will be an MN for the mechanism that exported the name.

Returns GSS_S_COMPLETE for successful completion, GSS_S_BAD_NAMETYPE when the input_name_type was unrecognized, GSS_S_BAD_NAME when the input_name parameter could not be interpreted as a name of the specified type, and GSS_S_BAD_MECH when the input name-type was GSS_C_NT_EXPORT_NAME, but the mechanism contained within the input-name is not supported.

`OM_uint32` **gss_display_name** (`OM_uint32 *` *`minor_status`*`, const gss_name_t` *`input_name`*`, gss_buffer_t` *`output_name_buffer`*`, gss_OID *` *`output_name_type`*) [Function]

minor_status: Mechanism specific status code.

input_name: Name to be displayed

output_name_buffer: Buffer to receive textual name string. The application must free storage associated with this name after use with a call to `gss_release_buffer()`.

output_name_type: Optional type of the returned name. The returned gss_OID will be a pointer into static storage, and should be treated as read-only by the caller (in particular, the application should not attempt to free it). Specify NULL if not required.

Allows an application to obtain a textual representation of an opaque internal-form name for display purposes. The syntax of a printable name is defined by the GSS-API implementation.

If input_name denotes an anonymous principal, the implementation should return the gss_OID value GSS_C_NT_ANONYMOUS as the output_name_type, and a textual name that is syntactically distinct from all valid supported printable names in output_name_buffer.

If input_name was created by a call to gss_import_name, specifying GSS_C_NO_OID as the name-type, implementations that employ lazy conversion between name types may return GSS_C_NO_OID via the output_name_type parameter.

Returns GSS_S_COMPLETE for successful completion, GSS_S_BAD_NAME when input_name was ill-formed.

`OM_uint32` **gss_compare_name** (`OM_uint32 *` *`minor_status`*`, const gss_name_t` *`name1`*`, const gss_name_t` *`name2`*`, int *` *`name_equal`*) [Function]

minor_status: Mechanism specific status code.

name1: Internal-form name.

name2: Internal-form name.

name_equal: non-zero if names refer to same entity.

Allows an application to compare two internal-form names to determine whether they refer to the same entity.

If either name presented to gss_compare_name denotes an anonymous principal, the routines should indicate that the two names do not refer to the same identity.

Returns GSS_S_COMPLETE for successful completion, GSS_S_BAD_NAMETYPE when the two names were of incomparable types, and GSS_S_BAD_NAME if one or both of name1 or name2 was ill-formed.

`OM_uint32` **gss_release_name** (`OM_uint32 *` *minor_status*, `gss_name_t *` *name*) [Function]

minor_status: Mechanism specific status code.

name: The name to be deleted.

Free GSSAPI-allocated storage associated with an internal-form name. Implementations are encouraged to set the name to GSS_C_NO_NAME on successful completion of this call.

Returns GSS_S_COMPLETE for successful completion, and GSS_S_BAD_NAME when the name parameter did not contain a valid name.

`OM_uint32` **gss_canonicalize_name** (`OM_uint32 *` *minor_status*, `const gss_name_t` *input_name*, `const gss_OID` *mech_type*, `gss_name_t *` *output_name*) [Function]

minor_status: Mechanism specific status code.

input_name: The name for which a canonical form is desired.

mech_type: The authentication mechanism for which the canonical form of the name is desired. The desired mechanism must be specified explicitly; no default is provided.

output_name: The resultant canonical name. Storage associated with this name must be freed by the application after use with a call to `gss_release_name()`.

Generate a canonical mechanism name (MN) from an arbitrary internal name. The mechanism name is the name that would be returned to a context acceptor on successful authentication of a context where the initiator used the input_name in a successful call to gss_acquire_cred, specifying an OID set containing <mech_type> as its only member, followed by a call to gss_init_sec_context, specifying <mech_type> as the authentication mechanism.

Returns

GSS_S_COMPLETE Successful completion.

GSS_S_BAD_MECH The identified mechanism is not supported.

GSS_S_BAD_NAMETYPE The provided internal name contains no elements that could be processed by the specified mechanism.

GSS_S_BAD_NAME The provided internal name was ill-formed.

`OM_uint32` **gss_inquire_names_for_mech** (`OM_uint32 *minor_status, const gss_OID mechanism, gss_OID_set *name_types`) [Function]

minor_status: Implementation specific status code.

mechanism: The mechanism to be interrogated.

name_types: Output set of name-types supported by the specified mechanism. The returned OID set must be freed by the application after use with a call to gss_release_oid_set().

Outputs the set of nametypes supported by the specified mechanism.

Returns GSS_S_COMPLETE for successful completion.

`OM_uint32` **gss_inquire_mechs_for_name** (`OM_uint32 *minor_status, const gss_name_t input_name, gss_OID_set *mech_types`) [Function]

minor_status: Implementation specific status code.

input_name: The name to which the inquiry relates.

mech_types: Output set of mechanisms that may support the specified name. The returned OID set must be freed by the caller after use with a call to gss_release_oid_set().

Outputs the set of mechanisms supported by the GSS-API implementation that may be able to process the specified name.

Each mechanism returned will recognize at least one element within the name. It is permissible for this routine to be implemented within a mechanism-independent GSS-API layer, using the type information contained within the presented name, and based on registration information provided by individual mechanism implementations. This means that the returned mech_types set may indicate that a particular mechanism will understand the name when in fact it would refuse to accept the name as input to gss_canonicalize_name(), gss_init_sec_context(), gss_acquire_cred() or gss_add_cred() (due to some property of the specific name, as opposed to the name type). Thus this routine should be used only as a pre-filter for a call to a subsequent mechanism-specific routine.

Returns GSS_S_COMPLETE for successful completion, GSS_S_BAD_NAME to indicate that the input_name parameter was ill-formed, and GSS_S_BAD_NAMETYPE to indicate that the input_name parameter contained an invalid or unsupported type of name.

`OM_uint32` **gss_canonicalize_name** (`OM_uint32 *minor_status, const gss_name_t input_name, const gss_OID mech_type, gss_name_t *output_name`) [Function]

minor_status: Mechanism specific status code.

input_name: The name for which a canonical form is desired.

mech_type: The authentication mechanism for which the canonical form of the name is desired. The desired mechanism must be specified explicitly; no default is provided.

output_name: The resultant canonical name. Storage associated with this name must be freed by the application after use with a call to gss_release_name().

Generate a canonical mechanism name (MN) from an arbitrary internal name. The mechanism name is the name that would be returned to a context acceptor on successful authentication of a context where the initiator used the input_name in a successful call to gss_acquire_cred, specifying an OID set containing <mech_type> as its only member, followed by a call to gss_init_sec_context, specifying <mech_type> as the authentication mechanism.

Returns GSS_S_COMPLETE for successful completion, GSS_S_BAD_MECH to indicate that the identified mechanism is not supported, GSS_S_BAD_NAMETYPE to indicate that the provided internal name contains no elements that could be processed by the specified mechanism, and GSS_S_BAD_NAME to indicate that the provided internal name was ill-formed.

`OM_uint32` **gss_export_name** (`OM_uint32 *`*minor_status*`, const gss_name_t` *input_name*`, gss_buffer_t` *exported_name*`)` [Function]

minor_status: Mechanism specific status code.

input_name: The mechanism name to be exported.

exported_name: Output variable with canonical contiguous string form of *input_name*. Storage associated with this string must freed by the application after use with gss_release_buffer().

To produce a canonical contiguous string representation of a mechanism name (MN), suitable for direct comparison (e.g. with memcmp) for use in authorization functions (e.g. matching entries in an access-control list). The *input_name* parameter must specify a valid MN (i.e. an internal name generated by gss_accept_sec_context or by gss_canonicalize_name).

Returns GSS_S_COMPLETE for successful completion, GSS_S_NAME_NOT_MN to indicate that the provided internal name was not a mechanism name, GSS_S_BAD_NAME to indicate that the provided internal name was ill-formed, and GSS_S_BAD_NAMETYPE to indicate that the internal name was of a type not supported by the GSS-API implementation.

`OM_uint32` **gss_duplicate_name** (`OM_uint32 *` *minor_status*`, const gss_name_t` *src_name*`, gss_name_t *` *dest_name*`)` [Function]

minor_status: Mechanism specific status code.

src_name: Internal name to be duplicated.

dest_name: The resultant copy of <src_name>. Storage associated with this name must be freed by the application after use with a call to `gss_release_name()`.

Create an exact duplicate of the existing internal name src_name. The new dest_name will be independent of src_name (i.e. src_name and dest_name must both be released, and the release of one shall not affect the validity of the other).

Returns GSS_S_COMPLETE for successful completion, and GSS_S_BAD_NAME when the src_name parameter was ill-formed.

3.6 Miscellaneous Routines

`Table 2-5 GSS-API Miscellaneous Routines`

Routine	Section	Function
gss_add_oid_set_member	5.4	Add an object identifier to a set
gss_display_status	5.11	Convert a GSS-API status code to text
gss_indicate_mechs	5.18	Determine available underlying authentication mechanisms
gss_release_buffer	5.26	Discard a buffer
gss_release_oid_set	5.29	Discard a set of object identifiers
gss_create_empty_oid_set	5.8	Create a set containing no object identifiers
gss_test_oid_set_member	5.30	Determines whether an object identifier is a member of a set.

OM_uint32 **gss_release_buffer** (OM_uint32 * *minor_status*, gss_buffer_t *buffer*) [Function]

minor_status: Mechanism specific status code.

buffer: The storage associated with the buffer will be deleted. The gss_buffer_desc object will not be freed, but its length field will be zeroed.

Free storage associated with a buffer. The storage must have been allocated by a GSS-API routine. In addition to freeing the associated storage, the routine will zero the length field in the descriptor to which the buffer parameter refers, and implementations are encouraged to additionally set the pointer field in the descriptor to NULL. Any buffer object returned by a GSS-API routine may be passed to gss_release_buffer (even if there is no storage associated with the buffer).

Returns GSS_S_COMPLETE for successful completion.

OM_uint32 **gss_create_empty_oid_set** (OM_uint32 * *minor_status*, gss_OID_set * *oid_set*) [Function]

minor_status: Mechanism specific status code

oid_set: The empty object identifier set. The routine will allocate the gss_OID_set_desc object, which the application must free after use with a call to `gss_release_oid_set()`.

Create an object-identifier set containing no object identifiers, to which members may be subsequently added using the `gss_add_oid_set_member()` routine. These routines are intended to be used to construct sets of mechanism object identifiers, for input to gss_acquire_cred.

Returns GSS_S_COMPLETE for successful completion.

OM_uint32 **gss_add_oid_set_member** (OM_uint32 * *minor_status*, const gss_OID *member_oid*, gss_OID_set * *oid_set*) [Function]

minor_status: Mechanism specific status code

member_oid: The object identifier to copied into the set.

oid_set: The set in which the object identifier should be inserted.

Add an Object Identifier to an Object Identifier set. This routine is intended for use in conjunction with gss_create_empty_oid_set when constructing a set of mechanism OIDs for input to gss_acquire_cred. The oid_set parameter must refer to an OID-set that was created by GSS-API (e.g. a set returned by `gss_create_empty_oid_set()`). GSS-API creates a copy of the member_oid and inserts this copy into the set, expanding the storage allocated to the OID-set's elements array if necessary. The routine may add the new member OID anywhere within the elements array, and implementations should verify that the new member_oid is not already contained within the elements array; if the member_oid is already present, the oid_set should remain unchanged.

Returns GSS_S_COMPLETE for successful completion.

`OM_uint32` **gss_test_oid_set_member** (`OM_uint32 *` *minor_status*, `const gss_OID` *member*, `const gss_OID_set` *set*, `int *` *present*) [Function]

minor_status: Mechanism specific status code

member: The object identifier whose presence is to be tested.

set: The Object Identifier set.

present: output indicating if the specified OID is a member of the set, zero if not.

Interrogate an Object Identifier set to determine whether a specified Object Identifier is a member. This routine is intended to be used with OID sets returned by `gss_indicate_mechs()`, `gss_acquire_cred()`, and `gss_inquire_cred()`, but will also work with user-generated sets.

Returns GSS_S_COMPLETE for successful completion.

`OM_uint32` **gss_release_oid_set** (`OM_uint32 *` *minor_status*, `gss_OID_set *` *set*) [Function]

minor_status: Mechanism specific status code

set: The storage associated with the gss_OID_set will be deleted.

Free storage associated with a GSSAPI-generated gss_OID_set object. The set parameter must refer to an OID-set that was returned from a GSS-API routine. `gss_release_oid_set()` will free the storage associated with each individual member OID, the OID set's elements array, and the gss_OID_set_desc.

Implementations are encouraged to set the gss_OID_set parameter to GSS_C_NO_OID_SET on successful completion of this routine.

Returns GSS_S_COMPLETE for successful completion.

`OM_uint32` **gss_indicate_mechs** (`OM_uint32 *`*minor_status*, `gss_OID_set *`*mech_set*) [Function]

minor_status: Mechanism specific status code.

mech_set: Output OID set with implementation-supported mechanisms.

Allows an application to determine which underlying security mechanisms are available.

The returned gss_OID_set value will be a dynamically-allocated OID set, that should be released by the caller after use with a call to gss_release_oid_set().

Returns GSS_S_COMPLETE for successful completion.

`OM_uint32` **gss_display_status** (`OM_uint32 *`*minor_status*`,` [Function]
`OM_uint32` *status_value*`, int` *status_type*`, const gss_OID` *mech_type*`,`
`OM_uint32 *`*message_context*`, gss_buffer_t` *status_string*`)`

minor_status: Mechanism specific status code.

status_value Status value to be converted

status_type: Type of status code. Valid values include GSS_C_GSS_CODE to indicate that status_value is a GSS status code, and GSS_C_MECH_CODE to indicate that status_value is a mechanism status code.

mech_type: Optional OID of underlying mechanism (used to interpret a minor status value) Supply GSS_C_NO_OID to obtain the system default.

message_context: Input/output variable that should be initialized to zero by the application prior to the first call. On return from gss_display_status(), a non-zero status_value parameter indicates that additional messages may be extracted from the status code via subsequent calls to gss_display_status(), passing the same status_value, status_type, mech_type, and message_context parameters.

status_string: Output textual interpretation of the status_value. Storage associated with this parameter must be freed by the application after use with a call to gss_release_buffer().

Allows an application to obtain a textual representation of a GSS-API status code, for display to the user or for logging purposes. Since some status values may indicate multiple conditions, applications may need to call gss_display_status multiple times, each call generating a single text string. The message_context parameter is used by gss_display_status to store state information about which error messages have already been extracted from a given status_value; message_context must be initialized to 0 by the application prior to the first call, and gss_display_status will return a non-zero value in this parameter if there are further messages to extract.

The message_context parameter contains all state information required by gss_display_status in order to extract further messages from the status_value; even when a non-zero value is returned in this parameter, the application is not required to call gss_display_status again unless subsequent messages are desired. The following code extracts all messages from a given status code and prints them to stderr:

```
OM_uint32 message_context;
OM_uint32 status_code;
OM_uint32 maj_status;
OM_uint32 min_status;
gss_buffer_desc status_string;

       ...

message_context = 0;

do {
```

```
        maj_status = gss_display_status (
                        &min_status,
                        status_code,
                        GSS_C_GSS_CODE,
                        GSS_C_NO_OID,
                        &message_context,
                        &status_string)

        fprintf(stderr,
                "%.*s\n",
               (int)status_string.length,

               (char *)status_string.value);

        gss_release_buffer(&min_status, &status_string);

      } while (message_context != 0);
```

Returns GSS_S_COMPLETE for successful completion, GSS_S_BAD_MECH to indicate that translation in accordance with an unsupported mechanism type was requested, and GSS_S_BAD_STATUS to indicate that the status value was not recognized, or the status type was neither GSS_C_GSS_CODE nor GSS_C_MECH_CODE.

4 Extended GSS API

None of the following functions are standard GSS API functions. As such, they are not declared in 'gss/api.h', but rather in 'gss/ext.h' (which is included from 'gss.h').

`const char *` **gss_check_version** (`const char *` *req_version*) [Function]

req_version: version string to compare with, or NULL

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. It is a pretty good idea to run this function as soon as possible, because it may also intializes some subsystems. In a multithreaded environment if should be called before any more threads are created.

`int` **gss_oid_equal** (`gss_OID` *first_oid*, `gss_OID` *second_oid*) [Function]

Compare two OIDs for equality. Compares actual content, not just pointer equality. Returns a boolean true iff the OIDs are equal.

`OM_uint32` **gss_copy_oid** (`OM_uint32 *` *minor_status*, `const gss_OID` *src_oid*, `gss_OID` *dest_oid*); [Function]

Make an exact copy of the given OID, that shares no memory areas with the original. The contents of the copied OID must be deallocated by the caller. Returns GSS_S_COMPLETE on success.

`OM_uint32` **gss_duplicate_oid** (`OM_uint32 *` *minor_status*, `const gss_OID` *src_oid*, `gss_OID *` *dest_oid*) [Function]

Allocate an exact copy of the given OID, that shares no memory areas with the original. The newly created OID, and its contents, must be deallocated by the caller. Returns GSS_S_COMPLETE on success.

`int` **gss_encapsulate_token** (`gss_buffer_t` *input_message*, `gss_OID` *token_oid*, `gss_buffer_t` *output_message*) [Function]

input_message: Message to be encapsulated.

token_oid: OID of mechanism.

input_message: Output buffer with encapsulated message.

Wrap a buffer in the mechanism-independent token format. This is used for the initial token of a GSS-API context establishment sequence. It incorporates an identifier of the mechanism type to be used on that context, and enables tokens to be interpreted unambiguously at GSS-API peers. See further section 3.1 of RFC 2743.

`int` **gss_decapsulate_token** (`gss_buffer_t` *input_message*, `gss_OID` *token_oid*, `gss_buffer_t` *output_message*) [Function]

input_message: Message to decapsulated.

token_oid: Output buffer with mechanism OID used in message.

input_message: Output buffer with encapsulated message.

Unwrap a buffer in the mechanism-independent token format. This is the reverse of `gss_encapsulate_token`. The translation is loss-less, all data is preserved as is.

5 Acknowledgements

This manual borrows text from RFC 2743 and RFC 2744 that describe GSS API formally.

Appendix A Criticism of GSS

The author has doubts whether GSS is the best solution for free software projects looking for a implementation agnostic security framework. We express these doubts in this section, so that the reader can judge for herself if any of the potential problems discussed here are relevant for their project, or if the benefit outweigh the problems. GSS can be criticized on several levels. We start with the actual implementation.

GSS does not appear to be designed by experienced C programmers. While generally this may be a good thing (C is not the best language), but since they defined the API in C, it is unfortunate. The primary evidence of this is the major_status and minor_status error code solution. It is a complicated way to describe error conditions, but what makes matters worse, the error condition is separated; half of the error condition is in the function return value and the other half is in the first argument to the function, which is always a pointer to an integer. (The pointer is not even allowed to be `NULL`, if the application doesn't care about the minor error code.) This makes the API unreadable, and difficult to use. A better solutions would be to return a struct containing the entire error condition, which can be accessed using macros, although we acknowledge that the C language used at the time GSS was designed may not have allowed this (this may in fact be the reason the awkward solution was chosen). Instead, the return value could have been passed back to callers using a pointer to a struct, accessible using various macros, and the function could have a void prototype. The fact that minor_status is placed first in the parameter list increases the pain it is to use the API. Important parameters should be placed first. A better place for minor_status (if it must be present at all) would have been last in the prototypes.

Another evidence of the C inexperience are the memory management issues; GSS provides functions to deallocate data stored within, e.g., `gss_buffer_t` but the caller is responsible of deallocating the structure pointed at by the `gss_buffer_t` (i.e., the `gss_buffer_desc`) itself. Memory management issues are error prone, and this division easily leads to memory leaks (or worse). Instead, the API should be the sole owner of all `gss_ctx_id_t`, `gss_cred_id_t`, and `gss_buffer_t` structures: they should be allocated by the library, and deallocated (using the utility functions defined for this purpose) by the library.

TBA: thread issues

TBA: multiple mechanisms in a GSS library

TBA: high-level design criticism.

TBA: no credential forwarding.

TBA: internationalization

TBA: krb5: no way to access authorization-data

TBA: krb5: firewall/pre-IP: iakerb status?

TBA: krb5: single-DES only

Finally we note that few free security applications uses GSS, perhaps the only major exception to this are Kerberos 5 implementations. While not substantial evidence, this do suggest that the GSS may not be the simplest solution available to solve actual problems, since otherwise more projects would have chosen to take advantage of the work that went into GSS instead of using another framework (or designing their own solution).

Our conclusion is that free software projects that are looking for a security framework should evaluate carefully whether GSS actually is the best solution before using it. In particular it is recommended to compare GSS with the Simple Authentication and Security Layer (SASL) framework, which in several situations provide the same feature as GSS does. The most compelling argument for SASL over GSS is, as its acronym suggest, Simple, whereas GSS is far from it.

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