GNU TLS

Transport Layer Security Library for the GNU system
for version 2.6.5, 11 April 2009

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1 Preface

This document tries to demonstrate and explain the GnuTLS library API. A brief introduction to the protocols and the technology involved, is also included so that an application programmer can better understand the GnuTLS purpose and actual offerings. Even if GnuTLS is a typical library software, it operates over several security and cryptographic protocols, which require the programmer to make careful and correct usage of them, otherwise he risks to offer just a false sense of security. Security and the network security terms are very general terms even for computer software thus cannot be easily restricted to a single cryptographic library. For that reason, do not consider a program secure just because it uses GnuTLS; there are several ways to compromise a program or a communication line and GnuTLS only helps with some of them.

Although this document tries to be self contained, basic network programming and PKI knowlegde is assumed in most of it. A good introduction to networking can be found in [STEVENS] (see [Bibliography], page 318) and for Public Key Infrastructure in [GUTPKI] (see [Bibliography], page 318).

Updated versions of the GnuTLS software and this document will be available from `http://www.gnutls.org/` and `http://www.gnu.org/software/gnutls/`.

1.1 Getting Help

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

A mailing list for developers are also available, see `http://www.gnu.org/software/gnutls/lists.html`.

Bug reports should be sent to `bug-gnutls@gnu.org`, see See Section 1.4 [Bug Reports], page 3.

1.2 Commercial Support

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

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

If you are interested, please write to:

```
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113 47 Stockholm
Sweden

E-mail: simon@josefsson.org
```

If your company provide support related to GnuTLS and would like to be mentioned here, contact the author (see Section 1.4 [Bug Reports], page 3).

1.3 Downloading and Installing

GnuTLS is available for download from the following URL:

http://www.gnutls.org/download.html

The latest version is stored in a file, e.g., 'gnutls-2.6.5.tar.gz' where the '2.6.5' value is the highest version number in the directory.

GnuTLS uses a Linux-like development cycle: even minor version numbers indicate a stable release and a odd minor version number indicates a development release. For example, GnuTLS 1.6.3 denote a stable release since 6 is even, and GnuTLS 1.7.11 denote a development release since 7 is odd.

GnuTLS depends on Libgcrypt, and you will need to install Libgcrypt before installing GnuTLS. Libgcrypt is available from ftp://ftp.gnupg.org/gcrypt/libgcrypt. Libgcrypt needs another library, libgpg-error, and you need to install libgpg-error before installing Libgcrypt. Libgpg-error is available from ftp://ftp.gnupg.org/gcrypt/libgpg-error.

Don't forget to verify the cryptographic signature after downloading source code packages.

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. Typically you invoke `./configure` and then `make check install`. There are a number of compile-time parameters, as discussed below.

The compression libraries (libz and lzo) are optional dependencies. You can get libz from http://www.zlib.net/. You can get lzo from http://www.oberhumer.com/opensource/lzo/.

The X.509 part of GnuTLS needs ASN.1 functionality, from a library called libtasn1. A copy of libtasn1 is included in GnuTLS. If you want to install it separately (e.g., to make it possibly to use libtasn1 in other programs), you can get it from http://www.gnu.org/software/gnutls/download.html.

The OpenPGP part of GnuTLS uses a stripped down version of OpenCDK for parsing OpenPGP packets. It is included GnuTLS. Use parameter `--disable-openpgp-authentication` to disable the OpenPGP functionality in GnuTLS. Unfortunately, we didn't have resources to maintain the code in a separate library.

Regarding the Guile bindings, there are additional installation considerations, see See Section 11.1 [Guile Preparations], page 267.

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

`--disable-srp-authentication`
`--disable-psk-authentication`
`--disable-anon-authentication`
`--disable-extra-pki`
`--disable-openpgp-authentication`
`--disable-openssl-compatibility`
: Disable or enable particular features. Generally not recommended.

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

1.4 Bug Reports

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

- Please make sure that the bug is really in GnuTLS, 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-gnutls@gnu.org`'

1.5 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 1.4 [Bug Reports], page 3). 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 ⟨undefined⟩ [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 ⟨undefined⟩ [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 The Library

In brief GnuTLS can be described as a library which offers an API to access secure communication protocols. These protocols provide privacy over insecure lines, and were designed to prevent eavesdropping, tampering, or message forgery.

Technically GnuTLS is a portable ANSI C based library which implements the TLS 1.1 and SSL 3.0 protocols (See Chapter 3 [Introduction to TLS], page 8, for a more detailed description of the protocols), accompanied with the required framework for authentication and public key infrastructure. Important features of the GnuTLS library include:

- Support for TLS 1.0, TLS 1.1, and SSL 3.0 protocols.
- Support for both X.509 and OpenPGP certificates.
- Support for handling and verification of certificates.
- Support for SRP for TLS authentication.
- Support for PSK for TLS authentication.
- Support for TLS Extension mechanism.
- Support for TLS Compression Methods.

Additionally GnuTLS provides a limited emulation API for the widely used OpenSSL[1] library, to ease integration with existing applications.

GnuTLS consists of three independent parts, namely the "TLS protocol part", the "Certificate part", and the "Cryptographic backend" part. The 'TLS protocol part' is the actual protocol implementation, and is entirely implemented within the GnuTLS library. The 'Certificate part' consists of the certificate parsing, and verification functions which is partially implemented in the GnuTLS library. The Libtasn1[2], a library which offers ASN.1 parsing capabilities, is used for the X.509 certificate parsing functions. A smaller version of OpenCDK[3] is used for the OpenPGP key support in GnuTLS. The "Cryptographic backend" is provided by the Libgcrypt[4] library[5].

In order to ease integration in embedded systems, parts of the GnuTLS library can be disabled at compile time. That way a small library, with the required features, can be generated.

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[1] http://www.openssl.org/

[2] ftp://ftp.gnupg.org/gcrypt/alpha/gnutls/libtasn1/

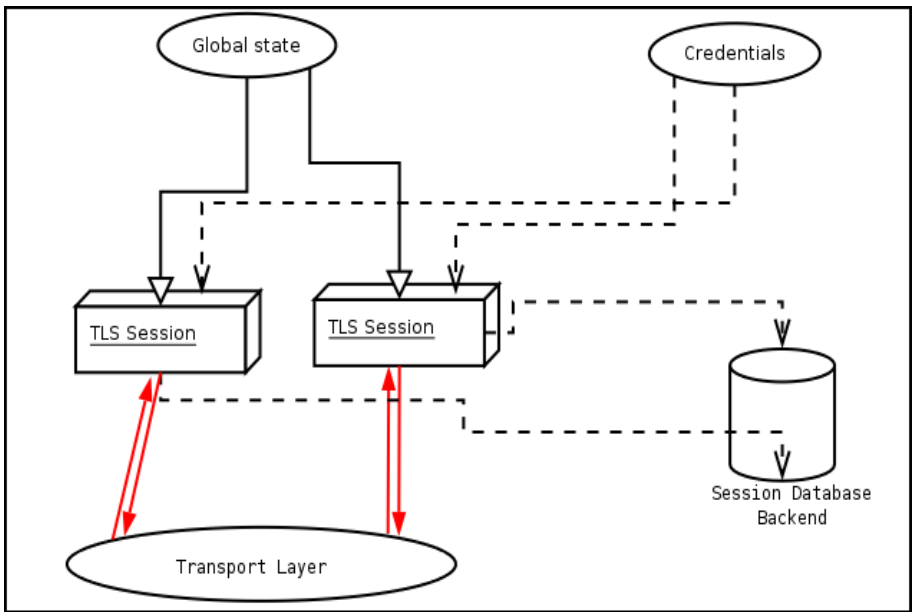
[3] ftp://ftp.gnupg.org/gcrypt/alpha/gnutls/opencdk/

[4] ftp://ftp.gnupg.org/gcrypt/alpha/libgcrypt/

[5] On current versions of GnuTLS it is possible to override the default crypto backend. Check see Section 12.6 [Cryptographic Backend], page 290 for details

2.1 General Idea

A brief description of how GnuTLS works internally is shown at the figure below. This section may be easier to understand after having seen the examples (see [examples], page 32).



As shown in the figure, there is a read-only global state that is initialized once by the global initialization function. This global structure, among others, contains the memory allocation functions used, and some structures needed for the ASN.1 parser. This structure is never modified by any GnuTLS function, except for the deinitialization function which frees all memory allocated in the global structure and is called after the program has permanently finished using GnuTLS.

The credentials structure is used by some authentication methods, such as certificate authentication (see [Certificate Authentication], page 23). A credentials structure may contain certificates, private keys, temporary parameters for diffie hellman or RSA key exchange, and other stuff that may be shared between several TLS sessions.

This structure should be initialized using the appropriate initialization functions. For example an application which uses certificate authentication would probably initialize the credentials, using the appropriate functions, and put its trusted certificates in this structure. The next step is to associate the credentials structure with each TLS session.

A GnuTLS session contains all the required stuff for a session to handle one secure connection. This session calls directly to the transport layer functions, in order to communicate with the peer. Every session has a unique session ID shared with the peer.

Since TLS sessions can be resumed, servers would probably need a database backend to hold the session's parameters. Every GnuTLS session after a successful handshake calls the appropriate backend function (See [resume], page 13, for information on initialization) to store the newly negotiated session. The session database is examined by the server just after having received the client hello[6], and if the session ID sent by the client, matches a

[6] The first message in a TLS handshake

stored session, the stored session will be retrieved, and the new session will be a resumed one, and will share the same session ID with the previous one.

2.2 Error Handling

In GnuTLS most functions return an integer type as a result. In almost all cases a zero or a positive number means success, and a negative number indicates failure, or a situation that some action has to be taken. Thus negative error codes may be fatal or not.

Fatal errors terminate the connection immediately and further sends and receives will be disallowed. An example of a fatal error code is `GNUTLS_E_DECRYPTION_FAILED`. Non-fatal errors may warn about something, i.e., a warning alert was received, or indicate the some action has to be taken. This is the case with the error code `GNUTLS_E_REHANDSHAKE` returned by [gnutls_record_recv], page 163. This error code indicates that the server requests a re-handshake. The client may ignore this request, or may reply with an alert. You can test if an error code is a fatal one by using the [gnutls_error_is_fatal], page 143.

If any non fatal errors, that require an action, are to be returned by a function, these error codes will be documented in the function's reference. See [Error Codes], page 257, for all the error codes.

2.3 Memory Handling

GnuTLS internally handles heap allocated objects differently, depending on the sensitivity of the data they contain. However for performance reasons, the default memory functions do not overwrite sensitive data from memory, nor protect such objects from being written to the swap. In order to change the default behavior the [gnutls_global_set_mem_functions], page 146 function is available which can be used to set other memory handlers than the defaults.

The Libgcrypt library on which GnuTLS depends, has such secure memory allocation functions available. These should be used in cases where even the system's swap memory is not considered secure. See the documentation of Libgcrypt for more information.

2.4 Callback Functions

There are several cases where GnuTLS may need some out of band input from your program. This is now implemented using some callback functions, which your program is expected to register.

An example of this type of functions are the push and pull callbacks which are used to specify the functions that will retrieve and send data to the transport layer.

- [gnutls_transport_set_push_function], page 180
- [gnutls_transport_set_pull_function], page 180

Other callback functions such as the one set by [gnutls_srp_set_server_credentials_function], page 176, may require more complicated input, including data to be allocated. These callbacks should allocate and free memory using the functions shown below.

- [gnutls_malloc], page 151
- [gnutls_free], page 144

3 Introduction to TLS

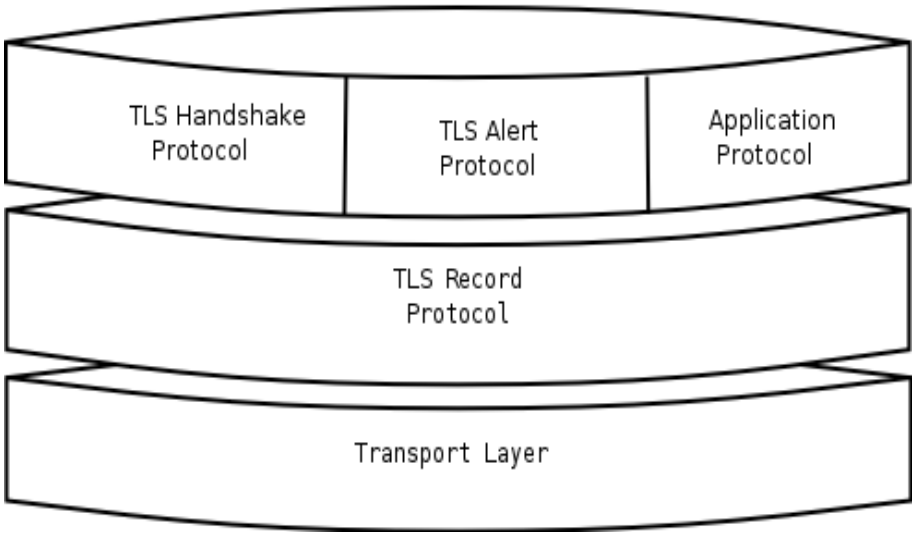
TLS stands for "Transport Layer Security" and is the successor of SSL, the Secure Sockets Layer protocol [SSL3] (see [Bibliography], page 318) designed by Netscape. TLS is an Internet protocol, defined by IETF[1], described in RFC 4346 and also in [RESCORLA] (see [Bibliography], page 318). The protocol provides confidentiality, and authentication layers over any reliable transport layer. The description, below, refers to TLS 1.0 but also applies to TLS 1.1 [RFC4346] (see [Bibliography], page 318) and SSL 3.0, since the differences of these protocols are minor. Older protocols such as SSL 2.0 are not discussed nor implemented in GnuTLS since they are not considered secure today. GnuTLS also supports X.509 and OpenPGP [RFC4880] (see [Bibliography], page 318).

3.1 TLS Layers

TLS is a layered protocol, and consists of the Record Protocol, the Handshake Protocol and the Alert Protocol. The Record Protocol is to serve all other protocols and is above the transport layer. The Record protocol offers symmetric encryption, data authenticity, and optionally compression.

The Alert protocol offers some signaling to the other protocols. It can help informing the peer for the cause of failures and other error conditions. See [The Alert Protocol], page 11, for more information. The alert protocol is above the record protocol.

The Handshake protocol is responsible for the security parameters' negotiation, the initial key exchange and authentication. See [The Handshake Protocol], page 11, for more information about the handshake protocol. The protocol layering in TLS is shown in the figure below.



[1] IETF, or Internet Engineering Task Force, is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is open to any interested individual.

3.2 The Transport Layer

TLS is not limited to one transport layer, it can be used above any transport layer, as long as it is a reliable one. A set of functions is provided and their purpose is to load to GnuTLS the required callbacks to access the transport layer.

- [gnutls_transport_set_push_function], page 180
- [gnutls_transport_set_pull_function], page 180
- [gnutls_transport_set_ptr], page 179
- [gnutls_transport_set_lowat], page 179
- [gnutls_transport_set_errno], page 178

These functions accept a callback function as a parameter. The callback functions should return the number of bytes written, or -1 on error and should set `errno` appropriately.

In some environments, setting `errno` is unreliable, for example Windows have several errno variables in different CRTs, or it may be that errno is not a thread-local variable. If this is a concern to you, call `gnutls_transport_set_errno` with the intended errno value instead of setting `errno` directly.

GnuTLS currently only interprets the EINTR and EAGAIN errno values and returns the corresponding GnuTLS error codes `GNUTLS_E_INTERRUPTED` and `GNUTLS_E_AGAIN`. These values are usually returned by interrupted system calls, or when non blocking IO is used. All GnuTLS functions can be resumed (called again), if any of these error codes is returned. The error codes above refer to the system call, not the GnuTLS function, since signals do not interrupt GnuTLS' functions.

For non blocking sockets or other custom made pull/push functions the [gnutls_transport_set_lowat], page 179 must be called, with a zero low water mark value.

By default, if the transport functions are not set, GnuTLS will use the Berkeley Sockets functions. In this case GnuTLS will use some hacks in order for `select` to work, thus making it easy to add TLS support to existing TCP/IP servers.

3.3 The TLS Record Protocol

The Record protocol is the secure communications provider. Its purpose is to encrypt, authenticate and —optionally— compress packets. The following functions are available:

[gnutls_record_send], page 163:
: To send a record packet (with application data).

[gnutls_record_recv], page 163:
: To receive a record packet (with application data).

[gnutls_record_get_direction], page 162:
: To get the direction of the last interrupted function call.

As you may have already noticed, the functions which access the Record protocol, are quite limited, given the importance of this protocol in TLS. This is because the Record protocol's parameters are all set by the Handshake protocol.

The Record protocol initially starts with NULL parameters, which means no encryption, and no MAC is used. Encryption and authentication begin just after the handshake protocol has finished.

3.3.1 Encryption Algorithms Used in the Record Layer

Confidentiality in the record layer is achieved by using symmetric block encryption algorithms like `3DES`, `AES`[2], or stream algorithms like `ARCFOUR_128`[3]. Ciphers are encryption algorithms that use a single, secret, key to encrypt and decrypt data. Block algorithms in TLS also provide protection against statistical analysis of the data. Thus, if you're using the TLS protocol, a random number of blocks will be appended to data, to prevent eavesdroppers from guessing the actual data size.

Supported cipher algorithms:

`3DES_CBC` `3DES_CBC` is the DES block cipher algorithm used with triple encryption (EDE). Has 64 bits block size and is used in CBC mode.

`ARCFOUR_128`
ARCFOUR is a fast stream cipher.

`ARCFOUR_40`
This is the ARCFOUR cipher that is fed with a 40 bit key, which is considered weak.

`AES_CBC` AES or RIJNDAEL is the block cipher algorithm that replaces the old DES algorithm. Has 128 bits block size and is used in CBC mode. This is not officially supported in TLS.

Supported MAC algorithms:

`MAC_MD5` MD5 is a cryptographic hash algorithm designed by Ron Rivest. Outputs 128 bits of data.

`MAC_SHA` SHA is a cryptographic hash algorithm designed by NSA. Outputs 160 bits of data.

3.3.2 Compression Algorithms Used in the Record Layer

The TLS record layer also supports compression. The algorithms implemented in GnuTLS can be found in the table below. All the algorithms except for DEFLATE which is referenced in [RFC3749] (see [Bibliography], page 318), should be considered as GnuTLS' extensions[4], and should be advertised only when the peer is known to have a compliant client, to avoid interoperability problems.

The included algorithms perform really good when text, or other compressible data are to be transfered, but offer nothing on already compressed data, such as compressed images, zipped archives etc. These compression algorithms, may be useful in high bandwidth TLS tunnels, and in cases where network usage has to be minimized. As a drawback, compression increases latency.

The record layer compression in GnuTLS is implemented based on the proposal [RFC3749] (see [Bibliography], page 318). The supported compression algorithms are:

`DEFLATE` Zlib compression, using the deflate algorithm.

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[2] AES, or Advanced Encryption Standard, is actually the RIJNDAEL algorithm. This is the algorithm that replaced DES.

[3] `ARCFOUR_128` is a compatible algorithm with RSA's RC4 algorithm, which is considered to be a trade secret.

[4] You should use [gnutls_handshake_set_private_extensions], page 147 to enable private extensions.

`LZO` LZO is a very fast compression algorithm. This algorithm is only available if the GnuTLS-extra library has been initialized and the private extensions are enabled, and if GnuTLS was built with LZO support.

3.3.3 Weaknesses and Countermeasures

Some weaknesses that may affect the security of the Record layer have been found in TLS 1.0 protocol. These weaknesses can be exploited by active attackers, and exploit the facts that

1. TLS has separate alerts for "decryption_failed" and "bad_record_mac"
2. The decryption failure reason can be detected by timing the response time.
3. The IV for CBC encrypted packets is the last block of the previous encrypted packet.

Those weaknesses were solved in TLS 1.1 [RFC4346] (see [Bibliography], page 318) which is implemented in GnuTLS. For a detailed discussion see the archives of the TLS Working Group mailing list and the paper [CBCATT] (see [Bibliography], page 318).

3.4 The TLS Alert Protocol

The Alert protocol is there to allow signals to be sent between peers. These signals are mostly used to inform the peer about the cause of a protocol failure. Some of these signals are used internally by the protocol and the application protocol does not have to cope with them (see `GNUTLS_A_CLOSE_NOTIFY`), and others refer to the application protocol solely (see `GNUTLS_A_USER_CANCELLED`). An alert signal includes a level indication which may be either fatal or warning. Fatal alerts always terminate the current connection, and prevent future renegotiations using the current session ID.

The alert messages are protected by the record protocol, thus the information that is included does not leak. You must take extreme care for the alert information not to leak to a possible attacker, via public log files etc.

[gnutls_alert_send], page 117:
To send an alert signal.

[gnutls_error_to_alert], page 143:
To map a gnutls error number to an alert signal.

[gnutls_alert_get], page 116:
Returns the last received alert.

[gnutls_alert_get_name], page 116:
Returns the name, in a character array, of the given alert.

3.5 The TLS Handshake Protocol

The Handshake protocol is responsible for the ciphersuite negotiation, the initial key exchange, and the authentication of the two peers. This is fully controlled by the application layer, thus your program has to set up the required parameters. Available functions to control the handshake protocol include:

[gnutls_priority_init], page 156:
To initialize a priority set of ciphers.

[gnutls_priority_deinit], page 156:
To deinitialize a priority set of ciphers.

[gnutls_priority_set], page 157:
To associate a priority set with a TLS session.

[gnutls_priority_set_direct], page 157:
To directly associate a session with a given priority string.

[gnutls_credentials_set], page 134:
To set the appropriate credentials structures.

[gnutls_certificate_server_set_request], page 123:
To set whether client certificate is required or not.

[gnutls_handshake], page 148:
To initiate the handshake.

3.5.1 TLS Cipher Suites

The Handshake Protocol of TLS negotiates cipher suites of the form `TLS_DHE_RSA_WITH_3DES_CBC_SHA`. The usual cipher suites contain these parameters:

- The key exchange algorithm. `DHE_RSA` in the example.
- The Symmetric encryption algorithm and mode `3DES_CBC` in this example.
- The MAC[5] algorithm used for authentication. `MAC_SHA` is used in the above example.

The cipher suite negotiated in the handshake protocol will affect the Record Protocol, by enabling encryption and data authentication. Note that you should not over rely on TLS to negotiate the strongest available cipher suite. Do not enable ciphers and algorithms that you consider weak.

The priority functions, dicussed above, allow the application layer to enable and set priorities on the individual ciphers. It may imply that all combinations of ciphersuites are allowed, but this is not true. For several reasons, not discussed here, some combinations were not defined in the TLS protocol. The supported ciphersuites are shown in [ciphersuites], page 264.

3.5.2 Client Authentication

In the case of ciphersuites that use certificate authentication, the authentication of the client is optional in TLS. A server may request a certificate from the client — using the [gnutls_certificate_server_set_request], page 123 function. If a certificate is to be requested from the client during the handshake, the server will send a certificate request message that contains a list of acceptable certificate signers. In GnuTLS the certificate signers list is constructed using the trusted Certificate Authorities by the server. That is the ones set using

- [gnutls_certificate_set_x509_trust_file], page 128
- [gnutls_certificate_set_x509_trust_mem], page 128

Sending of the names of the CAs can be controlled using [gnutls_certificate_send_x509_rdn_sequence], page 123. The client, then, may send a certificate, signed by one of the server's acceptable signers.

[5] MAC stands for Message Authentication Code. It can be described as a keyed hash algorithm. See RFC2104.

3.5.3 Resuming Sessions

The [gnutls_handshake], page 148 function, is expensive since a lot of calculations are performed. In order to support many fast connections to the same server a client may use session resuming. **Session resuming** is a feature of the TLS protocol which allows a client to connect to a server, after a successful handshake, without the expensive calculations. This is achieved by using the previously established keys. GnuTLS supports this feature, and the example (see [ex:resume-client], page 55) illustrates a typical use of it.

Keep in mind that sessions are expired after some time, for security reasons, thus it may be normal for a server not to resume a session even if you requested that. Also note that you must enable, using the priority functions, at least the algorithms used in the last session.

3.5.4 Resuming Internals

The resuming capability, mostly in the server side, is one of the problems of a thread-safe TLS implementations. The problem is that all threads must share information in order to be able to resume sessions. The gnutls approach is, in case of a client, to leave all the burden of resuming to the client. I.e., copy and keep the necessary parameters. See the functions:

- [gnutls_session_get_data], page 169
- [gnutls_session_get_id], page 169
- [gnutls_session_set_data], page 170

The server side is different. A server has to specify some callback functions which store, retrieve and delete session data. These can be registered with:

- [gnutls_db_set_remove_function], page 139
- [gnutls_db_set_store_function], page 139
- [gnutls_db_set_retrieve_function], page 139
- [gnutls_db_set_ptr], page 139

It might also be useful to be able to check for expired sessions in order to remove them, and save space. The function [gnutls_db_check_entry], page 138 is provided for that reason.

3.6 TLS Extensions

A number of extensions to the TLS protocol have been proposed mainly in [TLSEXT] (see [Bibliography], page 318). The extensions supported in GnuTLS are:

- Maximum fragment length negotiation
- Server name indication

and they will be discussed in the subsections that follow.

3.6.1 Maximum Fragment Length Negotiation

This extension allows a TLS implementation to negotiate a smaller value for record packet maximum length. This extension may be useful to clients with constrained capabilities. See the [gnutls_record_set_max_size], page 164 and the [gnutls_record_get_max_size], page 163 functions.

3.6.2 Server Name Indication

A common problem in HTTPS servers is the fact that the TLS protocol is not aware of the hostname that a client connects to, when the handshake procedure begins. For that reason the TLS server has no way to know which certificate to send.

This extension solves that problem within the TLS protocol, and allows a client to send the HTTP hostname before the handshake begins within the first handshake packet. The functions [gnutls_server_name_set], page 168 and [gnutls_server_name_get], page 167 can be used to enable this extension, or to retrieve the name sent by a client.

3.7 Selecting Cryptographic Key Sizes

In TLS, since a lot of algorithms are involved, it is not easy to set a consistent security level. For this reason this section will present some correspondance between key sizes of symmetric algorithms and public key algorithms based on the most conservative values of [SELKEY] (see [Bibliography], page 318). Those can be used to generate certificates with appropriate key sizes as well as parameters for Diffie Hellman and SRP authentication.

Year	Symmetric key size	RSA key size, DH and SRP prime size	ECC key size
1982	56	417	105
1988	61	566	114
2002	72	1028	139
2015	82	1613	173
2028	92	2362	210
2040	101	3214	244
2050	109	4047	272

The first column provides an estimation of the year until these parameters are considered safe and the rest of the columns list the parameters for the various algorithms.

Note however that the values suggested here are nothing more than an educated guess that is valid today. There are no guarrantees that an algorithm will remain unbreakable or that these values will remain constant in time. There could be scientific breakthroughs that cannot be predicted or total failure of the current public key systems by quantum computers. On the other hand though the cryptosystems used in TLS are selected in a conservative way and such catastrophic breakthroughs or failures are believed to be unlikely.

NIST publication SP 800-57 [NISTSP80057] (see [Bibliography], page 318) contains a similar table that extends beyond the key sizes given above.

Bits of security	Symmetric key algorithms	RSA key size, DSA, DH and SRP prime size	ECC key size
80	2TDEA	1024	160-223
112	3DES	2048	224-255
128	AES-128	3072	256-383
192	AES-192	7680	384-511
256	AES-256	15360	512+

The recommendations are fairly consistent.

3.8 On SSL 2 and Older Protocols

One of the initial decisions in the GnuTLS development was to implement the known security protocols for the transport layer. Initially TLS 1.0 was implemented since it was the latest at that time, and was considered to be the most advanced in security properties. Later the SSL 3.0 protocol was implemented since it is still the only protocol supported by several servers and there are no serious security vulnerabilities known.

One question that may arise is why we didn't implement SSL 2.0 in the library. There are several reasons, most important being that it has serious security flaws, unacceptable for a modern security library. Other than that, this protocol is barely used by anyone these days since it has been deprecated since 1996. The security problems in SSL 2.0 include:

- Message integrity compromised. The SSLv2 message authentication uses the MD5 function, and is insecure.
- Man-in-the-middle attack. There is no protection of the handshake in SSLv2, which permits a man-in-the-middle attack.
- Truncation attack. SSLv2 relies on TCP FIN to close the session, so the attacker can forge a TCP FIN, and the peer cannot tell if it was a legitimate end of data or not.
- Weak message integrity for export ciphers. The cryptographic keys in SSLv2 are used for both message authentication and encryption, so if weak encryption schemes are negotiated (say 40-bit keys) the message authentication code use the same weak key, which isn't necessary.

Other protocols such as Microsoft's PCT 1 and PCT 2 were not implemented because they were also abandoned and deprecated by SSL 3.0 and later TLS 1.0.

3.9 On Record Padding

The TLS protocol allows for random padding of records, to make it more difficult to perform analysis on the length of exchanged messages. (In RFC 4346 this is specified in section 6.2.3.2.) GnuTLS appears to be one of few implementation that take advantage of this text, and pad records by a random length.

The TLS implementation in the Symbian operating system, frequently used by Nokia and Sony-Ericsson mobile phones, cannot handle non-minimal record padding. What happens when one of these clients handshake with a GnuTLS server is that the client will fail to compute the correct MAC for the record. The client sends a TLS alert (`bad_record_mac`) and disconnects. Typically this will result in error messages such as 'A TLS fatal alert has been received', 'Bad record MAC', or both, on the GnuTLS server side.

GnuTLS implements a work around for this problem. However, it has to be enabled specifically. It can be enabled by using [gnutls_record_disable_padding], page 162, or [gnutls_priority_set], page 157 with the `%COMPAT` priority string.

If you implement an application that have a configuration file, we recommend that you make it possible for users or administrators to specify a GnuTLS protocol priority string, which is used by your application via [gnutls_priority_set], page 157. To allow the best flexibility, make it possible to have a different priority string for different incoming IP addresses.

To enable the workaround in the `gnutls-cli` client or the `gnutls-serv` server, for testing of other implementations, use the following parameter: `--priority "%COMPAT"`.

This problem has been discussed on mailing lists and in bug reports. This section tries to collect all pieces of information that we know about the problem. If you wish to go back to the old discussions, here are some links:

`http://bugs.debian.org/390712`

`http://bugs.debian.org/402861`

`http://bugs.debian.org/438137`

`http://thread.gmane.org/gmane.ietf.tls/3079`

4 Authentication Methods

The TLS protocol provides confidentiality and encryption, but also offers authentication, which is a prerequisite for a secure connection. The available authentication methods in GnuTLS are:

- Certificate authentication
- Anonymous authentication
- SRP authentication
- PSK authentication

4.1 Certificate Authentication

4.1.1 Authentication Using X.509 Certificates

X.509 certificates contain the public parameters, of a public key algorithm, and an authority's signature, which proves the authenticity of the parameters. See Section 5.1 [The X.509 trust model], page 23, for more information on X.509 protocols.

4.1.2 Authentication Using OpenPGP Keys

OpenPGP keys also contain public parameters of a public key algorithm, and signatures from several other parties. Depending on whether a signer is trusted the key is considered trusted or not. GnuTLS's OpenPGP authentication implementation is based on the [TLSPGP] (see [Bibliography], page 318) proposal.

See Section 5.2 [The OpenPGP trust model], page 26, for more information about the OpenPGP trust model. For a more detailed introduction to OpenPGP and GnuPG see [GPGH] (see [Bibliography], page 318).

4.1.3 Using Certificate Authentication

In GnuTLS both the OpenPGP and X.509 certificates are part of the certificate authentication and thus are handled using a common API.

When using certificates the server is required to have at least one certificate and private key pair. A client may or may not have such a pair. The certificate and key pair should be loaded, before any TLS session is initialized, in a certificate credentials structure. This should be done by using [gnutls_certificate_set_x509_key_file], page 126 or [gnutls_certificate_set_openpgp_key_file], page 232 depending on the certificate type. In the X.509 case, the functions will also accept and use a certificate list that leads to a trusted authority. The certificate list must be ordered in such way that every certificate certifies the one before it. The trusted authority's certificate need not to be included, since the peer should possess it already.

As an alternative, a callback may be used so the server or the client specify the certificate and the key at the handshake time. That callback can be set using the functions:

- [gnutls_certificate_server_set_retrieve_function], page 123
- [gnutls_certificate_client_set_retrieve_function], page 120

Certificate verification is possible by loading the trusted authorities into the credentials structure by using [gnutls_certificate_set_x509_trust_file], page 128 or

[gnutls_certificate_set_openpgp_keyring_file], page 233 for openpgp keys. Note however that the peer's certificate is not automatically verified, you should call [gnutls_certificate_verify_peers2], page 130, after a successful handshake, to verify the signatures of the certificate. An alternative way, which reports a more detailed verification output, is to use [gnutls_certificate_get_peers], page 122 to obtain the raw certificate of the peer and verify it using the functions discussed in Section 5.1 [The X.509 trust model], page 23.

In a handshake, the negotiated cipher suite depends on the certificate's parameters, so not all key exchange methods will be available with some certificates. GnuTLS will disable ciphersuites that are not compatible with the key, or the enabled authentication methods. For example keys marked as sign-only, will not be able to access the plain RSA ciphersuites, but only the `DHE_RSA` ones. It is recommended not to use RSA keys for both signing and encryption. If possible use the same key for the `DHE_RSA` and `RSA_EXPORT` ciphersuites, which use signing, and a different key for the plain RSA ciphersuites, which use encryption. All the key exchange methods shown below are available in certificate authentication.

Note that the DHE key exchange methods are generally slower[1] than plain RSA and require Diffie Hellman parameters to be generated and associated with a credentials structure, by the server. The `RSA-EXPORT` method also requires 512 bit RSA parameters, that should also be generated and associated with the credentials structure. See the functions:

- [gnutls_dh_params_generate2], page 142
- [gnutls_certificate_set_dh_params], page 124
- [gnutls_rsa_params_generate2], page 166
- [gnutls_certificate_set_rsa_export_params], page 124

Sometimes in order to avoid bottlenecks in programs it is usefull to store and read parameters from formats that can be generated by external programs such as `certtool`. This is possible with GnuTLS by using the following functions:

- [gnutls_dh_params_import_pkcs3], page 142
- [gnutls_rsa_params_import_pkcs1], page 166
- [gnutls_dh_params_export_pkcs3], page 141
- [gnutls_rsa_params_export_pkcs1], page 165

Key exchange algorithms for OpenPGP and X.509 certificates:

`RSA:` The RSA algorithm is used to encrypt a key and send it to the peer. The certificate must allow the key to be used for encryption.

`RSA_EXPORT:`
The RSA algorithm is used to encrypt a key and send it to the peer. In the EXPORT algorithm, the server signs temporary RSA parameters of 512 bits — which are considered weak — and sends them to the client.

`DHE_RSA:` The RSA algorithm is used to sign Ephemeral Diffie Hellman parameters which are sent to the peer. The key in the certificate must allow the key to be used for signing. Note that key exchange algorithms which use Ephemeral Diffie

[1] It really depends on the group used. Primes with lesser bits are always faster, but also easier to break. Values less than 768 should not be used today

Hellman parameters, offer perfect forward secrecy. That means that even if the private key used for signing is compromised, it cannot be used to reveal past session data.

`DHE_DSS:` The DSS algorithm is used to sign Ephemeral Diffie Hellman parameters which are sent to the peer. The certificate must contain DSA parameters to use this key exchange algorithm. DSS stands for Digital Signature Standard.

4.2 Anonymous Authentication

The anonymous key exchange performs encryption but there is no indication of the identity of the peer. This kind of authentication is vulnerable to a man in the middle attack, but this protocol can be used even if there is no prior communication and trusted parties with the peer, or when full anonymity is required. Unless really required, do not use anonymous authentication. Available key exchange methods are shown below.

Note that the key exchange methods for anonymous authentication require Diffie Hellman parameters to be generated by the server and associated with an anonymous credentials structure.

Supported anonymous key exchange algorithms:

`ANON_DH:` This algorithm exchanges Diffie Hellman parameters.

4.3 Authentication using SRP

Authentication via the Secure Remote Password protocol, SRP[2], is supported. The SRP key exchange is an extension to the TLS protocol, and it is a password based authentication (unlike X.509 or OpenPGP that use certificates). The two peers can be identified using a single password, or there can be combinations where the client is authenticated using SRP and the server using a certificate.

The advantage of SRP authentication, over other proposed secure password authentication schemes, is that SRP does not require the server to hold the user's password. This kind of protection is similar to the one used traditionally in the *UNIX* '`/etc/passwd`' file, where the contents of this file did not cause harm to the system security if they were revealed. The SRP needs instead of the plain password something called a verifier, which is calculated using the user's password, and if stolen cannot be used to impersonate the user. Check [TOMSRP] (see [Bibliography], page 318) for a detailed description of the SRP protocol and the Stanford SRP libraries, which includes a PAM module that synchronizes the system's users passwords with the SRP password files. That way SRP authentication could be used for all the system's users.

The implementation in GnuTLS is based on paper [TLSSRP] (see [Bibliography], page 318). The supported SRP key exchange methods are:

`SRP:` Authentication using the SRP protocol.

`SRP_DSS:` Client authentication using the SRP protocol. Server is authenticated using a certificate with DSA parameters.

[2] SRP is described in [RFC2945] (see [Bibliography], page 318)

`SRP_RSA:` Client authentication using the SRP protocol. Server is authenticated using a certificate with RSA parameters.

If clients supporting SRP know the username and password before the connection, should initialize the client credentials and call the function [gnutls_srp_set_client_credentials], page 176. Alternatively they could specify a callback function by using the function [gnutls_srp_set_client_credentials_function], page 175. This has the advantage that allows probing the server for SRP support. In that case the callback function will be called twice per handshake. The first time is before the ciphersuite is negotiated, and if the callback returns a negative error code, the callback will be called again if SRP has been negotiated. This uses a special TLS-SRP handshake idiom in order to avoid, in interactive applications, to ask the user for SRP password and username if the server does not negotiate an SRP ciphersuite.

In server side the default behaviour of GnuTLS is to read the usernames and SRP verifiers from password files. These password files are the ones used by the *Stanford srp libraries* and can be specified using the [gnutls_srp_set_server_credentials_file], page 176. If a different password file format is to be used, then the function [gnutls_srp_set_server_credentials_function], page 176, should be called, in order to set an appropriate callback.

Some helper functions such as

- [gnutls_srp_verifier], page 177
- [gnutls_srp_base64_encode], page 174
- [gnutls_srp_base64_decode], page 174

are included in GnuTLS, and can be used to generate and maintain SRP verifiers and password files. A program to manipulate the required parameters for SRP authentication is also included. See [srptool], page 115, for more information.

4.4 Authentication using PSK

Authentication using Pre-shared keys is a method to authenticate using usernames and binary keys. This protocol avoids making use of public key infrastructure and expensive calculations, thus it is suitable for constraint clients.

The implementation in GnuTLS is based on paper [TLSPSK] (see [Bibliography], page 318). The supported PSK key exchange methods are:

`PSK:` Authentication using the PSK protocol.

`DHE-PSK:` Authentication using the PSK protocol and Diffie Hellman key exchange. This method offers perfect forward secrecy.

Clients supporting PSK should supply the username and key before the connection to the client credentials by calling the function [gnutls_psk_set_client_credentials], page 160. Alternatively they could specify a callback function by using the function [gnutls_psk_set_client_credentials_function], page 160. This has the advantage that the callback will be called only if PSK has been negotiated.

In server side the default behaviour of GnuTLS is to read the usernames and PSK keys from a password file. The password file should contain usernames and keys in hexadecimal

format. The name of the password file can be stored to the credentials structure by calling [gnutls_psk_set_server_credentials_file], page 161. If a different password file format is to be used, then the function [gnutls_psk_set_server_credentials_function], page 161, should be used instead.

The server can help the client chose a suitable username and password, by sending a hint. In the server, specify the hint by calling [gnutls_psk_set_server_credentials_hint], page 161. The client can retrieve the hint, for example in the callback function, using [gnutls_psk_client_get_hint], page 159.

There is no standard mechanism to derive a PSK key from a password specified by the TLS PSK document. However, GnuTLS provides [gnutls_psk_netconf_derive_key], page 159 which follows the algorithm specified in '`draft-ietf-netconf-tls-02.txt`'.

Some helper functions such as:

- [gnutls_hex_encode], page 149
- [gnutls_hex_decode], page 148

are included in GnuTLS, and may be used to generate and maintain PSK keys.

4.5 Authentication and Credentials

In GnuTLS every key exchange method is associated with a credentials type. So in order to enable to enable a specific method, the corresponding credentials type should be initialized and set using [gnutls_credentials_set], page 134. A mapping is shown below.

Key exchange algorithms and the corresponding credential types:

Key exchange	**Client credentials**	**Server credentials**
KX_RSA		
KX_DHE_RSA		
KX_DHE_DSS		
KX_RSA_EXPORT	CRD_CERTIFICATE	CRD_CERTIFICATE
KX_SRP_RSA	CRD_SRP	CRD_SRP
KX_SRP_DSS		CRD_CERTIFICATE
KX_SRP	CRD_SRP	CRD_SRP
KX_ANON_DH	CRD_ANON	CRD_ANON
KX_PSK	CRD_PSK	CRD_PSK

4.6 Parameters Stored in Credentials

Several parameters such as the ones used for Diffie-Hellman authentication are stored within the credentials structures, so all sessions can access them. Those parameters are stored in structures such as `gnutls_dh_params_t` and `gnutls_rsa_params_t`, and functions like

[gnutls_certificate_set_dh_params], page 124 and [gnutls_certificate_set_rsa_export_params], page 124 can be used to associate those parameters with the given credentials structure.

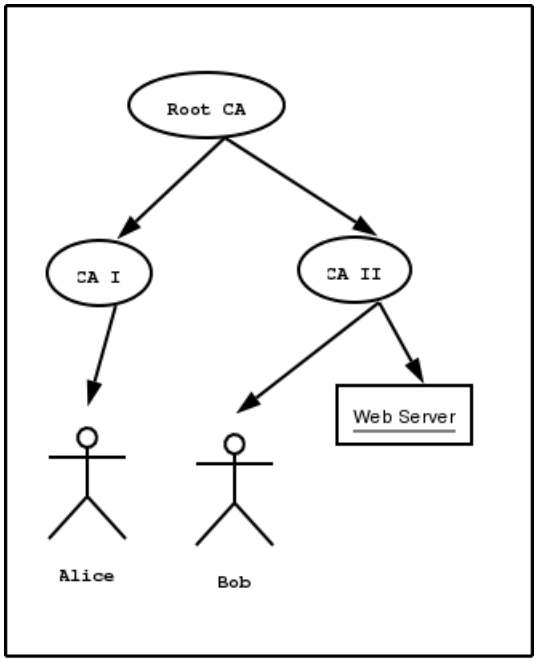
Since those parameters need to be renewed from time to time and a global structure such as the credentials, may not be easy to modify since it is accessible by all sessions, an alternative interface is available using a callback function. This can be set using the [gnutls_certificate_set_params_function], page 124. An example is shown below.

```
#include <gnutls.h>

gnutls_rsa_params_t rsa_params;
gnutls_dh_params_t dh_params;

/* This function will be called once a session requests DH
 * or RSA parameters. The parameters returned (if any) will
 * be used for the first handshake only.
 */
static int get_params( gnutls_session_t session,
        gnutls_params_type_t type,
        gnutls_params_st *st)
{
   if (type == GNUTLS_PARAMS_RSA_EXPORT)
      st->params.rsa_export = rsa_params;
   else if (type == GNUTLS_PARAMS_DH)
      st->params.dh = dh_params;
   else return -1;

   st->type = type;
   /* do not deinitialize those parameters.
    */
   st->deinit = 0;

   return 0;
}

int main()
{
   gnutls_certificate_credentials_t cert_cred;

   initialize_params();

   /* ...
    */

   gnutls_certificate_set_params_function( cert_cred, get_params);
}
```

5 More on Certificate Authentication

5.1 The X.509 Trust Model

The X.509 protocols rely on a hierarchical trust model. In this trust model Certification Authorities (CAs) are used to certify entities. Usually more than one certification authorities exist, and certification authorities may certify other authorities to issue certificates as well, following a hierarchical model.



Two typical X.509 Certification paths

One needs to trust one or more CAs for his secure communications. In that case only the certificates issued by the trusted authorities are acceptable. See the figure above for a typical example. The API for handling X.509 certificates is described at section [sec:x509api], page 180. Some examples are listed below.

5.1.1 X.509 Certificates

An X.509 certificate usually contains information about the certificate holder, the signer, a unique serial number, expiration dates and some other fields [RFC3280] (see [Bibliography], page 318) as shown in the table below.

`version:` The field that indicates the version of the certificate.

`serialNumber:`
This field holds a unique serial number per certificate.

`issuer:` Holds the issuer's distinguished name.

`validity:`
The activation and expiration dates.

`subject:` The subject's distinguished name of the certificate.

`extensions:`
The extensions are fields only present in version 3 certificates.

The certificate's *subject or issuer name* is not just a single string. It is a Distinguished name and in the ASN.1 notation is a sequence of several object IDs with their corresponding values. Some of available OIDs to be used in an X.509 distinguished name are defined in '`gnutls/x509.h`'.

The *Version* field in a certificate has values either 1 or 3 for version 3 certificates. Version 1 certificates do not support the extensions field so it is not possible to distinguish a CA from a person, thus their usage should be avoided.

The *validity* dates are there to indicate the date that the specific certificate was activated and the date the certificate's key would be considered invalid.

Certificate *extensions* are there to include information about the certificate's subject that did not fit in the typical certificate fields. Those may be e-mail addresses, flags that indicate whether the belongs to a CA etc. All the supported X.509 version 3 extensions are shown in the table below.

`subject key id (2.5.29.14):`
An identifier of the key of the subject.

`authority key id (2.5.29.35):`
An identifier of the authority's key used to sign the certificate.

`subject alternative name (2.5.29.17):`
Alternative names to subject's distinguished name.

`key usage (2.5.29.15):`
Constraints the key's usage of the certificate.

`extended key usage (2.5.29.37):`
Constraints the purpose of the certificate.

`basic constraints (2.5.29.19):`
Indicates whether this is a CA certificate or not, and specify the maximum path lengths of certificate chains.

`CRL distribution points (2.5.29.31):`
This extension is set by the CA, in order to inform about the issued CRLs.

`Proxy Certification Information (1.3.6.1.5.5.7.1.14):`
Proxy Certificates includes this extension that contains the OID of the proxy policy language used, and can specify limits on the maximum lengths of proxy chains. Proxy Certificates are specified in [RFC3820] (see [Bibliography], page 318).

In GnuTLS the X.509 certificate structures are handled using the `gnutls_x509_crt_t` type and the corresponding private keys with the `gnutls_x509_privkey_t` type. All the available functions for X.509 certificate handling have their prototypes in '`gnutls/x509.h`'. An example program to demonstrate the X.509 parsing capabilities can be found at section [ex:x509-info], page 95.

5.1.2 Verifying X.509 Certificate Paths

Verifying certificate paths is important in X.509 authentication. For this purpose the function [gnutls_x509_crt_verify], page 223 is provided. The output of this function is the bitwise OR of the elements of the `gnutls_certificate_status_t` enumeration. A detailed description of these elements can be found in figure below. The function [gnutls_certificate_verify_peers2], page 130 is equivalent to the previous one, and will verify the peer's certificate in a TLS session.

`CERT_INVALID:`
: The certificate is not signed by one of the known authorities, or the signature is invalid.

`CERT_REVOKED:`
: The certificate has been revoked by its CA.

`CERT_SIGNER_NOT_FOUND:`
: The certificate's issuer is not known. This is the case when the issuer is not in the trusted certificates list.

`GNUTLS_CERT_SIGNER_NOT_CA:`
: The certificate's signer was not a CA. This may happen if this was a version 1 certificate, which is common with some CAs, or a version 3 certificate without the basic constrains extension.

`GNUTLS_CERT_INSECURE_ALGORITHM:`
: The certificate was signed using an insecure algorithm such as MD2 or MD5. These algorithms have been broken and should not be trusted.

There is also to possibility to pass some input to the verification functions in the form of flags. For [gnutls_x509_crt_verify], page 223 the flags are passed straightforward, but [gnutls_certificate_verify_peers2], page 130 depends on the flags set by calling [gnutls_certificate_set_verify_flags], page 124. All the available flags are part of the enumeration [gnutls_certificate_verify_flags], page 25 and are explained in the table below.

`GNUTLS_VERIFY_DISABLE_CA_SIGN:`
: If set a signer does not have to be a certificate authority. This flag should normaly be disabled, unless you know what this means.

`GNUTLS_VERIFY_ALLOW_X509_V1_CA_CRT:`
: Allow only trusted CA certificates that have version 1. This is safer than GNUTLS_VERIFY_ALLOW_ANY_X509_V1_CA_CRT, and should be used instead. That way only signers in your trusted list will be allowed to have certificates of version 1.

`GNUTLS_VERIFY_ALLOW_ANY_X509_V1_CA_CRT:`
: Allow CA certificates that have version 1 (both root and intermediate). This is dangerous since those haven't the basicConstraints extension. Must be used in combination with GNUTLS_VERIFY_ALLOW_X509_V1_CA_CRT.

`GNUTLS_VERIFY_DO_NOT_ALLOW_SAME:`
: If a certificate is not signed by anyone trusted but exists in the trusted CA list do not treat it as trusted.

`GNUTLS_VERIFY_ALLOW_SIGN_RSA_MD2`:
: Allow certificates to be signed using the old MD2 algorithm.

`GNUTLS_VERIFY_ALLOW_SIGN_RSA_MD5`:
: Allow certificates to be signed using the broken MD5 algorithm.

Although the verification of a certificate path indicates that the certificate is signed by trusted authority, does not reveal anything about the peer's identity. It is required to verify if the certificate's owner is the one you expect. For more information consult [RFC2818] (see [Bibliography], page 318) and section [ex:verify], page 42 for an example.

5.1.3 PKCS #10 Certificate Requests

A certificate request is a structure, which contain information about an applicant of a certificate service. It usually contains a private key, a distinguished name and secondary data such as a challenge password. GnuTLS supports the requests defined in PKCS #10 [RFC2986] (see [Bibliography], page 318). Other certificate request's format such as PKIX's [RFC4211] (see [Bibliography], page 318) are not currently supported.

In GnuTLS the PKCS #10 structures are handled using the `gnutls_x509_crq_t` type. An example of a certificate request generation can be found at section [ex:crq], page 97.

5.1.4 PKCS #12 Structures

A PKCS #12 structure [PKCS12] (see [Bibliography], page 318) usually contains a user's private keys and certificates. It is commonly used in browsers to export and import the user's identities.

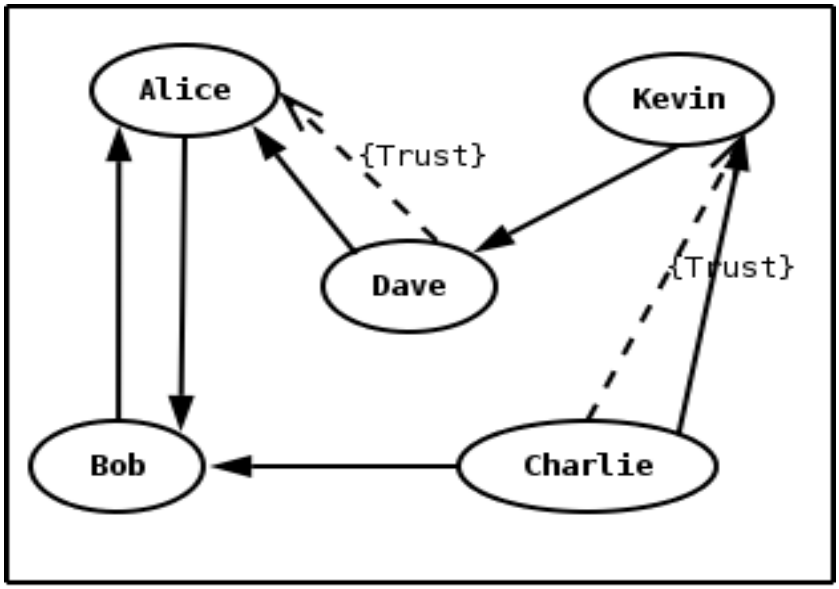
In GnuTLS the PKCS #12 structures are handled using the `gnutls_pkcs12_t` type. This is an abstract type that may hold several `gnutls_pkcs12_bag_t` types. The Bag types are the holders of the actual data, which may be certificates, private keys or encrypted data. An Bag of type encrypted should be decrypted in order for its data to be accessed.

An example of a PKCS #12 structure generation can be found at section [ex:pkcs12], page 99.

5.2 The OpenPGP Trust Model

The OpenPGP key authentication relies on a distributed trust model, called the "web of trust". The "web of trust" uses a decentralized system of trusted introducers, which are the same as a CA. OpenPGP allows anyone to sign anyone's else public key. When Alice

signs Bob's key, she is introducing Bob's key to anyone who trusts Alice. If someone trusts Alice to introduce keys, then Alice is a trusted introducer in the mind of that observer.



An example of the web of trust model

For example: If David trusts Alice to be an introducer, and Alice signed Bob's key, Dave also trusts Bob's key to be the real one.

There are some key points that are important in that model. In the example Alice has to sign Bob's key, only if she is sure that the key belongs to Bob. Otherwise she may also make Dave falsely believe that this is Bob's key. Dave has also the responsibility to know who to trust. This model is similar to real life relations.

Just see how Charlie behaves in the previous example. Although he has signed Bob's key - because he knows, somehow, that it belongs to Bob - he does not trust Bob to be an introducer. Charlie decided to trust only Kevin, for some reason. A reason could be that Bob is lazy enough, and signs other people's keys without being sure that they belong to the actual owner.

5.2.1 OpenPGP Keys

In GnuTLS the OpenPGP key structures [RFC2440] (see [Bibliography], page 318) are handled using the `gnutls_openpgp_crt_t` type and the corresponding private keys with the `gnutls_openpgp_privkey_t` type. All the prototypes for the key handling functions can be found at '`gnutls/openpgp.h`'.

5.2.2 Verifying an OpenPGP Key

The verification functions of OpenPGP keys, included in GnuTLS, are simple ones, and do not use the features of the "web of trust". For that reason, if the verification needs are complex, the assistance of external tools like GnuPG and GPGME (`http://www.gnupg.org/related_software/gpgme/`) is recommended.

There is one verification function in GnuTLS, the [gnutls_openpgp_crt_verify_ring], page 242. This checks an OpenPGP key against a given set of public keys (keyring) and returns the key status. The key verification status is the same as in X.509 certificates, although the meaning and interpretation are different. For example an OpenPGP key may be valid, if the self signature is ok, even if no signers were found. The meaning of verification status is shown in the figure below.

`CERT_INVALID:`
: A signature on the key is invalid. That means that the key was modified by somebody, or corrupted during transport.

`CERT_REVOKED:`
: The key has been revoked by its owner.

`CERT_SIGNER_NOT_FOUND:`
: The key was not signed by a known signer.

`GNUTLS_CERT_INSECURE_ALGORITHM:`
: The certificate was signed using an insecure algorithm such as MD2 or MD5. These algorithms have been broken and should not be trusted.

5.3 Digital Signatures

In this section we will provide some information about digital signatures, how they work, and give the rationale for disabling some of the algorithms used.

Digital signatures work by using somebody's secret key to sign some arbitrary data. Then anybody else could use the public key of that person to verify the signature. Since the data may be arbitrary it is not suitable input to a cryptographic digital signature algorithm. For this reason and also for performance cryptographic hash algorithms are used to preprocess the input to the signature algorithm. This works as long as it is difficult enough to generate two different messages with the same hash algorithm output. In that case the same signature could be used as a proof for both messages. Nobody wants to sign an innocent message of donating 1 € to Greenpeace and find out that he donated 1.000.000 € to Bad Inc.

For a hash algorithm to be called cryptographic the following three requirements must hold:

1. Preimage resistance. That means the algorithm must be one way and given the output of the hash function $H(x)$, it is impossible to calculate x.
2. 2nd preimage resistance. That means that given a pair x, y with $y = H(x)$ it is impossible to calculate an x' such that $y = H(x')$.
3. Collision resistance. That means that it is impossible to calculate random x and x' such $H(x') = H(x)$.

The last two requirements in the list are the most important in digital signatures. These protect against somebody who would like to generate two messages with the same hash output. When an algorithm is considered broken usually it means that the Collision resistance of the algorithm is less than brute force. Using the birthday paradox the brute force attack takes $2^{(\text{hash size})/2}$ operations. Today colliding certificates using the MD5 hash algorithm have been generated as shown in [WEGER] (see [Bibliography], page 318).

There has been cryptographic results for the SHA-1 hash algorithms as well, although they are not yet critical. Before 2004, MD5 had a presumed collision strength of 2^{64}, but it

has been showed to have a collision strength well under 2^{50}. As of November 2005, it is believed that SHA-1's collision strength is around 2^{63}. We consider this sufficiently hard so that we still support SHA-1. We anticipate that SHA-256/386/512 will be used in publicly-distributed certificates in the future. When 2^{63} can be considered too weak compared to the computer power available sometime in the future, SHA-1 will be disabled as well. The collision attacks on SHA-1 may also get better, given the new interest in tools for creating them.

5.3.1 Trading Security for Interoperability

If you connect to a server and use GnuTLS' functions to verify the certificate chain, and get a [GNUTLS_CERT_INSECURE_ALGORITHM], page 25 validation error (see Section 5.1.2 [Verifying X.509 certificate paths], page 25), it means that somewhere in the certificate chain there is a certificate signed using `RSA-MD2` or `RSA-MD5`. These two digital signature algorithms are considered broken, so GnuTLS fail when attempting to verify the certificate. In some situations, it may be useful to be able to verify the certificate chain anyway, assuming an attacker did not utilize the fact that these signatures algorithms are broken. This section will give help on how to achieve that.

First, it is important to know that you do not have to enable any of the flags discussed here to be able to use trusted root CA certificates signed using `RSA-MD2` or `RSA-MD5`. The only attack today is that it is possible to generate certificates with colliding signatures (collision resistance); you cannot generate a certificate that has the same signature as an already existing signature (2nd preimage resistance).

If you are using [gnutls_certificate_verify_peers2], page 130 to verify the certificate chain, you can call [gnutls_certificate_set_verify_flags], page 124 with the `GNUTLS_VERIFY_ALLOW_SIGN_RSA_MD2` or `GNUTLS_VERIFY_ALLOW_SIGN_RSA_MD5` flag, as in:

```
gnutls_certificate_set_verify_flags (x509cred,
                                     GNUTLS_VERIFY_ALLOW_SIGN_RSA_MD5);
```

This will tell the verifier algorithm to enable `RSA-MD5` when verifying the certificates.

If you are using [gnutls_x509_crt_verify], page 223 or [gnutls_x509_crt_list_verify], page 215, you can pass the `GNUTLS_VERIFY_ALLOW_SIGN_RSA_MD5` parameter directly in the `flags` parameter.

If you are using these flags, it may also be a good idea to warn the user when verification failure occur for this reason. The simplest is to not use the flags by default, and only fall back to using them after warning the user. If you wish to inspect the certificate chain yourself, you can use [gnutls_certificate_get_peers], page 122 to extract the raw server's certificate chain, then use [gnutls_x509_crt_import], page 214 to parse each of the certificates, and then use [gnutls_x509_crt_get_signature_algorithm], page 211 to find out the signing algorithm used for each certificate. If any of the intermediary certificates are using `GNUTLS_SIGN_RSA_MD2` or `GNUTLS_SIGN_RSA_MD5`, you could present a warning.

6 How To Use TLS in Application Protocols

This chapter is intended to provide some hints on how to use the TLS over simple custom made application protocols. The discussion below mainly refers to the *TCP/IP* transport layer but may be extended to other ones too.

6.1 Separate Ports

Traditionally SSL was used in application protocols by assigning a new port number for the secure services. That way two separate ports were assigned, one for the non secure sessions, and one for the secured ones. This has the benefit that if a user requests a secure session then the client will try to connect to the secure port and fail otherwise. The only possible attack with this method is a denial of service one. The most famous example of this method is the famous "HTTP over TLS" or HTTPS protocol [RFC2818] (see [Bibliography], page 318).

Despite its wide use, this method is not as good as it seems. This approach starts the TLS Handshake procedure just after the client connects on the —so called— secure port. That way the TLS protocol does not know anything about the client, and popular methods like the host advertising in HTTP do not work[1]. There is no way for the client to say "I connected to YYY server" before the Handshake starts, so the server cannot possibly know which certificate to use.

Other than that it requires two separate ports to run a single service, which is unnecessary complication. Due to the fact that there is a limitation on the available privileged ports, this approach was soon obsoleted.

6.2 Upward Negotiation

Other application protocols[2] use a different approach to enable the secure layer. They use something called the "TLS upgrade" method. This method is quite tricky but it is more flexible. The idea is to extend the application protocol to have a "STARTTLS" request, whose purpose it to start the TLS protocols just after the client requests it. This is a really neat idea and does not require an extra port.

This method is used by almost all modern protocols and there is even the [RFC2817] (see [Bibliography], page 318) paper which proposes extensions to HTTP to support it.

The tricky part, in this method, is that the "STARTTLS" request is sent in the clear, thus is vulnerable to modifications. A typical attack is to modify the messages in a way that the client is fooled and thinks that the server does not have the "STARTTLS" capability. See a typical conversation of a hypothetical protocol:

(client connects to the server)
CLIENT: HELLO I'M MR. XXX
SERVER: NICE TO MEET YOU XXX
CLIENT: PLEASE START TLS
SERVER: OK

[1] See also the Server Name Indication extension on [serverind], page 14.
[2] See LDAP, IMAP etc.

*** TLS STARTS

CLIENT: HERE ARE SOME CONFIDENTIAL DATA

And see an example of a conversation where someone is acting in between:

(client connects to the server)

CLIENT: HELLO I'M MR. XXX

SERVER: NICE TO MEET YOU XXX

CLIENT: PLEASE START TLS

(here someone inserts this message)

SERVER: SORRY I DON'T HAVE THIS CAPABILITY

CLIENT: HERE ARE SOME CONFIDENTIAL DATA

As you can see above the client was fooled, and was dummy enough to send the confidential data in the clear.

How to avoid the above attack? As you may have already thought this one is easy to avoid. The client has to ask the user before it connects whether the user requests TLS or not. If the user answered that he certainly wants the secure layer the last conversation should be:

(client connects to the server)

CLIENT: HELLO I'M MR. XXX

SERVER: NICE TO MEET YOU XXX

CLIENT: PLEASE START TLS

(here someone inserts this message)

SERVER: SORRY I DON'T HAVE THIS CAPABILITY

CLIENT: BYE

(the client notifies the user that the secure connection was not possible)

This method, if implemented properly, is far better than the traditional method, and the security properties remain the same, since only denial of service is possible. The benefit is that the server may request additional data before the TLS Handshake protocol starts, in order to send the correct certificate, use the correct password file[3], or anything else!

[3] in SRP authentication

7 How To Use GnuTLS in Applications

7.1 Preparation

To use GnuTLS, you have to perform some changes to your sources and your build system. The necessary changes are explained in the following subsections.

7.1.1 Headers

All the data types and functions of the GnuTLS library are defined in the header file '`gnutls/gnutls.h`'. This must be included in all programs that make use of the GnuTLS library.

The extra functionality of the GnuTLS-extra library is available by including the header file '`gnutls/extra.h`' in your programs.

7.1.2 Initialization

GnuTLS must be initialized before it can be used. The library is initialized by calling [gnutls_global_init], page 145. The resources allocated by the initialization process can be released if the application no longer has a need to call GnuTLS functions, this is done by calling [gnutls_global_deinit], page 145.

The extra functionality of the GnuTLS-extra library is available after calling [gnutls_global_init_extra], page 232.

In order to take advantage of the internationalisation features in GnuTLS, such as translated error messages, the application must set the current locale using `setlocale` before initializing GnuTLS.

7.1.3 Version Check

It is often desirable to check that the version of 'gnutls' 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. See the function [gnutls_check_version], page 131.

7.1.4 Debugging

In many cases things may not go as expected and further information, to assist debugging, from GnuTLS is desired. Those are the case where the [gnutls_global_set_log_level], page 145 and [gnutls_global_set_log_function], page 145 are to be used. Those will print verbose information on the GnuTLS functions internal flow.

7.1.5 Building the Source

If you want to compile a source file including the 'gnutls/gnutls.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, GnuTLS ships with two small helper programs `libgnutls-config`

and `libgnutls-extra-config` that knows about 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 `libgnutls-config`. The following example shows how it can be used at the command line:

```
gcc -c foo.c `libgnutls-config --cflags`
```

Adding the output of `libgnutls-config --cflags` to the compilers command line will ensure that the compiler can find the GnuTLS 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 `libgnutls-config` can be used. For convenience, this option also outputs all other options that are required to link the program with the GnuTLS libararies. The example shows how to link 'foo.o' with the GnuTLS libraries to a program *foo*.

```
gcc -o foo foo.o `libgnutls-config --libs`
```

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

```
gcc -o foo foo.c `libgnutls-config --cflags --libs`
```

7.2 Multi-Threaded Applications

Although the GnuTLS library is thread safe by design, some parts of Libgcrypt, such as the random generator, are not. Applications have to register callback functions to ensure proper locking in the sensitive parts of *libgcrypt*.

There are helper macros to help you properly initialize the libraries. Examples are shown below.

- POSIX threads

```
#include <gnutls.h>
#include <gcrypt.h>
#include <errno.h>
#include <pthread.h>
GCRY_THREAD_OPTION_PTHREAD_IMPL;

int main()
{
   /* The order matters.
    */
   gcry_control (GCRYCTL_SET_THREAD_CBS, &gcry_threads_pthread);
   gnutls_global_init();
}
```

- GNU PTH threads

```
#include <gnutls.h>
#include <gcrypt.h>
#include <errno.h>
#include <pth.h>
GCRY_THREAD_OPTION_PTH_IMPL;
```

```
int main()
{
   gcry_control (GCRYCTL_SET_THREAD_CBS, &gcry_threads_pth);
   gnutls_global_init();
}
```

- Other thread packages

```
/* The gcry_thread_cbs structure must have been
 * initialized.
 */
static struct gcry_thread_cbs gcry_threads_other = { ... };

int main()
{
   gcry_control (GCRYCTL_SET_THREAD_CBS, &gcry_threads_other);
}
```

7.3 Client Examples

This section contains examples of TLS and SSL clients, using GnuTLS. Note that these examples contain little or no error checking. Some of the examples require functions implemented by another example.

7.3.1 Simple Client Example with Anonymous Authentication

The simplest client using TLS is the one that doesn't do any authentication. This means no external certificates or passwords are needed to set up the connection. As could be expected, the connection is vulnerable to man-in-the-middle (active or redirection) attacks. However, the data is integrity and privacy protected.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <unistd.h>
#include <gnutls/gnutls.h>
```

```
/* A very basic TLS client, with anonymous authentication.
 */

#define MAX_BUF 1024
#define SA struct sockaddr
#define MSG "GET / HTTP/1.0\r\n\r\n"

extern int tcp_connect (void);
extern void tcp_close (int sd);

int
main (void)
{
  int ret, sd, ii;
  gnutls_session_t session;
  char buffer[MAX_BUF + 1];
  gnutls_anon_client_credentials_t anoncred;
  /* Need to enable anonymous KX specifically.  */

  gnutls_global_init ();

  gnutls_anon_allocate_client_credentials (&anoncred);

  /* Initialize TLS session
   */
  gnutls_init (&session, GNUTLS_CLIENT);

  /* Use default priorities */
  gnutls_priority_set_direct (session, "PERFORMANCE:+ANON-DH:!ARCFOUR-128",
                              NULL);

  /* put the anonymous credentials to the current session
   */
  gnutls_credentials_set (session, GNUTLS_CRD_ANON, anoncred);

  /* connect to the peer
   */
  sd = tcp_connect ();

  gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);

  /* Perform the TLS handshake
   */
  ret = gnutls_handshake (session);

  if (ret < 0)
```

```
    {
      fprintf (stderr, "*** Handshake failed\n");
      gnutls_perror (ret);
      goto end;
    }
  else
    {
      printf ("- Handshake was completed\n");
    }

  gnutls_record_send (session, MSG, strlen (MSG));

  ret = gnutls_record_recv (session, buffer, MAX_BUF);
  if (ret == 0)
    {
      printf ("- Peer has closed the TLS connection\n");
      goto end;
    }
  else if (ret < 0)
    {
      fprintf (stderr, "*** Error:  %s\n", gnutls_strerror (ret));
      goto end;
    }

  printf ("- Received %d bytes:  ", ret);
  for (ii = 0; ii < ret; ii++)
    {
      fputc (buffer[ii], stdout);
    }
  fputs ("\n", stdout);

  gnutls_bye (session, GNUTLS_SHUT_RDWR);

end:

  tcp_close (sd);

  gnutls_deinit (session);

  gnutls_anon_free_client_credentials (anoncred);

  gnutls_global_deinit ();

  return 0;
}
```

7.3.2 Simple Client Example with X.509 Certificate Support

Let's assume now that we want to create a TCP client which communicates with servers that use X.509 or OpenPGP certificate authentication. The following client is a very simple TLS client, it does not support session resuming, not even certificate verification. The TCP functions defined in this example are used in most of the other examples below, without redefining them.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <unistd.h>
#include <gnutls/gnutls.h>

/* A very basic TLS client, with X.509 authentication.
 */

#define MAX_BUF 1024
#define CAFILE "ca.pem"
#define MSG "GET / HTTP/1.0\r\n\r\n"

extern int tcp_connect (void);
extern void tcp_close (int sd);

int
main (void)
{
  int ret, sd, ii;
  gnutls_session_t session;
  char buffer[MAX_BUF + 1];
  const char *err;
  gnutls_certificate_credentials_t xcred;

  gnutls_global_init ();
```

```
/* X509 stuff */
gnutls_certificate_allocate_credentials (&xcred);

/* sets the trusted cas file
 */
gnutls_certificate_set_x509_trust_file (xcred, CAFILE, GNUTLS_X509_FMT_PEM);

/* Initialize TLS session
 */
gnutls_init (&session, GNUTLS_CLIENT);

/* Use default priorities */
ret = gnutls_priority_set_direct (session, "PERFORMANCE", &err);
if (ret < 0)
  {
    if (ret == GNUTLS_E_INVALID_REQUEST)
      {
        fprintf (stderr, "Syntax error at:  %s\n", err);
      }
    exit (1);
  }

/* put the x509 credentials to the current session
 */
gnutls_credentials_set (session, GNUTLS_CRD_CERTIFICATE, xcred);

/* connect to the peer
 */
sd = tcp_connect ();

gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);

/* Perform the TLS handshake
 */
ret = gnutls_handshake (session);

if (ret < 0)
  {
    fprintf (stderr, "*** Handshake failed\n");
    gnutls_perror (ret);
    goto end;
  }
else
  {
    printf ("- Handshake was completed\n");
  }
```

```
  gnutls_record_send (session, MSG, strlen (MSG));

  ret = gnutls_record_recv (session, buffer, MAX_BUF);
  if (ret == 0)
    {
      printf ("- Peer has closed the TLS connection\n");
      goto end;
    }
  else if (ret < 0)
    {
      fprintf (stderr, "*** Error:  %s\n", gnutls_strerror (ret));
      goto end;
    }

  printf ("- Received %d bytes:  ", ret);
  for (ii = 0; ii < ret; ii++)
    {
      fputc (buffer[ii], stdout);
    }
  fputs ("\n", stdout);

  gnutls_bye (session, GNUTLS_SHUT_RDWR);

end:

  tcp_close (sd);

  gnutls_deinit (session);

  gnutls_certificate_free_credentials (xcred);

  gnutls_global_deinit ();

  return 0;
}
```

7.3.3 Obtaining Session Information

Most of the times it is desirable to know the security properties of the current established session. This includes the underlying ciphers and the protocols involved. That is the purpose of the following function. Note that this function will print meaningful values only if called after a successful [gnutls_handshake], page 148.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
```

```
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <gnutls/gnutls.h>
#include <gnutls/x509.h>

extern void print_x509_certificate_info (gnutls_session_t);

/* This function will print some details of the
 * given session.
 */
int
print_info (gnutls_session_t session)
{
  const char *tmp;
  gnutls_credentials_type_t cred;
  gnutls_kx_algorithm_t kx;

  /* print the key exchange's algorithm name
   */
  kx = gnutls_kx_get (session);
  tmp = gnutls_kx_get_name (kx);
  printf ("- Key Exchange:  %s\n", tmp);

  /* Check the authentication type used and switch
   * to the appropriate.
   */
  cred = gnutls_auth_get_type (session);
  switch (cred)
    {
    case GNUTLS_CRD_IA:
      printf ("- TLS/IA session\n");
      break;


#ifdef ENABLE_SRP
    case GNUTLS_CRD_SRP:
      printf ("- SRP session with username %s\n",
              gnutls_srp_server_get_username (session));
      break;
#endif
```

```
  case GNUTLS_CRD_PSK:
    /* This returns NULL in server side.
     */
    if (gnutls_psk_client_get_hint (session) != NULL)
      printf ("- PSK authentication.  PSK hint '%s'\n",
              gnutls_psk_client_get_hint (session));
    /* This returns NULL in client side.
     */
    if (gnutls_psk_server_get_username (session) != NULL)
      printf ("- PSK authentication.  Connected as '%s'\n",
              gnutls_psk_server_get_username (session));
    break;

  case GNUTLS_CRD_ANON:       /* anonymous authentication */

    printf ("- Anonymous DH using prime of %d bits\n",
            gnutls_dh_get_prime_bits (session));
    break;

  case GNUTLS_CRD_CERTIFICATE:        /* certificate authentication */

    /* Check if we have been using ephemeral Diffie Hellman.
     */
    if (kx == GNUTLS_KX_DHE_RSA || kx == GNUTLS_KX_DHE_DSS)
      {
        printf ("\n- Ephemeral DH using prime of %d bits\n",
                gnutls_dh_get_prime_bits (session));
      }

    /* if the certificate list is available, then
     * print some information about it.
     */
    print_x509_certificate_info (session);

  }                           /* switch */

/* print the protocol's name (ie TLS 1.0)
 */
tmp = gnutls_protocol_get_name (gnutls_protocol_get_version (session));
printf ("- Protocol:  %s\n", tmp);

/* print the certificate type of the peer.
 * ie X.509
 */
tmp =
  gnutls_certificate_type_get_name (gnutls_certificate_type_get (session));
```

```
  printf ("- Certificate Type:  %s\n", tmp);

  /* print the compression algorithm (if any)
   */
  tmp = gnutls_compression_get_name (gnutls_compression_get (session));
  printf ("- Compression:  %s\n", tmp);

  /* print the name of the cipher used.
   * ie 3DES.
   */
  tmp = gnutls_cipher_get_name (gnutls_cipher_get (session));
  printf ("- Cipher:  %s\n", tmp);

  /* Print the MAC algorithms name.
   * ie SHA1
   */
  tmp = gnutls_mac_get_name (gnutls_mac_get (session));
  printf ("- MAC: %s\n", tmp);

  return 0;
}
```

7.3.4 Verifying Peer's Certificate

A TLS session is not secure just after the handshake procedure has finished. It must be considered secure, only after the peer's certificate and identity have been verified. That is, you have to verify the signature in peer's certificate, the hostname in the certificate, and expiration dates. Just after this step you should treat the connection as being a secure one.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <gnutls/gnutls.h>
#include <gnutls/x509.h>

/* This function will try to verify the peer's certificate, and
 * also check if the hostname matches, and the activation, expiration dates.
 */
```

```
void
verify_certificate (gnutls_session_t session, const char *hostname)
{
  unsigned int status;
  const gnutls_datum_t *cert_list;
  unsigned int cert_list_size;
  int ret;
  gnutls_x509_crt_t cert;


  /* This verification function uses the trusted CAs in the credentials
   * structure.  So you must have installed one or more CA certificates.
   */
  ret = gnutls_certificate_verify_peers2 (session, &status);

  if (ret < 0)
    {
      printf ("Error\n");
      return;
    }

  if (status & GNUTLS_CERT_INVALID)
    printf ("The certificate is not trusted.\n");

  if (status & GNUTLS_CERT_SIGNER_NOT_FOUND)
    printf ("The certificate hasn't got a known issuer.\n");

  if (status & GNUTLS_CERT_REVOKED)
    printf ("The certificate has been revoked.\n");


  /* Up to here the process is the same for X.509 certificates and
   * OpenPGP keys.  From now on X.509 certificates are assumed.  This can
   * be easily extended to work with openpgp keys as well.
   */
  if (gnutls_certificate_type_get (session) != GNUTLS_CRT_X509)
    return;

  if (gnutls_x509_crt_init (&cert) < 0)
    {
      printf ("error in initialization\n");
      return;
    }

  cert_list = gnutls_certificate_get_peers (session, &cert_list_size);
  if (cert_list == NULL)
    {
```

```
      printf ("No certificate was found!\n");
      return;
    }

  /* This is not a real world example, since we only check the first
   * certificate in the given chain.
   */
  if (gnutls_x509_crt_import (cert, &cert_list[0], GNUTLS_X509_FMT_DER) < 0)
    {
      printf ("error parsing certificate\n");
      return;
    }

  /* Beware here we do not check for errors.
   */
  if (gnutls_x509_crt_get_expiration_time (cert) < time (0))
    {
      printf ("The certificate has expired\n");
      return;
    }

  if (gnutls_x509_crt_get_activation_time (cert) > time (0))
    {
      printf ("The certificate is not yet activated\n");
      return;
    }

  if (!gnutls_x509_crt_check_hostname (cert, hostname))
    {
      printf ("The certificate's owner does not match hostname '%s'\n",
              hostname);
      return;
    }

  gnutls_x509_crt_deinit (cert);

  return;
}
```

An other example is listed below which provides a more detailed verification output.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */
```

```
#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <gnutls/gnutls.h>
#include <gnutls/x509.h>

/* All the available CRLs
 */
gnutls_x509_crl_t *crl_list;
int crl_list_size;

/* All the available trusted CAs
 */
gnutls_x509_crt_t *ca_list;
int ca_list_size;

static void verify_cert2 (gnutls_x509_crt_t crt,
                          gnutls_x509_crt_t issuer,
                          gnutls_x509_crl_t * crl_list, int crl_list_size);
static void verify_last_cert (gnutls_x509_crt_t crt,
                              gnutls_x509_crt_t * ca_list, int ca_list_size,
                              gnutls_x509_crl_t * crl_list,
                              int crl_list_size);


/* This function will try to verify the peer's certificate chain, and
 * also check if the hostname matches, and the activation, expiration dates.
 */
void
verify_certificate_chain (gnutls_session_t session,
                          const char *hostname,
                          const gnutls_datum_t * cert_chain,
                          int cert_chain_length)
{
  int i;
  gnutls_x509_crt_t *cert;

  cert = malloc (sizeof (*cert) * cert_chain_length);

  /* Import all the certificates in the chain to
   * native certificate format.
   */
  for (i = 0; i < cert_chain_length; i++)
    {
```

```
      gnutls_x509_crt_init (&cert[i]);
      gnutls_x509_crt_import (cert[i], &cert_chain[i], GNUTLS_X509_FMT_DER);
    }

  /* If the last certificate in the chain is self signed ignore it.
   * That is because we want to check against our trusted certificate
   * list.
   */
  if (gnutls_x509_crt_check_issuer (cert[cert_chain_length - 1],
                                    cert[cert_chain_length - 1]) > 0
      && cert_chain_length > 0)
    {
      cert_chain_length--;
    }

  /* Now verify the certificates against their issuers
   * in the chain.
   */
  for (i = 1; i < cert_chain_length; i++)
    {
      verify_cert2 (cert[i - 1], cert[i], crl_list, crl_list_size);
    }

  /* Here we must verify the last certificate in the chain against
   * our trusted CA list.
   */
  verify_last_cert (cert[cert_chain_length - 1],
                    ca_list, ca_list_size, crl_list, crl_list_size);

  /* Check if the name in the first certificate matches our destination!
   */
  if (!gnutls_x509_crt_check_hostname (cert[0], hostname))
    {
      printf ("The certificate's owner does not match hostname '%s'\n",
              hostname);
    }

  for (i = 0; i < cert_chain_length; i++)
    gnutls_x509_crt_deinit (cert[i]);

  return;
}


/* Verifies a certificate against an other certificate
 * which is supposed to be it's issuer.  Also checks the
 * crl_list if the certificate is revoked.
```

```
 */
static void
verify_cert2 (gnutls_x509_crt_t crt, gnutls_x509_crt_t issuer,
              gnutls_x509_crl_t * crl_list, int crl_list_size)
{
  unsigned int output;
  int ret;
  time_t now = time (0);
  size_t name_size;
  char name[64];

  /* Print information about the certificates to
   * be checked.
   */
  name_size = sizeof (name);
  gnutls_x509_crt_get_dn (crt, name, &name_size);

  fprintf (stderr, "\nCertificate:  %s\n", name);

  name_size = sizeof (name);
  gnutls_x509_crt_get_issuer_dn (crt, name, &name_size);

  fprintf (stderr, "Issued by:  %s\n", name);

  /* Get the DN of the issuer cert.
   */
  name_size = sizeof (name);
  gnutls_x509_crt_get_dn (issuer, name, &name_size);

  fprintf (stderr, "Checking against:  %s\n", name);

  /* Do the actual verification.
   */
  gnutls_x509_crt_verify (crt, &issuer, 1, 0, &output);

  if (output & GNUTLS_CERT_INVALID)
    {
      fprintf (stderr, "Not trusted");

      if (output & GNUTLS_CERT_SIGNER_NOT_FOUND)
        fprintf (stderr, ":  no issuer was found");
      if (output & GNUTLS_CERT_SIGNER_NOT_CA)
        fprintf (stderr, ":  issuer is not a CA");

      fprintf (stderr, "\n");
    }
  else
```

```
    fprintf (stderr, "Trusted\n");


  /* Now check the expiration dates.
   */
  if (gnutls_x509_crt_get_activation_time (crt) > now)
    fprintf (stderr, "Not yet activated\n");

  if (gnutls_x509_crt_get_expiration_time (crt) < now)
    fprintf (stderr, "Expired\n");

  /* Check if the certificate is revoked.
   */
  ret = gnutls_x509_crt_check_revocation (crt, crl_list, crl_list_size);
  if (ret == 1)
    {                           /* revoked */
      fprintf (stderr, "Revoked\n");
    }
}


/* Verifies a certificate against our trusted CA list.
 * Also checks the crl_list if the certificate is revoked.
 */
static void
verify_last_cert (gnutls_x509_crt_t crt,
                  gnutls_x509_crt_t * ca_list, int ca_list_size,
                  gnutls_x509_crl_t * crl_list, int crl_list_size)
{
  unsigned int output;
  int ret;
  time_t now = time (0);
  size_t name_size;
  char name[64];

  /* Print information about the certificates to
   * be checked.
   */
  name_size = sizeof (name);
  gnutls_x509_crt_get_dn (crt, name, &name_size);

  fprintf (stderr, "\nCertificate:  %s\n", name);

  name_size = sizeof (name);
  gnutls_x509_crt_get_issuer_dn (crt, name, &name_size);

  fprintf (stderr, "Issued by:  %s\n", name);
```

```
  /* Do the actual verification.
   */
  gnutls_x509_crt_verify (crt, ca_list, ca_list_size,
                          GNUTLS_VERIFY_ALLOW_X509_V1_CA_CRT, &output);

  if (output & GNUTLS_CERT_INVALID)
    {
      fprintf (stderr, "Not trusted");

      if (output & GNUTLS_CERT_SIGNER_NOT_CA)
        fprintf (stderr, ":  Issuer is not a CA\n");
      else
        fprintf (stderr, "\n");
    }
  else
    fprintf (stderr, "Trusted\n");


  /* Now check the expiration dates.
   */
  if (gnutls_x509_crt_get_activation_time (crt) > now)
    fprintf (stderr, "Not yet activated\n");

  if (gnutls_x509_crt_get_expiration_time (crt) < now)
    fprintf (stderr, "Expired\n");

  /* Check if the certificate is revoked.
   */
  ret = gnutls_x509_crt_check_revocation (crt, crl_list, crl_list_size);
  if (ret == 1)
    {                           /* revoked */
      fprintf (stderr, "Revoked\n");
    }
}
```

7.3.5 Using a Callback to Select the Certificate to Use

There are cases where a client holds several certificate and key pairs, and may not want to load all of them in the credentials structure. The following example demonstrates the use of the certificate selection callback.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */
```

```
#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <unistd.h>
#include <gnutls/gnutls.h>
#include <gnutls/x509.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>

/* A TLS client that loads the certificate and key.
 */

#define MAX_BUF 1024
#define MSG "GET / HTTP/1.0\r\n\r\n"

#define CERT_FILE "cert.pem"
#define KEY_FILE "key.pem"
#define CAFILE "ca.pem"

extern int tcp_connect (void);
extern void tcp_close (int sd);

static int cert_callback (gnutls_session_t session,
                          const gnutls_datum_t * req_ca_rdn, int nreqs,
                          const gnutls_pk_algorithm_t * sign_algos,
                          int sign_algos_length, gnutls_retr_st * st);

gnutls_x509_crt_t crt;
gnutls_x509_privkey_t key;

/* Helper functions to load a certificate and key
 * files into memory.
 */
static gnutls_datum_t
load_file (const char *file)
{
  FILE *f;
  gnutls_datum_t loaded_file = { NULL, 0 };
```

```
  long filelen;
  void *ptr;

  if (!(f = fopen (file, "r"))
      || fseek (f, 0, SEEK_END) != 0
      || (filelen = ftell (f)) < 0
      || fseek (f, 0, SEEK_SET) != 0
      || !(ptr = malloc ((size_t) filelen))
      || fread (ptr, 1, (size_t) filelen, f) < (size_t) filelen)
    {
      return loaded_file;
    }

  loaded_file.data = ptr;
  loaded_file.size = (unsigned int) filelen;
  return loaded_file;
}

static void
unload_file (gnutls_datum_t data)
{
  free (data.data);
}

/* Load the certificate and the private key.
 */
static void
load_keys (void)
{
  int ret;
  gnutls_datum_t data;

  data = load_file (CERT_FILE);
  if (data.data == NULL)
    {
      fprintf (stderr, "*** Error loading cert file.\n");
      exit (1);
    }
  gnutls_x509_crt_init (&crt);

  ret = gnutls_x509_crt_import (crt, &data, GNUTLS_X509_FMT_PEM);
  if (ret < 0)
    {
      fprintf (stderr, "*** Error loading key file:  %s\n",
               gnutls_strerror (ret));
      exit (1);
    }
```

```
  unload_file (data);

  data = load_file (KEY_FILE);
  if (data.data == NULL)
    {
      fprintf (stderr, "*** Error loading key file.\n");
      exit (1);
    }

  gnutls_x509_privkey_init (&key);

  ret = gnutls_x509_privkey_import (key, &data, GNUTLS_X509_FMT_PEM);
  if (ret < 0)
    {
      fprintf (stderr, "*** Error loading key file:  %s\n",
               gnutls_strerror (ret));
      exit (1);
    }

  unload_file (data);

}

int
main (void)
{
  int ret, sd, ii;
  gnutls_session_t session;
  gnutls_priority_t priorities_cache;
  char buffer[MAX_BUF + 1];
  gnutls_certificate_credentials_t xcred;
  /* Allow connections to servers that have OpenPGP keys as well.
   */

  gnutls_global_init ();

  load_keys ();

  /* X509 stuff */
  gnutls_certificate_allocate_credentials (&xcred);

  /* priorities */
  gnutls_priority_init (&priorities_cache, "NORMAL", NULL);


  /* sets the trusted cas file
```

```
 */
gnutls_certificate_set_x509_trust_file (xcred, CAFILE, GNUTLS_X509_FMT_PEM);

gnutls_certificate_client_set_retrieve_function (xcred, cert_callback);

/* Initialize TLS session
 */
gnutls_init (&session, GNUTLS_CLIENT);

/* Use default priorities */
gnutls_priority_set (session, priorities_cache);

/* put the x509 credentials to the current session
 */
gnutls_credentials_set (session, GNUTLS_CRD_CERTIFICATE, xcred);

/* connect to the peer
 */
sd = tcp_connect ();

gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);

/* Perform the TLS handshake
 */
ret = gnutls_handshake (session);

if (ret < 0)
  {
    fprintf (stderr, "*** Handshake failed\n");
    gnutls_perror (ret);
    goto end;
  }
else
  {
    printf ("- Handshake was completed\n");
  }

gnutls_record_send (session, MSG, strlen (MSG));

ret = gnutls_record_recv (session, buffer, MAX_BUF);
if (ret == 0)
  {
    printf ("- Peer has closed the TLS connection\n");
    goto end;
  }
else if (ret < 0)
  {
```

```
      fprintf (stderr, "*** Error:  %s\n", gnutls_strerror (ret));
      goto end;
    }

  printf ("- Received %d bytes:  ", ret);
  for (ii = 0; ii < ret; ii++)
    {
      fputc (buffer[ii], stdout);
    }
  fputs ("\n", stdout);

  gnutls_bye (session, GNUTLS_SHUT_RDWR);

end:

  tcp_close (sd);

  gnutls_deinit (session);

  gnutls_certificate_free_credentials (xcred);
  gnutls_priority_deinit (priorities_cache);

  gnutls_global_deinit ();

  return 0;
}



/* This callback should be associated with a session by calling
 * gnutls_certificate_client_set_retrieve_function( session, cert_callback),
 * before a handshake.
 */

static int
cert_callback (gnutls_session_t session,
               const gnutls_datum_t * req_ca_rdn, int nreqs,
               const gnutls_pk_algorithm_t * sign_algos,
               int sign_algos_length, gnutls_retr_st * st)
{
  char issuer_dn[256];
  int i, ret;
  size_t len;
  gnutls_certificate_type_t type;

  /* Print the server's trusted CAs
   */
```

```
  if (nreqs > 0)
    printf ("- Server's trusted authorities:\n");
  else
    printf ("- Server did not send us any trusted authorities names.\n");

  /* print the names (if any) */
  for (i = 0; i < nreqs; i++)
    {
      len = sizeof (issuer_dn);
      ret = gnutls_x509_rdn_get (&req_ca_rdn[i], issuer_dn, &len);
      if (ret >= 0)
        {
          printf ("   [%d]:  ", i);
          printf ("%s\n", issuer_dn);
        }
    }

  /* Select a certificate and return it.
   * The certificate must be of any of the "sign algorithms"
   * supported by the server.
   */

  type = gnutls_certificate_type_get (session);
  if (type == GNUTLS_CRT_X509)
    {
      st->type = type;
      st->ncerts = 1;

      st->cert.x509 = &crt;
      st->key.x509 = key;

      st->deinit_all = 0;
    }
  else
    {
      return -1;
    }

  return 0;

}
```

7.3.6 Client with Resume Capability Example

This is a modification of the simple client example. Here we demonstrate the use of session resumption. The client tries to connect once using TLS, close the connection and then try to establish a new connection using the previously negotiated data.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <string.h>
#include <stdio.h>
#include <stdlib.h>
#include <gnutls/gnutls.h>

/* Those functions are defined in other examples.
 */
extern void check_alert (gnutls_session_t session, int ret);
extern int tcp_connect (void);
extern void tcp_close (int sd);

#define MAX_BUF 1024
#define CRLFILE "crl.pem"
#define CAFILE "ca.pem"
#define MSG "GET / HTTP/1.0\r\n\r\n"

int
main (void)
{
  int ret;
  int sd, ii;
  gnutls_session_t session;
  char buffer[MAX_BUF + 1];
  gnutls_certificate_credentials_t xcred;

  /* variables used in session resuming
   */
  int t;
  char *session_data = NULL;
  size_t session_data_size = 0;

  gnutls_global_init ();

  /* X509 stuff */
  gnutls_certificate_allocate_credentials (&xcred);
```

```
gnutls_certificate_set_x509_trust_file (xcred, CAFILE, GNUTLS_X509_FMT_PEM);

for (t = 0; t < 2; t++)
  {                           /* connect 2 times to the server */

    sd = tcp_connect ();

    gnutls_init (&session, GNUTLS_CLIENT);

    gnutls_priority_set_direct (session, "PERFORMANCE:!ARCFOUR-128", NULL);

    gnutls_credentials_set (session, GNUTLS_CRD_CERTIFICATE, xcred);

    if (t > 0)
      {
        /* if this is not the first time we connect */
        gnutls_session_set_data (session, session_data, session_data_size);
        free (session_data);
      }

    gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);

    /* Perform the TLS handshake
     */
    ret = gnutls_handshake (session);

    if (ret < 0)
      {
        fprintf (stderr, "*** Handshake failed\n");
        gnutls_perror (ret);
        goto end;
      }
    else
      {
        printf ("- Handshake was completed\n");
      }

    if (t == 0)
      {                       /* the first time we connect */
        /* get the session data size */
        gnutls_session_get_data (session, NULL, &session_data_size);
        session_data = malloc (session_data_size);

        /* put session data to the session variable */
        gnutls_session_get_data (session, session_data, &session_data_size);

      }
```

```
  else
    {                       /* the second time we connect */

      /* check if we actually resumed the previous session */
      if (gnutls_session_is_resumed (session) != 0)
        {
          printf ("- Previous session was resumed\n");
        }
      else
        {
          fprintf (stderr, "*** Previous session was NOT resumed\n");
        }
    }

  /* This function was defined in a previous example
   */
  /* print_info(session); */

  gnutls_record_send (session, MSG, strlen (MSG));

  ret = gnutls_record_recv (session, buffer, MAX_BUF);
  if (ret == 0)
    {
      printf ("- Peer has closed the TLS connection\n");
      goto end;
    }
  else if (ret < 0)
    {
      fprintf (stderr, "*** Error:  %s\n", gnutls_strerror (ret));
      goto end;
    }

  printf ("- Received %d bytes:  ", ret);
  for (ii = 0; ii < ret; ii++)
    {
      fputc (buffer[ii], stdout);
    }
  fputs ("\n", stdout);

  gnutls_bye (session, GNUTLS_SHUT_RDWR);

end:

  tcp_close (sd);

  gnutls_deinit (session);
```

```
    }                           /* for() */

  gnutls_certificate_free_credentials (xcred);

  gnutls_global_deinit ();

  return 0;
}
```

7.3.7 Simple Client Example with SRP Authentication

The following client is a very simple SRP TLS client which connects to a server and authenticates using a *username* and a *password*. The server may authenticate itself using a certificate, and in that case it has to be verified.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <gnutls/gnutls.h>
#include <gnutls/extra.h>

/* Those functions are defined in other examples.
 */
extern void check_alert (gnutls_session_t session, int ret);
extern int tcp_connect (void);
extern void tcp_close (int sd);

#define MAX_BUF 1024
#define USERNAME "user"
#define PASSWORD "pass"
#define CAFILE "ca.pem"
#define SA struct sockaddr
#define MSG "GET / HTTP/1.0\r\n\r\n"

#define MAX_PRIORITIES 3

int
```

```
main (void)
{
  int ret;
  int sd, ii;
  gnutls_session_t session;
  char buffer[MAX_BUF + 1];
  gnutls_srp_client_credentials_t srp_cred;
  gnutls_certificate_credentials_t cert_cred;

  gnutls_global_init ();

  /* now enable the gnutls-extra library which contains the
   * SRP stuff.
   */
  gnutls_global_init_extra ();

  gnutls_srp_allocate_client_credentials (&srp_cred);
  gnutls_certificate_allocate_credentials (&cert_cred);

  gnutls_certificate_set_x509_trust_file (cert_cred, CAFILE,
                                          GNUTLS_X509_FMT_PEM);
  gnutls_srp_set_client_credentials (srp_cred, USERNAME, PASSWORD);

  /* connects to server
   */
  sd = tcp_connect ();

  /* Initialize TLS session
   */
  gnutls_init (&session, GNUTLS_CLIENT);


  /* Set the priorities.
   */
  gnutls_priority_set_direct (session, "NORMAL:+SRP:+SRP-RSA:+SRP-DSS", NULL);

  /* put the SRP credentials to the current session
   */
  gnutls_credentials_set (session, GNUTLS_CRD_SRP, srp_cred);
  gnutls_credentials_set (session, GNUTLS_CRD_CERTIFICATE, cert_cred);

  gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);

  /* Perform the TLS handshake
   */
  ret = gnutls_handshake (session);
```

```
  if (ret < 0)
    {
      fprintf (stderr, "*** Handshake failed\n");
      gnutls_perror (ret);
      goto end;
    }
  else
    {
      printf ("- Handshake was completed\n");
    }

  gnutls_record_send (session, MSG, strlen (MSG));

  ret = gnutls_record_recv (session, buffer, MAX_BUF);
  if (gnutls_error_is_fatal (ret) == 1 || ret == 0)
    {
      if (ret == 0)
        {
          printf ("- Peer has closed the GNUTLS connection\n");
          goto end;
        }
      else
        {
          fprintf (stderr, "*** Error:  %s\n", gnutls_strerror (ret));
          goto end;
        }
    }
  else
    check_alert (session, ret);

  if (ret > 0)
    {
      printf ("- Received %d bytes:  ", ret);
      for (ii = 0; ii < ret; ii++)
        {
          fputc (buffer[ii], stdout);
        }
      fputs ("\n", stdout);
    }
  gnutls_bye (session, GNUTLS_SHUT_RDWR);

end:

  tcp_close (sd);

  gnutls_deinit (session);
```

```
  gnutls_srp_free_client_credentials (srp_cred);
  gnutls_certificate_free_credentials (cert_cred);

  gnutls_global_deinit ();

  return 0;
}
```

7.3.8 Simple Client Example with TLS/IA Support

The following client is a simple client which uses the TLS/IA extension to authenticate with the server.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <unistd.h>
#include <gnutls/gnutls.h>
#include <gnutls/extra.h>

/* A basic TLS client, with anonymous authentication and TLS/IA handshake.
 */

#define MAX_BUF 1024
#define SA struct sockaddr
#define MSG "GET / HTTP/1.0\r\n\r\n"

extern int tcp_connect (void);
extern void tcp_close (int sd);

static int
client_avp (gnutls_session_t session, void *ptr,
            const char *last, size_t lastlen, char **new, size_t * newlen)
{
```

```
  if (last)
    printf ("- received %d bytes AVP: `%.*s'\n", lastlen, lastlen, last);
  else
    printf ("- new application phase\n");

  *new = gnutls_strdup ("client avp");
  if (!*new)
    return -1;
  *newlen = strlen (*new);

  printf ("- sending %d bytes AVP: `%s'\n", *newlen, *new);

  gnutls_ia_permute_inner_secret (session, 3, "foo");

  return 0;

}

int
main (void)
{
  int ret, sd, ii;
  gnutls_session_t session;
  char buffer[MAX_BUF + 1];
  gnutls_anon_client_credentials_t anoncred;
  gnutls_ia_client_credentials_t iacred;
  /* Need to enable anonymous KX specifically.  */

  gnutls_global_init ();

  gnutls_anon_allocate_client_credentials (&anoncred);
  gnutls_ia_allocate_client_credentials (&iacred);

  /* Set TLS/IA stuff
   */
  gnutls_ia_set_client_avp_function (iacred, client_avp);

  /* Initialize TLS session
   */
  gnutls_init (&session, GNUTLS_CLIENT);

  /* Use default priorities */
  gnutls_priority_set_direct (session, "NORMAL:+ANON-DH", NULL);

  /* put the anonymous and TLS/IA credentials to the current session
   */
```

```
gnutls_credentials_set (session, GNUTLS_CRD_ANON, anoncred);
gnutls_credentials_set (session, GNUTLS_CRD_IA, iacred);

/* connect to the peer
 */
sd = tcp_connect ();

gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);

/* Perform the TLS handshake
 */
ret = gnutls_handshake (session);

if (ret < 0)
  {
    fprintf (stderr, "*** Handshake failed\n");
    gnutls_perror (ret);
    goto end;
  }
else
  {
    printf ("- Handshake was completed\n");
  }

if (!gnutls_ia_handshake_p (session))
  {
    fprintf (stderr, "*** TLS/IA not negotiated...\n");
    goto end;
  }
else
  {
    printf ("- Starting TLS/IA handshake...\n");

    ret = gnutls_ia_handshake (session);

    if (ret < 0)
      {
        fprintf (stderr, "*** TLS/IA handshake failed\n");
        gnutls_perror (ret);
        goto end;
      }
    else
      {
        printf ("- TLS/IA Handshake was completed\n");
      }
  }
```

```
  gnutls_record_send (session, MSG, strlen (MSG));

  ret = gnutls_record_recv (session, buffer, MAX_BUF);
  if (ret == 0)
    {
      printf ("- Peer has closed the TLS connection\n");
      goto end;
    }
  else if (ret < 0)
    {
      fprintf (stderr, "*** Error:  %s\n", gnutls_strerror (ret));
      goto end;
    }

  printf ("- Received %d bytes:  ", ret);
  for (ii = 0; ii < ret; ii++)
    {
      fputc (buffer[ii], stdout);
    }
  fputs ("\n", stdout);

  gnutls_bye (session, GNUTLS_SHUT_RDWR);

end:

  tcp_close (sd);

  gnutls_deinit (session);

  gnutls_ia_free_client_credentials (iacred);
  gnutls_anon_free_client_credentials (anoncred);

  gnutls_global_deinit ();

  return 0;
}
```

7.3.9 Simple Client Example using the C++ API

The following client is a simple example of a client client utilizing the GnuTLS C++ API.

```
#ifdef HAVE_CONFIG_H
# include <config.h>
#else
#endif
#include <iostream>
#include <stdexcept>
```

```
#include <gnutls/gnutls.h>
#include <gnutls/gnutlsxx.h>
#include <cstring> /* for strlen */

/* A very basic TLS client, with anonymous authentication.
 * written by Eduardo Villanueva Che.
 */

#define MAX_BUF 1024
#define SA struct sockaddr

#define CAFILE "ca.pem"
#define MSG "GET / HTTP/1.0\r\n\r\n"

extern "C"
{
    int tcp_connect(void);
    void tcp_close(int sd);
}


int main(void)
{
    int sd = -1;
    gnutls_global_init();

    try
    {

        /* Allow connections to servers that have OpenPGP keys as well.
         */
        gnutls::client_session session;

        /* X509 stuff */
        gnutls::certificate_credentials credentials;


        /* sets the trusted cas file
         */
        credentials.set_x509_trust_file(CAFILE, GNUTLS_X509_FMT_PEM);
        /* put the x509 credentials to the current session
         */
        session.set_credentials(credentials);

        /* Use default priorities */
        session.set_priority ("NORMAL", NULL);
```

```
        /* connect to the peer
         */
        sd = tcp_connect();
        session.set_transport_ptr((gnutls_transport_ptr_t) sd);

        /* Perform the TLS handshake
         */
        int ret = session.handshake();
        if (ret < 0)
        {
//              gnutls_perror(ret);
            throw std::runtime_error("Handshake failed");
        }
        else
        {
            std::cout << "- Handshake was completed" << std::endl;
        }

        session.send(MSG, strlen(MSG));
        char buffer[MAX_BUF + 1];
        ret = session.recv(buffer, MAX_BUF);
        if (ret == 0)
        {
            throw std::runtime_error("Peer has closed the TLS connection");
        }
        else if (ret < 0)
        {
            throw std::runtime_error(gnutls_strerror(ret));
        }

        std::cout << "- Received " << ret << " bytes:" << std::endl;
        std::cout.write(buffer, ret);
        std::cout << std::endl;

        session.bye(GNUTLS_SHUT_RDWR);
    }
    catch (std::exception &ex)
    {
        std::cerr << "Exception caught:  " << ex.what() << std::endl;
    }

    if (sd != -1)
        tcp_close(sd);

    gnutls_global_deinit();

    return 0;
```

```
}
```

7.3.10 Helper Function for TCP Connections

This helper function abstracts away TCP connection handling from the other examples. It is required to build some examples.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <unistd.h>

#define SA struct sockaddr

/* Connects to the peer and returns a socket
 * descriptor.
 */
extern int
tcp_connect (void)
{
  const char *PORT = "5556";
  const char *SERVER = "127.0.0.1";
  int err, sd;
  struct sockaddr_in sa;

  /* connects to server
   */
  sd = socket (AF_INET, SOCK_STREAM, 0);

  memset (&sa, '\0', sizeof (sa));
  sa.sin_family = AF_INET;
  sa.sin_port = htons (atoi (PORT));
  inet_pton (AF_INET, SERVER, &sa.sin_addr);
```

```
  err = connect (sd, (SA *) & sa, sizeof (sa));
  if (err < 0)
    {
      fprintf (stderr, "Connect error\n");
      exit (1);
    }

  return sd;
}

/* closes the given socket descriptor.
 */
extern void
tcp_close (int sd)
{
  shutdown (sd, SHUT_RDWR);     /* no more receptions */
  close (sd);
}
```

7.4 Server Examples

This section contains examples of TLS and SSL servers, using GnuTLS.

7.4.1 Echo Server with X.509 Authentication

This example is a very simple echo server which supports X.509 authentication, using the RSA ciphersuites.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <string.h>
#include <unistd.h>
```

```
#include <gnutls/gnutls.h>
#include <gcrypt.h>             /* for gcry_control */

#define KEYFILE "key.pem"
#define CERTFILE "cert.pem"
#define CAFILE "ca.pem"
#define CRLFILE "crl.pem"

/* This is a sample TLS 1.0 echo server, using X.509 authentication.
 */


#define SA struct sockaddr
#define SOCKET_ERR(err,s) if(err==-1) {perror(s);return(1);}
#define MAX_BUF 1024
#define PORT 5556               /* listen to 5556 port */
#define DH_BITS 1024

/* These are global */
gnutls_certificate_credentials_t x509_cred;
gnutls_priority_t priority_cache;

static gnutls_session_t
initialize_tls_session (void)
{
  gnutls_session_t session;

  gnutls_init (&session, GNUTLS_SERVER);

  gnutls_priority_set (session, priority_cache);

  gnutls_credentials_set (session, GNUTLS_CRD_CERTIFICATE, x509_cred);

  /* request client certificate if any.
   */
  gnutls_certificate_server_set_request (session, GNUTLS_CERT_REQUEST);

  /* Set maximum compatibility mode.  This is only suggested on public webservers
   * that need to trade security for compatibility
   */
  gnutls_session_enable_compatibility_mode (session);

  return session;
}

static gnutls_dh_params_t dh_params;
```

```
static int
generate_dh_params (void)
{

  /* Generate Diffie Hellman parameters - for use with DHE
   * kx algorithms.  When short bit length is used, it might
   * be wise to regenerate parameters.
   *
   * Check the ex-serv-export.c example for using static
   * parameters.
   */
  gnutls_dh_params_init (&dh_params);
  gnutls_dh_params_generate2 (dh_params, DH_BITS);

  return 0;
}

int
main (void)
{
  int err, listen_sd, i;
  int sd, ret;
  struct sockaddr_in sa_serv;
  struct sockaddr_in sa_cli;
  int client_len;
  char topbuf[512];
  gnutls_session_t session;
  char buffer[MAX_BUF + 1];
  int optval = 1;

  /* to disallow usage of the blocking /dev/random
   */
  gcry_control (GCRYCTL_ENABLE_QUICK_RANDOM, 0);

  /* this must be called once in the program
   */
  gnutls_global_init ();

  gnutls_certificate_allocate_credentials (&x509_cred);
  gnutls_certificate_set_x509_trust_file (x509_cred, CAFILE,
                                          GNUTLS_X509_FMT_PEM);

  gnutls_certificate_set_x509_crl_file (x509_cred, CRLFILE,
                                        GNUTLS_X509_FMT_PEM);

  gnutls_certificate_set_x509_key_file (x509_cred, CERTFILE, KEYFILE,
                                        GNUTLS_X509_FMT_PEM);
```

```
generate_dh_params ();

gnutls_priority_init (&priority_cache, "NORMAL", NULL);


gnutls_certificate_set_dh_params (x509_cred, dh_params);

/* Socket operations
 */
listen_sd = socket (AF_INET, SOCK_STREAM, 0);
SOCKET_ERR (listen_sd, "socket");

memset (&sa_serv, '\0', sizeof (sa_serv));
sa_serv.sin_family = AF_INET;
sa_serv.sin_addr.s_addr = INADDR_ANY;
sa_serv.sin_port = htons (PORT);      /* Server Port number */

setsockopt (listen_sd, SOL_SOCKET, SO_REUSEADDR, &optval, sizeof (int));

err = bind (listen_sd, (SA *) & sa_serv, sizeof (sa_serv));
SOCKET_ERR (err, "bind");
err = listen (listen_sd, 1024);
SOCKET_ERR (err, "listen");

printf ("Server ready.  Listening to port '%d'.\n\n", PORT);

client_len = sizeof (sa_cli);
for (;;)
  {
    session = initialize_tls_session ();

    sd = accept (listen_sd, (SA *) & sa_cli, &client_len);

    printf ("- connection from %s, port %d\n",
            inet_ntop (AF_INET, &sa_cli.sin_addr, topbuf,
                       sizeof (topbuf)), ntohs (sa_cli.sin_port));

    gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);
    ret = gnutls_handshake (session);
    if (ret < 0)
      {
        close (sd);
        gnutls_deinit (session);
        fprintf (stderr, "*** Handshake has failed (%s)\n\n",
                 gnutls_strerror (ret));
        continue;
```

```
      }
    printf ("- Handshake was completed\n");

    /* see the Getting peer's information example */
    /* print_info(session); */

    i = 0;
    for (;;)
      {
        memset (buffer, 0, MAX_BUF + 1);
        ret = gnutls_record_recv (session, buffer, MAX_BUF);

        if (ret == 0)
          {
            printf ("\n- Peer has closed the GNUTLS connection\n");
            break;
          }
        else if (ret < 0)
          {
            fprintf (stderr, "\n*** Received corrupted "
                     "data(%d).  Closing the connection.\n\n", ret);
            break;
          }
        else if (ret > 0)
          {
            /* echo data back to the client
             */
            gnutls_record_send (session, buffer, strlen (buffer));
          }
      }
    printf ("\n");
    /* do not wait for the peer to close the connection.
     */
    gnutls_bye (session, GNUTLS_SHUT_WR);

    close (sd);
    gnutls_deinit (session);

  }
close (listen_sd);

gnutls_certificate_free_credentials (x509_cred);
gnutls_priority_deinit (priority_cache);

gnutls_global_deinit ();

return 0;
```

```
}
```

7.4.2 Echo Server with X.509 Authentication II

The following example is a server which supports X.509 authentication. This server supports the export-grade cipher suites, the DHE ciphersuites and session resuming.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <string.h>
#include <unistd.h>
#include <gnutls/gnutls.h>
#include <gcrypt.h>             /* for gcry_control */

#define KEYFILE "key.pem"
#define CERTFILE "cert.pem"
#define CAFILE "ca.pem"
#define CRLFILE "crl.pem"

/* This is a sample TLS 1.0 echo server.
 * Export-grade ciphersuites and session resuming are supported.
 */

#define SA struct sockaddr
#define SOCKET_ERR(err,s) if(err==-1) {perror(s);return(1);}
#define MAX_BUF 1024
#define PORT 5556               /* listen to 5556 port */
#define DH_BITS 1024

/* These are global */
gnutls_certificate_credentials_t cert_cred;
```

```
static void wrap_db_init (void);
static void wrap_db_deinit (void);
static int wrap_db_store (void *dbf, gnutls_datum_t key, gnutls_datum_t data);
static gnutls_datum_t wrap_db_fetch (void *dbf, gnutls_datum_t key);
static int wrap_db_delete (void *dbf, gnutls_datum_t key);

#define TLS_SESSION_CACHE 50

static gnutls_session_t
initialize_tls_session (void)
{
  gnutls_session_t session;

  gnutls_init (&session, GNUTLS_SERVER);

  /* Use the default priorities, plus, export cipher suites.
   */
  gnutls_priority_set_direct (session, "EXPORT", NULL);

  gnutls_credentials_set (session, GNUTLS_CRD_CERTIFICATE, cert_cred);

  /* request client certificate if any.
   */
  gnutls_certificate_server_set_request (session, GNUTLS_CERT_REQUEST);

  gnutls_dh_set_prime_bits (session, DH_BITS);

  if (TLS_SESSION_CACHE != 0)
    {
      gnutls_db_set_retrieve_function (session, wrap_db_fetch);
      gnutls_db_set_remove_function (session, wrap_db_delete);
      gnutls_db_set_store_function (session, wrap_db_store);
      gnutls_db_set_ptr (session, NULL);
    }

  return session;
}

gnutls_dh_params_t dh_params;
/* Export-grade cipher suites require temporary RSA
 * keys.
 */
gnutls_rsa_params_t rsa_params;

static char srp_dh_group2048[] =
  "-----BEGIN DH PARAMETERS-----\n"
```

```
  "MIIBBwKCAQCsa9tBMkqam/Fm3l4TiVgvr3K2ZRmH7gf8MZKUPbVgUKNzKcu0oJnt\n"
  "gZPgdXdnoT3VIxKrSwMxDc1/SKnaBP1Q6Ag5ae23Z7DPYJUXmhY6s2YaBfvV+qro\n"
  "KRipli8Lk7hV+XmT7Jde6qgNdArb9P90c1nQQdXDPqcdKB5EaxR3O8qXtDoj+4AW\n"
  "dr0gekNsZIHx0rkHhxdGGludMuaI+HdIVEUjtSSw1X1ep3onddLs+gMs+9v1L7N4\n"
  "YWAnkATleuavh05zA85TKZzMBBx7wwjYKlaY86jQw4JxrjX46dv7tpS1yAPYn3rk\n"
  "Nd4jbVJfVHWbZeNy/NaO8g+nER+eSv9zAgEC\n" "-----END DH PARAMETERS-----\n";

static int
generate_dh_params (void)
{
  gnutls_datum_t dparams = { srp_dh_group2048, sizeof (srp_dh_group2048) };
  /* Here instead of generating Diffie Hellman parameters (for use with DHE
   * kx algorithms) we import them.
   */
  gnutls_dh_params_init (&dh_params);
  gnutls_dh_params_import_pkcs3 (dh_params, &dparams, GNUTLS_X509_FMT_PEM);

  return 0;
}

static int
generate_rsa_params (void)
{
  gnutls_rsa_params_init (&rsa_params);

  /* Generate RSA parameters - for use with RSA-export
   * cipher suites.  This is an RSA private key and should be
   * discarded and regenerated once a day, once every 500
   * transactions etc.  Depends on the security requirements.
   */

  gnutls_rsa_params_generate2 (rsa_params, 512);

  return 0;
}

int
main (void)
{
  int err, listen_sd, i;
  int sd, ret;
  struct sockaddr_in sa_serv;
  struct sockaddr_in sa_cli;
  int client_len;
  char topbuf[512];
  gnutls_session_t session;
  char buffer[MAX_BUF + 1];
```

```
int optval = 1;
char name[256];

strcpy (name, "Echo Server");

/* to disallow usage of the blocking /dev/random
 */
gcry_control (GCRYCTL_ENABLE_QUICK_RANDOM, 0);

/* this must be called once in the program
 */
gnutls_global_init ();


gnutls_certificate_allocate_credentials (&cert_cred);

gnutls_certificate_set_x509_trust_file (cert_cred, CAFILE,
                                        GNUTLS_X509_FMT_PEM);

gnutls_certificate_set_x509_crl_file (cert_cred, CRLFILE,
                                      GNUTLS_X509_FMT_PEM);

gnutls_certificate_set_x509_key_file (cert_cred, CERTFILE, KEYFILE,
                                      GNUTLS_X509_FMT_PEM);

generate_dh_params ();
generate_rsa_params ();

if (TLS_SESSION_CACHE != 0)
  {
    wrap_db_init ();
  }

gnutls_certificate_set_dh_params (cert_cred, dh_params);
gnutls_certificate_set_rsa_export_params (cert_cred, rsa_params);

/* Socket operations
 */
listen_sd = socket (AF_INET, SOCK_STREAM, 0);
SOCKET_ERR (listen_sd, "socket");

memset (&sa_serv, '\0', sizeof (sa_serv));
sa_serv.sin_family = AF_INET;
sa_serv.sin_addr.s_addr = INADDR_ANY;
sa_serv.sin_port = htons (PORT);      /* Server Port number */

setsockopt (listen_sd, SOL_SOCKET, SO_REUSEADDR, &optval, sizeof (int));
```

```
err = bind (listen_sd, (SA *) & sa_serv, sizeof (sa_serv));
SOCKET_ERR (err, "bind");
err = listen (listen_sd, 1024);
SOCKET_ERR (err, "listen");

printf ("%s ready.  Listening to port '%d'.\n\n", name, PORT);

client_len = sizeof (sa_cli);
for (;;)
  {
    session = initialize_tls_session ();

    sd = accept (listen_sd, (SA *) & sa_cli, &client_len);

    printf ("- connection from %s, port %d\n",
            inet_ntop (AF_INET, &sa_cli.sin_addr, topbuf,
                       sizeof (topbuf)), ntohs (sa_cli.sin_port));

    gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);
    ret = gnutls_handshake (session);
    if (ret < 0)
      {
        close (sd);
        gnutls_deinit (session);
        fprintf (stderr, "*** Handshake has failed (%s)\n\n",
                 gnutls_strerror (ret));
        continue;
      }
    printf ("- Handshake was completed\n");

    /* print_info(session); */

    i = 0;
    for (;;)
      {
        memset (buffer, 0, MAX_BUF + 1);
        ret = gnutls_record_recv (session, buffer, MAX_BUF);

        if (ret == 0)
          {
            printf ("\n- Peer has closed the TLS connection\n");
            break;
          }
        else if (ret < 0)
          {
            fprintf (stderr, "\n*** Received corrupted "
```

```
                        "data(%d).  Closing the connection.\n\n", ret);
              break;
            }
          else if (ret > 0)
            {
              /* echo data back to the client
               */
              gnutls_record_send (session, buffer, strlen (buffer));
            }
        }
      printf ("\n");
      /* do not wait for the peer to close the connection.
       */
      gnutls_bye (session, GNUTLS_SHUT_WR);

      close (sd);
      gnutls_deinit (session);

    }
  close (listen_sd);

  if (TLS_SESSION_CACHE != 0)
    {
      wrap_db_deinit ();
    }

  gnutls_certificate_free_credentials (cert_cred);

  gnutls_global_deinit ();

  return 0;

}


/* Functions and other stuff needed for session resuming.
 * This is done using a very simple list which holds session ids
 * and session data.
 */

#define MAX_SESSION_ID_SIZE 32
#define MAX_SESSION_DATA_SIZE 512

typedef struct
{
  char session_id[MAX_SESSION_ID_SIZE];
  int session_id_size;
```

```
  char session_data[MAX_SESSION_DATA_SIZE];
  int session_data_size;
} CACHE;

static CACHE *cache_db;
static int cache_db_ptr = 0;

static void
wrap_db_init (void)
{

  /* allocate cache_db */
  cache_db = calloc (1, TLS_SESSION_CACHE * sizeof (CACHE));
}

static void
wrap_db_deinit (void)
{
  if (cache_db)
    free (cache_db);
  cache_db = NULL;
  return;
}

static int
wrap_db_store (void *dbf, gnutls_datum_t key, gnutls_datum_t data)
{

  if (cache_db == NULL)
    return -1;

  if (key.size > MAX_SESSION_ID_SIZE)
    return -1;
  if (data.size > MAX_SESSION_DATA_SIZE)
    return -1;

  memcpy (cache_db[cache_db_ptr].session_id, key.data, key.size);
  cache_db[cache_db_ptr].session_id_size = key.size;

  memcpy (cache_db[cache_db_ptr].session_data, data.data, data.size);
  cache_db[cache_db_ptr].session_data_size = data.size;

  cache_db_ptr++;
  cache_db_ptr %= TLS_SESSION_CACHE;

  return 0;
```

```
}

static gnutls_datum_t
wrap_db_fetch (void *dbf, gnutls_datum_t key)
{
  gnutls_datum_t res = { NULL, 0 };
  int i;

  if (cache_db == NULL)
    return res;

  for (i = 0; i < TLS_SESSION_CACHE; i++)
    {
      if (key.size == cache_db[i].session_id_size &&
          memcmp (key.data, cache_db[i].session_id, key.size) == 0)
        {


          res.size = cache_db[i].session_data_size;

          res.data = gnutls_malloc (res.size);
          if (res.data == NULL)
            return res;

          memcpy (res.data, cache_db[i].session_data, res.size);

          return res;
        }
    }
  return res;
}

static int
wrap_db_delete (void *dbf, gnutls_datum_t key)
{
  int i;

  if (cache_db == NULL)
    return -1;

  for (i = 0; i < TLS_SESSION_CACHE; i++)
    {
      if (key.size == cache_db[i].session_id_size &&
          memcmp (key.data, cache_db[i].session_id, key.size) == 0)
        {

          cache_db[i].session_id_size = 0;
```

```
          cache_db[i].session_data_size = 0;

          return 0;
        }
    }

  return -1;

}
```

7.4.3 Echo Server with OpenPGP Authentication

The following example is an echo server which supports OpenPGP key authentication. You can easily combine this functionality —that is have a server that supports both X.509 and OpenPGP certificates— but we separated them to keep these examples as simple as possible.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <string.h>
#include <unistd.h>
#include <gnutls/gnutls.h>
#include <gnutls/openpgp.h>

#define KEYFILE "secret.asc"
#define CERTFILE "public.asc"
#define RINGFILE "ring.gpg"

/* This is a sample TLS 1.0-OpenPGP echo server.
 */


#define SA struct sockaddr
```

```
#define SOCKET_ERR(err,s) if(err==-1) {perror(s);return(1);}
#define MAX_BUF 1024
#define PORT 5556               /* listen to 5556 port */
#define DH_BITS 1024

/* These are global */
gnutls_certificate_credentials_t cred;
gnutls_dh_params_t dh_params;

static int
generate_dh_params (void)
{

  /* Generate Diffie Hellman parameters - for use with DHE
   * kx algorithms.  These should be discarded and regenerated
   * once a day, once a week or once a month.  Depending on the
   * security requirements.
   */
  gnutls_dh_params_init (&dh_params);
  gnutls_dh_params_generate2 (dh_params, DH_BITS);

  return 0;
}

static gnutls_session_t
initialize_tls_session (void)
{
  gnutls_session_t session;

  gnutls_init (&session, GNUTLS_SERVER);

  gnutls_priority_set_direct (session, "NORMAL", NULL);

  /* request client certificate if any.
   */
  gnutls_certificate_server_set_request (session, GNUTLS_CERT_REQUEST);

  gnutls_dh_set_prime_bits (session, DH_BITS);

  return session;
}

int
main (void)
{
  int err, listen_sd, i;
  int sd, ret;
```

```
struct sockaddr_in sa_serv;
struct sockaddr_in sa_cli;
int client_len;
char topbuf[512];
gnutls_session_t session;
char buffer[MAX_BUF + 1];
int optval = 1;
char name[256];

strcpy (name, "Echo Server");

/* this must be called once in the program
 */
gnutls_global_init ();

gnutls_certificate_allocate_credentials (&cred);
gnutls_certificate_set_openpgp_keyring_file (cred, RINGFILE,
                                             GNUTLS_OPENPGP_FMT_BASE64);

gnutls_certificate_set_openpgp_key_file (cred, CERTFILE, KEYFILE,
                                         GNUTLS_OPENPGP_FMT_BASE64);

generate_dh_params ();

gnutls_certificate_set_dh_params (cred, dh_params);

/* Socket operations
 */
listen_sd = socket (AF_INET, SOCK_STREAM, 0);
SOCKET_ERR (listen_sd, "socket");

memset (&sa_serv, '\0', sizeof (sa_serv));
sa_serv.sin_family = AF_INET;
sa_serv.sin_addr.s_addr = INADDR_ANY;
sa_serv.sin_port = htons (PORT);      /* Server Port number */

setsockopt (listen_sd, SOL_SOCKET, SO_REUSEADDR, &optval, sizeof (int));

err = bind (listen_sd, (SA *) & sa_serv, sizeof (sa_serv));
SOCKET_ERR (err, "bind");
err = listen (listen_sd, 1024);
SOCKET_ERR (err, "listen");

printf ("%s ready.  Listening to port '%d'.\n\n", name, PORT);

client_len = sizeof (sa_cli);
for (;;)
```

```
{
  session = initialize_tls_session ();

  sd = accept (listen_sd, (SA *) & sa_cli, &client_len);

  printf ("- connection from %s, port %d\n",
          inet_ntop (AF_INET, &sa_cli.sin_addr, topbuf,
                     sizeof (topbuf)), ntohs (sa_cli.sin_port));

  gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);
  ret = gnutls_handshake (session);
  if (ret < 0)
    {
      close (sd);
      gnutls_deinit (session);
      fprintf (stderr, "*** Handshake has failed (%s)\n\n",
               gnutls_strerror (ret));
      continue;
    }
  printf ("- Handshake was completed\n");

  /* see the Getting peer's information example */
  /* print_info(session); */

  i = 0;
  for (;;)
    {
      memset (buffer, 0, MAX_BUF + 1);
      ret = gnutls_record_recv (session, buffer, MAX_BUF);

      if (ret == 0)
        {
          printf ("\n- Peer has closed the GNUTLS connection\n");
          break;
        }
      else if (ret < 0)
        {
          fprintf (stderr, "\n*** Received corrupted "
                   "data(%d).  Closing the connection.\n\n", ret);
          break;
        }
      else if (ret > 0)
        {
          /* echo data back to the client
           */
          gnutls_record_send (session, buffer, strlen (buffer));
        }
```

```
        }
      printf ("\n");
      /* do not wait for the peer to close the connection.
       */
      gnutls_bye (session, GNUTLS_SHUT_WR);

      close (sd);
      gnutls_deinit (session);

    }
  close (listen_sd);

  gnutls_certificate_free_credentials (cred);

  gnutls_global_deinit ();

  return 0;

}
```

7.4.4 Echo Server with SRP Authentication

This is a server which supports SRP authentication. It is also possible to combine this functionality with a certificate server. Here it is separate for simplicity.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <string.h>
#include <unistd.h>
#include <gnutls/gnutls.h>
#include <gnutls/extra.h>
```

```
#define SRP_PASSWD "tpasswd"
#define SRP_PASSWD_CONF "tpasswd.conf"

#define KEYFILE "key.pem"
#define CERTFILE "cert.pem"
#define CAFILE "ca.pem"

/* This is a sample TLS-SRP echo server.
 */

#define SA struct sockaddr
#define SOCKET_ERR(err,s) if(err==-1) {perror(s);return(1);}
#define MAX_BUF 1024
#define PORT 5556               /* listen to 5556 port */

/* These are global */
gnutls_srp_server_credentials_t srp_cred;
gnutls_certificate_credentials_t cert_cred;

static gnutls_session_t
initialize_tls_session (void)
{
  gnutls_session_t session;

  gnutls_init (&session, GNUTLS_SERVER);

  gnutls_priority_set_direct (session, "NORMAL:+SRP:+SRP-DSS:+SRP-RSA", NULL);

  gnutls_credentials_set (session, GNUTLS_CRD_SRP, srp_cred);
  /* for the certificate authenticated ciphersuites.
   */
  gnutls_credentials_set (session, GNUTLS_CRD_CERTIFICATE, cert_cred);

  /* request client certificate if any.
   */
  gnutls_certificate_server_set_request (session, GNUTLS_CERT_IGNORE);

  return session;
}

int
main (void)
{
  int err, listen_sd, i;
  int sd, ret;
  struct sockaddr_in sa_serv;
  struct sockaddr_in sa_cli;
```

```
int client_len;
char topbuf[512];
gnutls_session_t session;
char buffer[MAX_BUF + 1];
int optval = 1;
char name[256];

strcpy (name, "Echo Server");

/* these must be called once in the program
 */
gnutls_global_init ();
gnutls_global_init_extra ();  /* for SRP */

/* SRP_PASSWD a password file (created with the included srptool utility)
 */
gnutls_srp_allocate_server_credentials (&srp_cred);
gnutls_srp_set_server_credentials_file (srp_cred, SRP_PASSWD,
                                        SRP_PASSWD_CONF);

gnutls_certificate_allocate_credentials (&cert_cred);
gnutls_certificate_set_x509_trust_file (cert_cred, CAFILE,
                                        GNUTLS_X509_FMT_PEM);
gnutls_certificate_set_x509_key_file (cert_cred, CERTFILE, KEYFILE,
                                      GNUTLS_X509_FMT_PEM);

/* TCP socket operations
 */
listen_sd = socket (AF_INET, SOCK_STREAM, 0);
SOCKET_ERR (listen_sd, "socket");

memset (&sa_serv, '\0', sizeof (sa_serv));
sa_serv.sin_family = AF_INET;
sa_serv.sin_addr.s_addr = INADDR_ANY;
sa_serv.sin_port = htons (PORT);      /* Server Port number */

setsockopt (listen_sd, SOL_SOCKET, SO_REUSEADDR, &optval, sizeof (int));

err = bind (listen_sd, (SA *) & sa_serv, sizeof (sa_serv));
SOCKET_ERR (err, "bind");
err = listen (listen_sd, 1024);
SOCKET_ERR (err, "listen");

printf ("%s ready.  Listening to port '%d'.\n\n", name, PORT);

client_len = sizeof (sa_cli);
for (;;)
```

```
{
  session = initialize_tls_session ();

  sd = accept (listen_sd, (SA *) & sa_cli, &client_len);

  printf ("- connection from %s, port %d\n",
          inet_ntop (AF_INET, &sa_cli.sin_addr, topbuf,
                     sizeof (topbuf)), ntohs (sa_cli.sin_port));

  gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);
  ret = gnutls_handshake (session);
  if (ret < 0)
    {
      close (sd);
      gnutls_deinit (session);
      fprintf (stderr, "*** Handshake has failed (%s)\n\n",
               gnutls_strerror (ret));
      continue;
    }
  printf ("- Handshake was completed\n");

  /* print_info(session); */

  i = 0;
  for (;;)
    {
      memset (buffer, 0, MAX_BUF + 1);
      ret = gnutls_record_recv (session, buffer, MAX_BUF);

      if (ret == 0)
        {
          printf ("\n- Peer has closed the GNUTLS connection\n");
          break;
        }
      else if (ret < 0)
        {
          fprintf (stderr, "\n*** Received corrupted "
                   "data(%d).  Closing the connection.\n\n", ret);
          break;
        }
      else if (ret > 0)
        {
          /* echo data back to the client
           */
          gnutls_record_send (session, buffer, strlen (buffer));
        }
    }
```

```
      printf ("\n");
      /* do not wait for the peer to close the connection.  */
      gnutls_bye (session, GNUTLS_SHUT_WR);

      close (sd);
      gnutls_deinit (session);

    }
  close (listen_sd);

  gnutls_srp_free_server_credentials (srp_cred);
  gnutls_certificate_free_credentials (cert_cred);

  gnutls_global_deinit ();

  return 0;

}
```

7.4.5 Echo Server with Anonymous Authentication

This example server support anonymous authentication, and could be used to serve the example client for anonymous authentication.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <string.h>
#include <unistd.h>
#include <gnutls/gnutls.h>

/* This is a sample TLS 1.0 echo server, for anonymous authentication only.
 */
```

```
#define SA struct sockaddr
#define SOCKET_ERR(err,s) if(err==-1) {perror(s);return(1);}
#define MAX_BUF 1024
#define PORT 5556               /* listen to 5556 port */
#define DH_BITS 1024

/* These are global */
gnutls_anon_server_credentials_t anoncred;

static gnutls_session_t
initialize_tls_session (void)
{
  gnutls_session_t session;

  gnutls_init (&session, GNUTLS_SERVER);

  gnutls_priority_set_direct (session, "NORMAL:+ANON-DH", NULL);

  gnutls_credentials_set (session, GNUTLS_CRD_ANON, anoncred);

  gnutls_dh_set_prime_bits (session, DH_BITS);

  return session;
}

static gnutls_dh_params_t dh_params;

static int
generate_dh_params (void)
{

  /* Generate Diffie Hellman parameters - for use with DHE
   * kx algorithms.  These should be discarded and regenerated
   * once a day, once a week or once a month.  Depending on the
   * security requirements.
   */
  gnutls_dh_params_init (&dh_params);
  gnutls_dh_params_generate2 (dh_params, DH_BITS);

  return 0;
}

int
main (void)
{
```

```
int err, listen_sd, i;
int sd, ret;
struct sockaddr_in sa_serv;
struct sockaddr_in sa_cli;
int client_len;
char topbuf[512];
gnutls_session_t session;
char buffer[MAX_BUF + 1];
int optval = 1;

/* this must be called once in the program
 */
gnutls_global_init ();

gnutls_anon_allocate_server_credentials (&anoncred);

generate_dh_params ();

gnutls_anon_set_server_dh_params (anoncred, dh_params);

/* Socket operations
 */
listen_sd = socket (AF_INET, SOCK_STREAM, 0);
SOCKET_ERR (listen_sd, "socket");

memset (&sa_serv, '\0', sizeof (sa_serv));
sa_serv.sin_family = AF_INET;
sa_serv.sin_addr.s_addr = INADDR_ANY;
sa_serv.sin_port = htons (PORT);      /* Server Port number */

setsockopt (listen_sd, SOL_SOCKET, SO_REUSEADDR, &optval, sizeof (int));

err = bind (listen_sd, (SA *) & sa_serv, sizeof (sa_serv));
SOCKET_ERR (err, "bind");
err = listen (listen_sd, 1024);
SOCKET_ERR (err, "listen");

printf ("Server ready.  Listening to port '%d'.\n\n", PORT);

client_len = sizeof (sa_cli);
for (;;)
  {
    session = initialize_tls_session ();

    sd = accept (listen_sd, (SA *) & sa_cli, &client_len);

    printf ("- connection from %s, port %d\n",
```

```
        inet_ntop (AF_INET, &sa_cli.sin_addr, topbuf,
                   sizeof (topbuf)), ntohs (sa_cli.sin_port));

gnutls_transport_set_ptr (session, (gnutls_transport_ptr_t) sd);
ret = gnutls_handshake (session);
if (ret < 0)
  {
    close (sd);
    gnutls_deinit (session);
    fprintf (stderr, "*** Handshake has failed (%s)\n\n",
             gnutls_strerror (ret));
    continue;
  }
printf ("- Handshake was completed\n");

/* see the Getting peer's information example */
/* print_info(session); */

i = 0;
for (;;)
  {
    memset (buffer, 0, MAX_BUF + 1);
    ret = gnutls_record_recv (session, buffer, MAX_BUF);

    if (ret == 0)
      {
        printf ("\n- Peer has closed the GNUTLS connection\n");
        break;
      }
    else if (ret < 0)
      {
        fprintf (stderr, "\n*** Received corrupted "
                 "data(%d).  Closing the connection.\n\n", ret);
        break;
      }
    else if (ret > 0)
      {
        /* echo data back to the client
         */
        gnutls_record_send (session, buffer, strlen (buffer));
      }
  }
printf ("\n");
/* do not wait for the peer to close the connection.
 */
gnutls_bye (session, GNUTLS_SHUT_WR);
```

```
      close (sd);
      gnutls_deinit (session);

    }
  close (listen_sd);

  gnutls_anon_free_server_credentials (anoncred);

  gnutls_global_deinit ();

  return 0;

}
```

7.5 Miscellaneous Examples

7.5.1 Checking for an Alert

This is a function that checks if an alert has been received in the current session.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <gnutls/gnutls.h>

/* This function will check whether the given return code from
 * a gnutls function (recv/send), is an alert, and will print
 * that alert.
 */
void
check_alert (gnutls_session_t session, int ret)
{
  int last_alert;

  if (ret == GNUTLS_E_WARNING_ALERT_RECEIVED
      || ret == GNUTLS_E_FATAL_ALERT_RECEIVED)
    {
      last_alert = gnutls_alert_get (session);
```

```
      /* The check for renegotiation is only useful if we are
       * a server, and we had requested a rehandshake.
       */
      if (last_alert == GNUTLS_A_NO_RENEGOTIATION &&
          ret == GNUTLS_E_WARNING_ALERT_RECEIVED)
        printf ("* Received NO_RENEGOTIATION alert.  "
                "Client Does not support renegotiation.\n");
      else
        printf ("* Received alert '%d':  %s.\n", last_alert,
                gnutls_alert_get_name (last_alert));
    }
}
```

7.5.2 X.509 Certificate Parsing Example

To demonstrate the X.509 parsing capabilities an example program is listed below. That program reads the peer's certificate, and prints information about it.

```
/* Copyright 2007, 2008 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <gnutls/gnutls.h>
#include <gnutls/x509.h>

static const char *
bin2hex (const void *bin, size_t bin_size)
{
  static char printable[110];
  const unsigned char *_bin = bin;
  char *print;
  size_t i;

  if (bin_size > 50)
    bin_size = 50;

  print = printable;
  for (i = 0; i < bin_size; i++)
```

```
    {
      sprintf (print, "%.2x ", _bin[i]);
      print += 2;
    }

  return printable;
}

/* This function will print information about this session's peer
 * certificate.
 */
void
print_x509_certificate_info (gnutls_session_t session)
{
  char serial[40];
  char dn[128];
  size_t size;
  unsigned int algo, bits;
  time_t expiration_time, activation_time;
  const gnutls_datum_t *cert_list;
  unsigned int cert_list_size = 0;
  gnutls_x509_crt_t cert;

  /* This function only works for X.509 certificates.
   */
  if (gnutls_certificate_type_get (session) != GNUTLS_CRT_X509)
    return;

  cert_list = gnutls_certificate_get_peers (session, &cert_list_size);

  printf ("Peer provided %d certificates.\n", cert_list_size);

  if (cert_list_size > 0)
    {

      /* we only print information about the first certificate.
       */
      gnutls_x509_crt_init (&cert);

      gnutls_x509_crt_import (cert, &cert_list[0], GNUTLS_X509_FMT_DER);

      printf ("Certificate info:\n");

      expiration_time = gnutls_x509_crt_get_expiration_time (cert);
      activation_time = gnutls_x509_crt_get_activation_time (cert);

      printf ("\tCertificate is valid since:  %s", ctime (&activation_time));
```

```
      printf ("\tCertificate expires:  %s", ctime (&expiration_time));

      /* Print the serial number of the certificate.
       */
      size = sizeof (serial);
      gnutls_x509_crt_get_serial (cert, serial, &size);

      printf ("\tCertificate serial number:  %s\n", bin2hex (serial, size));

      /* Extract some of the public key algorithm's parameters
       */
      algo = gnutls_x509_crt_get_pk_algorithm (cert, &bits);

      printf ("Certificate public key:  %s",
              gnutls_pk_algorithm_get_name (algo));

      /* Print the version of the X.509
       * certificate.
       */
      printf ("\tCertificate version:  #%d\n",
              gnutls_x509_crt_get_version (cert));

      size = sizeof (dn);
      gnutls_x509_crt_get_dn (cert, dn, &size);
      printf ("\tDN: %s\n", dn);

      size = sizeof (dn);
      gnutls_x509_crt_get_issuer_dn (cert, dn, &size);
      printf ("\tIssuer's DN: %s\n", dn);

      gnutls_x509_crt_deinit (cert);

    }
}
```

7.5.3 Certificate Request Generation

The following example is about generating a certificate request, and a private key. A certificate request can be later be processed by a CA, which should return a signed certificate.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
```

```
# include <config.h>
#endif

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <gnutls/gnutls.h>
#include <gnutls/x509.h>
#include <time.h>

/* This example will generate a private key and a certificate
 * request.
 */

int
main (void)
{
  gnutls_x509_crq_t crq;
  gnutls_x509_privkey_t key;
  unsigned char buffer[10 * 1024];
  size_t buffer_size = sizeof (buffer);

  gnutls_global_init ();

  /* Initialize an empty certificate request, and
   * an empty private key.
   */
  gnutls_x509_crq_init (&crq);

  gnutls_x509_privkey_init (&key);

  /* Generate a 1024 bit RSA private key.
   */
  gnutls_x509_privkey_generate (key, GNUTLS_PK_RSA, 1024, 0);

  /* Add stuff to the distinguished name
   */
  gnutls_x509_crq_set_dn_by_oid (crq, GNUTLS_OID_X520_COUNTRY_NAME,
                                 0, "GR", 2);

  gnutls_x509_crq_set_dn_by_oid (crq, GNUTLS_OID_X520_COMMON_NAME,
                                 0, "Nikos", strlen ("Nikos"));

  /* Set the request version.
   */
  gnutls_x509_crq_set_version (crq, 1);
```

```
  /* Set a challenge password.
   */
  gnutls_x509_crq_set_challenge_password (crq, "something to remember here");

  /* Associate the request with the private key
   */
  gnutls_x509_crq_set_key (crq, key);

  /* Self sign the certificate request.
   */
  gnutls_x509_crq_sign (crq, key);

  /* Export the PEM encoded certificate request, and
   * display it.
   */
  gnutls_x509_crq_export (crq, GNUTLS_X509_FMT_PEM, buffer, &buffer_size);

  printf ("Certificate Request:  \n%s", buffer);


  /* Export the PEM encoded private key, and
   * display it.
   */
  buffer_size = sizeof (buffer);
  gnutls_x509_privkey_export (key, GNUTLS_X509_FMT_PEM, buffer, &buffer_size);

  printf ("\n\nPrivate key:  \n%s", buffer);

  gnutls_x509_crq_deinit (crq);
  gnutls_x509_privkey_deinit (key);

  return 0;

}
```

7.5.4 PKCS #12 Structure Generation

The following example is about generating a PKCS #12 structure.

```
/* Copyright 2007 Free Software Foundation
 *
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 * are permitted in any medium without royalty provided the copyright
 * notice and this notice are preserved.
 */

#ifdef HAVE_CONFIG_H
# include <config.h>
```

```
#endif

#include <stdio.h>
#include <stdlib.h>
#include <gnutls/gnutls.h>
#include <gnutls/pkcs12.h>

#define OUTFILE "out.p12"

/* This function will write a pkcs12 structure into a file.
 * cert:  is a DER encoded certificate
 * pkcs8_key:  is a PKCS #8 encrypted key (note that this must be
 *  encrypted using a PKCS #12 cipher, or some browsers will crash)
 * password:  is the password used to encrypt the PKCS #12 packet.
 */
int
write_pkcs12 (const gnutls_datum_t * cert,
              const gnutls_datum_t * pkcs8_key, const char *password)
{
  gnutls_pkcs12_t pkcs12;
  int ret, bag_index;
  gnutls_pkcs12_bag_t bag, key_bag;
  char pkcs12_struct[10 * 1024];
  size_t pkcs12_struct_size;
  FILE *fd;

  /* A good idea might be to use gnutls_x509_privkey_get_key_id()
   * to obtain a unique ID.
   */
  gnutls_datum_t key_id = { "\x00\x00\x07", 3 };

  gnutls_global_init ();

  /* Firstly we create two helper bags, which hold the certificate,
   * and the (encrypted) key.
   */

  gnutls_pkcs12_bag_init (&bag);
  gnutls_pkcs12_bag_init (&key_bag);

  ret = gnutls_pkcs12_bag_set_data (bag, GNUTLS_BAG_CERTIFICATE, cert);
  if (ret < 0)
    {
      fprintf (stderr, "ret:  %s\n", gnutls_strerror (ret));
      return 1;
    }
```

```
/* ret now holds the bag's index.
 */
bag_index = ret;

/* Associate a friendly name with the given certificate.  Used
 * by browsers.
 */
gnutls_pkcs12_bag_set_friendly_name (bag, bag_index, "My name");

/* Associate the certificate with the key using a unique key
 * ID.
 */
gnutls_pkcs12_bag_set_key_id (bag, bag_index, &key_id);

/* use weak encryption for the certificate.
 */
gnutls_pkcs12_bag_encrypt (bag, password, GNUTLS_PKCS_USE_PKCS12_RC2_40);

/* Now the key.
 */

ret = gnutls_pkcs12_bag_set_data (key_bag,
                                  GNUTLS_BAG_PKCS8_ENCRYPTED_KEY,
                                  pkcs8_key);
if (ret < 0)
  {
    fprintf (stderr, "ret:  %s\n", gnutls_strerror (ret));
    return 1;
  }

/* Note that since the PKCS #8 key is already encrypted we don't
 * bother encrypting that bag.
 */
bag_index = ret;

gnutls_pkcs12_bag_set_friendly_name (key_bag, bag_index, "My name");

gnutls_pkcs12_bag_set_key_id (key_bag, bag_index, &key_id);


/* The bags were filled.  Now create the PKCS #12 structure.
 */
gnutls_pkcs12_init (&pkcs12);

/* Insert the two bags in the PKCS #12 structure.
 */
```

```
  gnutls_pkcs12_set_bag (pkcs12, bag);
  gnutls_pkcs12_set_bag (pkcs12, key_bag);


  /* Generate a message authentication code for the PKCS #12
   * structure.
   */
  gnutls_pkcs12_generate_mac (pkcs12, password);

  pkcs12_struct_size = sizeof (pkcs12_struct);
  ret =
    gnutls_pkcs12_export (pkcs12, GNUTLS_X509_FMT_DER, pkcs12_struct,
                          &pkcs12_struct_size);
  if (ret < 0)
    {
      fprintf (stderr, "ret:  %s\n", gnutls_strerror (ret));
      return 1;
    }

  fd = fopen (OUTFILE, "w");
  if (fd == NULL)
    {
      fprintf (stderr, "cannot open file\n");
      return 1;
    }
  fwrite (pkcs12_struct, 1, pkcs12_struct_size, fd);
  fclose (fd);

  gnutls_pkcs12_bag_deinit (bag);
  gnutls_pkcs12_bag_deinit (key_bag);
  gnutls_pkcs12_deinit (pkcs12);

  return 0;
}
```

7.6 Compatibility with the OpenSSL Library

To ease GnuTLS' integration with existing applications, a compatibility layer with the widely used OpenSSL library is included in the `gnutls-openssl` library. This compatibility layer is not complete and it is not intended to completely reimplement the OpenSSL API with GnuTLS. It only provides source-level compatibility. There is currently no attempt to make it binary-compatible with OpenSSL.

The prototypes for the compatibility functions are in the '`gnutls/openssl.h`' header file.

Current limitations imposed by the compatibility layer include:

- Error handling is not thread safe.

7.7 Opaque PRF Input TLS Extension

GnuTLS supports the Opaque PRF Input TLS extension (`draft-rescorla-tls-opaque-prf-input-00.txt`). The API consists of one API for use in the client, [gnutls_oprfi_enable_client], page 152, and one API for use in the server, [gnutls_oprfi_enable_server], page 152. You must invoke both functions before calling [gnutls_handshake], page 148. The server utilizes a callback function into the application. The callback can look at the random string provided by the client, and also set the server string. The string lengths must be equal according to the protocol.

8 Included Programs

Included with GnuTLS are also a few command line tools that let you use the library for common tasks without writing an application. The applications are discussed in this chapter.

8.1 Invoking certtool

This is a program to generate X.509 certificates, certificate requests, CRLs and private keys.

```
Certtool help
Usage: certtool [options]
     -s, --generate-self-signed
                            Generate a self-signed certificate.
     -c, --generate-certificate
                            Generate a signed certificate.
     --generate-proxy       Generate a proxy certificate.
     --generate-crl         Generate a CRL.
     -u, --update-certificate
                            Update a signed certificate.
     -p, --generate-privkey Generate a private key.
     -q, --generate-request Generate a PKCS #10 certificate
                            request.
     -e, --verify-chain     Verify a PEM encoded certificate chain.
                            The last certificate in the chain must
                            be a self signed one.
     --verify-crl           Verify a CRL.
     --generate-dh-params   Generate PKCS #3 encoded Diffie Hellman
                            parameters.
     --get-dh-params        Get the included PKCS #3 encoded Diffie
                            Hellman parameters.
     --load-privkey FILE    Private key file to use.
     --load-request FILE    Certificate request file to use.
     --load-certificate FILE
                            Certificate file to use.
     --load-ca-privkey FILE Certificate authority's private key
                            file to use.
     --load-ca-certificate FILE
                            Certificate authority's certificate
                            file to use.
     --password PASSWORD    Password to use.
     -i, --certificate-info Print information on a certificate.
     -l, --crl-info         Print information on a CRL.
     --p12-info             Print information on a PKCS #12
                            structure.
     --p7-info              Print information on a PKCS #7
                            structure.
     --smime-to-p7          Convert S/MIME to PKCS #7 structure.
```

```
-k, --key-info          Print information on a private key.
--fix-key               Regenerate the parameters in a private
                        key.
--to-p12                Generate a PKCS #12 structure.
-8, --pkcs8             Use PKCS #8 format for private keys.
--dsa                   Use DSA keys.
--hash STR              Hash algorithm to use for signing
                        (MD5,SHA1,RMD160).
--export-ciphers        Use weak encryption algorithms.
--inder                 Use DER format for input certificates
                        and private keys.
--outder                Use DER format for output certificates
                        and private keys.
--bits BITS             specify the number of bits for key
                        generation.
--outfile FILE          Output file.
--infile FILE           Input file.
--template FILE         Template file to use for non
                        interactive operation.
-d, --debug LEVEL       specify the debug level. Default is 1.
-h, --help              shows this help text
-v, --version           shows the program's version
```

The program can be used interactively or non interactively by specifying the `--template` command line option. See below for an example of a template file.

How to use certtool interactively:

- To generate parameters for Diffie Hellman key exchange, use the command:

  ```
  $ certtool --generate-dh-params --outfile dh.pem
  ```

- To generate parameters for the RSA-EXPORT key exchange, use the command:

  ```
  $ certtool --generate-privkey --bits 512 --outfile rsa.pem
  ```

- To create a self signed certificate, use the command:

  ```
  $ certtool --generate-privkey --outfile ca-key.pem
  $ certtool --generate-self-signed --load-privkey ca-key.pem \
     --outfile ca-cert.pem
  ```

  Note that a self-signed certificate usually belongs to a certificate authority, that signs other certificates.

- To create a private key, run:

  ```
  $ certtool --generate-privkey --outfile key.pem
  ```

- To generate a certificate using the private key, use the command:

  ```
  $ certtool --generate-certificate --load-privkey key.pem \
     --outfile cert.pem --load-ca-certificate ca-cert.pem \
     --load-ca-privkey ca-key.pem
  ```

- To create a certificate request (needed when the certificate is issued by another party), run:

```
$ certtool --generate-request --load-privkey key.pem \
  --outfile request.pem
```

- To generate a certificate using the previous request, use the command:

```
$ certtool --generate-certificate --load-request request.pem \
   --outfile cert.pem \
   --load-ca-certificate ca-cert.pem --load-ca-privkey ca-key.pem
```

- To view the certificate information, use:

```
$ certtool --certificate-info --infile cert.pem
```

- To generate a PKCS #12 structure using the previous key and certificate, use the command:

```
$ certtool --load-certificate cert.pem --load-privkey key.pem \
  --to-p12 --outder --outfile key.p12
```

- Proxy certificate can be used to delegate your credential to a temporary, typically short-lived, certificate. To create one from the previously created certificate, first create a temporary key and then generate a proxy certificate for it, using the commands:

```
$ certtool --generate-privkey > proxy-key.pem
$ certtool --generate-proxy --load-ca-privkey key.pem \
  --load-privkey proxy-key.pem --load-certificate cert.pem \
  --outfile proxy-cert.pem
```

- To create an empty Certificate Revocation List (CRL) do:

```
$ certtool --generate-crl --load-ca-privkey x509-ca-key.pem --load-ca-certificate x
```

  To create a CRL that contains some revoked certificates, place the certificates in a file and use `--load-certificate` as follows:

```
$ certtool --generate-crl --load-ca-privkey x509-ca-key.pem --load-ca-certificate x
```

- To verify a Certificate Revocation List (CRL) do:

```
$ certtool --verify-crl --load-ca-certificate x509-ca.pem < crl.pem
```

Certtool's template file format:

- Firstly create a file named 'cert.cfg' that contains the information about the certificate. An example file is listed below.
- Then execute:

```
$ certtool --generate-certificate cert.pem --load-privkey key.pem  \
   --template cert.cfg \
   --load-ca-certificate ca-cert.pem --load-ca-privkey ca-key.pem
```

An example certtool template file:

```
# X.509 Certificate options
#
# DN options

# The organization of the subject.
organization = "Koko inc."

# The organizational unit of the subject.
```

```
unit = "sleeping dept."

# The locality of the subject.
# locality =

# The state of the certificate owner.
state = "Attiki"

# The country of the subject. Two letter code.
country = GR

# The common name of the certificate owner.
cn = "Cindy Lauper"

# A user id of the certificate owner.
#uid = "clauper"

# If the supported DN OIDs are not adequate you can set
# any OID here.
# For example set the X.520 Title and the X.520 Pseudonym
# by using OID and string pairs.
#dn_oid = "2.5.4.12" "Dr." "2.5.4.65" "jackal"

# This is deprecated and should not be used in new
# certificates.
# pkcs9_email = "none@none.org"

# The serial number of the certificate
serial = 007

# In how many days, counting from today, this certificate will expire.
expiration_days = 700

# X.509 v3 extensions

# A dnsname in case of a WWW server.
#dns_name = "www.none.org"
#dns_name = "www.morethanone.org"

# An IP address in case of a server.
#ip_address = "192.168.1.1"

# An email in case of a person
email = "none@none.org"

# An URL that has CRLs (certificate revocation lists)
# available. Needed in CA certificates.
```

```
#crl_dist_points = "http://www.getcrl.crl/getcrl/"

# Whether this is a CA certificate or not
#ca

# Whether this certificate will be used for a TLS client
#tls_www_client

# Whether this certificate will be used for a TLS server
#tls_www_server

# Whether this certificate will be used to sign data (needed
# in TLS DHE ciphersuites).
signing_key

# Whether this certificate will be used to encrypt data (needed
# in TLS RSA ciphersuites). Note that it is prefered to use different
# keys for encryption and signing.
#encryption_key

# Whether this key will be used to sign other certificates.
#cert_signing_key

# Whether this key will be used to sign CRLs.
#crl_signing_key

# Whether this key will be used to sign code.
#code_signing_key

# Whether this key will be used to sign OCSP data.
#ocsp_signing_key

# Whether this key will be used for time stamping.
#time_stamping_key
```

8.2 Invoking gnutls-cli

Simple client program to set up a TLS connection to some other computer. It sets up a TLS connection and forwards data from the standard input to the secured socket and vice versa.

```
GNU TLS test client
Usage:  gnutls-cli [options] hostname

     -d, --debug integer      Enable debugging
     -r, --resume             Connect, establish a session. Connect
                              again and resume this session.
     -s, --starttls           Connect, establish a plain session and
```

```
                          start TLS when EOF or a SIGALRM is
                          received.
--crlf                    Send CR LF instead of LF.
--x509fmtder              Use DER format for certificates to read
                          from.
-f, --fingerprint         Send the openpgp fingerprint, instead
                          of the key.
--disable-extensions      Disable all the TLS extensions.
--print-cert              Print the certificate in PEM format.
-p, --port integer        The port to connect to.
--recordsize integer      The maximum record size to advertize.
-V, --verbose             More verbose output.
--ciphers cipher1 cipher2...
                          Ciphers to enable.
--protocols protocol1 protocol2...
                          Protocols to enable.
--comp comp1 comp2...     Compression methods to enable.
--macs mac1 mac2...       MACs to enable.
--kx kx1 kx2...           Key exchange methods to enable.
--ctypes certType1 certType2...
                          Certificate types to enable.
--x509cafile FILE         Certificate file to use.
--x509crlfile FILE        CRL file to use.
--pgpkeyfile FILE         PGP Key file to use.
--pgpkeyring FILE         PGP Key ring file to use.
--pgptrustdb FILE         PGP trustdb file to use.
--pgpcertfile FILE        PGP Public Key (certificate) file to
                          use.
--x509keyfile FILE        X.509 key file to use.
--x509certfile FILE       X.509 Certificate file to use.
--srpusername NAME        SRP username to use.
--srppasswd PASSWD        SRP password to use.
--insecure                Don't abort program if server
                          certificate can't be validated.
-l, --list                Print a list of the supported
                          algorithms  and modes.
-h, --help                prints this help
-v, --version             prints the program's version number
```

To connect to a server using PSK authentication, you may use something like:

```
$ gnutls-cli -p 5556 test.gnutls.org --pskusername jas --pskkey 9e32cf7786321a828ef7668f09fb35db --priori
```

8.2.1 Example client PSK connection

If your server only supports the PSK ciphersuite, connecting to it should be as simple as connecting to the server:

```
$ ./gnutls-cli -p 5556 localhost
Resolving 'localhost'...
Connecting to '127.0.0.1:5556'...
```

```
- PSK client callback. PSK hint 'psk_identity_hint'
Enter PSK identity: psk_identity
Enter password:
- PSK authentication. PSK hint 'psk_identity_hint'
- Version: TLS1.1
- Key Exchange: PSK
- Cipher: AES-128-CBC
- MAC: SHA1
- Compression: NULL
- Handshake was completed

- Simple Client Mode:
```

If the server supports several cipher suites, you may need to force it to chose PSK by using a cipher priority parameter such as `--priority NORMAL:+PSK:-RSA:-DHE-RSA:-DHE-PSK`.

Instead of using the Netconf-way to derive the PSK key from a password, you can also give the PSK username and key directly on the command line:

```
$ ./gnutls-cli -p 5556 localhost --pskusername psk_identity --pskkey 88f3824b3e5659f52d00e959bacab954b654
Resolving 'localhost'...
Connecting to '127.0.0.1:5556'...
- PSK authentication. PSK hint 'psk_identity_hint'
- Version: TLS1.1
- Key Exchange: PSK
- Cipher: AES-128-CBC
- MAC: SHA1
- Compression: NULL
- Handshake was completed

- Simple Client Mode:
```

By keeping the `--pskusername` parameter and removing the `--pskkey` parameter, it will query only for the password during the handshake.

8.3 Invoking gnutls-cli-debug

This program was created to assist in debugging GnuTLS, but it might be useful to extract a TLS server's capabilities. It's purpose is to connect onto a TLS server, perform some tests and print the server's capabilities. If called with the '-v' parameter a more checks will be performed. An example output is:

```
crystal:/cvs/gnutls/src$ ./gnutls-cli-debug localhost -p 5556
Resolving 'localhost'...
Connecting to '127.0.0.1:5556'...
Checking for TLS 1.1 support... yes
Checking fallback from TLS 1.1 to... N/A
Checking for TLS 1.0 support... yes
Checking for SSL 3.0 support... yes
Checking for version rollback bug in RSA PMS... no
Checking for version rollback bug in Client Hello... no
Checking whether we need to disable TLS 1.0... N/A
Checking whether the server ignores the RSA PMS version... no
Checking whether the server can accept Hello Extensions... yes
Checking whether the server can accept cipher suites not in SSL 3.0 spec... yes
Checking whether the server can accept a bogus TLS record version in the client hello... yes
Checking for certificate information... N/A
Checking for trusted CAs... N/A
Checking whether the server understands TLS closure alerts... yes
```

```
Checking whether the server supports session resumption... yes
Checking for export-grade ciphersuite support... no
Checking RSA-export ciphersuite info... N/A
Checking for anonymous authentication support... no
Checking anonymous Diffie Hellman group info... N/A
Checking for ephemeral Diffie Hellman support... no
Checking ephemeral Diffie Hellman group info... N/A
Checking for AES cipher support (TLS extension)... yes
Checking for 3DES cipher support... yes
Checking for ARCFOUR 128 cipher support... yes
Checking for ARCFOUR 40 cipher support... no
Checking for MD5 MAC support... yes
Checking for SHA1 MAC support... yes
Checking for ZLIB compression support (TLS extension)... yes
Checking for LZO compression support (GnuTLS extension)... yes
Checking for max record size (TLS extension)... yes
Checking for SRP authentication support (TLS extension)... yes
Checking for OpenPGP authentication support (TLS extension)... no
```

8.4 Invoking gnutls-serv

Simple server program that listens to incoming TLS connections.

```
GNU TLS test server
Usage: gnutls-serv [options]

     -d, --debug integer      Enable debugging
     -g, --generate           Generate Diffie Hellman Parameters.
     -p, --port integer       The port to connect to.
     -q, --quiet              Suppress some messages.
     --nodb                   Does not use the resume database.
     --http                   Act as an HTTP Server.
     --echo                   Act as an Echo Server.
     --dhparams FILE          DH params file to use.
     --x509fmtder             Use DER format for certificates
     --x509cafile FILE        Certificate file to use.
     --x509crlfile FILE       CRL file to use.
     --pgpkeyring FILE        PGP Key ring file to use.
     --pgptrustdb FILE        PGP trustdb file to use.
     --pgpkeyfile FILE        PGP Key file to use.
     --pgpcertfile FILE       PGP Public Key (certificate) file to
                              use.
     --x509keyfile FILE       X.509 key file to use.
     --x509certfile FILE      X.509 Certificate file to use.
     --x509dsakeyfile FILE    Alternative X.509 key file to use.
     --x509dsacertfile FILE   Alternative X.509 certificate file to
                              use.
     --srppasswd FILE         SRP password file to use.
     --srppasswdconf FILE     SRP password conf file to use.
     --ciphers cipher1 cipher2...
                              Ciphers to enable.
```

```
--protocols protocol1 protocol2...
                        Protocols to enable.
--comp comp1 comp2...   Compression methods to enable.
--macs mac1 mac2...     MACs to enable.
--kx kx1 kx2...         Key exchange methods to enable.
--ctypes certType1 certType2...
                        Certificate types to enable.
-l, --list              Print a list of the supported
                        algorithms  and modes.
-h, --help              prints this help
-v, --version           prints the program's version number
```

8.4.1 Setting Up a Test HTTPS Server

Running your own TLS server based on GnuTLS can be useful when debugging clients and/or GnuTLS itself. This section describes how to use `gnutls-serv` as a simple HTTPS server.

The most basic server can be started as:

```
gnutls-serv --http
```

It will only support anonymous ciphersuites, which many TLS clients refuse to use.

The next step is to add support for X.509. First we generate a CA:

```
certtool --generate-privkey > x509-ca-key.pem
echo 'cn = GnuTLS test CA' > ca.tmpl
echo 'ca' >> ca.tmpl
echo 'cert_signing_key' >> ca.tmpl
certtool --generate-self-signed --load-privkey x509-ca-key.pem \
  --template ca.tmpl --outfile x509-ca.pem
...
```

Then generate a server certificate. Remember to change the dns_name value to the name of your server host, or skip that command to avoid the field.

```
certtool --generate-privkey > x509-server-key.pem
echo 'organization = GnuTLS test server' > server.tmpl
echo 'cn = test.gnutls.org' >> server.tmpl
echo 'tls_www_server' >> server.tmpl
echo 'encryption_key' >> server.tmpl
echo 'signing_key' >> server.tmpl
echo 'dns_name = test.gnutls.org' >> server.tmpl
certtool --generate-certificate --load-privkey x509-server-key.pem \
  --load-ca-certificate x509-ca.pem --load-ca-privkey x509-ca-key.pem \
  --template server.tmpl --outfile x509-server.pem
...
```

For use in the client, you may want to generate a client certificate as well.

```
certtool --generate-privkey > x509-client-key.pem
echo 'cn = GnuTLS test client' > client.tmpl
echo 'tls_www_client' >> client.tmpl
echo 'encryption_key' >> client.tmpl
```

```
echo 'signing_key' >> client.tmpl
certtool --generate-certificate --load-privkey x509-client-key.pem \
  --load-ca-certificate x509-ca.pem --load-ca-privkey x509-ca-key.pem \
  --template client.tmpl --outfile x509-client.pem
...
```

To be able to import the client key/certificate into some applications, you will need to convert them into a PKCS#12 structure. This also encrypts the security sensitive key with a password.

```
certtool --to-p12 --load-privkey x509-client-key.pem --load-certificate x509-client.pe
```

For icing, we'll create a proxy certificate for the client too.

```
certtool --generate-privkey > x509-proxy-key.pem
echo 'cn = GnuTLS test client proxy' > proxy.tmpl
certtool --generate-proxy --load-privkey x509-proxy-key.pem \
  --load-ca-certificate x509-client.pem --load-ca-privkey x509-client-key.pem \
  --load-certificate x509-client.pem --template proxy.tmpl \
  --outfile x509-proxy.pem
...
```

Then start the server again:

```
gnutls-serv --http \
            --x509cafile x509-ca.pem \
            --x509keyfile x509-server-key.pem \
            --x509certfile x509-server.pem
```

Try connecting to the server using your web browser. Note that the server listens to port 5556 by default.

While you are at it, to allow connections using DSA, you can also create a DSA key and certificate for the server. These credentials will be used in the final example below.

```
certtool --generate-privkey --dsa > x509-server-key-dsa.pem
certtool --generate-certificate --load-privkey x509-server-key-dsa.pem \
  --load-ca-certificate x509-ca.pem --load-ca-privkey x509-ca-key.pem \
  --template server.tmpl --outfile x509-server-dsa.pem
...
```

The next step is to create OpenPGP credentials for the server.

```
gpg --gen-key
...enter whatever details you want, use 'test.gnutls.org' as name...
```

Make a note of the OpenPGP key identifier of the newly generated key, here it was `5D1D14D8`. You will need to export the key for GnuTLS to be able to use it.

```
gpg -a --export 5D1D14D8 > openpgp-server.txt
gpg --export 5D1D14D8 > openpgp-server.bin
gpg --export-secret-keys 5D1D14D8 > openpgp-server-key.bin
gpg -a --export-secret-keys 5D1D14D8 > openpgp-server-key.txt
```

Let's start the server with support for OpenPGP credentials:

```
gnutls-serv --http \
            --pgpkeyfile openpgp-server-key.txt \
```

```
            --pgpcertfile openpgp-server.txt
```

The next step is to add support for SRP authentication.

```
srptool --create-conf srp-tpasswd.conf
srptool --passwd-conf srp-tpasswd.conf --username jas --passwd srp-passwd.txt
Enter password: [TYPE "foo"]
```

Start the server with SRP support:

```
gnutls-serv --http \
            --srppasswdconf srp-tpasswd.conf \
            --srppasswd srp-passwd.txt
```

Let's also add support for PSK.

```
$ psktool --passwd psk-passwd.txt
```

Start the server with PSK support:

```
gnutls-serv --http \
            --pskpasswd psk-passwd.txt
```

Finally, we start the server with all the earlier parameters and you get this command:

```
gnutls-serv --http \
            --x509cafile x509-ca.pem \
            --x509keyfile x509-server-key.pem \
            --x509certfile x509-server.pem \
            --x509dsakeyfile x509-server-key-dsa.pem \
            --x509dsacertfile x509-server-dsa.pem \
            --pgpkeyfile openpgp-server-key.txt \
            --pgpcertfile openpgp-server.txt \
            --srppasswdconf srp-tpasswd.conf \
            --srppasswd srp-passwd.txt \
            --pskpasswd psk-passwd.txt
```

8.4.2 Example server PSK connection

To set up a PSK server with `gnutls-serv` you need to create PSK password file (see Section 8.5 [Invoking psktool], page 115). In the example below, I type `password` at the prompt.

```
$ ./psktool -u psk_identity -p psks.txt -n psk_identity_hint
Enter password:
Key stored to psks.txt
$ cat psks.txt
psk_identity:88f3824b3e5659f52d00e959bacab954b6540344
$
```

After this, start the server pointing to the password file. We disable DHE-PSK.

```
$ ./gnutls-serv --pskpasswd psks.txt  --pskhint psk_identity_hint --priority NORMAL:-DHE-PSK
Set static Diffie Hellman parameters, consider --dhparams.
Echo Server ready. Listening to port '5556'.
```

You can now connect to the server using a PSK client (see Section 8.2.1 [Example client PSK connection], page 109).

8.5 Invoking psktool

This is a program to manage PSK username and keys.

```
PSKtool help
Usage : psktool [options]
     -u, --username username
                              specify username.
     -p, --passwd FILE        specify a password file.
     -n, --netconf-hint HINT
                              derive key from Netconf password, using
                              HINT as the psk_identity_hint.
     -s, --keysize SIZE       specify the key size in bytes.
     -v, --version            prints the program's version number
     -h, --help               shows this help text
```

Normally the file will generate random keys for the indicate username. You may also derive PSK keys from passwords, using the algorithm specified in '`draft-ietf-netconf-tls-02.txt`'. The algorithm needs a PSK identity hint, which you specify using `--netconf-hint`. To derive a PSK key from a password with an empty PSK identity hint, using `--netconf-hint ""`.

8.6 Invoking srptool

The '`srptool`' is a very simple program that emulates the programs in the *Stanford SRP libraries*. It is intended for use in places where you don't expect SRP authentication to be the used for system users. Traditionally *libsrp* used two files. One called 'tpasswd' which holds usernames and verifiers, and 'tpasswd.conf' which holds generators and primes.

How to use srptool:

- To create tpasswd.conf which holds the g and n values for SRP protocol (generator and a large prime), run:

  ```
  $ srptool --create-conf /etc/tpasswd.conf
  ```

- This command will create /etc/tpasswd and will add user 'test' (you will also be prompted for a password). Verifiers are stored by default in the way libsrp expects.

  ```
  $ srptool --passwd /etc/tpasswd \
      --passwd-conf /etc/tpasswd.conf -u test
  ```

- This command will check against a password. If the password matches the one in /etc/tpasswd you will get an ok.

  ```
  $ srptool --passwd /etc/tpasswd \
      --passwd-conf /etc/tpasswd.conf --verify -u test
  ```

9 Function Reference

9.1 Core Functions

The prototypes for the following functions lie in 'gnutls/gnutls.h'.

gnutls_alert_get_name

`const char * gnutls_alert_get_name (gnutls_alert_description_t alert)` [Function]

alert: is an alert number gnutls_session_t structure.

This function will return a string that describes the given alert number, or NULL. See gnutls_alert_get().

Returns: string corresponding to gnutls_alert_description_t value.

gnutls_alert_get

`gnutls_alert_description_t gnutls_alert_get (gnutls_session_t session)` [Function]

session: is a gnutls_session_t structure.

This function will return the last alert number received. This function should be called if GNUTLS_E_WARNING_ALERT_RECEIVED or GNUTLS_E_FATAL_ALERT_RECEIVED has been returned by a gnutls function. The peer may send alerts if he thinks some things were not right. Check gnutls.h for the available alert descriptions.

If no alert has been received the returned value is undefined.

Returns: returns the last alert received, a gnutls_alert_description_t value.

gnutls_alert_send_appropriate

`int gnutls_alert_send_appropriate (gnutls_session_t session, int err)` [Function]

session: is a gnutls_session_t structure.

err: is an integer

Sends an alert to the peer depending on the error code returned by a gnutls function. This function will call gnutls_error_to_alert() to determine the appropriate alert to send.

This function may also return GNUTLS_E_AGAIN, or GNUTLS_E_INTERRUPTED.

If the return value is GNUTLS_E_INVALID_REQUEST, then no alert has been sent to the peer.

Returns: On success, GNUTLS_E_SUCCESS (0) is returned, otherwise an error code is returned.

gnutls_alert_send

`int gnutls_alert_send (`*gnutls_session_t* `session`, *gnutls_alert_level_t* `level`, *gnutls_alert_description_t* `desc`)` [Function]

session: is a `gnutls_session_t` structure.

level: is the level of the alert

desc: is the alert description

This function will send an alert to the peer in order to inform him of something important (eg. his Certificate could not be verified). If the alert level is Fatal then the peer is expected to close the connection, otherwise he may ignore the alert and continue.

The error code of the underlying record send function will be returned, so you may also receive `GNUTLS_E_INTERRUPTED` or `GNUTLS_E_AGAIN` as well.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_anon_allocate_client_credentials

`int gnutls_anon_allocate_client_credentials (`*gnutls_anon_client_credentials_t* * `sc`)` [Function]

sc: is a pointer to an `gnutls_anon_client_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_anon_allocate_server_credentials

`int gnutls_anon_allocate_server_credentials (`*gnutls_anon_server_credentials_t* * `sc`)` [Function]

sc: is a pointer to an `gnutls_anon_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_anon_free_client_credentials

`void gnutls_anon_free_client_credentials (`*gnutls_anon_client_credentials_t* `sc`)` [Function]

sc: is an `gnutls_anon_client_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_anon_free_server_credentials

`void gnutls_anon_free_server_credentials (`*gnutls_anon_server_credentials_t* `sc`)` [Function]

sc: is an `gnutls_anon_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_anon_set_params_function

`void gnutls_anon_set_params_function` [Function]
(*gnutls_anon_server_credentials_t* **`res`**, *gnutls_params_function* * **`func`**)

res: is a gnutls_anon_server_credentials_t structure

func: is the function to be called

This function will set a callback in order for the server to get the diffie hellman or RSA parameters for anonymous authentication. The callback should return zero on success.

gnutls_anon_set_server_dh_params

`void gnutls_anon_set_server_dh_params` [Function]
(*gnutls_anon_server_credentials_t* **`res`**, *gnutls_dh_params_t* **`dh_params`**)

res: is a gnutls_anon_server_credentials_t structure

dh_params: is a structure that holds diffie hellman parameters.

This function will set the diffie hellman parameters for an anonymous server to use. These parameters will be used in Anonymous Diffie Hellman cipher suites.

gnutls_anon_set_server_params_function

`void gnutls_anon_set_server_params_function` [Function]
(*gnutls_anon_server_credentials_t* **`res`**, *gnutls_params_function* * **`func`**)

res: is a gnutls_certificate_credentials_t structure

func: is the function to be called

This function will set a callback in order for the server to get the diffie hellman parameters for anonymous authentication. The callback should return zero on success.

gnutls_auth_client_get_type

`gnutls_credentials_type_t gnutls_auth_client_get_type` [Function]
(*gnutls_session_t* **`session`**)

session: is a `gnutls_session_t` structure.

Returns the type of credentials that were used for client authentication. The returned information is to be used to distinguish the function used to access authentication data.

Returns: The type of credentials for the client authentication schema, an `gnutls_credentials_type_t` type.

gnutls_auth_get_type

`gnutls_credentials_type_t gnutls_auth_get_type` [Function]
(*gnutls_session_t* **`session`**)

session: is a `gnutls_session_t` structure.

Returns type of credentials for the current authentication schema. The returned information is to be used to distinguish the function used to access authentication data.

Eg. for CERTIFICATE ciphersuites (key exchange algorithms: KX_RSA, KX_DHE_RSA), the same function are to be used to access the authentication data.

Returns: The type of credentials for the current authentication schema, an `gnutls_credentials_type_t` type.

gnutls_auth_server_get_type

`gnutls_credentials_type_t gnutls_auth_server_get_type` [Function]
(*gnutls_session_t* ***session***)

session: is a `gnutls_session_t` structure.

Returns the type of credentials that were used for server authentication. The returned information is to be used to distinguish the function used to access authentication data.

Returns: The type of credentials for the server authentication schema, an `gnutls_credentials_type_t` type.

gnutls_bye

`int gnutls_bye` (*gnutls_session_t* ***session***, *gnutls_close_request_t* ***how***) [Function]

session: is a `gnutls_session_t` structure.

how: is an integer

Terminates the current TLS/SSL connection. The connection should have been initiated using `gnutls_handshake()`. `how` should be one of `GNUTLS_SHUT_RDWR`, `GNUTLS_SHUT_WR`.

In case of `GNUTLS_SHUT_RDWR` then the TLS connection gets terminated and further receives and sends will be disallowed. If the return value is zero you may continue using the connection. `GNUTLS_SHUT_RDWR` actually sends an alert containing a close request and waits for the peer to reply with the same message.

In case of `GNUTLS_SHUT_WR` then the TLS connection gets terminated and further sends will be disallowed. In order to reuse the connection you should wait for an EOF from the peer. `GNUTLS_SHUT_WR` sends an alert containing a close request.

Note that not all implementations will properly terminate a TLS connection. Some of them, usually for performance reasons, will terminate only the underlying transport layer, thus causing a transmission error to the peer. This error cannot be distinguished from a malicious party prematurely terminating the session, thus this behavior is not recommended.

This function may also return `GNUTLS_E_AGAIN` or `GNUTLS_E_INTERRUPTED`; cf. `gnutls_record_get_direction()`.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code, see function documentation for entire semantics.

gnutls_certificate_activation_time_peers

`time_t gnutls_certificate_activation_time_peers` [Function]
(*gnutls_session_t* ***session***)

session: is a gnutls session

This function will return the peer's certificate activation time. This is the creation time for openpgp keys.

Returns: (time_t)-1 on error.

gnutls_certificate_allocate_credentials

`int gnutls_certificate_allocate_credentials` [Function]
(*gnutls_certificate_credentials_t* * ***res***)

res: is a pointer to an `gnutls_certificate_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_certificate_client_get_request_status

`int gnutls_certificate_client_get_request_status` [Function]
(*gnutls_session_t* ***session***)

session: is a gnutls session

Get whether client certificate is requested or not.

Returns: 0 if the peer (server) did not request client authentication or 1 otherwise, or a negative value in case of error.

gnutls_certificate_client_set_retrieve_function

`void gnutls_certificate_client_set_retrieve_function` [Function]
(*gnutls_certificate_credentials_t* ***cred***, *gnutls_certificate_client_retrieve_function* * ***func***)

cred: is a `gnutls_certificate_credentials_t` structure.

func: is the callback function

This function sets a callback to be called in order to retrieve the certificate to be used in the handshake. The callback's function prototype is: int (*callback)(gnutls_session_t, const gnutls_datum_t* req_ca_dn, int nreqs, const gnutls_pk_algorithm_t* pk_algos, int pk_algos_length, gnutls_retr_st* st);

`req_ca_cert` is only used in X.509 certificates. Contains a list with the CA names that the server considers trusted. Normally we should send a certificate that is signed by one of these CAs. These names are DER encoded. To get a more meaningful value use the function `gnutls_x509_rdn_get()`.

`pk_algos` contains a list with server's acceptable signature algorithms. The certificate returned should support the server's given algorithms.

`st` should contain the certificates and private keys.

If the callback function is provided then gnutls will call it, in the handshake, after the certificate request message has been received.

The callback function should set the certificate list to be sent, and return 0 on success. If no certificate was selected then the number of certificates should be set to zero. The value (-1) indicates error and the handshake will be terminated.

gnutls_certificate_expiration_time_peers

`time_t gnutls_certificate_expiration_time_peers` [Function]
(*gnutls_session_t* `session`)

session: is a gnutls session

This function will return the peer's certificate expiration time.

Returns: (time_t)-1 on error.

gnutls_certificate_free_ca_names

`void gnutls_certificate_free_ca_names` [Function]
(*gnutls_certificate_credentials_t* `sc`)

sc: is an `gnutls_certificate_credentials_t` structure.

This function will delete all the CA name in the given credentials. Clients may call this to save some memory since in client side the CA names are not used.

CA names are used by servers to advertize the CAs they support to clients.

gnutls_certificate_free_cas

`void gnutls_certificate_free_cas (`*gnutls_certificate_credentials_t* [Function]
`sc`)

sc: is an `gnutls_certificate_credentials_t` structure.

This function will delete all the CAs associated with the given credentials. Servers that do not use `gnutls_certificate_verify_peers2()` may call this to save some memory.

gnutls_certificate_free_credentials

`void gnutls_certificate_free_credentials` [Function]
(*gnutls_certificate_credentials_t* `sc`)

sc: is an `gnutls_certificate_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

This function does not free any temporary parameters associated with this structure (ie RSA and DH parameters are not freed by this function).

gnutls_certificate_free_crls

`void gnutls_certificate_free_crls (`*gnutls_certificate_credentials_t* [Function]
`sc`)

sc: is an `gnutls_certificate_credentials_t` structure.

This function will delete all the CRLs associated with the given credentials.

gnutls_certificate_free_keys

`void gnutls_certificate_free_keys (`*gnutls_certificate_credentials_t* `sc``)` [Function]

sc: is an `gnutls_certificate_credentials_t` structure.

This function will delete all the keys and the certificates associated with the given credentials. This function must not be called when a TLS negotiation that uses the credentials is in progress.

gnutls_certificate_get_openpgp_keyring

`void gnutls_certificate_get_openpgp_keyring` [Function]
`(`*gnutls_certificate_credentials_t* `sc`, *gnutls_openpgp_keyring_t* * `keyring`)

sc: is an `gnutls_certificate_credentials_t` structure.

This function will export the OpenPGP keyring associated with the given credentials.

Since: 2.4.0

gnutls_certificate_get_ours

`const gnutls_datum_t * gnutls_certificate_get_ours` [Function]
`(`*gnutls_session_t* `session`)

session: is a gnutls session

Get the certificate as sent to the peer, in the last handshake. These certificates are in raw format. In X.509 this is a certificate list. In OpenPGP this is a single certificate.

Returns: return a pointer to a `gnutls_datum_t` containing our certificates, or `NULL` in case of an error or if no certificate was used.

gnutls_certificate_get_peers

`const gnutls_datum_t * gnutls_certificate_get_peers` [Function]
`(`*gnutls_session_t* `session`, *unsigned int* * `list_size`)

session: is a gnutls session

list_size: is the length of the certificate list

Get the peer's raw certificate (chain) as sent by the peer. These certificates are in raw format (DER encoded for X.509). In case of a X.509 then a certificate list may be present. The first certificate in the list is the peer's certificate, following the issuer's certificate, then the issuer's issuer etc.

In case of OpenPGP keys a single key will be returned in raw format.

Returns: return a pointer to a `gnutls_datum_t` containing our certificates, or `NULL` in case of an error or if no certificate was used.

gnutls_certificate_get_x509_cas

`void gnutls_certificate_get_x509_cas` [Function]
`(`*gnutls_certificate_credentials_t* `sc`, *gnutls_x509_crt_t* ** `x509_ca_list`, *unsigned int* * `ncas`)

sc: is an `gnutls_certificate_credentials_t` structure.

x509_ca_list: will point to the CA list. Should be treated as constant

ncas: the number of CAs

This function will export all the CAs associated with the given credentials.

Since: 2.4.0

gnutls_certificate_get_x509_crls

`void gnutls_certificate_get_x509_crls` [Function]
(*gnutls_certificate_credentials_t* `sc`, *gnutls_x509_crl_t ** `x509_crl_list`, *unsigned int ** `ncrls`)

sc: is an `gnutls_certificate_credentials_t` structure.

x509_crl_list: the exported CRL list. Should be treated as constant

ncrls: the number of exported CRLs

This function will export all the CRLs associated with the given credentials.

Since: 2.4.0

gnutls_certificate_send_x509_rdn_sequence

`void gnutls_certificate_send_x509_rdn_sequence` [Function]
(*gnutls_session_t* `session`, *int* `status`)

session: is a pointer to a `gnutls_session_t` structure.

status: is 0 or 1

If status is non zero, this function will order gnutls not to send the rdnSequence in the certificate request message. That is the server will not advertize it's trusted CAs to the peer. If status is zero then the default behaviour will take effect, which is to advertize the server's trusted CAs.

This function has no effect in clients, and in authentication methods other than certificate with X.509 certificates.

gnutls_certificate_server_set_request

`void gnutls_certificate_server_set_request (`*gnutls_session_t* [Function]
`session`, *gnutls_certificate_request_t* `req`)

session: is an `gnutls_session_t` structure.

req: is one of GNUTLS_CERT_REQUEST, GNUTLS_CERT_REQUIRE

This function specifies if we (in case of a server) are going to send a certificate request message to the client. If `req` is GNUTLS_CERT_REQUIRE then the server will return an error if the peer does not provide a certificate. If you do not call this function then the client will not be asked to send a certificate.

gnutls_certificate_server_set_retrieve_function

`void gnutls_certificate_server_set_retrieve_function` [Function]
(*gnutls_certificate_credentials_t* `cred`,
*gnutls_certificate_server_retrieve_function ** `func`)

cred: is a `gnutls_certificate_credentials_t` structure.

func: is the callback function

This function sets a callback to be called in order to retrieve the certificate to be used in the handshake. The callback's function prototype is: int (*callback)(gnutls_session_t, gnutls_retr_st* st);

`st` should contain the certificates and private keys.

If the callback function is provided then gnutls will call it, in the handshake, after the certificate request message has been received.

The callback function should set the certificate list to be sent, and return 0 on success. The value (-1) indicates error and the handshake will be terminated.

gnutls_certificate_set_dh_params

`void gnutls_certificate_set_dh_params` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *gnutls_dh_params_t* **`dh_params`**)

res: is a gnutls_certificate_credentials_t structure

dh_params: is a structure that holds diffie hellman parameters.

This function will set the diffie hellman parameters for a certificate server to use. These parameters will be used in Ephemeral Diffie Hellman cipher suites. Note that only a pointer to the parameters are stored in the certificate handle, so if you deallocate the parameters before the certificate is deallocated, you must change the parameters stored in the certificate first.

gnutls_certificate_set_params_function

`void gnutls_certificate_set_params_function` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *gnutls_params_function* * **`func`**)

res: is a gnutls_certificate_credentials_t structure

func: is the function to be called

This function will set a callback in order for the server to get the diffie hellman or RSA parameters for certificate authentication. The callback should return zero on success.

gnutls_certificate_set_rsa_export_params

`void gnutls_certificate_set_rsa_export_params` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *gnutls_rsa_params_t* **`rsa_params`**)

res: is a gnutls_certificate_credentials_t structure

rsa_params: is a structure that holds temporary RSA parameters.

This function will set the temporary RSA parameters for a certificate server to use. These parameters will be used in RSA-EXPORT cipher suites.

gnutls_certificate_set_verify_flags

`void gnutls_certificate_set_verify_flags` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *unsigned int* **`flags`**)

res: is a gnutls_certificate_credentials_t structure

flags: are the flags

This function will set the flags to be used at verification of the certificates. Flags must be OR of the `gnutls_certificate_verify_flags` enumerations.

gnutls_certificate_set_verify_limits

`void gnutls_certificate_set_verify_limits` [Function]
(*gnutls_certificate_credentials_t* `res`, *unsigned int* `max_bits`, *unsigned int* `max_depth`)

res: is a gnutls_certificate_credentials structure

max_bits: is the number of bits of an acceptable certificate (default 8200)

max_depth: is maximum depth of the verification of a certificate chain (default 5)

This function will set some upper limits for the default verification function, `gnutls_certificate_verify_peers2()`, to avoid denial of service attacks. You can set them to zero to disable limits.

gnutls_certificate_set_x509_crl_file

`int gnutls_certificate_set_x509_crl_file` [Function]
(*gnutls_certificate_credentials_t* `res`, *const char ** `crlfile`, *gnutls_x509_crt_fmt_t* `type`)

res: is an `gnutls_certificate_credentials_t` structure.

crlfile: is a file containing the list of verified CRLs (DER or PEM list)

type: is PEM or DER

This function adds the trusted CRLs in order to verify client or server certificates. In case of a client this is not required to be called if the certificates are not verified using `gnutls_certificate_verify_peers2()`. This function may be called multiple times.

Returns: number of CRLs processed or a negative value on error.

gnutls_certificate_set_x509_crl_mem

`int gnutls_certificate_set_x509_crl_mem` [Function]
(*gnutls_certificate_credentials_t* `res`, *const gnutls_datum_t ** `CRL`, *gnutls_x509_crt_fmt_t* `type`)

res: is an `gnutls_certificate_credentials_t` structure.

CRL: is a list of trusted CRLs. They should have been verified before.

type: is DER or PEM

This function adds the trusted CRLs in order to verify client or server certificates. In case of a client this is not required to be called if the certificates are not verified using `gnutls_certificate_verify_peers2()`. This function may be called multiple times.

Returns: number of CRLs processed, or a negative value on error.

gnutls_certificate_set_x509_crl

`int gnutls_certificate_set_x509_crl` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *gnutls_x509_crl_t ** **`crl_list`**, *int* **`crl_list_size`**)

res: is an `gnutls_certificate_credentials_t` structure.

crl_list: is a list of trusted CRLs. They should have been verified before.

crl_list_size: holds the size of the crl_list

This function adds the trusted CRLs in order to verify client or server certificates. In case of a client this is not required to be called if the certificates are not verified using `gnutls_certificate_verify_peers2()`. This function may be called multiple times.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

Since: 2.4.0

gnutls_certificate_set_x509_key_file

`int gnutls_certificate_set_x509_key_file` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *const char ** **`CERTFILE`**, *const char ** **`KEYFILE`**, *gnutls_x509_crt_fmt_t* **`type`**)

res: is an `gnutls_certificate_credentials_t` structure.

CERTFILE: is a file that containing the certificate list (path) for the specified private key, in PKCS7 format, or a list of certificates

KEYFILE: is a file that contains the private key

type: is PEM or DER

This function sets a certificate/private key pair in the gnutls_certificate_credentials_t structure. This function may be called more than once (in case multiple keys/certificates exist for the server).

Currently only PKCS-1 encoded RSA and DSA private keys are accepted by this function.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_certificate_set_x509_key_mem

`int gnutls_certificate_set_x509_key_mem` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *const gnutls_datum_t ** **`cert`**, *const gnutls_datum_t ** **`key`**, *gnutls_x509_crt_fmt_t* **`type`**)

res: is an `gnutls_certificate_credentials_t` structure.

cert: contains a certificate list (path) for the specified private key

key: is the private key, or `NULL`

type: is PEM or DER

This function sets a certificate/private key pair in the gnutls_certificate_credentials_t structure. This function may be called more than once (in case multiple keys/certificates exist for the server).

Currently are supported: RSA PKCS-1 encoded private keys, DSA private keys.

DSA private keys are encoded the OpenSSL way, which is an ASN.1 DER sequence of 6 INTEGERs - version, p, q, g, pub, priv.

Note that the keyUsage (2.5.29.15) PKIX extension in X.509 certificates is supported. This means that certificates intended for signing cannot be used for ciphersuites that require encryption.

If the certificate and the private key are given in PEM encoding then the strings that hold their values must be null terminated.

The `key` may be `NULL` if you are using a sign callback, see `gnutls_sign_callback_set()`.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_certificate_set_x509_key

`int gnutls_certificate_set_x509_key` [Function]
(*gnutls_certificate_credentials_t* `res`, *gnutls_x509_crt_t* * `cert_list`, *int* `cert_list_size`, *gnutls_x509_privkey_t* `key`)

res: is an `gnutls_certificate_credentials_t` structure.

cert_list: contains a certificate list (path) for the specified private key

cert_list_size: holds the size of the certificate list

key: is a gnutls_x509_privkey_t key

This function sets a certificate/private key pair in the gnutls_certificate_credentials_t structure. This function may be called more than once (in case multiple keys/certificates exist for the server).

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

Since: 2.4.0

gnutls_certificate_set_x509_simple_pkcs12_file

`int gnutls_certificate_set_x509_simple_pkcs12_file` [Function]
(*gnutls_certificate_credentials_t* `res`, *const char* * `pkcs12file`, *gnutls_x509_crt_fmt_t* `type`, *const char* * `password`)

res: is an `gnutls_certificate_credentials_t` structure.

pkcs12file: filename of file containing PKCS12 blob.

type: is PEM or DER of the `pkcs12file`.

password: optional password used to decrypt PKCS12 file, bags and keys.

This function sets a certificate/private key pair and/or a CRL in the gnutls_certificate_credentials_t structure. This function may be called more than once (in case multiple keys/certificates exist for the server).

MAC: ed PKCS12 files are supported. Encrypted PKCS12 bags are supported. Encrypted PKCS8 private keys are supported. However, only password based security, and the same password for all operations, are supported.

The private keys may be RSA PKCS1 or DSA private keys encoded in the OpenSSL way.

PKCS12 file may contain many keys and/or certificates, and there is no way to identify which key/certificate pair you want. You should make sure the PKCS12 file only contain one key/certificate pair and/or one CRL.

It is believed that the limitations of this function is acceptable for most usage, and that any more flexibility would introduce complexity that would make it harder to use this functionality at all.

Returns: GNUTLS_E_SUCCESS on success, or an error code.

gnutls_certificate_set_x509_trust_file

`int gnutls_certificate_set_x509_trust_file` [Function]
(*gnutls_certificate_credentials_t* **res**, *const char ** **cafile**, *gnutls_x509_crt_fmt_t* **type**)

res: is an gnutls_certificate_credentials_t structure.

cafile: is a file containing the list of trusted CAs (DER or PEM list)

type: is PEM or DER

This function adds the trusted CAs in order to verify client or server certificates. In case of a client this is not required to be called if the certificates are not verified using gnutls_certificate_verify_peers2(). This function may be called multiple times.

In case of a server the names of the CAs set here will be sent to the client if a certificate request is sent. This can be disabled using gnutls_certificate_send_x509_rdn_sequence().

Returns: number of certificates processed, or a negative value on error.

gnutls_certificate_set_x509_trust_mem

`int gnutls_certificate_set_x509_trust_mem` [Function]
(*gnutls_certificate_credentials_t* **res**, *const gnutls_datum_t ** **ca**, *gnutls_x509_crt_fmt_t* **type**)

res: is an gnutls_certificate_credentials_t structure.

ca: is a list of trusted CAs or a DER certificate

type: is DER or PEM

This function adds the trusted CAs in order to verify client or server certificates. In case of a client this is not required to be called if the certificates are not verified using gnutls_certificate_verify_peers2(). This function may be called multiple times.

In case of a server the CAs set here will be sent to the client if a certificate request is sent. This can be disabled using gnutls_certificate_send_x509_rdn_sequence().

Returns: the number of certificates processed or a negative value on error.

gnutls_certificate_set_x509_trust

`int gnutls_certificate_set_x509_trust` [Function]
(*gnutls_certificate_credentials_t* **res**, *gnutls_x509_crt_t ** **ca_list**, *int* **ca_list_size**)

res: is an gnutls_certificate_credentials_t structure.

ca_list: is a list of trusted CAs

ca_list_size: holds the size of the CA list

This function adds the trusted CAs in order to verify client or server certificates. In case of a client this is not required to be called if the certificates are not verified using `gnutls_certificate_verify_peers2()`. This function may be called multiple times.

In case of a server the CAs set here will be sent to the client if a certificate request is sent. This can be disabled using `gnutls_certificate_send_x509_rdn_sequence()`.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

Since: 2.4.0

gnutls_certificate_type_get_id

`gnutls_certificate_type_t gnutls_certificate_type_get_id` [Function]
(*const char * **name***)

name: is a certificate type name

The names are compared in a case insensitive way.

Returns: an `gnutls_certificate_type_t` for the specified in a string certificate type, or `GNUTLS_CRT_UNKNOWN` on error.

gnutls_certificate_type_get_name

`const char * gnutls_certificate_type_get_name` [Function]
(*gnutls_certificate_type_t **type***)

type: is a certificate type

Convert a `gnutls_certificate_type_t` type to a string.

Returns: a string that contains the name of the specified certificate type, or `NULL` in case of unknown types.

gnutls_certificate_type_get

`gnutls_certificate_type_t gnutls_certificate_type_get` [Function]
(*gnutls_session_t **session***)

session: is a `gnutls_session_t` structure.

The certificate type is by default X.509, unless it is negotiated as a TLS extension.

Returns: the currently used `gnutls_certificate_type_t` certificate type.

gnutls_certificate_type_list

`const gnutls_certificate_type_t *` [Function]
`gnutls_certificate_type_list (` *void*`)`

Get a list of certificate types. Note that to be able to use OpenPGP certificates, you must link to libgnutls-extra and call `gnutls_global_init_extra()`.

Returns: a zero-terminated list of `gnutls_certificate_type_t` integers indicating the available certificate types.

gnutls_certificate_type_set_priority

`int gnutls_certificate_type_set_priority (`*gnutls_session_t* **`session`**, *const int * * list*`)` [Function]

session: is a `gnutls_session_t` structure.

list: is a 0 terminated list of gnutls_certificate_type_t elements.

Sets the priority on the certificate types supported by gnutls. Priority is higher for elements specified before others. After specifying the types you want, you must append a 0. Note that the certificate type priority is set on the client. The server does not use the cert type priority except for disabling types that were not specified.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_certificate_verify_peers2

`int gnutls_certificate_verify_peers2 (`*gnutls_session_t* **`session`**, *unsigned int * * status*`)` [Function]

session: is a gnutls session

status: is the output of the verification

This function will try to verify the peer's certificate and return its status (trusted, invalid etc.). The value of `status` should be one or more of the gnutls_certificate_status_t enumerated elements bitwise or'd. To avoid denial of service attacks some default upper limits regarding the certificate key size and chain size are set. To override them use `gnutls_certificate_set_verify_limits()`.

Note that you must also check the peer's name in order to check if the verified certificate belongs to the actual peer.

This is the same as `gnutls_x509_crt_list_verify()` and uses the loaded CAs in the credentials as trusted CAs.

Note that some commonly used X.509 Certificate Authorities are still using Version 1 certificates. If you want to accept them, you need to call `gnutls_certificate_set_verify_flags()` with, e.g., `GNUTLS_VERIFY_ALLOW_X509_V1_CA_CRT` parameter.

Returns: a negative error code on error and zero on success.

gnutls_certificate_verify_peers

`int gnutls_certificate_verify_peers (`*gnutls_session_t* **`session`**`)` [Function]

session: is a gnutls session

This function will try to verify the peer's certificate and return its status (trusted, invalid etc.). However you must also check the peer's name in order to check if the verified certificate belongs to the actual peer.

The return value should be one or more of the gnutls_certificate_status_t enumerated elements bitwise or'd, or a negative value on error.

This is the same as `gnutls_x509_crt_list_verify()`.

Deprecated: Use `gnutls_certificate_verify_peers2()` instead.

gnutls_check_version

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

req_version: the version to check

Check that the version of the library is at minimum the requested one and return the version string; return NULL if the condition is not satisfied. If a NULL is passed to this function, no check is done, but the version string is simply returned.

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

Return value: Version string of run-time library, or NULL if the run-time library does not meet the required version number. If `NULL` is passed to this function no check is done and only the version string is returned.

gnutls_cipher_get_id

`gnutls_cipher_algorithm_t gnutls_cipher_get_id (const char * name)` [Function]

name: is a MAC algorithm name

The names are compared in a case insensitive way.

Returns: return a `gnutls_cipher_algorithm_t` value corresponding to the specified cipher, or `GNUTLS_CIPHER_UNKNOWN` on error.

gnutls_cipher_get_key_size

`size_t gnutls_cipher_get_key_size (gnutls_cipher_algorithm_t algorithm)` [Function]

algorithm: is an encryption algorithm

Get key size for cipher.

Returns: length (in bytes) of the given cipher's key size, or 0 if the given cipher is invalid.

gnutls_cipher_get_name

`const char * gnutls_cipher_get_name (gnutls_cipher_algorithm_t algorithm)` [Function]

algorithm: is an encryption algorithm

Convert a `gnutls_cipher_algorithm_t` type to a string.

Returns: a pointer to a string that contains the name of the specified cipher, or `NULL`.

gnutls_cipher_get

`gnutls_cipher_algorithm_t gnutls_cipher_get (gnutls_session_t session)` [Function]

session: is a `gnutls_session_t` structure.

Get currently used cipher.

Returns: the currently used cipher, an `gnutls_cipher_algorithm_t` type.

gnutls_cipher_list

`const gnutls_cipher_algorithm_t * gnutls_cipher_list (` [Function]
`void``)`

Get a list of supported cipher algorithms. Note that not necessarily all ciphers are supported as TLS cipher suites. For example, DES is not supported as a cipher suite, but is supported for other purposes (e.g., PKCS8 or similar).

Returns: a zero-terminated list of `gnutls_cipher_algorithm_t` integers indicating the available ciphers.

gnutls_cipher_set_priority

`int gnutls_cipher_set_priority (`*gnutls_session_t* ***`session`***`,` *const int ** ***`list`***`)` [Function]

session: is a `gnutls_session_t` structure.

list: is a 0 terminated list of gnutls_cipher_algorithm_t elements.

Sets the priority on the ciphers supported by gnutls. Priority is higher for elements specified before others. After specifying the ciphers you want, you must append a 0. Note that the priority is set on the client. The server does not use the algorithm's priority except for disabling algorithms that were not specified.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_cipher_suite_get_name

`const char * gnutls_cipher_suite_get_name` [Function]
`(`*gnutls_kx_algorithm_t* ***`kx_algorithm`***`,` *gnutls_cipher_algorithm_t* ***`cipher_algorithm`***`,` *gnutls_mac_algorithm_t* ***`mac_algorithm`***`)`

kx_algorithm: is a Key exchange algorithm

cipher_algorithm: is a cipher algorithm

mac_algorithm: is a MAC algorithm

Note that the full cipher suite name must be prepended by TLS or SSL depending of the protocol in use.

Returns: a string that contains the name of a TLS cipher suite, specified by the given algorithms, or `NULL`.

gnutls_cipher_suite_info

`const char * gnutls_cipher_suite_info (`*size_t* ***`idx`***`,` *char ** [Function]
`cs_id``,` *gnutls_kx_algorithm_t ** ***`kx`***`,` *gnutls_cipher_algorithm_t ** ***`cipher`***`,` *gnutls_mac_algorithm_t ** ***`mac`***`,` *gnutls_protocol_t ** ***`version`***`)`

idx: index of cipher suite to get information about, starts on 0.

cs_id: output buffer with room for 2 bytes, indicating cipher suite value

kx: output variable indicating key exchange algorithm, or `NULL`.

cipher: output variable indicating cipher, or `NULL`.

mac: output variable indicating MAC algorithm, or `NULL`.

version: output variable indicating TLS protocol version, or `NULL`.

Get information about supported cipher suites. Use the function iteratively to get information about all supported cipher suites. Call with idx=0 to get information about first cipher suite, then idx=1 and so on until the function returns NULL.

Returns: the name of `idx` cipher suite, and set the information about the cipher suite in the output variables. If `idx` is out of bounds, `NULL` is returned.

gnutls_compression_get_id

`gnutls_compression_method_t gnutls_compression_get_id` [Function]
(*const char * **name***)

name: is a compression method name

The names are compared in a case insensitive way.

Returns: an id of the specified in a string compression method, or `GNUTLS_COMP_UNKNOWN` on error.

gnutls_compression_get_name

`const char * gnutls_compression_get_name` [Function]
(*gnutls_compression_method_t **algorithm***)

algorithm: is a Compression algorithm

Convert a `gnutls_compression_method_t` value to a string.

Returns: a pointer to a string that contains the name of the specified compression algorithm, or `NULL`.

gnutls_compression_get

`gnutls_compression_method_t gnutls_compression_get` [Function]
(*gnutls_session_t **session***)

session: is a `gnutls_session_t` structure.

Get currently used compression algorithm.

Returns: the currently used compression method, a `gnutls_compression_method_t` value.

gnutls_compression_list

`const gnutls_compression_method_t *` [Function]
`gnutls_compression_list ( void)`

Get a list of compression methods. Note that to be able to use LZO compression, you must link to libgnutls-extra and call `gnutls_global_init_extra()`.

Returns: a zero-terminated list of `gnutls_compression_method_t` integers indicating the available compression methods.

gnutls_compression_set_priority

`int gnutls_compression_set_priority (`*gnutls_session_t* **`session`**`,` [Function]
*const int * * `list`*`)`

session: is a `gnutls_session_t` structure.

list: is a 0 terminated list of gnutls_compression_method_t elements.

Sets the priority on the compression algorithms supported by gnutls. Priority is higher for elements specified before others. After specifying the algorithms you want, you must append a 0. Note that the priority is set on the client. The server does not use the algorithm's priority except for disabling algorithms that were not specified.

TLS 1.0 does not define any compression algorithms except NULL. Other compression algorithms are to be considered as gnutls extensions.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_credentials_clear

`void gnutls_credentials_clear (`*gnutls_session_t* **`session`**`)` [Function]

session: is a `gnutls_session_t` structure.

Clears all the credentials previously set in this session.

gnutls_credentials_set

`int gnutls_credentials_set (`*gnutls_session_t* **`session`**`,` [Function]
gnutls_credentials_type_t **`type`**`,` *void * * **`cred`**`)`

session: is a `gnutls_session_t` structure.

type: is the type of the credentials

cred: is a pointer to a structure.

Sets the needed credentials for the specified type. Eg username, password - or public and private keys etc. The (void* cred) parameter is a structure that depends on the specified type and on the current session (client or server). [In order to minimize memory usage, and share credentials between several threads gnutls keeps a pointer to cred, and not the whole cred structure. Thus you will have to keep the structure allocated until you call `gnutls_deinit()`.]

For GNUTLS_CRD_ANON cred should be gnutls_anon_client_credentials_t in case of a client. In case of a server it should be gnutls_anon_server_credentials_t.

For GNUTLS_CRD_SRP cred should be gnutls_srp_client_credentials_t in case of a client, and gnutls_srp_server_credentials_t, in case of a server.

For GNUTLS_CRD_CERTIFICATE cred should be gnutls_certificate_credentials_t.

gnutls_crypto_bigint_register2

`int gnutls_crypto_bigint_register2 (`*int* **`priority`**`,` *int* **`version`**`,` [Function]
*gnutls_crypto_bigint_st * * **`s`**`)`

priority: is the priority of the interface

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new interface's data

This function will register an interface for gnutls to operate on big integers. Any interface registered will override the included interface. The interface with the lowest priority will be used by gnutls.

Note that the bigint interface must interoperate with the public key interface. Thus if this interface is updated the `gnutls_crypto_pk_register()` should also be used.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_bigint_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_cipher_register2

`int gnutls_crypto_cipher_register2 (`*int* `priority`, *int* `version`, *gnutls_crypto_cipher_st* * `s``)` [Function]

priority: is the priority of the cipher interface

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new interface's data

This function will register a cipher interface to be used by gnutls. Any interface registered will override the included engine and by convention kernel implemented interfaces should have priority of 90. The interface with the lowest priority will be used by gnutls.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_cipher_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_digest_register2

`int gnutls_crypto_digest_register2 (`*int* `priority`, *int* `version`, *gnutls_crypto_digest_st* * `s``)` [Function]

priority: is the priority of the digest interface

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new interface's data

This function will register a digest interface to be used by gnutls. Any interface registered will override the included engine and by convention kernel implemented interfaces should have priority of 90. The interface with the lowest priority will be used by gnutls.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_digest_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_mac_register2

`int gnutls_crypto_mac_register2 (`*int* ***priority***`, `*int* ***version***`, `*gnutls_crypto_mac_st * **s***`)` [Function]

priority: is the priority of the mac interface

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new interface's data

This function will register a mac interface to be used by gnutls. Any interface registered will override the included engine and by convention kernel implemented interfaces should have priority of 90. The interface with the lowest priority will be used by gnutls.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_mac_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_pk_register2

`int gnutls_crypto_pk_register2 (`*int* ***priority***`, `*int* ***version***`, `*gnutls_crypto_pk_st * **s***`)` [Function]

priority: is the priority of the interface

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new interface's data

This function will register an interface for gnutls to operate on public key operations. Any interface registered will override the included interface. The interface with the lowest priority will be used by gnutls.

Note that the bigint interface must interoperate with the bigint interface. Thus if this interface is updated the `gnutls_crypto_bigint_register()` should also be used.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_pk_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_rnd_register2

`int gnutls_crypto_rnd_register2 (`*int* ***priority***`, `*int* ***version***`, `*gnutls_crypto_rnd_st * **s***`)` [Function]

priority: is the priority of the generator

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new generator's data

This function will register a random generator to be used by gnutls. Any generator registered will override the included generator and by convention kernel implemented generators have priority of 90. The generator with the lowest priority will be used by gnutls.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_rnd_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_single_cipher_register2

`int gnutls_crypto_single_cipher_register2` [Function]
(*gnutls_cipher_algorithm_t* **`algorithm`**, *int* **`priority`**, *int* **`version`**, *gnutls_crypto_single_cipher_st ** **`s`**)

algorithm: is the gnutls algorithm identifier

priority: is the priority of the algorithm

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new cipher's data

This function will register a cipher algorithm to be used by gnutls. Any algorithm registered will override the included algorithms and by convention kernel implemented algorithms have priority of 90. The algorithm with the lowest priority will be used by gnutls.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_single_cipher_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_single_digest_register2

`int gnutls_crypto_single_digest_register2` [Function]
(*gnutls_digest_algorithm_t* **`algorithm`**, *int* **`priority`**, *int* **`version`**, *gnutls_crypto_single_digest_st ** **`s`**)

algorithm: is the gnutls algorithm identifier

priority: is the priority of the algorithm

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new algorithms's data

This function will register a digest (hash) algorithm to be used by gnutls. Any algorithm registered will override the included algorithms and by convention kernel implemented algorithms have priority of 90. The algorithm with the lowest priority will be used by gnutls.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_single_digest_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_crypto_single_mac_register2

`int gnutls_crypto_single_mac_register2 (`*gnutls_mac_algorithm_t* **`algorithm`**, *int* **`priority`**, *int* **`version`**, *gnutls_crypto_single_mac_st ** **`s`**`)` [Function]

algorithm: is the gnutls algorithm identifier

priority: is the priority of the algorithm

version: should be set to `GNUTLS_CRYPTO_API_VERSION`

s: is a structure holding new algorithms's data

This function will register a MAC algorithm to be used by gnutls. Any algorithm registered will override the included algorithms and by convention kernel implemented algorithms have priority of 90. The algorithm with the lowest priority will be used by gnutls.

This function should be called before `gnutls_global_init()`.

For simplicity you can use the convenience `gnutls_crypto_single_mac_register()` macro.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.6.0

gnutls_db_check_entry

`int gnutls_db_check_entry (`*gnutls_session_t* **`session`**, *gnutls_datum_t* **`session_entry`**`)` [Function]

session: is a `gnutls_session_t` structure.

session_entry: is the session data (not key)

Check if database entry has expired. This function is to be used when you want to clear unnesessary session which occupy space in your backend.

Returns: Returns `GNUTLS_E_EXPIRED`, if the database entry has expired or 0 otherwise.

gnutls_db_get_ptr

`void * gnutls_db_get_ptr (`*gnutls_session_t* **`session`**`)` [Function]

session: is a `gnutls_session_t` structure.

Get db function pointer.

Returns: the pointer that will be sent to db store, retrieve and delete functions, as the first argument.

gnutls_db_remove_session

`void gnutls_db_remove_session (`*gnutls_session_t* **`session`**`)` [Function]

session: is a `gnutls_session_t` structure.

This function will remove the current session data from the session database. This will prevent future handshakes reusing these session data. This function should be called if a session was terminated abnormally, and before `gnutls_deinit()` is called.

Normally `gnutls_deinit()` will remove abnormally terminated sessions.

gnutls_db_set_cache_expiration

`void gnutls_db_set_cache_expiration (`*gnutls_session_t* **`session`**`,` *int* **`seconds`**`)` [Function]

session: is a `gnutls_session_t` structure.

seconds: is the number of seconds.

Set the expiration time for resumed sessions. The default is 3600 (one hour) at the time writing this.

gnutls_db_set_ptr

`void gnutls_db_set_ptr (`*gnutls_session_t* **`session`**`,` *void ** **`ptr`**`)` [Function]

session: is a `gnutls_session_t` structure.

ptr: is the pointer

Sets the pointer that will be provided to db store, retrieve and delete functions, as the first argument.

gnutls_db_set_remove_function

`void gnutls_db_set_remove_function (`*gnutls_session_t* **`session`**`,` *gnutls_db_remove_func* **`rem_func`**`)` [Function]

session: is a `gnutls_session_t` structure.

rem_func: is the function.

Sets the function that will be used to remove data from the resumed sessions database. This function must return 0 on success.

The first argument to `rem_func()` will be null unless `gnutls_db_set_ptr()` has been called.

gnutls_db_set_retrieve_function

`void gnutls_db_set_retrieve_function (`*gnutls_session_t* **`session`**`,` *gnutls_db_retr_func* **`retr_func`**`)` [Function]

session: is a `gnutls_session_t` structure.

retr_func: is the function.

Sets the function that will be used to retrieve data from the resumed sessions database. This function must return a gnutls_datum_t containing the data on success, or a gnutls_datum_t containing null and 0 on failure.

The datum's data must be allocated using the function `gnutls_malloc()`.

The first argument to `retr_func()` will be null unless `gnutls_db_set_ptr()` has been called.

gnutls_db_set_store_function

`void gnutls_db_set_store_function (`*gnutls_session_t* **`session`**`,` *gnutls_db_store_func* **`store_func`**`)` [Function]

session: is a `gnutls_session_t` structure.

store_func: is the function

Sets the function that will be used to store data from the resumed sessions database. This function must remove 0 on success.

The first argument to `store_func()` will be null unless `gnutls_db_set_ptr()` has been called.

gnutls_deinit

`void gnutls_deinit (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

This function clears all buffers associated with the `session`. This function will also remove session data from the session database if the session was terminated abnormally.

gnutls_dh_get_group

`int gnutls_dh_get_group (`*gnutls_session_t* ***session***`,` *gnutls_datum_t* ` * ` ***raw_gen***`,` *gnutls_datum_t* ` * ` ***raw_prime***`)` [Function]

session: is a gnutls session

raw_gen: will hold the generator.

raw_prime: will hold the prime.

This function will return the group parameters used in the last Diffie Hellman authentication with the peer. These are the prime and the generator used. This function should be used for both anonymous and ephemeral diffie Hellman. The output parameters must be freed with `gnutls_free()`.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_dh_get_peers_public_bits

`int gnutls_dh_get_peers_public_bits (`*gnutls_session_t* ***session***`)` [Function]

session: is a gnutls session

Get the Diffie-Hellman public key bit size. Can be used for both anonymous and ephemeral diffie Hellman.

Returns: the public key bit size used in the last Diffie Hellman authentication with the peer, or a negative value in case of error.

gnutls_dh_get_prime_bits

`int gnutls_dh_get_prime_bits (`*gnutls_session_t* ***session***`)` [Function]

session: is a gnutls session

This function will return the bits of the prime used in the last Diffie Hellman authentication with the peer. Should be used for both anonymous and ephemeral diffie Hellman.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_dh_get_pubkey

`int gnutls_dh_get_pubkey (`*gnutls_session_t* **`session`**`, `*gnutls_datum_t * * raw_key*`)` [Function]

session: is a gnutls session

raw_key: will hold the public key.

This function will return the peer's public key used in the last Diffie Hellman authentication. This function should be used for both anonymous and ephemeral diffie Hellman. The output parameters must be freed with `gnutls_free()`.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_dh_get_secret_bits

`int gnutls_dh_get_secret_bits (`*gnutls_session_t* **`session`**`)` [Function]

session: is a gnutls session

This function will return the bits used in the last Diffie Hellman authentication with the peer. Should be used for both anonymous and ephemeral diffie Hellman.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_dh_params_cpy

`int gnutls_dh_params_cpy (`*gnutls_dh_params_t* **`dst`**`, `*gnutls_dh_params_t* **`src`**`)` [Function]

dst: Is the destination structure, which should be initialized.

src: Is the source structure

This function will copy the DH parameters structure from source to destination.

gnutls_dh_params_deinit

`void gnutls_dh_params_deinit (`*gnutls_dh_params_t* **`dh_params`**`)` [Function]

dh_params: Is a structure that holds the prime numbers

This function will deinitialize the DH parameters structure.

gnutls_dh_params_export_pkcs3

`int gnutls_dh_params_export_pkcs3 (`*gnutls_dh_params_t* **`params`**`, `*gnutls_x509_crt_fmt_t* **`format`**`, unsigned char * `**`params_data`**`, size_t * `**`params_data_size`**`)` [Function]

params: Holds the DH parameters

format: the format of output params. One of PEM or DER.

params_data: will contain a PKCS3 DHParams structure PEM or DER encoded

params_data_size: holds the size of params_data (and will be replaced by the actual size of parameters)

This function will export the given dh parameters to a PKCS3 DHParams structure. This is the format generated by "openssl dhparam" tool. If the buffer provided is not long enough to hold the output, then GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN DH PARAMETERS".

In case of failure a negative value will be returned, and 0 on success.

gnutls_dh_params_export_raw

`int gnutls_dh_params_export_raw (`*gnutls_dh_params_t* **`params`**`,` *gnutls_datum_t ** **`prime`**`,` *gnutls_datum_t ** **`generator`**`,` *unsigned int ** **`bits`**`)` [Function]

params: Holds the DH parameters

prime: will hold the new prime

generator: will hold the new generator

bits: if non null will hold is the prime's number of bits

This function will export the pair of prime and generator for use in the Diffie-Hellman key exchange. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

gnutls_dh_params_generate2

`int gnutls_dh_params_generate2 (`*gnutls_dh_params_t* **`params`**`,` *unsigned int* **`bits`**`)` [Function]

params: Is the structure that the DH parameters will be stored

bits: is the prime's number of bits

This function will generate a new pair of prime and generator for use in the Diffie-Hellman key exchange. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum. This function is normally slow.

Note that the bits value should be one of 768, 1024, 2048, 3072 or 4096. Also note that the DH parameters are only useful to servers. Since clients use the parameters sent by the server, it's of no use to call this in client side.

gnutls_dh_params_import_pkcs3

`int gnutls_dh_params_import_pkcs3 (`*gnutls_dh_params_t* **`params`**`,` *const gnutls_datum_t ** **`pkcs3_params`**`,` *gnutls_x509_crt_fmt_t* **`format`**`)` [Function]

params: A structure where the parameters will be copied to

pkcs3_params: should contain a PKCS3 DHParams structure PEM or DER encoded

format: the format of params. PEM or DER.

This function will extract the DHParams found in a PKCS3 formatted structure. This is the format generated by "openssl dhparam" tool.

If the structure is PEM encoded, it should have a header of "BEGIN DH PARAMETERS".

In case of failure a negative value will be returned, and 0 on success.

gnutls_dh_params_import_raw

`int gnutls_dh_params_import_raw (`*gnutls_dh_params_t* **`dh_params`**`,` *const gnutls_datum_t ** **`prime`**`,` *const gnutls_datum_t ** **`generator`**`)` [Function]

dh_params: Is a structure that will hold the prime numbers

prime: holds the new prime

generator: holds the new generator

This function will replace the pair of prime and generator for use in the Diffie-Hellman key exchange. The new parameters should be stored in the appropriate gnutls_datum.

gnutls_dh_params_init

`int gnutls_dh_params_init (`*gnutls_dh_params_t ** **`dh_params`**`)` [Function]

dh_params: Is a structure that will hold the prime numbers

This function will initialize the DH parameters structure.

gnutls_dh_set_prime_bits

`void gnutls_dh_set_prime_bits (`*gnutls_session_t* **`session`**`,` *unsigned int* **`bits`**`)` [Function]

session: is a `gnutls_session_t` structure.

bits: is the number of bits

This function sets the number of bits, for use in an Diffie Hellman key exchange. This is used both in DH ephemeral and DH anonymous cipher suites. This will set the minimum size of the prime that will be used for the handshake.

In the client side it sets the minimum accepted number of bits. If a server sends a prime with less bits than that `GNUTLS_E_DH_PRIME_UNACCEPTABLE` will be returned by the handshake.

gnutls_error_is_fatal

`int gnutls_error_is_fatal (`*int* **`error`**`)` [Function]

error: is a GnuTLS error code, a negative value

If a GnuTLS function returns a negative value you may feed that value to this function to see if the error condition is fatal.

Note that you may want to check the error code manually, since some non-fatal errors to the protocol may be fatal for you program.

This function is only useful if you are dealing with errors from the record layer or the handshake layer.

Returns: 1 if the error code is fatal, for positive `error` values, 0 is returned. For unknown `error` values, -1 is returned.

gnutls_error_to_alert

`int gnutls_error_to_alert (`*int* **`err`**`,` *int ** **`level`**`)` [Function]

err: is a negative integer

level: the alert level will be stored there

Get an alert depending on the error code returned by a gnutls function. All alerts sent by this function should be considered fatal. The only exception is when `err` is `GNUTLS_E_REHANDSHAKE`, where a warning alert should be sent to the peer indicating that no renegotiation will be performed.

If there is no mapping to a valid alert the alert to indicate internal error is returned.

Returns: the alert code to use for a particular error code.

gnutls_ext_register

`int gnutls_ext_register (`*int* **`type`**, *const char ** **`name`**, *gnutls_ext_parse_type_t* **`parse_type`**, *gnutls_ext_recv_func* **`recv_func`**, *gnutls_ext_send_func* **`send_func`**`)` [Function]

type: the 16-bit integer referring to the extension type

name: human printable name of the extension used for debugging

parse_type: either `GNUTLS_EXT_TLS` or `GNUTLS_EXT_APPLICATION`.

recv_func: a function to receive extension data

send_func: a function to send extension data

This function is used to register a new TLS extension handler.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

Since: 2.6.0

gnutls_fingerprint

`int gnutls_fingerprint (`*gnutls_digest_algorithm_t* **`algo`**, *const gnutls_datum_t ** **`data`**, *void ** **`result`**, *size_t ** **`result_size`**`)` [Function]

algo: is a digest algorithm

data: is the data

result: is the place where the result will be copied (may be null).

result_size: should hold the size of the result. The actual size of the returned result will also be copied there.

This function will calculate a fingerprint (actually a hash), of the given data. The result is not printable data. You should convert it to hex, or to something else printable.

This is the usual way to calculate a fingerprint of an X.509 DER encoded certificate. Note however that the fingerprint of an OpenPGP is not just a hash and cannot be calculated with this function.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_free

`void gnutls_free (`*void ** **`ptr`**`)` [Function]

This function will free data pointed by ptr.

The deallocation function used is the one set by `gnutls_global_set_mem_functions()`.

gnutls_global_deinit

`void gnutls_global_deinit ( void)` [Function]

This function deinitializes the global data, that were initialized using `gnutls_global_init()`.

Note! This function is not thread safe. See the discussion for `gnutls_global_init()` for more information.

gnutls_global_init

`int gnutls_global_init ( void)` [Function]

This function initializes the global data to defaults. Every gnutls application has a global data which holds common parameters shared by gnutls session structures. You should call `gnutls_global_deinit()` when gnutls usage is no longer needed

Note that this function will also initialize libgcrypt, if it has not been initialized before. Thus if you want to manually initialize libgcrypt you must do it before calling this function. This is useful in cases you want to disable libgcrypt's internal lockings etc.

This function increment a global counter, so that `gnutls_global_deinit()` only releases resources when it has been called as many times as `gnutls_global_init()`. This is useful when GnuTLS is used by more than one library in an application. This function can be called many times, but will only do something the first time.

Note! This function is not thread safe. If two threads call this function simultaneously, they can cause a race between checking the global counter and incrementing it, causing both threads to execute the library initialization code. That would lead to a memory leak. To handle this, your application could invoke this function after aquiring a thread mutex. To ignore the potential memory leak is also an option.

Returns: On success, `GNUTLS_E_SUCCESS` (zero) is returned, otherwise an error code is returned.

gnutls_global_set_log_function

`void gnutls_global_set_log_function (gnutls_log_func log_func)` [Function]

log_func: it's a log function

This is the function where you set the logging function gnutls is going to use. This function only accepts a character array. Normally you may not use this function since it is only used for debugging purposes.

gnutls_log_func is of the form, void (*gnutls_log_func)(int level, const char*);

gnutls_global_set_log_level

`void gnutls_global_set_log_level (int level)` [Function]

level: it's an integer from 0 to 9.

This is the function that allows you to set the log level. The level is an integer between 0 and 9. Higher values mean more verbosity. The default value is 0. Larger values should only be used with care, since they may reveal sensitive information.

Use a log level over 10 to enable all debugging options.

gnutls_global_set_mem_functions

`void gnutls_global_set_mem_functions (`*gnutls_alloc_function* **`alloc_func`**, *gnutls_alloc_function* **`secure_alloc_func`**, *gnutls_is_secure_function* **`is_secure_func`**, *gnutls_realloc_function* **`realloc_func`**, *gnutls_free_function* **`free_func`**`)` [Function]

alloc_func: it's the default memory allocation function. Like `malloc()`.

secure_alloc_func: This is the memory allocation function that will be used for sensitive data.

is_secure_func: a function that returns 0 if the memory given is not secure. May be NULL.

realloc_func: A realloc function

free_func: The function that frees allocated data. Must accept a NULL pointer.

This is the function were you set the memory allocation functions gnutls is going to use. By default the libc's allocation functions (`malloc()`, `free()`), are used by gnutls, to allocate both sensitive and not sensitive data. This function is provided to set the memory allocation functions to something other than the defaults (ie the gcrypt allocation functions).

This function must be called before `gnutls_global_init()` is called.

gnutls_handshake_get_last_in

`gnutls_handshake_description_t` [Function]
`gnutls_handshake_get_last_in (`*gnutls_session_t* **`session`**`)`

session: is a `gnutls_session_t` structure.

This function is only useful to check where the last performed handshake failed. If the previous handshake succeed or was not performed at all then no meaningful value will be returned.

Check `gnutls_handshake_description_t` in gnutls.h for the available handshake descriptions.

Returns: the last handshake message type received, a `gnutls_handshake_description_t`.

gnutls_handshake_get_last_out

`gnutls_handshake_description_t` [Function]
`gnutls_handshake_get_last_out (`*gnutls_session_t* **`session`**`)`

session: is a `gnutls_session_t` structure.

This function is only useful to check where the last performed handshake failed. If the previous handshake succeed or was not performed at all then no meaningful value will be returned.

Check `gnutls_handshake_description_t` in gnutls.h for the available handshake descriptions.

Returns: the last handshake message type sent, a `gnutls_handshake_description_t`.

gnutls_handshake_set_max_packet_length

`void gnutls_handshake_set_max_packet_length (`*gnutls_session_t* `session`, *size_t* `max``)` [Function]

session: is a `gnutls_session_t` structure.

max: is the maximum number.

This function will set the maximum size of all handshake messages. Handshakes over this size are rejected with `GNUTLS_E_HANDSHAKE_TOO_LARGE` error code. The default value is 48kb which is typically large enough. Set this to 0 if you do not want to set an upper limit.

The reason for restricting the handshake message sizes are to limit Denial of Service attacks.

gnutls_handshake_set_post_client_hello_function

`void gnutls_handshake_set_post_client_hello_function` [Function]
`(`*gnutls_session_t* `session`, *gnutls_handshake_post_client_hello_func* `func`)

func: is the function to be called

This function will set a callback to be called after the client hello has been received (callback valid in server side only). This allows the server to adjust settings based on received extensions.

Those settings could be ciphersuites, requesting certificate, or anything else except for version negotiation (this is done before the hello message is parsed).

This callback must return 0 on success or a gnutls error code to terminate the handshake.

Warning: You should not use this function to terminate the handshake based on client input unless you know what you are doing. Before the handshake is finished there is no way to know if there is a man-in-the-middle attack being performed.

gnutls_handshake_set_private_extensions

`void gnutls_handshake_set_private_extensions (`*gnutls_session_t* `session`, *int* `allow``)` [Function]

session: is a `gnutls_session_t` structure.

allow: is an integer (0 or 1)

This function will enable or disable the use of private cipher suites (the ones that start with 0xFF). By default or if `allow` is 0 then these cipher suites will not be advertized nor used.

Unless this function is called with the option to allow (1), then no compression algorithms, like LZO. That is because these algorithms are not yet defined in any RFC or even internet draft.

Enabling the private ciphersuites when talking to other than gnutls servers and clients may cause interoperability problems.

gnutls_handshake

`int gnutls_handshake (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

This function does the handshake of the TLS/SSL protocol, and initializes the TLS connection.

This function will fail if any problem is encountered, and will return a negative error code. In case of a client, if the client has asked to resume a session, but the server couldn't, then a full handshake will be performed.

The non-fatal errors such as `GNUTLS_E_AGAIN` and `GNUTLS_E_INTERRUPTED` interrupt the handshake procedure, which should be later be resumed. Call this function again, until it returns 0; cf. `gnutls_record_get_direction()` and `gnutls_error_is_fatal()`.

If this function is called by a server after a rehandshake request then `GNUTLS_E_GOT_APPLICATION_DATA` or `GNUTLS_E_WARNING_ALERT_RECEIVED` may be returned. Note that these are non fatal errors, only in the specific case of a rehandshake. Their meaning is that the client rejected the rehandshake request.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

gnutls_hex2bin

`int gnutls_hex2bin (`*const char * **hex_data***, *size_t **hex_size***, *char * **bin_data***, *size_t * **bin_size***)` [Function]

hex_data: string with data in hex format

hex_size: size of hex data

bin_data: output array with binary data

bin_size: when calling *`bin_size` should hold size of `bin_data`, on return will hold actual size of `bin_data`.

Convert a buffer with hex data to binary data.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_hex_decode

`int gnutls_hex_decode (`*const gnutls_datum_t * **hex_data***, *char * **result***, *size_t * **result_size***)` [Function]

hex_data: contain the encoded data

result: the place where decoded data will be copied

result_size: holds the size of the result

This function will decode the given encoded data, using the hex encoding used by PSK password files.

Note that hex_data should be null terminated.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the buffer given is not long enough, or 0 on success.

gnutls_hex_encode

`int gnutls_hex_encode (const gnutls_datum_t * data, char * result, size_t * result_size)` [Function]

data: contain the raw data

result: the place where hex data will be copied

result_size: holds the size of the result

This function will convert the given data to printable data, using the hex encoding, as used in the PSK password files.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the buffer given is not long enough, or 0 on success.

gnutls_init

`int gnutls_init (gnutls_session_t * session, gnutls_connection_end_t con_end)` [Function]

session: is a pointer to a `gnutls_session_t` structure.

con_end: indicate if this session is to be used for server or client.

This function initializes the current session to null. Every session must be initialized before use, so internal structures can be allocated. This function allocates structures which can only be free'd by calling `gnutls_deinit()`. Returns zero on success.

`con_end` can be one of `GNUTLS_CLIENT` and `GNUTLS_SERVER`.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_kx_get_id

`gnutls_kx_algorithm_t gnutls_kx_get_id (const char * name)` [Function]

name: is a KX name

Convert a string to a `gnutls_kx_algorithm_t` value. The names are compared in a case insensitive way.

Returns: an id of the specified KX algorithm, or `GNUTLS_KX_UNKNOWN` on error.

gnutls_kx_get_name

`const char * gnutls_kx_get_name (gnutls_kx_algorithm_t algorithm)` [Function]

algorithm: is a key exchange algorithm

Convert a `gnutls_kx_algorithm_t` value to a string.

Returns: a pointer to a string that contains the name of the specified key exchange algorithm, or `NULL`.

gnutls_kx_get

`gnutls_kx_algorithm_t gnutls_kx_get (gnutls_session_t session)` [Function]

session: is a `gnutls_session_t` structure.

Get currently used key exchange algorithm.

Returns: the key exchange algorithm used in the last handshake, a `gnutls_kx_algorithm_t` value.

gnutls_kx_list

`const gnutls_kx_algorithm_t * gnutls_kx_list ( void)` [Function]

Get a list of supported key exchange algorithms.

Returns: a zero-terminated list of `gnutls_kx_algorithm_t` integers indicating the available key exchange algorithms.

gnutls_kx_set_priority

`int gnutls_kx_set_priority (gnutls_session_t session, const int * list)` [Function]

session: is a `gnutls_session_t` structure.

list: is a 0 terminated list of gnutls_kx_algorithm_t elements.

Sets the priority on the key exchange algorithms supported by gnutls. Priority is higher for elements specified before others. After specifying the algorithms you want, you must append a 0. Note that the priority is set on the client. The server does not use the algorithm's priority except for disabling algorithms that were not specified.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_mac_get_id

`gnutls_mac_algorithm_t gnutls_mac_get_id (const char * name)` [Function]

name: is a MAC algorithm name

Convert a string to a `gnutls_mac_algorithm_t` value. The names are compared in a case insensitive way.

Returns: an `gnutls_mac_algorithm_tid` of the specified in a string MAC algorithm, or `GNUTLS_MAC_UNKNOWN` on failures.

gnutls_mac_get_key_size

`size_t gnutls_mac_get_key_size (gnutls_mac_algorithm_t algorithm)` [Function]

algorithm: is an encryption algorithm

Get size of MAC key.

Returns: length (in bytes) of the given MAC key size, or 0 if the given MAC algorithm is invalid.

gnutls_mac_get_name

`const char * gnutls_mac_get_name (gnutls_mac_algorithm_t algorithm)` [Function]

algorithm: is a MAC algorithm

Convert a `gnutls_mac_algorithm_t` value to a string.

Returns: a string that contains the name of the specified MAC algorithm, or `NULL`.

gnutls_mac_get

`gnutls_mac_algorithm_t gnutls_mac_get (`*gnutls_session_t* `session`) [Function]

session: is a `gnutls_session_t` structure.

Get currently used MAC algorithm.

Returns: the currently used mac algorithm, a `gnutls_mac_algorithm_t` value.

gnutls_mac_list

`const gnutls_mac_algorithm_t * gnutls_mac_list ( void)` [Function]

Get a list of hash algorithms for use as MACs. Note that not necessarily all MACs are supported in TLS cipher suites. For example, MD2 is not supported as a cipher suite, but is supported for other purposes (e.g., X.509 signature verification or similar).

Returns: Return a zero-terminated list of `gnutls_mac_algorithm_t` integers indicating the available MACs.

gnutls_mac_set_priority

`int gnutls_mac_set_priority (`*gnutls_session_t* `session`, *const int ** `list`) [Function]

session: is a `gnutls_session_t` structure.

list: is a 0 terminated list of gnutls_mac_algorithm_t elements.

Sets the priority on the mac algorithms supported by gnutls. Priority is higher for elements specified before others. After specifying the algorithms you want, you must append a 0. Note that the priority is set on the client. The server does not use the algorithm's priority except for disabling algorithms that were not specified.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_malloc

`void * gnutls_malloc (`*size_t* `s`) [Function]

This function will allocate 's' bytes data, and return a pointer to memory. This function is supposed to be used by callbacks.

The allocation function used is the one set by `gnutls_global_set_mem_functions()`.

gnutls_openpgp_send_cert

`void gnutls_openpgp_send_cert (`*gnutls_session_t* `session`, *gnutls_openpgp_crt_status_t* `status`) [Function]

session: is a pointer to a `gnutls_session_t` structure.

status: is one of GNUTLS_OPENPGP_CERT, or GNUTLS_OPENPGP_CERT_FINGERPRINT

This function will order gnutls to send the key fingerprint instead of the key in the initial handshake procedure. This should be used with care and only when there is indication or knowledge that the server can obtain the client's key.

gnutls_oprfi_enable_client

`void gnutls_oprfi_enable_client (`*gnutls_session_t* **`session`**`, `*size_t* **`len`**`, `*unsigned char ** **`data`**`)` [Function]

session: is a `gnutls_session_t` structure.

len: length of Opaque PRF data to use in client.

data: Opaque PRF data to use in client.

Request that the client should attempt to negotiate the Opaque PRF Input TLS extension, using the given data as the client's Opaque PRF input.

The data is copied into the session context after this call, so you may de-allocate it immediately after calling this function.

gnutls_oprfi_enable_server

`void gnutls_oprfi_enable_server (`*gnutls_session_t* **`session`**`,` [Function]
gnutls_oprfi_callback_func **`cb`**`, `*void ** **`userdata`**`)`

session: is a `gnutls_session_t` structure.

cb: function pointer to Opaque PRF extension server callback.

userdata: hook passed to callback function for passing application state.

Request that the server should attempt to accept the Opaque PRF Input TLS extension. If the client requests the extension, the provided callback `cb` will be invoked. The callback must have the following prototype:

int callback (gnutls_session_t session, void *userdata, size_t oprfi_len, const unsigned char *in_oprfi, unsigned char *out_oprfi);

The callback can inspect the client-provided data in the input parameters, and specify its own opaque prf input data in the output variable. The function must return 0 on success, otherwise the handshake will be aborted.

gnutls_pem_base64_decode_alloc

`int gnutls_pem_base64_decode_alloc (`*const char ** **`header`**`,` *const* [Function]
*gnutls_datum_t ** **`b64_data`**`, `*gnutls_datum_t ** **`result`**`)`

header: The PEM header (eg. CERTIFICATE)

b64_data: contains the encoded data

result: the place where decoded data lie

This function will decode the given encoded data. The decoded data will be allocated, and stored into result. If the header given is non null this function will search for "—–BEGIN header" and decode only this part. Otherwise it will decode the first PEM packet found.

You should use `gnutls_free()` to free the returned data.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_pem_base64_decode

`int gnutls_pem_base64_decode (const char * header, const gnutls_datum_t * b64_data, unsigned char * result, size_t * result_size)` [Function]

header: A null terminated string with the PEM header (eg. CERTIFICATE)

b64_data: contain the encoded data

result: the place where decoded data will be copied

result_size: holds the size of the result

This function will decode the given encoded data. If the header given is non null this function will search for "----BEGIN header" and decode only this part. Otherwise it will decode the first PEM packet found.

Returns: On success `GNUTLS_E_SUCCESS` (0) is returned, `GNUTLS_E_SHORT_MEMORY_BUFFER` is returned if the buffer given is not long enough, or 0 on success.

gnutls_pem_base64_encode_alloc

`int gnutls_pem_base64_encode_alloc (const char * msg, const gnutls_datum_t * data, gnutls_datum_t * result)` [Function]

msg: is a message to be put in the encoded header

data: contains the raw data

result: will hold the newly allocated encoded data

This function will convert the given data to printable data, using the base64 encoding. This is the encoding used in PEM messages. This function will allocate the required memory to hold the encoded data.

You should use `gnutls_free()` to free the returned data.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_pem_base64_encode

`int gnutls_pem_base64_encode (const char * msg, const gnutls_datum_t * data, char * result, size_t * result_size)` [Function]

msg: is a message to be put in the header

data: contain the raw data

result: the place where base64 data will be copied

result_size: holds the size of the result

This function will convert the given data to printable data, using the base64 encoding. This is the encoding used in PEM messages.

The output string will be null terminated, although the size will not include the terminating null.

Returns: On success `GNUTLS_E_SUCCESS` (0) is returned, `GNUTLS_E_SHORT_MEMORY_BUFFER` is returned if the buffer given is not long enough, or 0 on success.

gnutls_perror

`void gnutls_perror (int error)` [Function]

error: is a GnuTLS error code, a negative value

This function is like `perror()`. The only difference is that it accepts an error number returned by a gnutls function.

gnutls_pk_algorithm_get_name

`const char * gnutls_pk_algorithm_get_name (gnutls_pk_algorithm_t algorithm)` [Function]

algorithm: is a pk algorithm

Convert a `gnutls_pk_algorithm_t` value to a string.

Returns: a string that contains the name of the specified public key algorithm, or `NULL`.

gnutls_pk_get_id

`gnutls_pk_algorithm_t gnutls_pk_get_id (const char * name)` [Function]

name: is a string containing a public key algorithm name.

Convert a string to a `gnutls_pk_algorithm_t` value. The names are compared in a case insensitive way. For example, gnutls_pk_get_id("RSA") will return `GNUTLS_PK_RSA`.

Returns: an `gnutls_pk_algorithm_tid` of the specified in a string public key algorithm, or `GNUTLS_PK_UNKNOWN` on failures.

Since: 2.6.0

gnutls_pk_get_name

`const char * gnutls_pk_get_name (gnutls_pk_algorithm_t algorithm)` [Function]

algorithm: is a public key algorithm

Convert a `gnutls_pk_algorithm_t` value to a string.

Returns: a pointer to a string that contains the name of the specified public key algorithm, or `NULL`.

Since: 2.6.0

gnutls_pk_list

`const gnutls_pk_algorithm_t * gnutls_pk_list ( void)` [Function]

Get a list of supported public key algorithms.

Returns: a zero-terminated list of `gnutls_pk_algorithm_t` integers indicating the available ciphers.

Since: 2.6.0

gnutls_prf_raw

`int gnutls_prf_raw (`*gnutls_session_t* `session`, *size_t* `label_size`, *const char * * `label`, *size_t* `seed_size`, *const char * * `seed`, *size_t* `outsize`, *char * * `out`)` [Function]

session: is a `gnutls_session_t` structure.

label_size: length of the `label` variable.

label: label used in PRF computation, typically a short string.

seed_size: length of the `seed` variable.

seed: optional extra data to seed the PRF with.

outsize: size of pre-allocated output buffer to hold the output.

out: pre-allocate buffer to hold the generated data.

Apply the TLS Pseudo-Random-Function (PRF) using the master secret on some data.

The `label` variable usually contain a string denoting the purpose for the generated data. The `seed` usually contain data such as the client and server random, perhaps together with some additional data that is added to guarantee uniqueness of the output for a particular purpose.

Because the output is not guaranteed to be unique for a particular session unless `seed` include the client random and server random fields (the PRF would output the same data on another connection resumed from the first one), it is not recommended to use this function directly. The `gnutls_prf()` function seed the PRF with the client and server random fields directly, and is recommended if you want to generate pseudo random data unique for each session.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_prf

`int gnutls_prf (`*gnutls_session_t* `session`, *size_t* `label_size`, *const char * * `label`, *int* `server_random_first`, *size_t* `extra_size`, *const char * * `extra`, *size_t* `outsize`, *char * * `out`)` [Function]

session: is a `gnutls_session_t` structure.

label_size: length of the `label` variable.

label: label used in PRF computation, typically a short string.

server_random_first: non-0 if server random field should be first in seed

extra_size: length of the `extra` variable.

extra: optional extra data to seed the PRF with.

outsize: size of pre-allocated output buffer to hold the output.

out: pre-allocate buffer to hold the generated data.

Apply the TLS Pseudo-Random-Function (PRF) using the master secret on some data, seeded with the client and server random fields.

The `label` variable usually contain a string denoting the purpose for the generated data. The `server_random_first` indicate whether the client random field or the

server random field should be first in the seed. Non-0 indicate that the server random field is first, 0 that the client random field is first.

The `extra` variable can be used to add more data to the seed, after the random variables. It can be used to tie make sure the generated output is strongly connected to some additional data (e.g., a string used in user authentication).

The output is placed in *`OUT`, which must be pre-allocated.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_priority_deinit

`void gnutls_priority_deinit (`*gnutls_priority_t* ***priority_cache***`)` [Function]

priority_cache: is a `gnutls_prioritity_t` structure.

Deinitializes the priority cache.

gnutls_priority_init

`int gnutls_priority_init (`*gnutls_priority_t ** ***priority_cache***`,` *const char ** ***priorities***`,` *const char *** ***err_pos***`)` [Function]

priority_cache: is a `gnutls_prioritity_t` structure.

priorities: is a string describing priorities

err_pos: In case of an error this will have the position in the string the error occured

Sets priorities for the ciphers, key exchange methods, macs and compression methods. This is to avoid using the gnutls_*`_priority()` functions.

The `priorities` option allows you to specify a semi-colon separated list of the cipher priorities to enable.

Unless the first keyword is "NONE" the defaults are:

Protocols: TLS1.1, TLS1.0, and SSL3.0.

Compression: NULL.

Certificate types: X.509, OpenPGP.

You can also use predefined sets of ciphersuites: "PERFORMANCE" all the "secure" ciphersuites are enabled, limited to 128 bit ciphers and sorted by terms of speed performance.

"NORMAL" option enables all "secure" ciphersuites. The 256-bit ciphers are included as a fallback only. The ciphers are sorted by security margin.

"SECURE128" flag enables all "secure" ciphersuites with ciphers up to 128 bits, sorted by security margin.

"SECURE256" flag enables all "secure" ciphersuites including the 256 bit ciphers, sorted by security margin.

"EXPORT" all the ciphersuites are enabled, including the low-security 40 bit ciphers.

"NONE" nothing is enabled. This disables even protocols and compression methods.

Special keywords: "!" or "-" appended with an algorithm will remove this algorithm. "+" appended with an algorithm will add this algorithm. "COMPAT" will enable compatibility features for a server. "SSL3_RECORD_VERSION" will use SSL3.0 record version in client hello.

To avoid collisions in order to specify a compression algorithm in this string you have to prefix it with "COMP-", protocol versions with "VERS-" and certificate types with "CTYPE-". All other algorithms don't need a prefix.

For key exchange algorithms when in NORMAL or SECURE levels the perfect forward secrecy algorithms take precendence of the other protocols. In all cases all the supported key exchange algorithms are enabled (except for the RSA-EXPORT which is only enabled in EXPORT level).

Note that although one can select very long key sizes (such as 256 bits) for symmetric algorithms, to actually increase security the public key algorithms have to use longer key sizes as well.

Examples: "NORMAL:!AES-128-CBC", "EXPORT:!VERS-TLS1.0:+COMP-DEFLATE:+CTYPE-OPENPGP", "NONE:+VERS-TLS1.0:+AES-128-CBC:+RSA:+SHA1:+COMP-NULL", "NORMAL", "NORMAL:COMPAT".

For all the current available algorithms and protocols use "gnutls-cli -l" to get a listing.

Returns: On syntax error GNUTLS_E_INVALID_REQUEST is returned, GNUTLS_E_SUCCESS on success, or an error code.

gnutls_priority_set_direct

`int gnutls_priority_set_direct (`*gnutls_session_t* **`session`**`, const char *` **`priorities`**`, const char **` **`err_pos`**`)` [Function]

session: is a gnutls_session_t structure.

priorities: is a string describing priorities

err_pos: In case of an error this will have the position in the string the error occured

Sets the priorities to use on the ciphers, key exchange methods, macs and compression methods. This function avoids keeping a priority cache and is used to directly set string priorities to a TLS session. For documentation check the gnutls_priority_init().

Returns: On syntax error GNUTLS_E_INVALID_REQUEST is returned, GNUTLS_E_SUCCESS on success, or an error code.

gnutls_priority_set

`int gnutls_priority_set (`*gnutls_session_t* **`session`**`, gnutls_priority_t` **`priority`**`)` [Function]

session: is a gnutls_session_t structure.

priority: is a gnutls_priority_t structure.

Sets the priorities to use on the ciphers, key exchange methods, macs and compression methods.

Returns: GNUTLS_E_SUCCESS on success, or an error code.

gnutls_protocol_get_id

`gnutls_protocol_t gnutls_protocol_get_id (const char * name)` [Function]

name: is a protocol name

The names are compared in a case insensitive way.

Returns: an id of the specified protocol, or `GNUTLS_VERSION_UNKNOWN` on error.

gnutls_protocol_get_name

`const char * gnutls_protocol_get_name (gnutls_protocol_t version)` [Function]

version: is a (gnutls) version number

Convert a `gnutls_protocol_t` value to a string.

Returns: a string that contains the name of the specified TLS version (e.g., "TLS1.0"), or `NULL`.

gnutls_protocol_get_version

`gnutls_protocol_t gnutls_protocol_get_version (gnutls_session_t session)` [Function]

session: is a `gnutls_session_t` structure.

Get TLS version, a `gnutls_protocol_t` value.

Returns: the version of the currently used protocol.

gnutls_protocol_list

`const gnutls_protocol_t * gnutls_protocol_list ( void)` [Function]

Get a list of supported protocols, e.g. SSL 3.0, TLS 1.0 etc.

Returns: a zero-terminated list of `gnutls_protocol_t` integers indicating the available protocols.

gnutls_protocol_set_priority

`int gnutls_protocol_set_priority (gnutls_session_t session, const int * list)` [Function]

session: is a `gnutls_session_t` structure.

list: is a 0 terminated list of gnutls_protocol_t elements.

Sets the priority on the protocol versions supported by gnutls. This function actually enables or disables protocols. Newer protocol versions always have highest priority.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_psk_allocate_client_credentials

`int gnutls_psk_allocate_client_credentials (gnutls_psk_client_credentials_t * sc)` [Function]

sc: is a pointer to an `gnutls_psk_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_psk_allocate_server_credentials

`int gnutls_psk_allocate_server_credentials` [Function]
(*gnutls_psk_server_credentials_t* * `sc`)

sc: is a pointer to an `gnutls_psk_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_psk_client_get_hint

`const char * gnutls_psk_client_get_hint` (*gnutls_session_t* `session`) [Function]

session: is a gnutls session

The PSK identity hint may give the client help in deciding which username to use. This should only be called in case of PSK authentication and in case of a client.

Returns: the identity hint of the peer, or `NULL` in case of an error.

Since: 2.4.0

gnutls_psk_free_client_credentials

`void gnutls_psk_free_client_credentials` [Function]
(*gnutls_psk_client_credentials_t* `sc`)

sc: is an `gnutls_psk_client_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_psk_free_server_credentials

`void gnutls_psk_free_server_credentials` [Function]
(*gnutls_psk_server_credentials_t* `sc`)

sc: is an `gnutls_psk_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_psk_netconf_derive_key

`int gnutls_psk_netconf_derive_key` (*const char* * `password`, *const char* * `psk_identity`, *const char* * `psk_identity_hint`, *gnutls_datum_t* * `output_key`) [Function]

password: zero terminated string containing password.

psk_identity: zero terminated string with PSK identity.

psk_identity_hint: zero terminated string with PSK identity hint.

output_key: output variable, contains newly allocated *data pointer.

This function will derive a PSK key from a password, for use with the Netconf protocol.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

Since: 2.4.0

gnutls_psk_server_get_username

`const char * gnutls_psk_server_get_username` (*gnutls_session_t* ***session***) [Function]

session: is a gnutls session

This should only be called in case of PSK authentication and in case of a server.

Returns: the username of the peer, or `NULL` in case of an error.

gnutls_psk_set_client_credentials_function

`void gnutls_psk_set_client_credentials_function` (*gnutls_psk_client_credentials_t* ***cred***, *gnutls_psk_client_credentials_function ** ***func***) [Function]

cred: is a `gnutls_psk_server_credentials_t` structure.

func: is the callback function

This function can be used to set a callback to retrieve the username and password for client PSK authentication. The callback's function form is: int (*callback)(gnutls_session_t, char** username, gnutls_datum_t* key);

The `username` and `key->`data must be allocated using `gnutls_malloc()`. `username` should be ASCII strings or UTF-8 strings prepared using the "SASLprep" profile of "stringprep".

The callback function will be called once per handshake.

The callback function should return 0 on success. -1 indicates an error.

gnutls_psk_set_client_credentials

`int gnutls_psk_set_client_credentials` (*gnutls_psk_client_credentials_t* ***res***, *const char * **username***, *const gnutls_datum_t * **key***, *gnutls_psk_key_flags* ***flags***) [Function]

res: is an `gnutls_psk_client_credentials_t` structure.

username: is the user's zero-terminated userid

key: is the user's key

This function sets the username and password, in a gnutls_psk_client_credentials_t structure. Those will be used in PSK authentication. `username` should be an ASCII string or UTF-8 strings prepared using the "SASLprep" profile of "stringprep". The key can be either in raw byte format or in Hex (not with the '0x' prefix).

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_psk_set_params_function

`void gnutls_psk_set_params_function` [Function]
(*gnutls_psk_server_credentials_t* **`res`**, *gnutls_params_function ** **`func`**)

res: is a gnutls_psk_server_credentials_t structure

func: is the function to be called

This function will set a callback in order for the server to get the diffie hellman or RSA parameters for psk authentication. The callback should return zero on success.

gnutls_psk_set_server_credentials_file

`int gnutls_psk_set_server_credentials_file` [Function]
(*gnutls_psk_server_credentials_t* **`res`**, *const char ** **`password_file`**)

res: is an `gnutls_psk_server_credentials_t` structure.

password_file: is the PSK password file (passwd.psk)

This function sets the password file, in a `gnutls_psk_server_credentials_t` structure. This password file holds usernames and keys and will be used for PSK authentication.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_psk_set_server_credentials_function

`void gnutls_psk_set_server_credentials_function` [Function]
(*gnutls_psk_server_credentials_t* **`cred`**, *gnutls_psk_server_credentials_function ** **`func`**)

cred: is a `gnutls_psk_server_credentials_t` structure.

func: is the callback function

This function can be used to set a callback to retrieve the user's PSK credentials. The callback's function form is: int (*callback)(gnutls_session_t, const char* username, gnutls_datum_t* key);

`username` contains the actual username. The `key` must be filled in using the `gnutls_malloc()`.

In case the callback returned a negative number then gnutls will assume that the username does not exist.

The callback function will only be called once per handshake. The callback function should return 0 on success, while -1 indicates an error.

gnutls_psk_set_server_credentials_hint

`int gnutls_psk_set_server_credentials_hint` [Function]
(*gnutls_psk_server_credentials_t* **`res`**, *const char ** **`hint`**)

res: is an `gnutls_psk_server_credentials_t` structure.

hint: is the PSK identity hint string

This function sets the identity hint, in a `gnutls_psk_server_credentials_t` structure. This hint is sent to the client to help it chose a good PSK credential (i.e., username and password).

Returns: GNUTLS_E_SUCCESS on success, or an error code.

Since: 2.4.0

gnutls_psk_set_server_dh_params

`void gnutls_psk_set_server_dh_params` [Function]
(*gnutls_psk_server_credentials_t* **res**, *gnutls_dh_params_t* **dh_params**)

res: is a gnutls_psk_server_credentials_t structure

dh_params: is a structure that holds diffie hellman parameters.

This function will set the diffie hellman parameters for an anonymous server to use. These parameters will be used in Diffie Hellman with PSK cipher suites.

gnutls_psk_set_server_params_function

`void gnutls_psk_set_server_params_function` [Function]
(*gnutls_psk_server_credentials_t* **res**, *gnutls_params_function* * **func**)

res: is a gnutls_certificate_credentials_t structure

func: is the function to be called

This function will set a callback in order for the server to get the diffie hellman parameters for PSK authentication. The callback should return zero on success.

gnutls_record_check_pending

`size_t gnutls_record_check_pending` (*gnutls_session_t* **session**) [Function]

session: is a `gnutls_session_t` structure.

This function checks if there are any data to receive in the gnutls buffers. Returns the size of that data or 0. Notice that you may also use `select()` to check for data in a TCP connection, instead of this function. (gnutls leaves some data in the tcp buffer in order for select to work).

gnutls_record_disable_padding

`void gnutls_record_disable_padding` (*gnutls_session_t* **session**) [Function]

session: is a `gnutls_session_t` structure.

Used to disabled padding in TLS 1.0 and above. Normally you do not need to use this function, but there are buggy clients that complain if a server pads the encrypted data. This of course will disable protection against statistical attacks on the data.

Normally only servers that require maximum compatibility with everything out there, need to call this function.

gnutls_record_get_direction

`int gnutls_record_get_direction` (*gnutls_session_t* **session**) [Function]

session: is a `gnutls_session_t` structure.

This function provides information about the internals of the record protocol and is only useful if a prior gnutls function call (e.g. `gnutls_handshake()`) was interrupted

for some reason, that is, if a function returned GNUTLS_E_INTERRUPTED or GNUTLS_E_AGAIN. In such a case, you might want to call select() or poll() before calling the interrupted gnutls function again. To tell you whether a file descriptor should be selected for either reading or writing, gnutls_record_get_direction() returns 0 if the interrupted function was trying to read data, and 1 if it was trying to write data.

Returns: 0 if trying to read data, 1 if trying to write data.

gnutls_record_get_max_size

`size_t gnutls_record_get_max_size (`*gnutls_session_t* ***session***`)` [Function]

session: is a gnutls_session_t structure.

This function returns the maximum record packet size in this connection. The maximum record size is negotiated by the client after the first handshake message.

gnutls_record_recv

`ssize_t gnutls_record_recv (`*gnutls_session_t* ***session***`, void *` ***data***`,` [Function]
size_t ***sizeofdata***`)`

session: is a gnutls_session_t structure.

data: the buffer that the data will be read into

sizeofdata: the number of requested bytes

This function has the similar semantics with recv(). The only difference is that is accepts a GNUTLS session, and uses different error codes.

In the special case that a server requests a renegotiation, the client may receive an error code of GNUTLS_E_REHANDSHAKE. This message may be simply ignored, replied with an alert containing NO_RENEGOTIATION, or replied with a new handshake, depending on the client's will.

If EINTR is returned by the internal push function (the default is recv()) then GNUTLS_E_INTERRUPTED will be returned. If GNUTLS_E_INTERRUPTED or GNUTLS_E_AGAIN is returned, you must call this function again to get the data. See also gnutls_record_get_direction().

A server may also receive GNUTLS_E_REHANDSHAKE when a client has initiated a handshake. In that case the server can only initiate a handshake or terminate the connection.

Returns: the number of bytes received and zero on EOF. A negative error code is returned in case of an error. The number of bytes received might be less than sizeofdata.

gnutls_record_send

`ssize_t gnutls_record_send (`*gnutls_session_t* ***session***`, const void *` [Function]
data`,` *size_t* ***sizeofdata***`)`

session: is a gnutls_session_t structure.

data: contains the data to send

sizeofdata: is the length of the data

This function has the similar semantics with `send()`. The only difference is that is accepts a GNUTLS session, and uses different error codes.

Note that if the send buffer is full, `send()` will block this function. See the `send()` documentation for full information. You can replace the default push function by using `gnutls_transport_set_ptr2()` with a call to `send()` with a MSG_DONTWAIT flag if blocking is a problem.

If the EINTR is returned by the internal push function (the default is `send()}` then `GNUTLS_E_INTERRUPTED` will be returned. If `GNUTLS_E_INTERRUPTED` or `GNUTLS_E_AGAIN` is returned, you must call this function again, with the same parameters; alternatively you could provide a `NULL` pointer for data, and 0 for size. cf. `gnutls_record_get_direction()`.

Returns: the number of bytes sent, or a negative error code. The number of bytes sent might be less than `sizeofdata`. The maximum number of bytes this function can send in a single call depends on the negotiated maximum record size.

gnutls_record_set_max_size

`ssize_t gnutls_record_set_max_size (`*gnutls_session_t* ***session***`,` [Function]
size_t ***size***`)`

session: is a `gnutls_session_t` structure.

size: is the new size

This function sets the maximum record packet size in this connection. This property can only be set to clients. The server may choose not to accept the requested size.

Acceptable values are 512(=2^9), 1024(=2^10), 2048(=2^11) and 4096(=2^12). Returns 0 on success. The requested record size does get in effect immediately only while sending data. The receive part will take effect after a successful handshake.

This function uses a TLS extension called 'max record size'. Not all TLS implementations use or even understand this extension.

gnutls_rehandshake

`int gnutls_rehandshake (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

This function will renegotiate security parameters with the client. This should only be called in case of a server.

This message informs the peer that we want to renegotiate parameters (perform a handshake).

If this function succeeds (returns 0), you must call the `gnutls_handshake()` function in order to negotiate the new parameters.

If the client does not wish to renegotiate parameters he will should with an alert message, thus the return code will be `GNUTLS_E_WARNING_ALERT_RECEIVED` and the alert will be `GNUTLS_A_NO_RENEGOTIATION`. A client may also choose to ignore this message.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

gnutls_rsa_export_get_modulus_bits

`int gnutls_rsa_export_get_modulus_bits (`*gnutls_session_t* `session``)` [Function]

session: is a gnutls session

Get the export RSA parameter's modulus size.

Returns: the bits used in the last RSA-EXPORT key exchange with the peer, or a negative value in case of error.

gnutls_rsa_export_get_pubkey

`int gnutls_rsa_export_get_pubkey (`*gnutls_session_t* `session`, *gnutls_datum_t* * `exponent`, *gnutls_datum_t* * `modulus``)` [Function]

session: is a gnutls session

exponent: will hold the exponent.

modulus: will hold the modulus.

This function will return the peer's public key exponent and modulus used in the last RSA-EXPORT authentication. The output parameters must be freed with `gnutls_free()`.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_rsa_params_cpy

`int gnutls_rsa_params_cpy (`*gnutls_rsa_params_t* `dst`, *gnutls_rsa_params_t* `src``)` [Function]

dst: Is the destination structure, which should be initialized.

src: Is the source structure

This function will copy the RSA parameters structure from source to destination.

gnutls_rsa_params_deinit

`void gnutls_rsa_params_deinit (`*gnutls_rsa_params_t* `rsa_params``)` [Function]

rsa_params: Is a structure that holds the parameters

This function will deinitialize the RSA parameters structure.

gnutls_rsa_params_export_pkcs1

`int gnutls_rsa_params_export_pkcs1 (`*gnutls_rsa_params_t* `params`, *gnutls_x509_crt_fmt_t* `format`, *unsigned char* * `params_data`, *size_t* * `params_data_size``)` [Function]

params: Holds the RSA parameters

format: the format of output params. One of PEM or DER.

params_data: will contain a PKCS1 RSAPublicKey structure PEM or DER encoded

params_data_size: holds the size of params_data (and will be replaced by the actual size of parameters)

This function will export the given RSA parameters to a PKCS1 RSAPublicKey structure. If the buffer provided is not long enough to hold the output, then GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN RSA PRIVATE KEY".

In case of failure a negative value will be returned, and 0 on success.

gnutls_rsa_params_export_raw

`int gnutls_rsa_params_export_raw (`*gnutls_rsa_params_t* `params`, *gnutls_datum_t* * `m`, *gnutls_datum_t* * `e`, *gnutls_datum_t* * `d`, *gnutls_datum_t* * `p`, *gnutls_datum_t* * `q`, *gnutls_datum_t* * `u`, *unsigned int* * `bits``)` [Function]

params: a structure that holds the rsa parameters

m: will hold the modulus

e: will hold the public exponent

d: will hold the private exponent

p: will hold the first prime (p)

q: will hold the second prime (q)

u: will hold the coefficient

bits: if non null will hold the prime's number of bits

This function will export the RSA parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

gnutls_rsa_params_generate2

`int gnutls_rsa_params_generate2 (`*gnutls_rsa_params_t* `params`, *unsigned int* `bits``)` [Function]

params: The structure where the parameters will be stored

bits: is the prime's number of bits

This function will generate new temporary RSA parameters for use in RSA-EXPORT ciphersuites. This function is normally slow.

Note that if the parameters are to be used in export cipher suites the bits value should be 512 or less. Also note that the generation of new RSA parameters is only useful to servers. Clients use the parameters sent by the server, thus it's no use calling this in client side.

gnutls_rsa_params_import_pkcs1

`int gnutls_rsa_params_import_pkcs1 (`*gnutls_rsa_params_t* `params`, *const gnutls_datum_t* * `pkcs1_params`, *gnutls_x509_crt_fmt_t* `format`)` [Function]

params: A structure where the parameters will be copied to

pkcs1_params: should contain a PKCS1 RSAPublicKey structure PEM or DER encoded

format: the format of params. PEM or DER.

This function will extract the RSAPublicKey found in a PKCS1 formatted structure.

If the structure is PEM encoded, it should have a header of "BEGIN RSA PRIVATE KEY".

In case of failure a negative value will be returned, and 0 on success.

gnutls_rsa_params_import_raw

`int gnutls_rsa_params_import_raw (`*gnutls_rsa_params_t* **`rsa_params`**, *const gnutls_datum_t ** **`m`**, *const gnutls_datum_t ** **`e`**, *const gnutls_datum_t ** **`d`**, *const gnutls_datum_t ** **`p`**, *const gnutls_datum_t ** **`q`**, *const gnutls_datum_t ** **`u`**`)` [Function]

rsa_params: Is a structure will hold the parameters

m: holds the modulus

e: holds the public exponent

d: holds the private exponent

p: holds the first prime (p)

q: holds the second prime (q)

u: holds the coefficient

This function will replace the parameters in the given structure. The new parameters should be stored in the appropriate gnutls_datum.

gnutls_rsa_params_init

`int gnutls_rsa_params_init (`*gnutls_rsa_params_t ** **`rsa_params`**`)` [Function]

rsa_params: Is a structure that will hold the parameters

This function will initialize the temporary RSA parameters structure.

gnutls_server_name_get

`int gnutls_server_name_get (`*gnutls_session_t* **`session`**, *void ** **`data`**, *size_t ** **`data_length`**, *unsigned int ** **`type`**, *unsigned int* **`indx`**`)` [Function]

session: is a `gnutls_session_t` structure.

data: will hold the data

data_length: will hold the data length. Must hold the maximum size of data.

type: will hold the server name indicator type

indx: is the index of the server_name

This function will allow you to get the name indication (if any), a client has sent. The name indication may be any of the enumeration gnutls_server_name_type_t.

If `type` is GNUTLS_NAME_DNS, then this function is to be used by servers that support virtual hosting, and the data will be a null terminated UTF-8 string.

If `data` has not enough size to hold the server name GNUTLS_E_SHORT_MEMORY_BUFFER is returned, and `data_length` will hold the required size.

`index` is used to retrieve more than one server names (if sent by the client). The first server name has an index of 0, the second 1 and so on. If no name with the given index exists GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE is returned.

gnutls_server_name_set

`int gnutls_server_name_set (`*gnutls_session_t* **`session`**, *gnutls_server_name_type_t* **`type`**, *const void ** **`name`**, *size_t* **`name_length`**`)` [Function]

session: is a `gnutls_session_t` structure.

type: specifies the indicator type

name: is a string that contains the server name.

name_length: holds the length of name

This function is to be used by clients that want to inform (via a TLS extension mechanism) the server of the name they connected to. This should be used by clients that connect to servers that do virtual hosting.

The value of `name` depends on the `ind` type. In case of GNUTLS_NAME_DNS, an ASCII or UTF-8 null terminated string, without the trailing dot, is expected. IPv4 or IPv6 addresses are not permitted.

gnutls_session_enable_compatibility_mode

`void gnutls_session_enable_compatibility_mode (`*gnutls_session_t* **`session`**`)` [Function]

session: is a `gnutls_session_t` structure.

This function can be used to disable certain (security) features in TLS in order to maintain maximum compatibility with buggy clients. It is equivalent to calling: `gnutls_record_disable_padding()`

Normally only servers that require maximum compatibility with everything out there, need to call this function.

gnutls_session_get_client_random

`const void * gnutls_session_get_client_random (`*gnutls_session_t* **`session`**`)` [Function]

session: is a `gnutls_session_t` structure.

Return a pointer to the 32-byte client random field used in the session. The pointer must not be modified or deallocated.

If a client random value has not yet been established, the output will be garbage; in particular, a `NULL` return value should not be expected.

Returns: pointer to client random data.

gnutls_session_get_data2

`int gnutls_session_get_data2 (`*gnutls_session_t* **`session`**, *gnutls_datum_t ** **`data`**`)` [Function]

session: is a `gnutls_session_t` structure.

Returns all session parameters, in order to support resuming. The client should call this, and keep the returned session, if he wants to resume that current version later by calling `gnutls_session_set_data()` This function must be called after a successful handshake. The returned datum must be freed with `gnutls_free()`.

Resuming sessions is really useful and speedups connections after a succesful one.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_session_get_data

`int gnutls_session_get_data (`*gnutls_session_t* ***session***`, void *` ***session_data***`, size_t *` ***session_data_size***`)` [Function]

session: is a `gnutls_session_t` structure.

session_data: is a pointer to space to hold the session.

session_data_size: is the session_data's size, or it will be set by the function.

Returns all session parameters, in order to support resuming. The client should call this, and keep the returned session, if he wants to resume that current version later by calling `gnutls_session_set_data()` This function must be called after a successful handshake.

Resuming sessions is really useful and speedups connections after a succesful one.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_session_get_id

`int gnutls_session_get_id (`*gnutls_session_t* ***session***`, void *` ***session_id***`, size_t *` ***session_id_size***`)` [Function]

session: is a `gnutls_session_t` structure.

session_id: is a pointer to space to hold the session id.

session_id_size: is the session id's size, or it will be set by the function.

Returns the current session id. This can be used if you want to check if the next session you tried to resume was actually resumed. This is because resumed sessions have the same sessionID with the original session.

Session id is some data set by the server, that identify the current session. In TLS 1.0 and SSL 3.0 session id is always less than 32 bytes.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_session_get_master_secret

`const void * gnutls_session_get_master_secret (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

Return a pointer to the 48-byte master secret in the session. The pointer must not be modified or deallocated.

If a master secret value has not yet been established, the output will be garbage; in particular, a `NULL` return value should not be expected.

Consider using `gnutls_prf()` rather than extracting the master secret and use it to derive further data.

Returns: pointer to master secret data.

gnutls_session_get_ptr

`void * gnutls_session_get_ptr (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

Get user pointer for session. Useful in callbacks. This is the pointer set with `gnutls_session_set_ptr()`.

Returns: the user given pointer from the session structure, or `NULL` if it was never set.

gnutls_session_get_server_random

`const void * gnutls_session_get_server_random (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

Return a pointer to the 32-byte server random field used in the session. The pointer must not be modified or deallocated.

If a server random value has not yet been established, the output will be garbage; in particular, a `NULL` return value should not be expected.

Returns: pointer to server random data.

gnutls_session_is_resumed

`int gnutls_session_is_resumed (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

Check whether session is resumed or not.

Returns: non zero if this session is resumed, or a zero if this is a new session.

gnutls_session_set_data

`int gnutls_session_set_data (`*gnutls_session_t* ***session***`, const void * ***session_data***`, size_t` ***session_data_size***`)` [Function]

session: is a `gnutls_session_t` structure.

session_data: is a pointer to space to hold the session.

session_data_size: is the session's size

Sets all session parameters, in order to resume a previously established session. The session data given must be the one returned by `gnutls_session_get_data()`. This function should be called before `gnutls_handshake()`.

Keep in mind that session resuming is advisory. The server may choose not to resume the session, thus a full handshake will be performed.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_session_set_finished_function

`void gnutls_session_set_finished_function (`*gnutls_session_t* ***session***, *gnutls_finished_callback_func* ***finished_func***`)` [Function]

session: is a `gnutls_session_t` structure.

finished_func: a `gnutls_finished_callback_func` callback.

Register a callback function for the session that will be called when a TLS Finished message has been generated. The function is typically used to copy away the TLS finished message for later use as a channel binding or similar purpose.

The callback should follow this prototype: void callback (gnutls_session_t session, const void *finished, size_t len);

The `finished` parameter will contain the binary TLS finished message, and `len` will contains its length. For SSLv3 connections, the `len` parameter will be 36 and for TLS connections it will be 12.

It is recommended that the function returns quickly in order to not delay the handshake. Use the function to store a copy of the TLS finished message for later use.

Since: 2.6.0

gnutls_session_set_ptr

`void gnutls_session_set_ptr (`*gnutls_session_t* ***session***, *void ** ***ptr***`)` [Function]

session: is a `gnutls_session_t` structure.

ptr: is the user pointer

This function will set (associate) the user given pointer `ptr` to the session structure. This is pointer can be accessed with `gnutls_session_get_ptr()`.

gnutls_set_default_export_priority

`int gnutls_set_default_export_priority (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

Sets some default priority on the ciphers, key exchange methods, macs and compression methods. This function also includes weak algorithms.

This is the same as calling: gnutls_priority_set_direct (session, "EXPORT", NULL);

This function is kept around for backwards compatibility, but because of its wide use it is still fully supported. If you wish to allow users to provide a string that specify which ciphers to use (which is recommended), you should use `gnutls_priority_set_direct()` or `gnutls_priority_set()` instead.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_set_default_priority

`int gnutls_set_default_priority (`*gnutls_session_t* ***session***`)` [Function]

session: is a `gnutls_session_t` structure.

Sets some default priority on the ciphers, key exchange methods, macs and compression methods.

This is the same as calling: gnutls_priority_set_direct (session, "NORMAL", NULL);

This function is kept around for backwards compatibility, but because of its wide use it is still fully supported. If you wish to allow users to provide a string that specify which ciphers to use (which is recommended), you should use `gnutls_priority_set_direct()` or `gnutls_priority_set()` instead.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_sign_algorithm_get_name

`const char * gnutls_sign_algorithm_get_name` [Function]
(*gnutls_sign_algorithm_t* ***sign***)

Convert a `gnutls_sign_algorithm_t` value to a string.

Returns: a string that contains the name of the specified sign algorithm, or `NULL`.

gnutls_sign_callback_get

`gnutls_sign_func gnutls_sign_callback_get` (*gnutls_session_t* ***session***, *void ** ***userdata***) [Function]

session: is a gnutls session

userdata: if non-`NULL`, will be set to abstract callback pointer.

Retrieve the callback function, and its userdata pointer.

Returns: The function pointer set by `gnutls_sign_callback_set()`, or if not set, `NULL`.

gnutls_sign_callback_set

`void gnutls_sign_callback_set` (*gnutls_session_t* ***session***, *gnutls_sign_func* ***sign_func***, *void * **userdata***) [Function]

session: is a gnutls session

sign_func: function pointer to application's sign callback.

userdata: void pointer that will be passed to sign callback.

Set the callback function. The function must have this prototype:

typedef int (*gnutls_sign_func) (gnutls_session_t session, void *userdata, gnutls_certificate_type_t cert_type, const gnutls_datum_t * cert, const gnutls_datum_t * hash, gnutls_datum_t * signature);

The `userdata` parameter is passed to the `sign_func` verbatim, and can be used to store application-specific data needed in the callback function. See also `gnutls_sign_callback_get()`.

gnutls_sign_get_id

`gnutls_sign_algorithm_t gnutls_sign_get_id` (*const char * **name***) [Function]

name: is a MAC algorithm name

The names are compared in a case insensitive way.

Returns: return a `gnutls_sign_algorithm_t` value corresponding to the specified cipher, or `GNUTLS_SIGN_UNKNOWN` on error.

gnutls_sign_get_name

`const char * gnutls_sign_get_name (`*gnutls_sign_algorithm_t* ***algorithm***`)` [Function]

algorithm: is a public key signature algorithm

Convert a `gnutls_sign_algorithm_t` value to a string.

Returns: a pointer to a string that contains the name of the specified public key signature algorithm, or `NULL`.

Since: 2.6.0

gnutls_sign_list

`const gnutls_sign_algorithm_t * gnutls_sign_list ( void)` [Function]

Get a list of supported public key signature algorithms.

Returns: a zero-terminated list of `gnutls_sign_algorithm_t` integers indicating the available ciphers.

gnutls_srp_allocate_client_credentials

`int gnutls_srp_allocate_client_credentials` [Function]
`(`*gnutls_srp_client_credentials_t* ` * sc``)`

sc: is a pointer to an `gnutls_srp_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, or an error code.

gnutls_srp_allocate_server_credentials

`int gnutls_srp_allocate_server_credentials` [Function]
`(`*gnutls_srp_server_credentials_t* ` * sc``)`

sc: is a pointer to an `gnutls_srp_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, or an error code.

gnutls_srp_base64_decode_alloc

`int gnutls_srp_base64_decode_alloc (`*const gnutls_datum_t ** ***b64_data***`,` *gnutls_datum_t* ` * result``)` [Function]

b64_data: contains the encoded data

result: the place where decoded data lie

This function will decode the given encoded data. The decoded data will be allocated, and stored into result. It will decode using the base64 algorithm as used in libsrp.

You should use `gnutls_free()` to free the returned data.

Warning! This base64 encoding is not the "standard" encoding, so do not use it for non-SRP purposes.

Returns: 0 on success, or an error code.

gnutls_srp_base64_decode

`int gnutls_srp_base64_decode (const gnutls_datum_t * b64_data, char * result, size_t * result_size)` [Function]

b64_data: contain the encoded data

result: the place where decoded data will be copied

result_size: holds the size of the result

This function will decode the given encoded data, using the base64 encoding found in libsrp.

Note that b64_data should be null terminated.

Warning! This base64 encoding is not the "standard" encoding, so do not use it for non-SRP purposes.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the buffer given is not long enough, or 0 on success.

gnutls_srp_base64_encode_alloc

`int gnutls_srp_base64_encode_alloc (const gnutls_datum_t * data, gnutls_datum_t * result)` [Function]

data: contains the raw data

result: will hold the newly allocated encoded data

This function will convert the given data to printable data, using the base64 encoding. This is the encoding used in SRP password files. This function will allocate the required memory to hold the encoded data.

You should use `gnutls_free()` to free the returned data.

Warning! This base64 encoding is not the "standard" encoding, so do not use it for non-SRP purposes.

Returns: 0 on success, or an error code.

gnutls_srp_base64_encode

`int gnutls_srp_base64_encode (const gnutls_datum_t * data, char * result, size_t * result_size)` [Function]

data: contain the raw data

result: the place where base64 data will be copied

result_size: holds the size of the result

This function will convert the given data to printable data, using the base64 encoding, as used in the libsrp. This is the encoding used in SRP password files. If the provided buffer is not long enough GNUTLS_E_SHORT_MEMORY_BUFFER is returned.

Warning! This base64 encoding is not the "standard" encoding, so do not use it for non-SRP purposes.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the buffer given is not long enough, or 0 on success.

gnutls_srp_free_client_credentials

`void gnutls_srp_free_client_credentials` [Function]
(*gnutls_srp_client_credentials_t* `sc`)

sc: is an `gnutls_srp_client_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_srp_free_server_credentials

`void gnutls_srp_free_server_credentials` [Function]
(*gnutls_srp_server_credentials_t* `sc`)

sc: is an `gnutls_srp_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_srp_server_get_username

`const char * gnutls_srp_server_get_username` (*gnutls_session_t* `session`) [Function]

session: is a gnutls session

This function will return the username of the peer. This should only be called in case of SRP authentication and in case of a server. Returns NULL in case of an error.

Returns: SRP username of the peer, or NULL in case of error.

gnutls_srp_set_client_credentials_function

`void gnutls_srp_set_client_credentials_function` [Function]
(*gnutls_srp_client_credentials_t* `cred`, *gnutls_srp_client_credentials_function* * `func`)

cred: is a `gnutls_srp_server_credentials_t` structure.

func: is the callback function

This function can be used to set a callback to retrieve the username and password for client SRP authentication.

The callback's function form is:

int (*callback)(gnutls_session_t, char** username, char**password);

The `username` and `password` must be allocated using `gnutls_malloc()`. `username` and `password` should be ASCII strings or UTF-8 strings prepared using the "SASLprep" profile of "stringprep".

The callback function will be called once per handshake before the initial hello message is sent.

The callback should not return a negative error code the second time called, since the handshake procedure will be aborted.

The callback function should return 0 on success. -1 indicates an error.

gnutls_srp_set_client_credentials

`int gnutls_srp_set_client_credentials` [Function]
(*gnutls_srp_client_credentials_t* **res**, *const char ** **username**, *const char ** **password**)

res: is an `gnutls_srp_client_credentials_t` structure.

username: is the user's userid

password: is the user's password

This function sets the username and password, in a `gnutls_srp_client_credentials_t` structure. Those will be used in SRP authentication. `username` and `password` should be ASCII strings or UTF-8 strings prepared using the "SASLprep" profile of "stringprep".

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, or an error code.

gnutls_srp_set_prime_bits

`void gnutls_srp_set_prime_bits` (*gnutls_session_t* **session**, *unsigned int* **bits**) [Function]

session: is a `gnutls_session_t` structure.

bits: is the number of bits

This function sets the minimum accepted number of bits, for use in an SRP key exchange. If zero, the default 2048 bits will be used.

In the client side it sets the minimum accepted number of bits. If a server sends a prime with less bits than that `GNUTLS_E_RECEIVED_ILLEGAL_PARAMETER` will be returned by the handshake.

Since: 2.6.0

gnutls_srp_set_server_credentials_file

`int gnutls_srp_set_server_credentials_file` [Function]
(*gnutls_srp_server_credentials_t* **res**, *const char ** **password_file**, *const char ** **password_conf_file**)

res: is an `gnutls_srp_server_credentials_t` structure.

password_file: is the SRP password file (tpasswd)

password_conf_file: is the SRP password conf file (tpasswd.conf)

This function sets the password files, in a `gnutls_srp_server_credentials_t` structure. Those password files hold usernames and verifiers and will be used for SRP authentication.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, or an error code.

gnutls_srp_set_server_credentials_function

`void gnutls_srp_set_server_credentials_function` [Function]
(*gnutls_srp_server_credentials_t* **cred**, *gnutls_srp_server_credentials_function ** **func**)

cred: is a `gnutls_srp_server_credentials_t` structure.

func: is the callback function

This function can be used to set a callback to retrieve the user's SRP credentials. The callback's function form is: int (*callback)(gnutls_session_t, const char* username, gnutls_datum_t* salt, gnutls_datum_t *verifier, gnutls_datum_t* g, gnutls_datum_t* n);

`username` contains the actual username. The `salt`, `verifier`, `generator` and `prime` must be filled in using the `gnutls_malloc()`. For convenience `prime` and `generator` may also be one of the static parameters defined in extra.h.

In case the callback returned a negative number then gnutls will assume that the username does not exist.

In order to prevent attackers from guessing valid usernames, if a user does not exist, g and n values should be filled in using a random user's parameters. In that case the callback must return the special value (1).

The callback function will only be called once per handshake. The callback function should return 0 on success, while -1 indicates an error.

gnutls_srp_verifier

`int gnutls_srp_verifier` (*const char * **username***, *const char * **password***, *const gnutls_datum_t * **salt***, *const gnutls_datum_t * **generator***, *const gnutls_datum_t * **prime***, *gnutls_datum_t * **res***) [Function]

username: is the user's name

password: is the user's password

salt: should be some randomly generated bytes

generator: is the generator of the group

prime: is the group's prime

res: where the verifier will be stored.

This function will create an SRP verifier, as specified in RFC2945. The `prime` and `generator` should be one of the static parameters defined in gnutls/extra.h or may be generated using the libgcrypt functions `gcry_prime_generate()` and `gcry_prime_group_generator()`.

The verifier will be allocated with `malloc` and will be stored in `res` using binary format.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, or an error code.

gnutls_strerror_name

`const char * gnutls_strerror_name` (*int **error***) [Function]

error: is an error returned by a gnutls function.

Return the GnuTLS error code define as a string. For example, gnutls_strerror_name (GNUTLS_E_DH_PRIME_UNACCEPTABLE) will return the string "GNUTLS_E_DH_PRIME_UNACCEPTABLE".

Returns: A string corresponding to the symbol name of the error code.

Since: 2.6.0

gnutls_strerror

`const char * gnutls_strerror (int error)` [Function]

error: is a GnuTLS error code, a negative value

This function is similar to `strerror()`. Differences: it accepts an error number returned by a gnutls function; In case of an unknown error a descriptive string is sent instead of NULL.

Error codes are always a negative value.

Returns: A string explaining the GnuTLS error message.

gnutls_transport_get_ptr2

`void gnutls_transport_get_ptr2 (gnutls_session_t session, gnutls_transport_ptr_t * recv_ptr, gnutls_transport_ptr_t * send_ptr)` [Function]

session: is a `gnutls_session_t` structure.

recv_ptr: will hold the value for the pull function

send_ptr: will hold the value for the push function

Used to get the arguments of the transport functions (like PUSH and PULL). These should have been set using `gnutls_transport_set_ptr2()`.

gnutls_transport_get_ptr

`gnutls_transport_ptr_t gnutls_transport_get_ptr (gnutls_session_t session)` [Function]

session: is a `gnutls_session_t` structure.

Used to get the first argument of the transport function (like PUSH and PULL). This must have been set using `gnutls_transport_set_ptr()`.

Returns: first argument of the transport function.

gnutls_transport_set_errno

`void gnutls_transport_set_errno (gnutls_session_t session, int err)` [Function]

session: is a `gnutls_session_t` structure.

err: error value to store in session-specific errno variable.

Store `err` in the session-specific errno variable. Useful values for `err` is EAGAIN and EINTR, other values are treated will be treated as real errors in the push/pull function.

This function is useful in replacement push/pull functions set by gnutls_transport_set_push_function and gnutls_transport_set_pullpush_function under Windows, where the replacement push/pull may not have access to the same `errno` variable that is used by GnuTLS (e.g., the application is linked to msvcr71.dll and gnutls is linked to msvcrt.dll).

If you don't have the `session` variable easily accessible from the push/pull function, and don't worry about thread conflicts, you can also use `gnutls_transport_set_global_errno()`.

gnutls_transport_set_global_errno

`void gnutls_transport_set_global_errno (int err)` [Function]

err: error value to store in global errno variable.

Store `err` in the global errno variable. Useful values for `err` is EAGAIN and EINTR, other values are treated will be treated as real errors in the push/pull function.

This function is useful in replacement push/pull functions set by gnutls_transport_set_push_function and gnutls_transport_set_pullpush_function under Windows, where the replacement push/pull may not have access to the same `errno` variable that is used by GnuTLS (e.g., the application is linked to msvcr71.dll and gnutls is linked to msvcrt.dll).

Whether this function is thread safe or not depends on whether the global variable errno is thread safe, some system libraries make it a thread-local variable. When feasible, using the guaranteed thread-safe `gnutls_transport_set_errno()` may be better.

gnutls_transport_set_lowat

`void gnutls_transport_set_lowat (gnutls_session_t session, int num)` [Function]

session: is a `gnutls_session_t` structure.

num: is the low water value.

Used to set the lowat value in order for select to check if there are pending data to socket buffer. Used only if you have changed the default low water value (default is 1). Normally you will not need that function. This function is only useful if using berkeley style sockets. Otherwise it must be called and set lowat to zero.

gnutls_transport_set_ptr2

`void gnutls_transport_set_ptr2 (gnutls_session_t session, gnutls_transport_ptr_t recv_ptr, gnutls_transport_ptr_t send_ptr)` [Function]

session: is a `gnutls_session_t` structure.

recv_ptr: is the value for the pull function

send_ptr: is the value for the push function

Used to set the first argument of the transport function (like PUSH and PULL). In berkeley style sockets this function will set the connection handle. With this function you can use two different pointers for receiving and sending.

gnutls_transport_set_ptr

`void gnutls_transport_set_ptr (gnutls_session_t session, gnutls_transport_ptr_t ptr)` [Function]

session: is a `gnutls_session_t` structure.

ptr: is the value.

Used to set the first argument of the transport function (like PUSH and PULL). In berkeley style sockets this function will set the connection handle.

gnutls_transport_set_pull_function

`void gnutls_transport_set_pull_function (`*gnutls_session_t* ***session***, *gnutls_pull_func* ***pull_func***`)` [Function]

session: gnutls session

pull_func: a callback function similar to `read()`

This is the function where you set a function for gnutls to receive data. Normally, if you use berkeley style sockets, do not need to use this function since the default (recv(2)) will probably be ok.

PULL_FUNC is of the form, ssize_t (*gnutls_pull_func)(gnutls_transport_ptr_t, void*, size_t);

gnutls_transport_set_push_function

`void gnutls_transport_set_push_function (`*gnutls_session_t* ***session***, *gnutls_push_func* ***push_func***`)` [Function]

session: gnutls session

push_func: a callback function similar to `write()`

This is the function where you set a push function for gnutls to use in order to send data. If you are going to use berkeley style sockets, you do not need to use this function since the default (send(2)) will probably be ok. Otherwise you should specify this function for gnutls to be able to send data.

PUSH_FUNC is of the form, ssize_t (*gnutls_push_func)(gnutls_transport_ptr_t, const void*, size_t);

9.2 X.509 Certificate Functions

The following functions are to be used for X.509 certificate handling. Their prototypes lie in '`gnutls/x509.h`'.

gnutls_pkcs12_bag_decrypt

`int gnutls_pkcs12_bag_decrypt (`*gnutls_pkcs12_bag_t* ***bag***, *const char * * ***pass***`)` [Function]

bag: The bag

pass: The password used for encryption. This can only be ASCII.

This function will decrypt the given encrypted bag and return 0 on success.

gnutls_pkcs12_bag_deinit

`void gnutls_pkcs12_bag_deinit (`*gnutls_pkcs12_bag_t* ***bag***`)` [Function]

bag: The structure to be initialized

This function will deinitialize a PKCS12 Bag structure.

gnutls_pkcs12_bag_encrypt

`int gnutls_pkcs12_bag_encrypt (`*gnutls_pkcs12_bag_t* `bag`, *const char ** `pass`, *unsigned int* `flags``)` [Function]

bag: The bag

pass: The password used for encryption. This can only be ASCII.

flags: should be one of gnutls_pkcs_encrypt_flags_t elements bitwise or'd

This function will encrypt the given bag and return 0 on success.

gnutls_pkcs12_bag_get_count

`int gnutls_pkcs12_bag_get_count (`*gnutls_pkcs12_bag_t* `bag``)` [Function]

bag: The bag

This function will return the number of the elements withing the bag.

gnutls_pkcs12_bag_get_data

`int gnutls_pkcs12_bag_get_data (`*gnutls_pkcs12_bag_t* `bag`, *int* `indx`, *gnutls_datum_t ** `data``)` [Function]

bag: The bag

indx: The element of the bag to get the data from

data: where the bag's data will be. Should be treated as constant.

This function will return the bag's data. The data is a constant that is stored into the bag. Should not be accessed after the bag is deleted.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative error code on error.

gnutls_pkcs12_bag_get_friendly_name

`int gnutls_pkcs12_bag_get_friendly_name (`*gnutls_pkcs12_bag_t* `bag`, *int* `indx`, *char *** `name``)` [Function]

bag: The bag

indx: The bag's element to add the id

name: will hold a pointer to the name (to be treated as const)

This function will return the friendly name, of the specified bag element. The key ID is usually used to distinguish the local private key and the certificate pair.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. or a negative value on error.

gnutls_pkcs12_bag_get_key_id

`int gnutls_pkcs12_bag_get_key_id (`*gnutls_pkcs12_bag_t* `bag`, *int* `indx`, *gnutls_datum_t ** `id``)` [Function]

bag: The bag

indx: The bag's element to add the id

id: where the ID will be copied (to be treated as const)

This function will return the key ID, of the specified bag element. The key ID is usually used to distinguish the local private key and the certificate pair.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. or a negative value on error.

gnutls_pkcs12_bag_get_type

`gnutls_pkcs12_bag_type_t gnutls_pkcs12_bag_get_type` [Function]
(*gnutls_pkcs12_bag_t* **bag**, *int* **indx**)

bag: The bag

indx: The element of the bag to get the type

This function will return the bag's type. One of the gnutls_pkcs12_bag_type_t enumerations.

gnutls_pkcs12_bag_init

`int gnutls_pkcs12_bag_init` (*gnutls_pkcs12_bag_t* * **bag**) [Function]

bag: The structure to be initialized

This function will initialize a PKCS12 bag structure. PKCS12 Bags usually contain private keys, lists of X.509 Certificates and X.509 Certificate revocation lists.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs12_bag_set_crl

`int gnutls_pkcs12_bag_set_crl` (*gnutls_pkcs12_bag_t* **bag**, [Function]
gnutls_x509_crl_t **crl**)

bag: The bag

crl: the CRL to be copied.

This function will insert the given CRL into the bag. This is just a wrapper over `gnutls_pkcs12_bag_set_data()`.

Returns: the index of the added bag on success, or a negative value on failure.

gnutls_pkcs12_bag_set_crt

`int gnutls_pkcs12_bag_set_crt` (*gnutls_pkcs12_bag_t* **bag**, [Function]
gnutls_x509_crt_t **crt**)

bag: The bag

crt: the certificate to be copied.

This function will insert the given certificate into the bag. This is just a wrapper over `gnutls_pkcs12_bag_set_data()`.

Returns: the index of the added bag on success, or a negative value on failure.

gnutls_pkcs12_bag_set_data

`int gnutls_pkcs12_bag_set_data (`*gnutls_pkcs12_bag_t* `bag`, *gnutls_pkcs12_bag_type_t* `type`, *const gnutls_datum_t ** `data``)` [Function]

bag: The bag

type: The data's type

data: the data to be copied.

This function will insert the given data of the given type into the bag.

Returns: the index of the added bag on success, or a negative value on error.

gnutls_pkcs12_bag_set_friendly_name

`int gnutls_pkcs12_bag_set_friendly_name (`*gnutls_pkcs12_bag_t* `bag`, *int* `indx`, *const char ** `name``)` [Function]

bag: The bag

indx: The bag's element to add the id

name: the name

This function will add the given key friendly name, to the specified, by the index, bag element. The name will be encoded as a 'Friendly name' bag attribute, which is usually used to set a user name to the local private key and the certificate pair.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. or a negative value on error.

gnutls_pkcs12_bag_set_key_id

`int gnutls_pkcs12_bag_set_key_id (`*gnutls_pkcs12_bag_t* `bag`, *int* `indx`, *const gnutls_datum_t ** `id``)` [Function]

bag: The bag

indx: The bag's element to add the id

id: the ID

This function will add the given key ID, to the specified, by the index, bag element. The key ID will be encoded as a 'Local key identifier' bag attribute, which is usually used to distinguish the local private key and the certificate pair.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. or a negative value on error.

gnutls_pkcs12_deinit

`void gnutls_pkcs12_deinit (`*gnutls_pkcs12_t* `pkcs12`) [Function]

pkcs12: The structure to be initialized

This function will deinitialize a PKCS12 structure.

gnutls_pkcs12_export

`int gnutls_pkcs12_export (`*gnutls_pkcs12_t* **`pkcs12`**, *gnutls_x509_crt_fmt_t* **`format`**, *void ** **`output_data`**, *size_t ** **`output_data_size`**`)` [Function]

pkcs12: Holds the pkcs12 structure

format: the format of output params. One of PEM or DER.

output_data: will contain a structure PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the pkcs12 structure to DER or PEM format.

If the buffer provided is not long enough to hold the output, then *output_data_size will be updated and GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN PKCS12".

Return value: In case of failure a negative value will be returned, and 0 on success.

gnutls_pkcs12_generate_mac

`int gnutls_pkcs12_generate_mac (`*gnutls_pkcs12_t* **`pkcs12`**, *const char ** **`pass`**`)` [Function]

pkcs12: should contain a gnutls_pkcs12_t structure

pass: The password for the MAC

This function will generate a MAC for the PKCS12 structure.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs12_get_bag

`int gnutls_pkcs12_get_bag (`*gnutls_pkcs12_t* **`pkcs12`**, *int* **`indx`**, *gnutls_pkcs12_bag_t* **`bag`**`)` [Function]

pkcs12: should contain a gnutls_pkcs12_t structure

indx: contains the index of the bag to extract

bag: An initialized bag, where the contents of the bag will be copied

This function will return a Bag from the PKCS12 structure.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

After the last Bag has been read GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_pkcs12_import

`int gnutls_pkcs12_import (`*gnutls_pkcs12_t* **`pkcs12`**, *const gnutls_datum_t ** **`data`**, *gnutls_x509_crt_fmt_t* **`format`**, *unsigned int* **`flags`**`)` [Function]

pkcs12: The structure to store the parsed PKCS12.

data: The DER or PEM encoded PKCS12.

format: One of DER or PEM

flags: an ORed sequence of gnutls_privkey_pkcs8_flags

This function will convert the given DER or PEM encoded PKCS12 to the native gnutls_pkcs12_t format. The output will be stored in 'pkcs12'.

If the PKCS12 is PEM encoded it should have a header of "PKCS12".

Returns: On success, GNUTLS_E_SUCCESS is returned, otherwise a negative error value.

gnutls_pkcs12_init

`int gnutls_pkcs12_init (`*gnutls_pkcs12_t * pkcs12*`)` [Function]

pkcs12: The structure to be initialized

This function will initialize a PKCS12 structure. PKCS12 structures usually contain lists of X.509 Certificates and X.509 Certificate revocation lists.

Returns: On success, GNUTLS_E_SUCCESS is returned, otherwise a negative error value.

gnutls_pkcs12_set_bag

`int gnutls_pkcs12_set_bag (`*gnutls_pkcs12_t pkcs12*, *gnutls_pkcs12_bag_t bag*`)` [Function]

pkcs12: should contain a gnutls_pkcs12_t structure

bag: An initialized bag

This function will insert a Bag into the PKCS12 structure.

Returns: On success, GNUTLS_E_SUCCESS is returned, otherwise a negative error value.

gnutls_pkcs12_verify_mac

`int gnutls_pkcs12_verify_mac (`*gnutls_pkcs12_t pkcs12*, *const char * pass*`)` [Function]

pkcs12: should contain a gnutls_pkcs12_t structure

pass: The password for the MAC

This function will verify the MAC for the PKCS12 structure.

Returns: On success, GNUTLS_E_SUCCESS is returned, otherwise a negative error value.

gnutls_pkcs7_deinit

`void gnutls_pkcs7_deinit (`*gnutls_pkcs7_t pkcs7*`)` [Function]

pkcs7: The structure to be initialized

This function will deinitialize a PKCS7 structure.

gnutls_pkcs7_delete_crl

`int gnutls_pkcs7_delete_crl (`*gnutls_pkcs7_t pkcs7*, *int indx*`)` [Function]

indx: the index of the crl to delete

This function will delete a crl from a PKCS7 or RFC2630 crl set. Index starts from 0. Returns 0 on success.

Returns: On success, GNUTLS_E_SUCCESS is returned, otherwise a negative error value.

gnutls_pkcs7_delete_crt

`int gnutls_pkcs7_delete_crt (`*gnutls_pkcs7_t* **`pkcs7`**`, `*int* **`indx`**`)` [Function]

indx: the index of the certificate to delete

This function will delete a certificate from a PKCS7 or RFC2630 certificate set. Index starts from 0. Returns 0 on success.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_export

`int gnutls_pkcs7_export (`*gnutls_pkcs7_t* **`pkcs7`**`,` [Function]
gnutls_x509_crt_fmt_t **`format`**`,` *void ** **`output_data`**`,` *size_t ** **`output_data_size`**`)`

pkcs7: Holds the pkcs7 structure

format: the format of output params. One of PEM or DER.

output_data: will contain a structure PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the pkcs7 structure to DER or PEM format.

If the buffer provided is not long enough to hold the output, then *`output_data_size` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN PKCS7".

Return value: In case of failure a negative value will be returned, and 0 on success.

gnutls_pkcs7_get_crl_count

`int gnutls_pkcs7_get_crl_count (`*gnutls_pkcs7_t* **`pkcs7`**`)` [Function]

This function will return the number of certifcates in the PKCS7 or RFC2630 crl set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_get_crl_raw

`int gnutls_pkcs7_get_crl_raw (`*gnutls_pkcs7_t* **`pkcs7`**`,` *int* **`indx`**`,` [Function]
*void ** **`crl`**`,` *size_t ** **`crl_size`**`)`

indx: contains the index of the crl to extract

crl: the contents of the crl will be copied there (may be null)

crl_size: should hold the size of the crl

This function will return a crl of the PKCS7 or RFC2630 crl set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. If the provided buffer is not long enough, then `crl_size` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` is returned. After the last crl has been read `GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE` will be returned.

gnutls_pkcs7_get_crt_count

`int gnutls_pkcs7_get_crt_count` (*gnutls_pkcs7_t* `pkcs7`) [Function]

This function will return the number of certifcates in the PKCS7 or RFC2630 certificate set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_get_crt_raw

`int gnutls_pkcs7_get_crt_raw` (*gnutls_pkcs7_t* `pkcs7`, *int* `indx`, *void * * `certificate`, *size_t * * `certificate_size`) [Function]

indx: contains the index of the certificate to extract

certificate: the contents of the certificate will be copied there (may be null)

certificate_size: should hold the size of the certificate

This function will return a certificate of the PKCS7 or RFC2630 certificate set.

After the last certificate has been read `GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE` will be returned.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. If the provided buffer is not long enough, then `certificate_size` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` is returned.

gnutls_pkcs7_import

`int gnutls_pkcs7_import` (*gnutls_pkcs7_t* `pkcs7`, *const gnutls_datum_t * * `data`, *gnutls_x509_crt_fmt_t* `format`) [Function]

pkcs7: The structure to store the parsed PKCS7.

data: The DER or PEM encoded PKCS7.

format: One of DER or PEM

This function will convert the given DER or PEM encoded PKCS7 to the native `gnutls_pkcs7_t` format. The output will be stored in 'pkcs7'.

If the PKCS7 is PEM encoded it should have a header of "PKCS7".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_init

`int gnutls_pkcs7_init` (*gnutls_pkcs7_t * * `pkcs7`) [Function]

pkcs7: The structure to be initialized

This function will initialize a PKCS7 structure. PKCS7 structures usually contain lists of X.509 Certificates and X.509 Certificate revocation lists.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_set_crl_raw

`int gnutls_pkcs7_set_crl_raw` (*gnutls_pkcs7_t* `pkcs7`, *const gnutls_datum_t * * `crl`) [Function]

crl: the DER encoded crl to be added

This function will add a crl to the PKCS7 or RFC2630 crl set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_set_crl

`int gnutls_pkcs7_set_crl (`*gnutls_pkcs7_t* ***pkcs7***, *gnutls_x509_crl_t* ***crl***`)` [Function]

crl: the DER encoded crl to be added

This function will add a parsed CRL to the PKCS7 or RFC2630 crl set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_set_crt_raw

`int gnutls_pkcs7_set_crt_raw (`*gnutls_pkcs7_t* ***pkcs7***, *const gnutls_datum_t ** ***crt***`)` [Function]

crt: the DER encoded certificate to be added

This function will add a certificate to the PKCS7 or RFC2630 certificate set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_pkcs7_set_crt

`int gnutls_pkcs7_set_crt (`*gnutls_pkcs7_t* ***pkcs7***, *gnutls_x509_crt_t* ***crt***`)` [Function]

crt: the certificate to be copied.

This function will add a parsed certificate to the PKCS7 or RFC2630 certificate set. This is a wrapper function over `gnutls_pkcs7_set_crt_raw()` .

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_check_issuer

`int gnutls_x509_crl_check_issuer (`*gnutls_x509_crl_t* ***cert***, *gnutls_x509_crt_t* ***issuer***`)` [Function]

issuer: is the certificate of a possible issuer

This function will check if the given CRL was issued by the given issuer certificate. It will return true (1) if the given CRL was issued by the given issuer, and false (0) if not.

A negative value is returned in case of an error.

gnutls_x509_crl_deinit

`void gnutls_x509_crl_deinit (`*gnutls_x509_crl_t* ***crl***`)` [Function]

crl: The structure to be initialized

This function will deinitialize a CRL structure.

gnutls_x509_crl_export

`int gnutls_x509_crl_export (`*gnutls_x509_crl_t* **`crl`**`,` [Function]
gnutls_x509_crt_fmt_t **`format`**`,` *void ** **`output_data`**`,` *size_t ** **`output_data_size`**`)`

crl: Holds the revocation list

format: the format of output params. One of PEM or DER.

output_data: will contain a private key PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the revocation list to DER or PEM format.

If the buffer provided is not long enough to hold the output, then GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN X509 CRL".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. and a negative value on failure.

gnutls_x509_crl_get_crt_count

`int gnutls_x509_crl_get_crt_count (`*gnutls_x509_crl_t* **`crl`**`)` [Function]

crl: should contain a `gnutls_x509_crl_t` structure

This function will return the number of revoked certificates in the given CRL.

Returns: number of certificates, a negative value on failure.

gnutls_x509_crl_get_crt_serial

`int gnutls_x509_crl_get_crt_serial (`*gnutls_x509_crl_t* **`crl`**`,` *int* [Function]
`indx``,` *unsigned char ** **`serial`**`,` *size_t ** **`serial_size`**`,` *time_t ** **`t`**`)`

crl: should contain a `gnutls_x509_crl_t` structure

indx: the index of the certificate to extract (starting from 0)

serial: where the serial number will be copied

serial_size: initially holds the size of serial

t: if non null, will hold the time this certificate was revoked

This function will retrieve the serial number of the specified, by the index, revoked certificate.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. and a negative value on error.

gnutls_x509_crl_get_dn_oid

`int gnutls_x509_crl_get_dn_oid (`*gnutls_x509_crl_t* **`crl`**`,` *int* **`indx`**`,` [Function]
*void ** **`oid`**`,` *size_t ** **`sizeof_oid`**`)`

crl: should contain a gnutls_x509_crl_t structure

indx: Specifies which DN OID to send. Use zero to get the first one.

oid: a pointer to a structure to hold the name (may be null)

sizeof_oid: initially holds the size of 'oid'

This function will extract the requested OID of the name of the CRL issuer, specified by the given index.

If oid is null then only the size will be filled.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the provided buffer is not long enough, and in that case the sizeof_oid will be updated with the required size. On success 0 is returned.

gnutls_x509_crl_get_issuer_dn_by_oid

`int gnutls_x509_crl_get_issuer_dn_by_oid (`*gnutls_x509_crl_t* **`crl`**, *const char * oid*, *int* **`indx`**, *unsigned int* **`raw_flag`**, *void * buf*, *size_t * sizeof_buf*`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

oid: holds an Object Identified in null terminated string

indx: In case multiple same OIDs exist in the RDN, this specifies which to send. Use zero to get the first one.

raw_flag: If non zero returns the raw DER data of the DN part.

buf: a pointer to a structure to hold the peer's name (may be null)

sizeof_buf: initially holds the size of `buf`

This function will extract the part of the name of the CRL issuer specified by the given OID. The output will be encoded as described in RFC2253. The output string will be ASCII or UTF-8 encoded, depending on the certificate data.

Some helper macros with popular OIDs can be found in gnutls/x509.h If raw flag is zero, this function will only return known OIDs as text. Other OIDs will be DER encoded, as described in RFC2253 – in hex format with a '\#' prefix. You can check about known OIDs using `gnutls_x509_dn_oid_known()`.

If buf is null then only the size will be filled.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the provided buffer is not long enough, and in that case the sizeof_buf will be updated with the required size, and 0 on success.

gnutls_x509_crl_get_issuer_dn

`int gnutls_x509_crl_get_issuer_dn (`*const gnutls_x509_crl_t* **`crl`**, *char * buf*, *size_t * sizeof_buf*`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

buf: a pointer to a structure to hold the peer's name (may be null)

sizeof_buf: initially holds the size of `buf`

This function will copy the name of the CRL issuer in the provided buffer. The name will be in the form `"C=xxxx,O=yyyy,CN=zzzz"` as described in RFC2253. The output string will be ASCII or UTF-8 encoded, depending on the certificate data.

If buf is `NULL` then only the size will be filled.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the provided buffer is not long enough, and in that case the sizeof_buf will be updated with the required size, and 0 on success.

gnutls_x509_crl_get_next_update

`time_t gnutls_x509_crl_get_next_update (`*gnutls_x509_crl_t* `crl``)` [Function]

crl: should contain a `gnutls_x509_crl_t` structure

This function will return the time the next CRL will be issued. This field is optional in a CRL so it might be normal to get an error instead.

Returns: when the next CRL will be issued, or (time_t)-1 on error.

gnutls_x509_crl_get_signature_algorithm

`int gnutls_x509_crl_get_signature_algorithm (`*gnutls_x509_crl_t* `crl``)` [Function]

crl: should contain a `gnutls_x509_crl_t` structure

This function will return a value of the `gnutls_sign_algorithm_t` enumeration that is the signature algorithm.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_get_signature

`int gnutls_x509_crl_get_signature (`*gnutls_x509_crl_t* `crl`, *char ** `sig`, *size_t ** `sizeof_sig``)` [Function]

crl: should contain a gnutls_x509_crl_t structure

sig: a pointer where the signature part will be copied (may be null).

sizeof_sig: initially holds the size of `sig`

This function will extract the signature field of a CRL.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. and a negative value on error.

gnutls_x509_crl_get_this_update

`time_t gnutls_x509_crl_get_this_update (`*gnutls_x509_crl_t* `crl``)` [Function]

crl: should contain a `gnutls_x509_crl_t` structure

This function will return the time this CRL was issued.

Returns: when the CRL was issued, or (time_t)-1 on error.

gnutls_x509_crl_get_version

`int gnutls_x509_crl_get_version (`*gnutls_x509_crl_t* `crl``)` [Function]

crl: should contain a `gnutls_x509_crl_t` structure

This function will return the version of the specified CRL.

Returns: The version number, or a negative value on error.

gnutls_x509_crl_import

`int gnutls_x509_crl_import (`*gnutls_x509_crl_t* **`crl`**`, const` *gnutls_datum_t* `*` **`data`**`,` *gnutls_x509_crt_fmt_t* **`format`**`)` [Function]

crl: The structure to store the parsed CRL.

data: The DER or PEM encoded CRL.

format: One of DER or PEM

This function will convert the given DER or PEM encoded CRL to the native `gnutls_x509_crl_t` format. The output will be stored in 'crl'.

If the CRL is PEM encoded it should have a header of "X509 CRL".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_init

`int gnutls_x509_crl_init (`*gnutls_x509_crl_t* `*` **`crl`**`)` [Function]

crl: The structure to be initialized

This function will initialize a CRL structure. CRL stands for Certificate Revocation List. A revocation list usually contains lists of certificate serial numbers that have been revoked by an Authority. The revocation lists are always signed with the authority's private key.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_print

`int gnutls_x509_crl_print (`*gnutls_x509_crl_t* **`crl`**`,` *gnutls_certificate_print_formats_t* **`format`**`,` *gnutls_datum_t* `*` **`out`**`)` [Function]

crl: The structure to be printed

format: Indicate the format to use

out: Newly allocated datum with zero terminated string.

This function will pretty print a X.509 certificate revocation list, suitable for display to a human.

The output `out` needs to be deallocate using `gnutls_free()`.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_set_crt_serial

`int gnutls_x509_crl_set_crt_serial (`*gnutls_x509_crl_t* **`crl`**`, const` *void* `*` **`serial`**`,` *size_t* **`serial_size`**`,` *time_t* **`revocation_time`**`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

serial: The revoked certificate's serial number

serial_size: Holds the size of the serial field.

revocation_time: The time this certificate was revoked

This function will set a revoked certificate's serial number to the CRL.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_set_crt

`int gnutls_x509_crl_set_crt (`*gnutls_x509_crl_t* **`crl`**`,` *gnutls_x509_crt_t* **`crt`**`,` *time_t* **`revocation_time`**`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

crt: a certificate of type `gnutls_x509_crt_t` with the revoked certificate

revocation_time: The time this certificate was revoked

This function will set a revoked certificate's serial number to the CRL.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_set_next_update

`int gnutls_x509_crl_set_next_update (`*gnutls_x509_crl_t* **`crl`**`,` *time_t* **`exp_time`**`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

exp_time: The actual time

This function will set the time this CRL will be updated.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_set_this_update

`int gnutls_x509_crl_set_this_update (`*gnutls_x509_crl_t* **`crl`**`,` *time_t* **`act_time`**`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

act_time: The actual time

This function will set the time this CRL was issued.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_set_version

`int gnutls_x509_crl_set_version (`*gnutls_x509_crl_t* **`crl`**`,` *unsigned int* **`version`**`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

version: holds the version number. For CRLv1 crls must be 1.

This function will set the version of the CRL. This must be one for CRL version 1, and so on. The CRLs generated by gnutls should have a version number of 2.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_sign2

`int gnutls_x509_crl_sign2 (`*gnutls_x509_crl_t* **`crl`**`,` *gnutls_x509_crt_t* **`issuer`**`,` *gnutls_x509_privkey_t* **`issuer_key`**`,` *gnutls_digest_algorithm_t* **`dig`**`,` *unsigned int* **`flags`**`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

issuer: is the certificate of the certificate issuer

issuer_key: holds the issuer's private key

dig: The message digest to use. GNUTLS_DIG_SHA1 is the safe choice unless you know what you're doing.

flags: must be 0

This function will sign the CRL with the issuer's private key, and will copy the issuer's information into the CRL.

This must be the last step in a certificate CRL since all the previously set parameters are now signed.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_sign

`int gnutls_x509_crl_sign (`*gnutls_x509_crl_t* **`crl`**`, `*gnutls_x509_crt_t* **`issuer`**`, `*gnutls_x509_privkey_t* **`issuer_key`**`)` [Function]

crl: should contain a gnutls_x509_crl_t structure

issuer: is the certificate of the certificate issuer

issuer_key: holds the issuer's private key

This function is the same a `gnutls_x509_crl_sign2()` with no flags, and SHA1 as the hash algorithm.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crl_verify

`int gnutls_x509_crl_verify (`*gnutls_x509_crl_t* **`crl`**`, const` *gnutls_x509_crt_t* `*` **`CA_list`**`, int` **`CA_list_length`**`, unsigned int` **`flags`**`, unsigned int *` **`verify`**`)` [Function]

crl: is the crl to be verified

CA_list: is a certificate list that is considered to be trusted one

CA_list_length: holds the number of CA certificates in CA_list

flags: Flags that may be used to change the verification algorithm. Use OR of the gnutls_certificate_verify_flags enumerations.

verify: will hold the crl verification output.

This function will try to verify the given crl and return its status. See `gnutls_x509_crt_list_verify()` for a detailed description of return values.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative value in case of an error.

gnutls_x509_crq_deinit

`void gnutls_x509_crq_deinit (`*gnutls_x509_crq_t* **`crq`**`)` [Function]

crq: The structure to be initialized

This function will deinitialize a CRL structure.

gnutls_x509_crq_export

`int gnutls_x509_crq_export (`*gnutls_x509_crq_t* **`crq`**`,` *gnutls_x509_crt_fmt_t* **`format`**`,` *void ** **`output_data`**`,` *size_t ** **`output_data_size`**`)` [Function]

crq: Holds the request

format: the format of output params. One of PEM or DER.

output_data: will contain a certificate request PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the certificate request to a PKCS10

If the buffer provided is not long enough to hold the output, then GNUTLS_E_SHORT_MEMORY_BUFFER will be returned and *output_data_size will be updated.

If the structure is PEM encoded, it will have a header of "BEGIN NEW CERTIFICATE REQUEST".

Return value: In case of failure a negative value will be returned, and 0 on success.

gnutls_x509_crq_get_attribute_by_oid

`int gnutls_x509_crq_get_attribute_by_oid (`*gnutls_x509_crq_t* **`crq`**`,` *const char ** **`oid`**`,` *int* **`indx`**`,` *void ** **`buf`**`,` *size_t ** **`sizeof_buf`**`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

oid: holds an Object Identified in null terminated string

indx: In case multiple same OIDs exist in the attribute list, this specifies which to send. Use zero to get the first one.

buf: a pointer to a structure to hold the attribute data (may be null)

sizeof_buf: initially holds the size of `buf`

This function will return the attribute in the certificate request specified by the given Object ID. The attribute will be DER encoded.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_get_challenge_password

`int gnutls_x509_crq_get_challenge_password (`*gnutls_x509_crq_t* **`crq`**`,` *char ** **`pass`**`,` *size_t ** **`sizeof_pass`**`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

pass: will hold a null terminated password

sizeof_pass: Initially holds the size of `pass`.

This function will return the challenge password in the request.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_get_dn_by_oid

`int gnutls_x509_crq_get_dn_by_oid (`*gnutls_x509_crq_t* **`crq`**, *const char ** **`oid`**, *int* **`indx`**, *unsigned int* **`raw_flag`**, *void ** **`buf`**, *size_t ** **`sizeof_buf`**`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

oid: holds an Object Identified in null terminated string

indx: In case multiple same OIDs exist in the RDN, this specifies which to send. Use zero to get the first one.

raw_flag: If non zero returns the raw DER data of the DN part.

buf: a pointer to a structure to hold the name (may be null)

sizeof_buf: initially holds the size of `buf`

This function will extract the part of the name of the Certificate request subject, specified by the given OID. The output will be encoded as described in RFC2253. The output string will be ASCII or UTF-8 encoded, depending on the certificate data.

Some helper macros with popular OIDs can be found in gnutls/x509.h If raw flag is zero, this function will only return known OIDs as text. Other OIDs will be DER encoded, as described in RFC2253 – in hex format with a '\#' prefix. You can check about known OIDs using `gnutls_x509_dn_oid_known()`.

If `buf` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_buf will be updated with the required size. On success 0 is returned.

gnutls_x509_crq_get_dn_oid

`int gnutls_x509_crq_get_dn_oid (`*gnutls_x509_crq_t* **`crq`**, *int* **`indx`**, *void ** **`oid`**, *size_t ** **`sizeof_oid`**`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

indx: Specifies which DN OID to send. Use zero to get the first one.

oid: a pointer to a structure to hold the name (may be null)

sizeof_oid: initially holds the size of `oid`

This function will extract the requested OID of the name of the Certificate request subject, specified by the given index.

If oid is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_oid will be updated with the required size. On success 0 is returned.

gnutls_x509_crq_get_dn

`int gnutls_x509_crq_get_dn (`*gnutls_x509_crq_t* **`crq`**, *char ** **`buf`**, *size_t ** **`sizeof_buf`**`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

buf: a pointer to a structure to hold the name (may be null)

sizeof_buf: initially holds the size of `buf`

This function will copy the name of the Certificate request subject in the provided buffer. The name will be in the form "C=xxxx,O=yyyy,CN=zzzz" as described in RFC2253. The output string will be ASCII or UTF-8 encoded, depending on the certificate data.

If `buf` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_buf will be updated with the required size. On success 0 is returned.

gnutls_x509_crq_get_pk_algorithm

`int gnutls_x509_crq_get_pk_algorithm (`*gnutls_x509_crq_t* `crq`, *unsigned int ** `bits``)` [Function]

crq: should contain a gnutls_x509_crq_t structure

bits: if bits is non null it will hold the size of the parameters' in bits

This function will return the public key algorithm of a PKCS `\10` certificate request.

If bits is non null, it should have enough size to hold the parameters size in bits. For RSA the bits returned is the modulus. For DSA the bits returned are of the public exponent.

Returns: a member of the `gnutls_pk_algorithm_t` enumeration on success, or a negative value on error.

gnutls_x509_crq_get_version

`int gnutls_x509_crq_get_version (`*gnutls_x509_crq_t* `crq`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

This function will return the version of the specified Certificate request.

Returns: version of certificate request, or a negative value on error.

gnutls_x509_crq_import

`int gnutls_x509_crq_import (`*gnutls_x509_crq_t* `crq`, *const gnutls_datum_t ** `data`, *gnutls_x509_crt_fmt_t* `format`)` [Function]

crq: The structure to store the parsed certificate request.

data: The DER or PEM encoded certificate.

format: One of DER or PEM

This function will convert the given DER or PEM encoded Certificate to the native gnutls_x509_crq_t format. The output will be stored in `cert`.

If the Certificate is PEM encoded it should have a header of "NEW CERTIFICATE REQUEST".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_init

`int gnutls_x509_crq_init (`*gnutls_x509_crq_t * `crq`*`)` [Function]

crq: The structure to be initialized

This function will initialize a PKCS10 certificate request structure.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_set_attribute_by_oid

`int gnutls_x509_crq_set_attribute_by_oid (`*gnutls_x509_crq_t `crq`, const char * `oid`, void * `buf`, size_t `sizeof_buf`*`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

oid: holds an Object Identified in null terminated string

buf: a pointer to a structure that holds the attribute data

sizeof_buf: holds the size of `buf`

This function will set the attribute in the certificate request specified by the given Object ID. The attribute must be be DER encoded.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_set_challenge_password

`int gnutls_x509_crq_set_challenge_password (`*gnutls_x509_crq_t `crq`, const char * `pass`*`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

pass: holds a null terminated password

This function will set a challenge password to be used when revoking the request.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_set_dn_by_oid

`int gnutls_x509_crq_set_dn_by_oid (`*gnutls_x509_crq_t `crq`, const char * `oid`, unsigned int `raw_flag`, const void * `data`, unsigned int `sizeof_data`*`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

oid: holds an Object Identifier in a null terminated string

raw_flag: must be 0, or 1 if the data are DER encoded

data: a pointer to the input data

sizeof_data: holds the size of `data`

This function will set the part of the name of the Certificate request subject, specified by the given OID. The input string should be ASCII or UTF-8 encoded.

Some helper macros with popular OIDs can be found in gnutls/x509.h With this function you can only set the known OIDs. You can test for known OIDs using `gnutls_x509_dn_oid_known()`. For OIDs that are not known (by gnutls) you should properly DER encode your data, and call this function with raw_flag set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_set_key_rsa_raw

`int gnutls_x509_crq_set_key_rsa_raw (`*gnutls_x509_crq_t* `crq`, *const gnutls_datum_t ** `m`, *const gnutls_datum_t ** `e``)` [Function]

crq: should contain a `gnutls_x509_crq_t` structure

m: holds the modulus

e: holds the public exponent

This function will set the public parameters from the given private key to the request. Only RSA keys are currently supported.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

Since: 2.6.0

gnutls_x509_crq_set_key

`int gnutls_x509_crq_set_key (`*gnutls_x509_crq_t* `crq`, *gnutls_x509_privkey_t* `key`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

key: holds a private key

This function will set the public parameters from the given private key to the request. Only RSA keys are currently supported.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_set_version

`int gnutls_x509_crq_set_version (`*gnutls_x509_crq_t* `crq`, *unsigned int* `version`)` [Function]

crq: should contain a gnutls_x509_crq_t structure

version: holds the version number. For v1 Requests must be 1.

This function will set the version of the certificate request. For version 1 requests this must be one.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crq_sign2

`int gnutls_x509_crq_sign2 (`*gnutls_x509_crq_t* `crq`, *gnutls_x509_privkey_t* `key`, *gnutls_digest_algorithm_t* `dig`, *unsigned int* `flags`)` [Function]

crq: should contain a `gnutls_x509_crq_t` structure

key: holds a private key

dig: The message digest to use, `GNUTLS_DIG_SHA1` is the safe choice unless you know what you're doing.

flags: must be 0

This function will sign the certificate request with a private key. This must be the same key as the one used in `gnutls_x509_crt_set_key()` since a certificate request is self signed.

This must be the last step in a certificate request generation since all the previously set parameters are now signed.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error. `GNUTLS_E_ASN1_VALUE_NOT_FOUND` is returned if you didn't set all information in the certificate request (e.g., the version using `gnutls_x509_crq_set_version()`).

gnutls_x509_crq_sign

`int gnutls_x509_crq_sign (`*gnutls_x509_crq_t* **`crq`**`,` [Function]
gnutls_x509_privkey_t **`key`**`)`

crq: should contain a gnutls_x509_crq_t structure

key: holds a private key

This function is the same a `gnutls_x509_crq_sign2()` with no flags, and SHA1 as the hash algorithm.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_check_hostname

`int gnutls_x509_crt_check_hostname (`*gnutls_x509_crt_t* **`cert`**`,` [Function]
*const char ** **`hostname`**`)`

cert: should contain an gnutls_x509_crt_t structure

hostname: A null terminated string that contains a DNS name

This function will check if the given certificate's subject matches the given hostname. This is a basic implementation of the matching described in RFC2818 (HTTPS), which takes into account wildcards, and the DNSName/IPAddress subject alternative name PKIX extension.

Returns: non zero for a successful match, and zero on failure.

gnutls_x509_crt_check_issuer

`int gnutls_x509_crt_check_issuer (`*gnutls_x509_crt_t* **`cert`**`,` [Function]
gnutls_x509_crt_t **`issuer`**`)`

cert: is the certificate to be checked

issuer: is the certificate of a possible issuer

This function will check if the given certificate was issued by the given issuer. It will return true (1) if the given certificate is issued by the given issuer, and false (0) if not.

A negative value is returned in case of an error.

gnutls_x509_crt_check_revocation

`int gnutls_x509_crt_check_revocation (`*gnutls_x509_crt_t* **`cert`**`,` [Function]
*const gnutls_x509_crl_t ** **`crl_list`**`,` *int* **`crl_list_length`**`)`

cert: should contain a `gnutls_x509_crt_t` structure

crl_list: should contain a list of gnutls_x509_crl_t structures

crl_list_length: the length of the crl_list

This function will return check if the given certificate is revoked. It is assumed that the CRLs have been verified before.

Returns: 0 if the certificate is NOT revoked, and 1 if it is. A negative value is returned on error.

gnutls_x509_crt_cpy_crl_dist_points

`int gnutls_x509_crt_cpy_crl_dist_points (`*gnutls_x509_crt_t* **`dst`**`,` *gnutls_x509_crt_t* **`src`**`)` [Function]

dst: a certificate of type `gnutls_x509_crt_t`

src: the certificate where the dist points will be copied from

This function will copy the CRL distribution points certificate extension, from the source to the destination certificate. This may be useful to copy from a CA certificate to issued ones.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_deinit

`void gnutls_x509_crt_deinit (`*gnutls_x509_crt_t* **`cert`**`)` [Function]

cert: The structure to be initialized

This function will deinitialize a CRL structure.

gnutls_x509_crt_export

`int gnutls_x509_crt_export (`*gnutls_x509_crt_t* **`cert`**`,` *gnutls_x509_crt_fmt_t* **`format`**`,` *void ** **`output_data`**`,` *size_t ** **`output_data_size`**`)` [Function]

cert: Holds the certificate

format: the format of output params. One of PEM or DER.

output_data: will contain a certificate PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the certificate to DER or PEM format.

If the buffer provided is not long enough to hold the output, then *output_data_size is updated and GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN CERTIFICATE".

Return value: In case of failure a negative value will be returned, and 0 on success.

gnutls_x509_crt_get_activation_time

`time_t gnutls_x509_crt_get_activation_time (`*gnutls_x509_crt_t* **`cert`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

This function will return the time this Certificate was or will be activated.

Returns: activation time, or (time_t)-1 on error.

gnutls_x509_crt_get_authority_key_id

`int gnutls_x509_crt_get_authority_key_id (`*gnutls_x509_crt_t* `cert`, *void ** `ret`, *size_t ** `ret_size`, *unsigned int ** `critical``)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

critical: will be non zero if the extension is marked as critical (may be null)

This function will return the X.509v3 certificate authority's key identifier. This is obtained by the X.509 Authority Key identifier extension field (2.5.29.35). Note that this function only returns the keyIdentifier field of the extension.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative value in case of an error.

gnutls_x509_crt_get_basic_constraints

`int gnutls_x509_crt_get_basic_constraints (`*gnutls_x509_crt_t* `cert`, *unsigned int ** `critical`, *int ** `ca`, *int ** `pathlen`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

critical: will be non zero if the extension is marked as critical

ca: pointer to output integer indicating CA status, may be NULL, value is 1 if the certificate CA flag is set, 0 otherwise.

pathlen: pointer to output integer indicating path length (may be NULL), non-negative values indicate a present pathLenConstraint field and the actual value, -1 indicate that the field is absent.

This function will read the certificate's basic constraints, and return the certificates CA status. It reads the basicConstraints X.509 extension (2.5.29.19).

Return value: If the certificate is a CA a positive value will be returned, or zero if the certificate does not have CA flag set. A negative value may be returned in case of errors. If the certificate does not contain the basicConstraints extension GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_ca_status

`int gnutls_x509_crt_get_ca_status (`*gnutls_x509_crt_t* `cert`, *unsigned int ** `critical`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

critical: will be non zero if the extension is marked as critical

This function will return certificates CA status, by reading the basicConstraints X.509 extension (2.5.29.19). If the certificate is a CA a positive value will be returned, or zero if the certificate does not have CA flag set.

Use `gnutls_x509_crt_get_basic_constraints()` if you want to read the pathLenConstraint field too.

A negative value may be returned in case of parsing error. If the certificate does not contain the basicConstraints extension GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_crl_dist_points

`int gnutls_x509_crt_get_crl_dist_points (`*gnutls_x509_crt_t* `cert`, *unsigned int* `seq`, *void ** `ret`, *size_t ** `ret_size`, *unsigned int ** `reason_flags`, *unsigned int ** `critical``)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

seq: specifies the sequence number of the distribution point (0 for the first one, 1 for the second etc.)

ret: is the place where the distribution point will be copied to

ret_size: holds the size of ret.

reason_flags: Revocation reasons flags.

critical: will be non zero if the extension is marked as critical (may be null)

This function will return the CRL distribution points (2.5.29.31), contained in the given certificate.

`reason_flags` should be an ORed sequence of GNUTLS_CRL_REASON_UNUSED, GNUTLS_CRL_REASON_KEY_COMPROMISE, GNUTLS_CRL_REASON_CA_COMPROMISE, GNUTLS_CRL_REASON_AFFILIATION_CHANGED, GNUTLS_CRL_REASON_SUPERSEEDED, GNUTLS_CRL_REASON_CESSATION_OF_OPERATION, GNUTLS_CRL_REASON_CERTIFICATE GNUTLS_CRL_REASON_PRIVILEGE_WITHDRAWN, GNUTLS_CRL_REASON_AA_COMPROMIS or zero for all possible reasons.

This is specified in X509v3 Certificate Extensions. GNUTLS will return the distribution point type, or a negative error code on error.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` and updates &`ret_size` if &`ret_size` is not enough to hold the distribution point, or the type of the distribution point if everything was ok. The type is one of the enumerated `gnutls_x509_subject_alt_name_t`. If the certificate does not have an Alternative name with the specified sequence number then `GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE` is returned.

gnutls_x509_crt_get_dn_by_oid

`int gnutls_x509_crt_get_dn_by_oid (`*gnutls_x509_crt_t* `cert`, *const char ** `oid`, *int* `indx`, *unsigned int* `raw_flag`, *void ** `buf`, *size_t ** `sizeof_buf``)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

oid: holds an Object Identified in null terminated string

indx: In case multiple same OIDs exist in the RDN, this specifies which to send. Use zero to get the first one.

raw_flag: If non zero returns the raw DER data of the DN part.

buf: a pointer where the DN part will be copied (may be null).

sizeof_buf: initially holds the size of `buf`

This function will extract the part of the name of the Certificate subject specified by the given OID. The output, if the raw flag is not used, will be encoded as described in RFC2253. Thus a string that is ASCII or UTF-8 encoded, depending on the certificate data.

Some helper macros with popular OIDs can be found in gnutls/x509.h If raw flag is zero, this function will only return known OIDs as text. Other OIDs will be DER encoded, as described in RFC2253 – in hex format with a '\#' prefix. You can check about known OIDs using `gnutls_x509_dn_oid_known()`.

If `buf` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_buf will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_dn_oid

`int gnutls_x509_crt_get_dn_oid (`*gnutls_x509_crt_t* **`cert`**`,` *int* **`indx`**`,` *void ** **`oid`**`,` *size_t ** **`sizeof_oid`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

indx: This specifies which OID to return. Use zero to get the first one.

oid: a pointer to a buffer to hold the OID (may be null)

sizeof_oid: initially holds the size of `oid`

This function will extract the OIDs of the name of the Certificate subject specified by the given index.

If oid is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_oid will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_dn

`int gnutls_x509_crt_get_dn (`*gnutls_x509_crt_t* **`cert`**`,` *char ** **`buf`**`,` *size_t ** **`sizeof_buf`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

buf: a pointer to a structure to hold the name (may be null)

sizeof_buf: initially holds the size of `buf`

This function will copy the name of the Certificate in the provided buffer. The name will be in the form `"C=xxxx,O=yyyy,CN=zzzz"` as described in RFC2253. The output string will be ASCII or UTF-8 encoded, depending on the certificate data.

If `buf` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_buf will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_expiration_time

`time_t gnutls_x509_crt_get_expiration_time (`*gnutls_x509_crt_t* **`cert`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

This function will return the time this Certificate was or will be expired.

Returns: expiration time, or (time_t)-1 on error.

gnutls_x509_crt_get_extension_by_oid

`int gnutls_x509_crt_get_extension_by_oid (`*gnutls_x509_crt_t* **`cert`**, *const char * * **`oid`**, *int* **`indx`**, *void * * **`buf`**, *size_t * * **`sizeof_buf`**, *unsigned int * * **`critical`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

oid: holds an Object Identified in null terminated string

indx: In case multiple same OIDs exist in the extensions, this specifies which to send. Use zero to get the first one.

buf: a pointer to a structure to hold the name (may be null)

sizeof_buf: initially holds the size of `buf`

critical: will be non zero if the extension is marked as critical

This function will return the extension specified by the OID in the certificate. The extensions will be returned as binary data DER encoded, in the provided buffer.

A negative value may be returned in case of parsing error. If the certificate does not contain the specified extension GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_extension_data

`int gnutls_x509_crt_get_extension_data (`*gnutls_x509_crt_t* **`cert`**, *int* **`indx`**, *void * * **`data`**, *size_t * * **`sizeof_data`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

indx: Specifies which extension OID to send. Use zero to get the first one.

data: a pointer to a structure to hold the data (may be null)

sizeof_data: initially holds the size of `oid`

This function will return the requested extension data in the certificate. The extension data will be stored as a string in the provided buffer.

Use `gnutls_x509_crt_get_extension_info()` to extract the OID and critical flag. Use `gnutls_x509_crt_get_extension_by_oid()` instead, if you want to get data indexed by the extension OID rather than sequence.

Return 0 on success. A negative value may be returned in case of parsing error. If you have reached the last extension available GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_extension_info

`int gnutls_x509_crt_get_extension_info (`*gnutls_x509_crt_t* **`cert`**, *int* **`indx`**, *void * * **`oid`**, *size_t * * **`sizeof_oid`**, *int * * **`critical`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

indx: Specifies which extension OID to send. Use zero to get the first one.

oid: a pointer to a structure to hold the OID

sizeof_oid: initially holds the maximum size of `oid`, on return holds actual size of `oid`.

critical: output variable with critical flag, may be NULL.

This function will return the requested extension OID in the certificate, and the critical flag for it. The extension OID will be stored as a string in the provided buffer. Use `gnutls_x509_crt_get_extension_data()` to extract the data.

If the buffer provided is not long enough to hold the output, then *`sizeof_oid` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` will be returned.

Return 0 on success. A negative value may be returned in case of parsing error. If you have reached the last extension available GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_extension_oid

`int gnutls_x509_crt_get_extension_oid` (*gnutls_x509_crt_t* **`cert`**, *int* **`indx`**, *void * * **`oid`**, *size_t * * **`sizeof_oid`**) [Function]

cert: should contain a `gnutls_x509_crt_t` structure

indx: Specifies which extension OID to send. Use zero to get the first one.

oid: a pointer to a structure to hold the OID (may be null)

sizeof_oid: initially holds the size of `oid`

This function will return the requested extension OID in the certificate. The extension OID will be stored as a string in the provided buffer.

A negative value may be returned in case of parsing error. If your have reached the last extension available GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_fingerprint

`int gnutls_x509_crt_get_fingerprint` (*gnutls_x509_crt_t* **`cert`**, *gnutls_digest_algorithm_t* **`algo`**, *void * * **`buf`**, *size_t * * **`sizeof_buf`**) [Function]

cert: should contain a `gnutls_x509_crt_t` structure

algo: is a digest algorithm

buf: a pointer to a structure to hold the fingerprint (may be null)

sizeof_buf: initially holds the size of `buf`

This function will calculate and copy the certificate's fingerprint in the provided buffer.

If the buffer is null then only the size will be filled.

Returns: `GNUTLS_E_SHORT_MEMORY_BUFFER` if the provided buffer is not long enough, and in that case the *sizeof_buf will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_issuer_dn_by_oid

`int gnutls_x509_crt_get_issuer_dn_by_oid` (*gnutls_x509_crt_t* **`cert`**, *const char * * **`oid`**, *int* **`indx`**, *unsigned int* **`raw_flag`**, *void * * **`buf`**, *size_t * * **`sizeof_buf`**) [Function]

cert: should contain a `gnutls_x509_crt_t` structure

oid: holds an Object Identified in null terminated string

indx: In case multiple same OIDs exist in the RDN, this specifies which to send. Use zero to get the first one.

raw_flag: If non zero returns the raw DER data of the DN part.

buf: a pointer to a structure to hold the name (may be null)

sizeof_buf: initially holds the size of `buf`

This function will extract the part of the name of the Certificate issuer specified by the given OID. The output, if the raw flag is not used, will be encoded as described in RFC2253. Thus a string that is ASCII or UTF-8 encoded, depending on the certificate data.

Some helper macros with popular OIDs can be found in gnutls/x509.h If raw flag is zero, this function will only return known OIDs as text. Other OIDs will be DER encoded, as described in RFC2253 – in hex format with a '\#' prefix. You can check about known OIDs using `gnutls_x509_dn_oid_known()`.

If `buf` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_buf will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_issuer_dn_oid

`int gnutls_x509_crt_get_issuer_dn_oid (`*gnutls_x509_crt_t* **`cert`**`,` *int* **`indx`**`,` *void ** **`oid`**`,` *size_t ** **`sizeof_oid`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

indx: This specifies which OID to return. Use zero to get the first one.

oid: a pointer to a buffer to hold the OID (may be null)

sizeof_oid: initially holds the size of `oid`

This function will extract the OIDs of the name of the Certificate issuer specified by the given index.

If `oid` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_oid will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_issuer_dn

`int gnutls_x509_crt_get_issuer_dn (`*gnutls_x509_crt_t* **`cert`**`,` *char ** **`buf`**`,` *size_t ** **`sizeof_buf`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

buf: a pointer to a structure to hold the name (may be null)

sizeof_buf: initially holds the size of `buf`

This function will copy the name of the Certificate issuer in the provided buffer. The name will be in the form `"C=xxxx,O=yyyy,CN=zzzz"` as described in RFC2253. The output string will be ASCII or UTF-8 encoded, depending on the certificate data.

If `buf` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_buf will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_issuer

`int gnutls_x509_crt_get_issuer (`*gnutls_x509_crt_t* **`cert`**`,` *gnutls_x509_dn_t ** **`dn`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

dn: output variable with pointer to opaque DN

Return the Certificate's Issuer DN as an opaque data type. You may use `gnutls_x509_dn_get_rdn_ava()` to decode the DN.

Note that `dn` should be treated as constant. Because points into the `cert` object, you may not deallocate `cert` and continue to access `dn`.

Returns: Returns 0 on success, or an error code.

gnutls_x509_crt_get_key_id

`int gnutls_x509_crt_get_key_id (`*gnutls_x509_crt_t* **`crt`**`,` *unsigned int* **`flags`**`,` *unsigned char ** **`output_data`**`,` *size_t ** **`output_data_size`**`)` [Function]

crt: Holds the certificate

flags: should be 0 for now

output_data: will contain the key ID

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will return a unique ID the depends on the public key parameters. This ID can be used in checking whether a certificate corresponds to the given private key.

If the buffer provided is not long enough to hold the output, then *output_data_size is updated and GNUTLS_E_SHORT_MEMORY_BUFFER will be returned. The output will normally be a SHA-1 hash output, which is 20 bytes.

Return value: In case of failure a negative value will be returned, and 0 on success.

gnutls_x509_crt_get_key_purpose_oid

`int gnutls_x509_crt_get_key_purpose_oid (`*gnutls_x509_crt_t* **`cert`**`,` *int* **`indx`**`,` *void ** **`oid`**`,` *size_t ** **`sizeof_oid`**`,` *unsigned int ** **`critical`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

indx: This specifies which OID to return. Use zero to get the first one.

oid: a pointer to a buffer to hold the OID (may be null)

sizeof_oid: initially holds the size of `oid`

This function will extract the key purpose OIDs of the Certificate specified by the given index. These are stored in the Extended Key Usage extension (2.5.29.37) See the GNUTLS_KP_* definitions for human readable names.

If `oid` is null then only the size will be filled.

Returns: GNUTLS_E_SHORT_MEMORY_BUFFER if the provided buffer is not long enough, and in that case the *sizeof_oid will be updated with the required size. On success 0 is returned.

gnutls_x509_crt_get_key_usage

int gnutls_x509_crt_get_key_usage (*gnutls_x509_crt_t* **cert**, *unsigned int * **key_usage***, *unsigned int * **critical***) [Function]

cert: should contain a gnutls_x509_crt_t structure

key_usage: where the key usage bits will be stored

critical: will be non zero if the extension is marked as critical

This function will return certificate's key usage, by reading the keyUsage X.509 extension (2.5.29.15). The key usage value will

ORed values of the: GNUTLS_KEY_DIGITAL_SIGNATURE, GNUTLS_KEY_NON_REPUDIATION, GNUTLS_KEY_KEY_ENCIPHERMENT, GNUTLS_KEY_DATA_ENCIPHERMENT, GNUTLS_KEY_KEY_AGREEMENT, GNUTLS_KEY_KEY_CERT_SIGN, GNUTLS_KEY_CRL_SIGN, GNUTLS_KEY_ENCIPHER_ONLY, GNUTLS_KEY_DECIPHER_ONLY.

Returns: the certificate key usage, or a negative value in case of parsing error. If the certificate does not contain the keyUsage extension GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_pk_algorithm

int gnutls_x509_crt_get_pk_algorithm (*gnutls_x509_crt_t* **cert**, *unsigned int * **bits***) [Function]

cert: should contain a gnutls_x509_crt_t structure

bits: if bits is non null it will hold the size of the parameters' in bits

This function will return the public key algorithm of an X.509 certificate.

If bits is non null, it should have enough size to hold the parameters size in bits. For RSA the bits returned is the modulus. For DSA the bits returned are of the public exponent.

Returns: a member of the gnutls_pk_algorithm_t enumeration on success, or a negative value on error.

gnutls_x509_crt_get_pk_dsa_raw

int gnutls_x509_crt_get_pk_dsa_raw (*gnutls_x509_crt_t* **crt**, *gnutls_datum_t * **p***, *gnutls_datum_t * **q***, *gnutls_datum_t * **g***, *gnutls_datum_t * **y***) [Function]

crt: Holds the certificate

p: will hold the p

q: will hold the q

g: will hold the g

y: will hold the y

This function will export the DSA public key's parameters found in the given certificate. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

gnutls_x509_crt_get_pk_rsa_raw

`int gnutls_x509_crt_get_pk_rsa_raw (`*gnutls_x509_crt_t* `crt`, *gnutls_datum_t* * `m`, *gnutls_datum_t* * `e``)` [Function]

crt: Holds the certificate

m: will hold the modulus

e: will hold the public exponent

This function will export the RSA public key's parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

gnutls_x509_crt_get_proxy

`int gnutls_x509_crt_get_proxy (`*gnutls_x509_crt_t* `cert`, *unsigned int* * `critical`, *int* * `pathlen`, *char* ** `policyLanguage`, *char* ** `policy`, *size_t* * `sizeof_policy``)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

critical: will be non zero if the extension is marked as critical

pathlen: pointer to output integer indicating path length (may be NULL), non-negative values indicate a present pCPathLenConstraint field and the actual value, -1 indicate that the field is absent.

This function will read the certificate's basic constraints, and return the certificates CA status. It reads the basicConstraints X.509 extension (2.5.29.19).

Return value: If the certificate is a CA a positive value will be returned, or zero if the certificate does not have CA flag set. A negative value may be returned in case of errors. If the certificate does not contain the basicConstraints extension GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE will be returned.

gnutls_x509_crt_get_raw_dn

`int gnutls_x509_crt_get_raw_dn (`*gnutls_x509_crt_t* `cert`, *gnutls_datum_t* * `start``)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

start: will hold the starting point of the DN

This function will return a pointer to the DER encoded DN structure and the length.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. or a negative value on error.

gnutls_x509_crt_get_raw_issuer_dn

`int gnutls_x509_crt_get_raw_issuer_dn (`*gnutls_x509_crt_t* `cert`, *gnutls_datum_t* * `start``)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

start: will hold the starting point of the DN

This function will return a pointer to the DER encoded DN structure and the length.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.or a negative value on error.

gnutls_x509_crt_get_serial

`int gnutls_x509_crt_get_serial (`*gnutls_x509_crt_t* `cert`, *void* * `result`, *size_t* * `result_size`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

result: The place where the serial number will be copied

result_size: Holds the size of the result field.

This function will return the X.509 certificate's serial number. This is obtained by the X509 Certificate serialNumber field. Serial is not always a 32 or 64bit number. Some CAs use large serial numbers, thus it may be wise to handle it as something opaque.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative value in case of an error.

gnutls_x509_crt_get_signature_algorithm

`int gnutls_x509_crt_get_signature_algorithm (`*gnutls_x509_crt_t* `cert`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

This function will return a value of the `gnutls_sign_algorithm_t` enumeration that is the signature algorithm.

Returns: a `gnutls_sign_algorithm_t` value, or a negative value on error.

gnutls_x509_crt_get_signature

`int gnutls_x509_crt_get_signature (`*gnutls_x509_crt_t* `cert`, *char* * `sig`, *size_t* * `sizeof_sig`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

sig: a pointer where the signature part will be copied (may be null).

sizeof_sig: initially holds the size of `sig`

This function will extract the signature field of a certificate.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value. and a negative value on error.

gnutls_x509_crt_get_subject_alt_name2

`int gnutls_x509_crt_get_subject_alt_name2 (`*gnutls_x509_crt_t* **`cert`**, *unsigned int* **`seq`**, *void ** **`ret`**, *size_t ** **`ret_size`**, *unsigned int ** **`ret_type`**, *unsigned int ** **`critical`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

seq: specifies the sequence number of the alt name (0 for the first one, 1 for the second etc.)

ret: is the place where the alternative name will be copied to

ret_size: holds the size of ret.

ret_type: holds the type of the alternative name (one of gnutls_x509_subject_alt_name_t).

critical: will be non zero if the extension is marked as critical (may be null)

This function will return the alternative names, contained in the given certificate. It is the same as `gnutls_x509_crt_get_subject_alt_name()` except for the fact that it will return the type of the alternative name in `ret_type` even if the function fails for some reason (i.e. the buffer provided is not enough).

The return values are the same as with `gnutls_x509_crt_get_subject_alt_name()`.

gnutls_x509_crt_get_subject_alt_name

`int gnutls_x509_crt_get_subject_alt_name (`*gnutls_x509_crt_t* **`cert`**, *unsigned int* **`seq`**, *void ** **`ret`**, *size_t ** **`ret_size`**, *unsigned int ** **`critical`**`)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

seq: specifies the sequence number of the alt name (0 for the first one, 1 for the second etc.)

ret: is the place where the alternative name will be copied to

ret_size: holds the size of ret.

critical: will be non zero if the extension is marked as critical (may be null)

This function will return the alternative names, contained in the given certificate.

This is specified in X509v3 Certificate Extensions. GNUTLS will return the Alternative name (2.5.29.17), or a negative error code.

When the SAN type is otherName, it will extract the data in the otherName's value field, and `GNUTLS_SAN_OTHERNAME` is returned. You may use `gnutls_x509_crt_get_subject_alt_othername_oid()` to get the corresponding OID and the "virtual" SAN types (e.g., `GNUTLS_SAN_OTHERNAME_XMPP`).

If an otherName OID is known, the data will be decoded. Otherwise the returned data will be DER encoded, and you will have to decode it yourself. Currently, only the RFC 3920 id-on-xmppAddr SAN is recognized.

Returns: the alternative subject name type on success, one of the enumerated `gnutls_x509_subject_alt_name_t`. It will return `GNUTLS_E_SHORT_MEMORY_BUFFER` if `ret_size` is not large enough to hold the value. In that case `ret_size` will be updated with the required size. If the certificate does not have an Alternative name with the specified sequence number then `GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE` is returned.

gnutls_x509_crt_get_subject_alt_othername_oid

`int gnutls_x509_crt_get_subject_alt_othername_oid` [Function]
(*gnutls_x509_crt_t* **cert**, *unsigned int* **seq**, *void ** **ret**, *size_t ** **ret_size**)

cert: should contain a `gnutls_x509_crt_t` structure

seq: specifies the sequence number of the alt name (0 for the first one, 1 for the second etc.)

ret: is the place where the otherName OID will be copied to

ret_size: holds the size of ret.

This function will extract the type OID of an otherName Subject Alternative Name, contained in the given certificate, and return the type as an enumerated element.

This function is only useful if `gnutls_x509_crt_get_subject_alt_name()` returned `GNUTLS_SAN_OTHERNAME`.

Returns: the alternative subject name type on success, one of the enumerated gnutls_x509_subject_alt_name_t. For supported OIDs, it will return one of the virtual (GNUTLS_SAN_OTHERNAME_*) types, e.g. `GNUTLS_SAN_OTHERNAME_XMPP`, and `GNUTLS_SAN_OTHERNAME` for unknown OIDs. It will return `GNUTLS_E_SHORT_MEMORY_BUFFER` if `ret_size` is not large enough to hold the value. In that case `ret_size` will be updated with the required size. If the certificate does not have an Alternative name with the specified sequence number and with the otherName type then `GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE` is returned.

gnutls_x509_crt_get_subject_key_id

`int gnutls_x509_crt_get_subject_key_id` (*gnutls_x509_crt_t* **cert**, [Function]
*void ** **ret**, *size_t ** **ret_size**, *unsigned int ** **critical**)

cert: should contain a `gnutls_x509_crt_t` structure

ret: The place where the identifier will be copied

ret_size: Holds the size of the result field.

critical: will be non zero if the extension is marked as critical (may be null)

This function will return the X.509v3 certificate's subject key identifier. This is obtained by the X.509 Subject Key identifier extension field (2.5.29.14).

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative value in case of an error.

gnutls_x509_crt_get_subject

`int gnutls_x509_crt_get_subject` (*gnutls_x509_crt_t* **cert**, [Function]
*gnutls_x509_dn_t ** **dn**)

cert: should contain a `gnutls_x509_crt_t` structure

dn: output variable with pointer to opaque DN.

Return the Certificate's Subject DN as an opaque data type. You may use `gnutls_x509_dn_get_rdn_ava()` to decode the DN.

Note that `dn` should be treated as constant. Because points into the `cert` object, you may not deallocate `cert` and continue to access `dn`.

Returns: Returns 0 on success, or an error code.

gnutls_x509_crt_get_version

`int gnutls_x509_crt_get_version (`*gnutls_x509_crt_t* `cert``)` [Function]

cert: should contain a `gnutls_x509_crt_t` structure

This function will return the version of the specified Certificate.

Returns: version of certificate, or a negative value on error.

gnutls_x509_crt_import

`int gnutls_x509_crt_import (`*gnutls_x509_crt_t* `cert`, *const gnutls_datum_t ** `data`, *gnutls_x509_crt_fmt_t* `format``)` [Function]

cert: The structure to store the parsed certificate.

data: The DER or PEM encoded certificate.

format: One of DER or PEM

This function will convert the given DER or PEM encoded Certificate to the native gnutls_x509_crt_t format. The output will be stored in `cert`.

If the Certificate is PEM encoded it should have a header of "X509 CERTIFICATE", or "CERTIFICATE".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_init

`int gnutls_x509_crt_init (`*gnutls_x509_crt_t ** `cert``)` [Function]

cert: The structure to be initialized

This function will initialize an X.509 certificate structure.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_list_import

`int gnutls_x509_crt_list_import (`*gnutls_x509_crt_t ** `certs`, *unsigned int ** `cert_max`, *const gnutls_datum_t ** `data`, *gnutls_x509_crt_fmt_t* `format`, *unsigned int* `flags``)` [Function]

certs: The structures to store the parsed certificate. Must not be initialized.

cert_max: Initially must hold the maximum number of certs. It will be updated with the number of certs available.

data: The PEM encoded certificate.

format: One of DER or PEM.

flags: must be zero or an OR'd sequence of gnutls_certificate_import_flags.

This function will convert the given PEM encoded certificate list to the native gnutls_x509_crt_t format. The output will be stored in `certs`. They will be automatically initialized.

If the Certificate is PEM encoded it should have a header of "X509 CERTIFICATE", or "CERTIFICATE".

Returns: the number of certificates read or a negative error value.

gnutls_x509_crt_list_verify

`int gnutls_x509_crt_list_verify (`*const gnutls_x509_crt_t ** `cert_list`, *int* `cert_list_length`, *const gnutls_x509_crt_t * * `CA_list`, *int* `CA_list_length`, *const gnutls_x509_crl_t * * `CRL_list`, *int* `CRL_list_length`, *unsigned int* `flags`, *unsigned int * * `verify`) [Function]

cert_list: is the certificate list to be verified

cert_list_length: holds the number of certificate in cert_list

CA_list: is the CA list which will be used in verification

CA_list_length: holds the number of CA certificate in CA_list

CRL_list: holds a list of CRLs.

CRL_list_length: the length of CRL list.

flags: Flags that may be used to change the verification algorithm. Use OR of the gnutls_certificate_verify_flags enumerations.

verify: will hold the certificate verification output.

This function will try to verify the given certificate list and return its status. Note that expiration and activation dates are not checked by this function, you should check them using the appropriate functions.

If no flags are specified (0), this function will use the basicConstraints (2.5.29.19) PKIX extension. This means that only a certificate authority is allowed to sign a certificate.

You must also check the peer's name in order to check if the verified certificate belongs to the actual peer.

The certificate verification output will be put in `verify` and will be one or more of the gnutls_certificate_status_t enumerated elements bitwise or'd. For a more detailed verification status use `gnutls_x509_crt_verify()` per list element.

GNUTLS_CERT_INVALID: the certificate chain is not valid.

GNUTLS_CERT_REVOKED: a certificate in the chain has been revoked.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative value in case of an error.

gnutls_x509_crt_print

`int gnutls_x509_crt_print (`*gnutls_x509_crt_t* `cert`, *gnutls_certificate_print_formats_t* `format`, *gnutls_datum_t * * `out`) [Function]

cert: The structure to be printed

format: Indicate the format to use

out: Newly allocated datum with zero terminated string.

This function will pretty print a X.509 certificate, suitable for display to a human.

If the format is `GNUTLS_CRT_PRINT_FULL` then all fields of the certificate will be output, on multiple lines. The `GNUTLS_CRT_PRINT_ONELINE` format will generate one line with some selected fields, which is useful for logging purposes.

The output `out` needs to be deallocate using `gnutls_free()`.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_activation_time

`int gnutls_x509_crt_set_activation_time (`*gnutls_x509_crt_t* `cert`, *time_t* `act_time``)` [Function]

cert: a certificate of type `gnutls_x509_crt_t`

act_time: The actual time

This function will set the time this Certificate was or will be activated.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_authority_key_id

`int gnutls_x509_crt_set_authority_key_id (`*gnutls_x509_crt_t* `cert`, *const void * * `id`, *size_t* `id_size`)` [Function]

cert: a certificate of type `gnutls_x509_crt_t`

id: The key ID

id_size: Holds the size of the serial field.

This function will set the X.509 certificate's authority key ID extension. Only the keyIdentifier field can be set with this function.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_basic_constraints

`int gnutls_x509_crt_set_basic_constraints (`*gnutls_x509_crt_t* `crt`, *unsigned int* `ca`, *int* `pathLenConstraint`)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

ca: true(1) or false(0). Depending on the Certificate authority status.

pathLenConstraint: non-negative values indicate maximum length of path, and negative values indicate that the pathLenConstraints field should not be present.

This function will set the basicConstraints certificate extension.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_ca_status

`int gnutls_x509_crt_set_ca_status (`*gnutls_x509_crt_t* `crt`, *unsigned int* `ca`)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

ca: true(1) or false(0). Depending on the Certificate authority status.

This function will set the basicConstraints certificate extension. Use `gnutls_x509_crt_set_basic_constraints()` if you want to control the pathLenConstraint field too.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_crl_dist_points2

`int gnutls_x509_crt_set_crl_dist_points2 (`*gnutls_x509_crt_t* `crt`, *gnutls_x509_subject_alt_name_t* `type`, *const void ** `data`, *unsigned int* `data_size`, *unsigned int* `reason_flags``)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

type: is one of the gnutls_x509_subject_alt_name_t enumerations

data: The data to be set

data_size: The data size

reason_flags: revocation reasons

This function will set the CRL distribution points certificate extension.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

Since: 2.6.0

gnutls_x509_crt_set_crl_dist_points

`int gnutls_x509_crt_set_crl_dist_points (`*gnutls_x509_crt_t* `crt`, *gnutls_x509_subject_alt_name_t* `type`, *const void ** `data_string`, *unsigned int* `reason_flags``)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

type: is one of the gnutls_x509_subject_alt_name_t enumerations

data_string: The data to be set

reason_flags: revocation reasons

This function will set the CRL distribution points certificate extension.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_crq

`int gnutls_x509_crt_set_crq (`*gnutls_x509_crt_t* `crt`, *gnutls_x509_crq_t* `crq``)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

crq: holds a certificate request

This function will set the name and public parameters from the given certificate request to the certificate. Only RSA keys are currently supported.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_dn_by_oid

`int gnutls_x509_crt_set_dn_by_oid (`*gnutls_x509_crt_t* `crt`, *const char ** `oid`, *unsigned int* `raw_flag`, *const void ** `name`, *unsigned int* `sizeof_name``)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

oid: holds an Object Identifier in a null terminated string

raw_flag: must be 0, or 1 if the data are DER encoded

name: a pointer to the name

sizeof_name: holds the size of `name`

This function will set the part of the name of the Certificate subject, specified by the given OID. The input string should be ASCII or UTF-8 encoded.

Some helper macros with popular OIDs can be found in gnutls/x509.h With this function you can only set the known OIDs. You can test for known OIDs using `gnutls_x509_dn_oid_known()`. For OIDs that are not known (by gnutls) you should properly DER encode your data, and call this function with `raw_flag` set.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_expiration_time

`int gnutls_x509_crt_set_expiration_time (`*gnutls_x509_crt_t* `cert`, *time_t* `exp_time`[Function]`)`

cert: a certificate of type `gnutls_x509_crt_t`

exp_time: The actual time

This function will set the time this Certificate will expire.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_extension_by_oid

`int gnutls_x509_crt_set_extension_by_oid (`*gnutls_x509_crt_t* `crt`, *const char * oid*, *const void * buf*, *size_t* `sizeof_buf`, *unsigned int* `critical`[Function]`)`

crt: a certificate of type `gnutls_x509_crt_t`

oid: holds an Object Identified in null terminated string

buf: a pointer to a DER encoded data

sizeof_buf: holds the size of `buf`

critical: should be non zero if the extension is to be marked as critical

This function will set an the extension, by the specified OID, in the certificate. The extension data should be binary data DER encoded.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative value in case of an error.

gnutls_x509_crt_set_issuer_dn_by_oid

`int gnutls_x509_crt_set_issuer_dn_by_oid (`*gnutls_x509_crt_t* `crt`, *const char * oid*, *unsigned int* `raw_flag`, *const void * name*, *unsigned int* `sizeof_name`[Function]`)`

crt: a certificate of type `gnutls_x509_crt_t`

oid: holds an Object Identifier in a null terminated string

raw_flag: must be 0, or 1 if the data are DER encoded

name: a pointer to the name

sizeof_name: holds the size of `name`

This function will set the part of the name of the Certificate issuer, specified by the given OID. The input string should be ASCII or UTF-8 encoded.

Some helper macros with popular OIDs can be found in gnutls/x509.h With this function you can only set the known OIDs. You can test for known OIDs using `gnutls_x509_dn_oid_known()`. For OIDs that are not known (by gnutls) you should properly DER encode your data, and call this function with `raw_flag` set.

Normally you do not need to call this function, since the signing operation will copy the signer's name as the issuer of the certificate.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_key_purpose_oid

`int gnutls_x509_crt_set_key_purpose_oid (`*gnutls_x509_crt_t* **`cert`**, *const void ** **`oid`**, *unsigned int* **`critical`**`)` [Function]

cert: a certificate of type `gnutls_x509_crt_t`

oid: a pointer to a null terminated string that holds the OID

critical: Whether this extension will be critical or not

This function will set the key purpose OIDs of the Certificate. These are stored in the Extended Key Usage extension (2.5.29.37) See the GNUTLS_KP_* definitions for human readable names.

Subsequent calls to this function will append OIDs to the OID list.

On success 0 is returned.

gnutls_x509_crt_set_key_usage

`int gnutls_x509_crt_set_key_usage (`*gnutls_x509_crt_t* **`crt`**, *unsigned int* **`usage`**`)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

usage: an ORed sequence of the GNUTLS_KEY_* elements.

This function will set the keyUsage certificate extension.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_key

`int gnutls_x509_crt_set_key (`*gnutls_x509_crt_t* **`crt`**, *gnutls_x509_privkey_t* **`key`**`)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

key: holds a private key

This function will set the public parameters from the given private key to the certificate. Only RSA keys are currently supported.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_proxy_dn

`int gnutls_x509_crt_set_proxy_dn (`*gnutls_x509_crt_t* `crt`, *gnutls_x509_crt_t* `eecrt`, *unsigned int* `raw_flag`, *const void ** `name`, *unsigned int* `sizeof_name``)` [Function]

crt: a gnutls_x509_crt_t structure with the new proxy cert

eecrt: the end entity certificate that will be issuing the proxy

raw_flag: must be 0, or 1 if the CN is DER encoded

name: a pointer to the CN name, may be NULL (but MUST then be added later)

sizeof_name: holds the size of `name`

This function will set the subject in `crt` to the end entity's `eecrt` subject name, and add a single Common Name component `name` of size `sizeof_name`. This corresponds to the required proxy certificate naming style. Note that if `name` is `NULL`, you MUST set it later by using `gnutls_x509_crt_set_dn_by_oid()` or similar.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_proxy

`int gnutls_x509_crt_set_proxy (`*gnutls_x509_crt_t* `crt`, *int* `pathLenConstraint`, *const char ** `policyLanguage`, *const char ** `policy`, *size_t* `sizeof_policy``)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

pathLenConstraint: non-negative values indicate maximum length of path, and negative values indicate that the pathLenConstraints field should not be present.

policyLanguage: OID describing the language of `policy`.

policy: opaque byte array with policy language, can be `NULL`

sizeof_policy: size of `policy`.

This function will set the proxyCertInfo extension.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_serial

`int gnutls_x509_crt_set_serial (`*gnutls_x509_crt_t* `cert`, *const void ** `serial`, *size_t* `serial_size``)` [Function]

cert: a certificate of type `gnutls_x509_crt_t`

serial: The serial number

serial_size: Holds the size of the serial field.

This function will set the X.509 certificate's serial number. Serial is not always a 32 or 64bit number. Some CAs use large serial numbers, thus it may be wise to handle it as something opaque.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_subject_alt_name

`int gnutls_x509_crt_set_subject_alt_name` (*gnutls_x509_crt_t* `crt`, *gnutls_x509_subject_alt_name_t* `type`, *const void * * `data`, *unsigned int* `data_size`, *unsigned int* `flags`) [Function]

crt: a certificate of type `gnutls_x509_crt_t`

type: is one of the gnutls_x509_subject_alt_name_t enumerations

data: The data to be set

data_size: The size of data to be set

flags: GNUTLS_FSAN_SET to clear previous data or GNUTLS_FSAN_APPEND to append.

This function will set the subject alternative name certificate extension. It can set the following types:

&GNUTLS_SAN_DNSNAME: as a text string

&GNUTLS_SAN_RFC822NAME: as a text string

&GNUTLS_SAN_URI: as a text string

&GNUTLS_SAN_IPADDRESS: as a binary IP address (4 or 16 bytes)

Other values can be set as binary values with the proper DER encoding.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

Since: 2.6.0

gnutls_x509_crt_set_subject_alternative_name

`int gnutls_x509_crt_set_subject_alternative_name` (*gnutls_x509_crt_t* `crt`, *gnutls_x509_subject_alt_name_t* `type`, *const char * `data_string`) [Function]

crt: a certificate of type `gnutls_x509_crt_t`

type: is one of the gnutls_x509_subject_alt_name_t enumerations

data_string: The data to be set, a zero terminated string

This function will set the subject alternative name certificate extension. This function assumes that data can be expressed as a null terminated string.

The name of the function is unfortunate since it is incosistent with `gnutls_x509_crt_get_subject_alt_name()`.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_subject_key_id

`int gnutls_x509_crt_set_subject_key_id` (*gnutls_x509_crt_t* `cert`, *const void * `id`, *size_t* `id_size`) [Function]

cert: a certificate of type `gnutls_x509_crt_t`

id: The key ID

id_size: Holds the size of the serial field.

This function will set the X.509 certificate's subject key ID extension.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_set_version

`int gnutls_x509_crt_set_version (`*gnutls_x509_crt_t* **`crt`**`, `*unsigned int* **`version`**`)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

version: holds the version number. For X.509v1 certificates must be 1.

This function will set the version of the certificate. This must be one for X.509 version 1, and so on. Plain certificates without extensions must have version set to one.

To create well-formed certificates, you must specify version 3 if you use any certificate extensions. Extensions are created by functions such as `gnutls_x509_crt_set_subject_alt_name()` or `gnutls_x509_crt_set_key_usage()`.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_sign2

`int gnutls_x509_crt_sign2 (`*gnutls_x509_crt_t* **`crt`**`, `*gnutls_x509_crt_t* **`issuer`**`, `*gnutls_x509_privkey_t* **`issuer_key`**`, `*gnutls_digest_algorithm_t* **`dig`**`, `*unsigned int* **`flags`**`)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

issuer: is the certificate of the certificate issuer

issuer_key: holds the issuer's private key

dig: The message digest to use, `GNUTLS_DIG_SHA1` is a safe choice

flags: must be 0

This function will sign the certificate with the issuer's private key, and will copy the issuer's information into the certificate.

This must be the last step in a certificate generation since all the previously set parameters are now signed.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_sign

`int gnutls_x509_crt_sign (`*gnutls_x509_crt_t* **`crt`**`, `*gnutls_x509_crt_t* **`issuer`**`, `*gnutls_x509_privkey_t* **`issuer_key`**`)` [Function]

crt: a certificate of type `gnutls_x509_crt_t`

issuer: is the certificate of the certificate issuer

issuer_key: holds the issuer's private key

This function is the same a `gnutls_x509_crt_sign2()` with no flags, and SHA1 as the hash algorithm.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_crt_verify_data

`int gnutls_x509_crt_verify_data (`*gnutls_x509_crt_t* **`crt`**`, `*unsigned int* **`flags`**`, `*const gnutls_datum_t ** **`data`**`, `*const gnutls_datum_t ** **`signature`**`)` [Function]

crt: Holds the certificate

flags: should be 0 for now

data: holds the data to be signed

signature: contains the signature

This function will verify the given signed data, using the parameters from the certificate.

Returns: In case of a verification failure 0 is returned, and 1 on success.

gnutls_x509_crt_verify

`int gnutls_x509_crt_verify (`*gnutls_x509_crt_t* **`cert`**`, const` *gnutls_x509_crt_t ** **`CA_list`**`, int` **`CA_list_length`**`, unsigned int` **`flags`**`, unsigned int *` **`verify`**`)` [Function]

cert: is the certificate to be verified

CA_list: is one certificate that is considered to be trusted one

CA_list_length: holds the number of CA certificate in CA_list

flags: Flags that may be used to change the verification algorithm. Use OR of the gnutls_certificate_verify_flags enumerations.

verify: will hold the certificate verification output.

This function will try to verify the given certificate and return its status. The verification output in this functions cannot be GNUTLS_CERT_NOT_VALID.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.and a negative value in case of an error.

gnutls_x509_dn_deinit

`void gnutls_x509_dn_deinit (`*gnutls_x509_dn_t* **`idn`**`)` [Function]

idn: a DN opaque object pointer.

This function deallocates the DN object as returned by `gnutls_x509_dn_import()`.

Since: 2.4.0

gnutls_x509_dn_export

`int gnutls_x509_dn_export (`*gnutls_x509_dn_t* **`dn`**`,` *gnutls_x509_crt_fmt_t* **`format`**`, void *` **`output_data`**`, size_t *` **`output_data_size`**`)` [Function]

dn: Holds the opaque DN object

format: the format of output params. One of PEM or DER.

output_data: will contain a DN PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the DN to DER or PEM format.

If the buffer provided is not long enough to hold the output, then *`output_data_size` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN NAME".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_dn_get_rdn_ava

`int gnutls_x509_dn_get_rdn_ava (`*gnutls_x509_dn_t* `dn`, *int* `irdn`, *int* `iava`, *gnutls_x509_ava_st* * `ava``)` [Function]

dn: input variable with opaque DN pointer

irdn: index of RDN

iava: index of AVA.

ava: Pointer to structure which will hold output information.

Get pointers to data within the DN.

Note that `ava` will contain pointers into the `dn` structure, so you should not modify any data or deallocate it. Note also that the DN in turn points into the original certificate structure, and thus you may not deallocate the certificate and continue to access `dn`.

Returns: Returns 0 on success, or an error code.

gnutls_x509_dn_import

`int gnutls_x509_dn_import (`*gnutls_x509_dn_t* `odn`, *const gnutls_datum_t* * `data``)` [Function]

odn: the structure that will hold the imported DN

data: should contain a DER encoded RDN sequence

This function parses an RDN sequence and stores the result to a `gnutls_x509_dn_t` structure. The structure must have been initialized with `gnutls_x509_dn_init()`. You may use `gnutls_x509_dn_get_rdn_ava()` to decode the DN. This function parses an RDN sequence and stores the result to a `gnutls_x509_dn_t` structure. The structure must have been initialized with `gnutls_x509_dn_init()`. You may use `gnutls_x509_dn_get_rdn_ava()` to decode the DN.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

Since: 2.4.0

gnutls_x509_dn_init

`int gnutls_x509_dn_init (`*gnutls_x509_dn_t* * `odn``)` [Function]

odn: the object to be initialized

This function initializes a `gnutls_x509_dn_t` structure.

The object returned must be deallocated using `gnutls_x509_dn_deinit()`.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

Since: 2.4.0

gnutls_x509_dn_oid_known

`int gnutls_x509_dn_oid_known (`*const char* * `oid``)` [Function]

oid: holds an Object Identifier in a null terminated string

This function will inform about known DN OIDs. This is useful since functions like `gnutls_x509_crt_set_dn_by_oid()` use the information on known OIDs to properly

encode their input. Object Identifiers that are not known are not encoded by these functions, and their input is stored directly into the ASN.1 structure. In that case of unknown OIDs, you have the responsibility of DER encoding your data.

Returns: 1 on known OIDs and 0 otherwise.

gnutls_x509_privkey_cpy

`int gnutls_x509_privkey_cpy (`*gnutls_x509_privkey_t* **`dst`**`,` *gnutls_x509_privkey_t* **`src`**`)` [Function]

dst: The destination key, which should be initialized.

src: The source key

This function will copy a private key from source to destination key.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_deinit

`void gnutls_x509_privkey_deinit (`*gnutls_x509_privkey_t* **`key`**`)` [Function]

key: The structure to be initialized

This function will deinitialize a private key structure.

gnutls_x509_privkey_export_dsa_raw

`int gnutls_x509_privkey_export_dsa_raw (`*gnutls_x509_privkey_t* **`key`**`,` *gnutls_datum_t * * **`p`**`,` *gnutls_datum_t * * **`q`**`,` *gnutls_datum_t * * **`g`**`,` *gnutls_datum_t * * **`y`**`,` *gnutls_datum_t * * **`x`**`)` [Function]

p: will hold the p

q: will hold the q

g: will hold the g

y: will hold the y

x: will hold the x

This function will export the DSA private key's parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_export_pkcs8

`int gnutls_x509_privkey_export_pkcs8 (`*gnutls_x509_privkey_t* **`key`**`,` *gnutls_x509_crt_fmt_t* **`format`**`,` *const char * * **`password`**`,` *unsigned int* **`flags`**`,` *void * * **`output_data`**`,` *size_t * * **`output_data_size`**`)` [Function]

key: Holds the key

format: the format of output params. One of PEM or DER.

password: the password that will be used to encrypt the key.

flags: an ORed sequence of gnutls_pkcs_encrypt_flags_t

output_data: will contain a private key PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the private key to a PKCS8 structure. Both RSA and DSA keys can be exported. For DSA keys we use PKCS `11` definitions. If the flags do not specify the encryption cipher, then the default 3DES (PBES2) will be used.

The `password` can be either ASCII or UTF-8 in the default PBES2 encryption schemas, or ASCII for the PKCS12 schemas.

If the buffer provided is not long enough to hold the output, then *output_data_size is updated and GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN ENCRYPTED PRIVATE KEY" or "BEGIN PRIVATE KEY" if encryption is not used.

Return value: In case of failure a negative value will be returned, and 0 on success.

gnutls_x509_privkey_export_rsa_raw

`int gnutls_x509_privkey_export_rsa_raw` (*gnutls_x509_privkey_t* `key`, *gnutls_datum_t* * `m`, *gnutls_datum_t* * `e`, *gnutls_datum_t* * `d`, *gnutls_datum_t* * `p`, *gnutls_datum_t* * `q`, *gnutls_datum_t* * `u`) [Function]

key: a structure that holds the rsa parameters

m: will hold the modulus

e: will hold the public exponent

d: will hold the private exponent

p: will hold the first prime (p)

q: will hold the second prime (q)

u: will hold the coefficient

This function will export the RSA private key's parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_export

`int gnutls_x509_privkey_export` (*gnutls_x509_privkey_t* `key`, *gnutls_x509_crt_fmt_t* `format`, *void* * `output_data`, *size_t* * `output_data_size`) [Function]

key: Holds the key

format: the format of output params. One of PEM or DER.

output_data: will contain a private key PEM or DER encoded

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will export the private key to a PKCS1 structure for RSA keys, or an integer sequence for DSA keys. The DSA keys are in the same format with the parameters used by openssl.

If the buffer provided is not long enough to hold the output, then *`output_data_size` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` will be returned.

If the structure is PEM encoded, it will have a header of "BEGIN RSA PRIVATE KEY".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_fix

`int gnutls_x509_privkey_fix (`*gnutls_x509_privkey_t* **`key`**`)` [Function]

key: Holds the key

This function will recalculate the secondary parameters in a key. In RSA keys, this can be the coefficient and exponent1,2.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_generate

`int gnutls_x509_privkey_generate (`*gnutls_x509_privkey_t* **`key`**`,` [Function]
gnutls_pk_algorithm_t **`algo`**`,` *unsigned int* **`bits`**`,` *unsigned int* **`flags`**`)`

key: should contain a `gnutls_x509_privkey_t` structure

algo: is one of RSA or DSA.

bits: the size of the modulus

flags: unused for now. Must be 0.

This function will generate a random private key. Note that this function must be called on an empty private key.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_get_key_id

`int gnutls_x509_privkey_get_key_id (`*gnutls_x509_privkey_t* **`key`**`,` [Function]
unsigned int **`flags`**`,` *unsigned char ** **`output_data`**`,` *size_t ** **`output_data_size`**`)`

key: Holds the key

flags: should be 0 for now

output_data: will contain the key ID

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will return a unique ID the depends on the public key parameters. This ID can be used in checking whether a certificate corresponds to the given key.

If the buffer provided is not long enough to hold the output, then *`output_data_size` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` will be returned. The output will normally be a SHA-1 hash output, which is 20 bytes.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_get_pk_algorithm

`int gnutls_x509_privkey_get_pk_algorithm (`*gnutls_x509_privkey_t* `key``)` [Function]

key: should contain a `gnutls_x509_privkey_t` structure

This function will return the public key algorithm of a private key.

Returns: a member of the `gnutls_pk_algorithm_t` enumeration on success, or a negative value on error.

gnutls_x509_privkey_import_dsa_raw

`int gnutls_x509_privkey_import_dsa_raw (`*gnutls_x509_privkey_t* `key`, *const gnutls_datum_t ** `p`, *const gnutls_datum_t ** `q`, *const gnutls_datum_t ** `g`, *const gnutls_datum_t ** `y`, *const gnutls_datum_t ** `x`)` [Function]

key: The structure to store the parsed key

p: holds the p

q: holds the q

g: holds the g

y: holds the y

x: holds the x

This function will convert the given DSA raw parameters to the native `gnutls_x509_privkey_t` format. The output will be stored in `key`.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_import_pkcs8

`int gnutls_x509_privkey_import_pkcs8 (`*gnutls_x509_privkey_t* `key`, *const gnutls_datum_t ** `data`, *gnutls_x509_crt_fmt_t* `format`, *const char ** `password`, *unsigned int* `flags`)` [Function]

key: The structure to store the parsed key

data: The DER or PEM encoded key.

format: One of DER or PEM

password: the password to decrypt the key (if it is encrypted).

flags: 0 if encrypted or GNUTLS_PKCS_PLAIN if not encrypted.

This function will convert the given DER or PEM encoded PKCS8 2.0 encrypted key to the native gnutls_x509_privkey_t format. The output will be stored in `key`. Both RSA and DSA keys can be imported, and flags can only be used to indicate an unencrypted key.

The `password` can be either ASCII or UTF-8 in the default PBES2 encryption schemas, or ASCII for the PKCS12 schemas.

If the Certificate is PEM encoded it should have a header of "ENCRYPTED PRIVATE KEY", or "PRIVATE KEY". You only need to specify the flags if the key is DER encoded, since in that case the encryption status cannot be auto-detected.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_import_rsa_raw

`int gnutls_x509_privkey_import_rsa_raw (`*gnutls_x509_privkey_t* `key`, *const gnutls_datum_t ** `m`, *const gnutls_datum_t ** `e`, *const gnutls_datum_t ** `d`, *const gnutls_datum_t ** `p`, *const gnutls_datum_t ** `q`, *const gnutls_datum_t ** `u``)` [Function]

key: The structure to store the parsed key

m: holds the modulus

e: holds the public exponent

d: holds the private exponent

p: holds the first prime (p)

q: holds the second prime (q)

u: holds the coefficient

This function will convert the given RSA raw parameters to the native `gnutls_x509_privkey_t` format. The output will be stored in `key`.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_import

`int gnutls_x509_privkey_import (`*gnutls_x509_privkey_t* `key`, *const gnutls_datum_t ** `data`, *gnutls_x509_crt_fmt_t* `format``)` [Function]

key: The structure to store the parsed key

data: The DER or PEM encoded certificate.

format: One of DER or PEM

This function will convert the given DER or PEM encoded key to the native `gnutls_x509_privkey_t` format. The output will be stored in `key` .

If the key is PEM encoded it should have a header of "RSA PRIVATE KEY", or "DSA PRIVATE KEY".

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_init

`int gnutls_x509_privkey_init (`*gnutls_x509_privkey_t ** `key``)` [Function]

key: The structure to be initialized

This function will initialize an private key structure.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_sign_data

`int gnutls_x509_privkey_sign_data (`*gnutls_x509_privkey_t* `key`, *gnutls_digest_algorithm_t* `digest`, *unsigned int* `flags`, *const gnutls_datum_t ** `data`, *void ** `signature`, *size_t ** `signature_size``)` [Function]

key: Holds the key

digest: should be MD5 or SHA1

flags: should be 0 for now

data: holds the data to be signed

signature: will contain the signature

signature_size: holds the size of signature (and will be replaced by the new size)

This function will sign the given data using a signature algorithm supported by the private key. Signature algorithms are always used together with a hash functions. Different hash functions may be used for the RSA algorithm, but only SHA-1 for the DSA keys.

If the buffer provided is not long enough to hold the output, then *`signature_size` is updated and `GNUTLS_E_SHORT_MEMORY_BUFFER` will be returned.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_sign_hash

`int gnutls_x509_privkey_sign_hash` (*gnutls_x509_privkey_t* **`key`**, *const gnutls_datum_t * **`hash`***, *gnutls_datum_t * **`signature`***) [Function]

key: Holds the key

hash: holds the data to be signed

signature: will contain newly allocated signature

This function will sign the given hash using the private key.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_x509_privkey_verify_data

`int gnutls_x509_privkey_verify_data` (*gnutls_x509_privkey_t* **`key`**, *unsigned int* **`flags`**, *const gnutls_datum_t * **`data`***, *const gnutls_datum_t * **`signature`***) [Function]

key: Holds the key

flags: should be 0 for now

data: holds the data to be signed

signature: contains the signature

This function will verify the given signed data, using the parameters in the private key.

Returns: In case of a verification failure 0 is returned, and 1 on success.

gnutls_x509_rdn_get_by_oid

`int gnutls_x509_rdn_get_by_oid` (*const gnutls_datum_t * **`idn`***, *const char * **`oid`***, *int **`indx`***, *unsigned int **`raw_flag`***, *void * **`buf`***, *size_t * **`sizeof_buf`***) [Function]

idn: should contain a DER encoded RDN sequence

oid: an Object Identifier

indx: In case multiple same OIDs exist in the RDN indicates which to send. Use 0 for the first one.

raw_flag: If non zero then the raw DER data are returned.

buf: a pointer to a structure to hold the peer's name

sizeof_buf: holds the size of `buf`

This function will return the name of the given Object identifier, of the RDN sequence. The name will be encoded using the rules from RFC2253.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, or `GNUTLS_E_SHORT_MEMORY_BUFFER` is returned and *`sizeof_buf` is updated if the provided buffer is not long enough, otherwise a negative error value.

gnutls_x509_rdn_get_oid

`int gnutls_x509_rdn_get_oid` (*const gnutls_datum_t * `idn`, int `indx`, void * `buf`, size_t * `sizeof_buf`*) [Function]

idn: should contain a DER encoded RDN sequence

indx: Indicates which OID to return. Use 0 for the first one.

This function will return the specified Object identifier, of the RDN sequence.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, or `GNUTLS_E_SHORT_MEMORY_BUFFER` is returned and *`sizeof_buf` is updated if the provided buffer is not long enough, otherwise a negative error value.

Since: 2.4.0

gnutls_x509_rdn_get

`int gnutls_x509_rdn_get` (*const gnutls_datum_t * `idn`, char * `buf`, size_t * `sizeof_buf`*) [Function]

idn: should contain a DER encoded RDN sequence

buf: a pointer to a structure to hold the peer's name

sizeof_buf: holds the size of `buf`

This function will return the name of the given RDN sequence. The name will be in the form "C=xxxx,O=yyyy,CN=zzzz" as described in RFC2253.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, or `GNUTLS_E_SHORT_MEMORY_BUFFER` is returned and *`sizeof_buf` is updated if the provided buffer is not long enough, otherwise a negative error value.

9.3 GnuTLS-extra Functions

These functions are only available in the GPLv3+ version of the library called `gnutls-extra`. The prototypes for this library lie in '`gnutls/extra.h`'.

gnutls_extra_check_version

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

req_version: the version to check

Check that the version of the gnutls-extra library is at minimum the requested one and return the version string; return NULL if the condition is not satisfied. If a NULL is passed to this function, no check is done, but the version string is simply returned.

gnutls_global_init_extra

`int gnutls_global_init_extra ( void)` [Function]

This function initializes the global state of gnutls-extra library to defaults. Returns zero on success.

Note that `gnutls_global_init()` has to be called before this function. If this function is not called then the gnutls-extra library will not be usable.

9.4 OpenPGP Functions

The following functions are to be used for OpenPGP certificate handling. Their prototypes lie in '`gnutls/openpgp.h`'.

gnutls_certificate_set_openpgp_key_file2

`int gnutls_certificate_set_openpgp_key_file2` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *const char ** **`certfile`**, *const char ** **`keyfile`**, *gnutls_openpgp_crt_fmt_t* **`format`**)

res: the destination context to save the data.

certfile: the file that contains the public key.

keyfile: the file that contains the secret key.

subkey_id: a hex encoded subkey id

format: the format of the keys

This funtion is used to load OpenPGP keys into the GnuTLS credential structure. The files should contain non encrypted keys.

The special keyword "auto" is also accepted as &subkey_id. In that case the `gnutls_openpgp_crt_get_auth_subkey()` will be used to retrieve the subkey.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

Since: 2.4.0

gnutls_certificate_set_openpgp_key_file

`int gnutls_certificate_set_openpgp_key_file` [Function]
(*gnutls_certificate_credentials_t* **`res`**, *const char ** **`certfile`**, *const char ** **`keyfile`**, *gnutls_openpgp_crt_fmt_t* **`format`**)

res: the destination context to save the data.

certfile: the file that contains the public key.

keyfile: the file that contains the secret key.

format: the format of the keys

This funtion is used to load OpenPGP keys into the GnuTLS credentials structure. The files should only contain one key which is not encrypted.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_certificate_set_openpgp_key_mem2

`int gnutls_certificate_set_openpgp_key_mem2` [Function]
(*gnutls_certificate_credentials_t* **res**, *const gnutls_datum_t ** **icert**, *const gnutls_datum_t ** **ikey**, *const char ** **subkey_id**, *gnutls_openpgp_crt_fmt_t* **format**)

res: the destination context to save the data.

subkey_id: a hex encoded subkey id

format: the format of the keys

This funtion is used to load OpenPGP keys into the GnuTLS credentials structure. The files should only contain one key which is not encrypted.

The special keyword "auto" is also accepted as &subkey_id. In that case the `gnutls_openpgp_crt_get_auth_subkey()` will be used to retrieve the subkey.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

Since: 2.4.0

gnutls_certificate_set_openpgp_key_mem

`int gnutls_certificate_set_openpgp_key_mem` [Function]
(*gnutls_certificate_credentials_t* **res**, *const gnutls_datum_t ** **icert**, *const gnutls_datum_t ** **ikey**, *gnutls_openpgp_crt_fmt_t* **format**)

res: the destination context to save the data.

format: the format of the keys

This funtion is used to load OpenPGP keys into the GnuTLS credential structure. The files should contain non encrypted keys.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_certificate_set_openpgp_keyring_file

`int gnutls_certificate_set_openpgp_keyring_file` [Function]
(*gnutls_certificate_credentials_t* **c**, *const char ** **file**, *gnutls_openpgp_crt_fmt_t* **format**)

c: A certificate credentials structure

file: filename of the keyring.

The function is used to set keyrings that will be used internally by various OpenPGP functions. For example to find a key when it is needed for an operations. The keyring will also be used at the verification functions.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_certificate_set_openpgp_keyring_mem

`int gnutls_certificate_set_openpgp_keyring_mem` [Function]
(*gnutls_certificate_credentials_t* **c**, *const opaque ** **data**, *size_t* **dlen**, *gnutls_openpgp_crt_fmt_t* **format**)

c: A certificate credentials structure

data: buffer with keyring data.

dlen: length of data buffer.

The function is used to set keyrings that will be used internally by various OpenPGP functions. For example to find a key when it is needed for an operations. The keyring will also be used at the verification functions.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_certificate_set_openpgp_key

`int gnutls_certificate_set_openpgp_key` [Function]
(*gnutls_certificate_credentials_t* `res`, *gnutls_openpgp_crt_t* `crt`, *gnutls_openpgp_privkey_t* `pkey`)

res: is an `gnutls_certificate_credentials_t` structure.

pkey: is an openpgp private key

This function sets a certificate/private key pair in the gnutls_certificate_credentials_t structure. This function may be called more than once (in case multiple keys/certificates exist for the server).

With this function the subkeys of the certificate are not used.

gnutls_openpgp_crt_check_hostname

`int gnutls_openpgp_crt_check_hostname` (*gnutls_openpgp_crt_t* `key`, *const char * hostname*) [Function]

key: should contain an `gnutls_openpgp_crt_t` structure

hostname: A null terminated string that contains a DNS name

This function will check if the given key's owner matches the given hostname. This is a basic implementation of the matching described in RFC2818 (HTTPS), which takes into account wildcards.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_crt_deinit

`void gnutls_openpgp_crt_deinit` (*gnutls_openpgp_crt_t* `key`) [Function]

key: The structure to be initialized

This function will deinitialize a key structure.

gnutls_openpgp_crt_export

`int gnutls_openpgp_crt_export` (*gnutls_openpgp_crt_t* `key`, *gnutls_openpgp_crt_fmt_t* `format`, *void * output_data*, *size_t * output_data_size*) [Function]

key: Holds the key.

format: One of gnutls_openpgp_crt_fmt_t elements.

output_data: will contain the key base64 encoded or raw

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will convert the given key to RAW or Base64 format. If the buffer provided is not long enough to hold the output, then GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

Returns: GNUTLS_E_SUCCESS on success, or an error code.

gnutls_openpgp_crt_get_auth_subkey

`int gnutls_openpgp_crt_get_auth_subkey (`*gnutls_openpgp_crt_t* `crt`, *gnutls_openpgp_keyid_t* `keyid`, *unsigned int* `flag``)` [Function]

keyid: the struct to save the keyid.

flag: Non zero indicates that a valid subkey is always returned.

Returns the 64-bit keyID of the first valid OpenPGP subkey marked for authentication. If flag is non zero and no authentication subkey exists, then a valid subkey will be returned even if it is not marked for authentication. Returns the 64-bit keyID of the first valid OpenPGP subkey marked for authentication. If flag is non zero and no authentication subkey exists, then a valid subkey will be returned even if it is not marked for authentication.

Returns: GNUTLS_E_SUCCESS on success, or an error code.

gnutls_openpgp_crt_get_creation_time

`time_t gnutls_openpgp_crt_get_creation_time (`*gnutls_openpgp_crt_t* `key``)` [Function]

key: the structure that contains the OpenPGP public key.

Get key creation time.

Returns: the timestamp when the OpenPGP key was created.

gnutls_openpgp_crt_get_expiration_time

`time_t gnutls_openpgp_crt_get_expiration_time (`*gnutls_openpgp_crt_t* `key``)` [Function]

key: the structure that contains the OpenPGP public key.

Get key expiration time. A value of '0' means that the key doesn't expire at all.

Returns: the time when the OpenPGP key expires.

gnutls_openpgp_crt_get_fingerprint

`int gnutls_openpgp_crt_get_fingerprint (`*gnutls_openpgp_crt_t* `key`, *void ** `fpr`, *size_t ** `fprlen``)` [Function]

key: the raw data that contains the OpenPGP public key.

fpr: the buffer to save the fingerprint, must hold at least 20 bytes.

fprlen: the integer to save the length of the fingerprint.

Get key fingerprint. Depending on the algorithm, the fingerprint can be 16 or 20 bytes.

Returns: On success, 0 is returned. Otherwise, an error code.

gnutls_openpgp_crt_get_key_id

`int gnutls_openpgp_crt_get_key_id (`*gnutls_openpgp_crt_t* `key`, *gnutls_openpgp_keyid_t* `keyid`)` [Function]

key: the structure that contains the OpenPGP public key.

keyid: the buffer to save the keyid.

Get key id string.

Returns: the 64-bit keyID of the OpenPGP key.

Since: 2.4.0

gnutls_openpgp_crt_get_key_usage

`int gnutls_openpgp_crt_get_key_usage (`*gnutls_openpgp_crt_t* `key`, *unsigned int ** `key_usage`)` [Function]

key: should contain a gnutls_openpgp_crt_t structure

key_usage: where the key usage bits will be stored

This function will return certificate's key usage, by checking the key algorithm. The key usage value will ORed values of the: `GNUTLS_KEY_DIGITAL_SIGNATURE`, `GNUTLS_KEY_KEY_ENCIPHERMENT`.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_crt_get_name

`int gnutls_openpgp_crt_get_name (`*gnutls_openpgp_crt_t* `key`, *int* `idx`, *char ** `buf`, *size_t ** `sizeof_buf`)` [Function]

key: the structure that contains the OpenPGP public key.

idx: the index of the ID to extract

buf: a pointer to a structure to hold the name

sizeof_buf: holds the maximum size of `buf`, on return hold the actual/required size of `buf`.

Extracts the userID from the parsed OpenPGP key.

Returns: `GNUTLS_E_SUCCESS` on success, and if the index of the ID does not exist `GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE`, or an error code.

gnutls_openpgp_crt_get_pk_algorithm

`gnutls_pk_algorithm_t gnutls_openpgp_crt_get_pk_algorithm (`*gnutls_openpgp_crt_t* `key`, *unsigned int ** `bits`)` [Function]

key: is an OpenPGP key

bits: if bits is non null it will hold the size of the parameters' in bits

This function will return the public key algorithm of an OpenPGP certificate.

If bits is non null, it should have enough size to hold the parameters size in bits. For RSA the bits returned is the modulus. For DSA the bits returned are of the public exponent.

Returns: a member of the `gnutls_pk_algorithm_t` enumeration on success, or a negative value on error.

gnutls_openpgp_crt_get_pk_dsa_raw

`int gnutls_openpgp_crt_get_pk_dsa_raw` (*gnutls_openpgp_crt_t* `crt`, *gnutls_datum_t* * `p`, *gnutls_datum_t* * `q`, *gnutls_datum_t* * `g`, *gnutls_datum_t* * `y`) [Function]

crt: Holds the certificate

p: will hold the p

q: will hold the q

g: will hold the g

y: will hold the y

This function will export the DSA public key's parameters found in the given certificate. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_crt_get_pk_rsa_raw

`int gnutls_openpgp_crt_get_pk_rsa_raw` (*gnutls_openpgp_crt_t* `crt`, *gnutls_datum_t* * `m`, *gnutls_datum_t* * `e`) [Function]

crt: Holds the certificate

m: will hold the modulus

e: will hold the public exponent

This function will export the RSA public key's parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_crt_get_preferred_key_id

`int gnutls_openpgp_crt_get_preferred_key_id` (*gnutls_openpgp_crt_t* `key`, *gnutls_openpgp_keyid_t* `keyid`) [Function]

key: the structure that contains the OpenPGP public key.

keyid: the struct to save the keyid.

Get preferred key id. If it hasn't been set it returns `GNUTLS_E_INVALID_REQUEST`.

Returns: the 64-bit preferred keyID of the OpenPGP key.

gnutls_openpgp_crt_get_revoked_status

`int gnutls_openpgp_crt_get_revoked_status` (*gnutls_openpgp_crt_t* `key`) [Function]

key: the structure that contains the OpenPGP public key.

Get revocation status of key.

Returns: true (1) if the key has been revoked, or false (0) if it has not.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_count

`int gnutls_openpgp_crt_get_subkey_count (`*gnutls_openpgp_crt_t* `key``)` [Function]

key: is an OpenPGP key

This function will return the number of subkeys present in the given OpenPGP certificate.

Returns: the number of subkeys, or a negative value on error.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_creation_time

`time_t gnutls_openpgp_crt_get_subkey_creation_time` [Function]
`(`*gnutls_openpgp_crt_t* `key`, *unsigned int* `idx``)`

key: the structure that contains the OpenPGP public key.

idx: the subkey index

Get subkey creation time.

Returns: the timestamp when the OpenPGP sub-key was created.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_expiration_time

`time_t gnutls_openpgp_crt_get_subkey_expiration_time` [Function]
`(`*gnutls_openpgp_crt_t* `key`, *unsigned int* `idx``)`

key: the structure that contains the OpenPGP public key.

idx: the subkey index

Get subkey expiration time. A value of '0' means that the key doesn't expire at all.

Returns: the time when the OpenPGP key expires.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_fingerprint

`int gnutls_openpgp_crt_get_subkey_fingerprint` [Function]
`(`*gnutls_openpgp_crt_t* `key`, *unsigned int* `idx`, *void ** `fpr`, *size_t ** `fprlen``)`

key: the raw data that contains the OpenPGP public key.

idx: the subkey index

fpr: the buffer to save the fingerprint, must hold at least 20 bytes.

fprlen: the integer to save the length of the fingerprint.

Get key fingerprint of a subkey. Depending on the algorithm, the fingerprint can be 16 or 20 bytes.

Returns: On success, 0 is returned. Otherwise, an error code.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_idx

`int gnutls_openpgp_crt_get_subkey_idx (`*gnutls_openpgp_crt_t* `key`, *const gnutls_openpgp_keyid_t* `keyid`) [Function]

key: the structure that contains the OpenPGP public key.

keyid: the keyid.

Get subkey's index.

Returns: the index of the subkey or a negative error value.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_id

`int gnutls_openpgp_crt_get_subkey_id (`*gnutls_openpgp_crt_t* `key`, *unsigned int* `idx`, *gnutls_openpgp_keyid_t* `keyid`) [Function]

key: the structure that contains the OpenPGP public key.

idx: the subkey index

keyid: the buffer to save the keyid.

Get the subkey's key-id.

Returns: the 64-bit keyID of the OpenPGP key.

gnutls_openpgp_crt_get_subkey_pk_algorithm

`gnutls_pk_algorithm_t` [Function]
`gnutls_openpgp_crt_get_subkey_pk_algorithm (`*gnutls_openpgp_crt_t* `key`, *unsigned int* `idx`, *unsigned int ** `bits`)

key: is an OpenPGP key

idx: is the subkey index

bits: if bits is non null it will hold the size of the parameters' in bits

This function will return the public key algorithm of a subkey of an OpenPGP certificate.

If bits is non null, it should have enough size to hold the parameters size in bits. For RSA the bits returned is the modulus. For DSA the bits returned are of the public exponent.

Returns: a member of the `gnutls_pk_algorithm_t` enumeration on success, or a negative value on error.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_pk_dsa_raw

`int gnutls_openpgp_crt_get_subkey_pk_dsa_raw` [Function]
`(`*gnutls_openpgp_crt_t* `crt`, *unsigned int* `idx`, *gnutls_datum_t ** `p`, *gnutls_datum_t ** `q`, *gnutls_datum_t ** `g`, *gnutls_datum_t ** `y`)

crt: Holds the certificate

idx: Is the subkey index

p: will hold the p

q: will hold the q

g: will hold the g

y: will hold the y

This function will export the DSA public key's parameters found in the given certificate. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_pk_rsa_raw

`int gnutls_openpgp_crt_get_subkey_pk_rsa_raw` [Function]
(*gnutls_openpgp_crt_t* `crt`, *unsigned int* `idx`, *gnutls_datum_t* * `m`, *gnutls_datum_t* * `e`)

crt: Holds the certificate

idx: Is the subkey index

m: will hold the modulus

e: will hold the public exponent

This function will export the RSA public key's parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_revoked_status

`int gnutls_openpgp_crt_get_subkey_revoked_status` [Function]
(*gnutls_openpgp_crt_t* `key`, *unsigned int* `idx`)

key: the structure that contains the OpenPGP public key.

idx: is the subkey index

Get subkey revocation status. A negative value indicates an error.

Returns: true (1) if the key has been revoked, or false (0) if it has not.

Since: 2.4.0

gnutls_openpgp_crt_get_subkey_usage

`int gnutls_openpgp_crt_get_subkey_usage` (*gnutls_openpgp_crt_t* `key`, *unsigned int* `idx`, *unsigned int* * `key_usage`) [Function]

key: should contain a gnutls_openpgp_crt_t structure

idx: the subkey index

key_usage: where the key usage bits will be stored

This function will return certificate's key usage, by checking the key algorithm. The key usage value will ORed values of `GNUTLS_KEY_DIGITAL_SIGNATURE` or `GNUTLS_KEY_KEY_ENCIPHERMENT`.

A negative value may be returned in case of parsing error.

Returns: key usage value.

Since: 2.4.0

gnutls_openpgp_crt_get_version

`int gnutls_openpgp_crt_get_version (`*gnutls_openpgp_crt_t* `key``)` [Function]

key: the structure that contains the OpenPGP public key.

Extract the version of the OpenPGP key.

Returns: the version number is returned, or a negative value on errors.

gnutls_openpgp_crt_import

`int gnutls_openpgp_crt_import (`*gnutls_openpgp_crt_t* `key`, *const gnutls_datum_t* * `data`, *gnutls_openpgp_crt_fmt_t* `format``)` [Function]

key: The structure to store the parsed key.

data: The RAW or BASE64 encoded key.

format: One of gnutls_openpgp_crt_fmt_t elements.

This function will convert the given RAW or Base64 encoded key to the native `gnutls_openpgp_crt_t` format. The output will be stored in 'key'.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_crt_init

`int gnutls_openpgp_crt_init (`*gnutls_openpgp_crt_t* * `key``)` [Function]

key: The structure to be initialized

This function will initialize an OpenPGP key structure.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_crt_print

`int gnutls_openpgp_crt_print (`*gnutls_openpgp_crt_t* `cert`, *gnutls_certificate_print_formats_t* `format`, *gnutls_datum_t* * `out``)` [Function]

cert: The structure to be printed

format: Indicate the format to use

out: Newly allocated datum with zero terminated string.

This function will pretty print an OpenPGP certificate, suitable for display to a human.

The format should be zero for future compatibility.

The output `out` needs to be deallocate using `gnutls_free()`.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_crt_set_preferred_key_id

`int gnutls_openpgp_crt_set_preferred_key_id` [Function]
(*gnutls_openpgp_crt_t* `key`, *const gnutls_openpgp_keyid_t* `keyid`)

key: the structure that contains the OpenPGP public key.

keyid: the selected keyid

This allows setting a preferred key id for the given certificate. This key will be used by functions that involve key handling.

gnutls_openpgp_crt_verify_ring

`int gnutls_openpgp_crt_verify_ring` (*gnutls_openpgp_crt_t* `key`, [Function]
gnutls_openpgp_keyring_t `keyring`, *unsigned int* `flags`, *unsigned int ** `verify`)

key: the structure that holds the key.

keyring: holds the keyring to check against

flags: unused (should be 0)

verify: will hold the certificate verification output.

Verify all signatures in the key, using the given set of keys (keyring).

The key verification output will be put in `verify` and will be one or more of the `gnutls_certificate_status_t` enumerated elements bitwise or'd.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_crt_verify_self

`int gnutls_openpgp_crt_verify_self` (*gnutls_openpgp_crt_t* `key`, [Function]
unsigned int `flags`, *unsigned int ** `verify`)

key: the structure that holds the key.

flags: unused (should be 0)

verify: will hold the key verification output.

Verifies the self signature in the key. The key verification output will be put in `verify` and will be one or more of the gnutls_certificate_status_t enumerated elements bitwise or'd.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_keyring_check_id

`int gnutls_openpgp_keyring_check_id` (*gnutls_openpgp_keyring_t* [Function]
`ring`, *const gnutls_openpgp_keyid_t* `keyid`, *unsigned int* `flags`)

ring: holds the keyring to check against

keyid: will hold the keyid to check for.

flags: unused (should be 0)

Check if a given key ID exists in the keyring.

Returns: `GNUTLS_E_SUCCESS` on success (if keyid exists) and a negative error code on failure.

gnutls_openpgp_keyring_deinit

`void gnutls_openpgp_keyring_deinit (`*gnutls_openpgp_keyring_t* `keyring``)` [Function]

keyring: The structure to be initialized

This function will deinitialize a keyring structure.

gnutls_openpgp_keyring_get_crt_count

`int gnutls_openpgp_keyring_get_crt_count (`*gnutls_openpgp_keyring_t* `ring``)` [Function]

ring: is an OpenPGP key ring

This function will return the number of OpenPGP certificates present in the given keyring.

Returns: the number of subkeys, or a negative value on error.

gnutls_openpgp_keyring_get_crt

`int gnutls_openpgp_keyring_get_crt (`*gnutls_openpgp_keyring_t* `ring`, *unsigned int* `idx`, *gnutls_openpgp_crt_t ** `cert``)` [Function]

idx: the index of the certificate to export

This function will extract an OpenPGP certificate from the given keyring. If the index given is out of range `GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE` will be returned. The returned structure needs to be deinited.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_keyring_import

`int gnutls_openpgp_keyring_import (`*gnutls_openpgp_keyring_t* `keyring`, *const gnutls_datum_t ** `data`, *gnutls_openpgp_crt_fmt_t* `format`)` [Function]

keyring: The structure to store the parsed key.

data: The RAW or BASE64 encoded keyring.

format: One of `gnutls_openpgp_keyring_fmt` elements.

This function will convert the given RAW or Base64 encoded keyring to the native `gnutls_openpgp_keyring_t` format. The output will be stored in 'keyring'.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_keyring_init

`int gnutls_openpgp_keyring_init (`*gnutls_openpgp_keyring_t ** `keyring`)` [Function]

keyring: The structure to be initialized

This function will initialize an keyring structure.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_privkey_deinit

`void gnutls_openpgp_privkey_deinit (gnutls_openpgp_privkey_t key)` [Function]

key: The structure to be initialized

This function will deinitialize a key structure.

gnutls_openpgp_privkey_export_dsa_raw

`int gnutls_openpgp_privkey_export_dsa_raw (gnutls_openpgp_privkey_t pkey, gnutls_datum_t * p, gnutls_datum_t * q, gnutls_datum_t * g, gnutls_datum_t * y, gnutls_datum_t * x)` [Function]

pkey: Holds the certificate

p: will hold the p

q: will hold the q

g: will hold the g

y: will hold the y

x: will hold the x

This function will export the DSA private key's parameters found in the given certificate. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_privkey_export_rsa_raw

`int gnutls_openpgp_privkey_export_rsa_raw (gnutls_openpgp_privkey_t pkey, gnutls_datum_t * m, gnutls_datum_t * e, gnutls_datum_t * d, gnutls_datum_t * p, gnutls_datum_t * q, gnutls_datum_t * u)` [Function]

pkey: Holds the certificate

m: will hold the modulus

e: will hold the public exponent

d: will hold the private exponent

p: will hold the first prime (p)

q: will hold the second prime (q)

u: will hold the coefficient

This function will export the RSA private key's parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_privkey_export_subkey_dsa_raw

`int gnutls_openpgp_privkey_export_subkey_dsa_raw` [Function]
(*gnutls_openpgp_privkey_t* `pkey`, *unsigned int* `idx`, *gnutls_datum_t* * `p`, *gnutls_datum_t* * `q`, *gnutls_datum_t* * `g`, *gnutls_datum_t* * `y`, *gnutls_datum_t* * `x`)

pkey: Holds the certificate

idx: Is the subkey index

p: will hold the p

q: will hold the q

g: will hold the g

y: will hold the y

x: will hold the x

This function will export the DSA private key's parameters found in the given certificate. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_privkey_export_subkey_rsa_raw

`int gnutls_openpgp_privkey_export_subkey_rsa_raw` [Function]
(*gnutls_openpgp_privkey_t* `pkey`, *unsigned int* `idx`, *gnutls_datum_t* * `m`, *gnutls_datum_t* * `e`, *gnutls_datum_t* * `d`, *gnutls_datum_t* * `p`, *gnutls_datum_t* * `q`, *gnutls_datum_t* * `u`)

pkey: Holds the certificate

idx: Is the subkey index

m: will hold the modulus

e: will hold the public exponent

d: will hold the private exponent

p: will hold the first prime (p)

q: will hold the second prime (q)

u: will hold the coefficient

This function will export the RSA private key's parameters found in the given structure. The new parameters will be allocated using `gnutls_malloc()` and will be stored in the appropriate datum.

Returns: `GNUTLS_E_SUCCESS` on success, otherwise an error.

Since: 2.4.0

gnutls_openpgp_privkey_export

`int gnutls_openpgp_privkey_export (`*gnutls_openpgp_privkey_t* `key`*, gnutls_openpgp_crt_fmt_t* `format`*, const char * * `password`*, unsigned int* `flags`*, void * * `output_data`*, size_t * * `output_data_size`*)* [Function]

key: Holds the key.

format: One of gnutls_openpgp_crt_fmt_t elements.

password: the password that will be used to encrypt the key. (unused for now)

flags: zero for future compatibility

output_data: will contain the key base64 encoded or raw

output_data_size: holds the size of output_data (and will be replaced by the actual size of parameters)

This function will convert the given key to RAW or Base64 format. If the buffer provided is not long enough to hold the output, then GNUTLS_E_SHORT_MEMORY_BUFFER will be returned.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

Since: 2.4.0

gnutls_openpgp_privkey_get_fingerprint

`int gnutls_openpgp_privkey_get_fingerprint (`*gnutls_openpgp_privkey_t* `key`*, void * * `fpr`*, size_t * * `fprlen`*)* [Function]

key: the raw data that contains the OpenPGP secret key.

fpr: the buffer to save the fingerprint, must hold at least 20 bytes.

fprlen: the integer to save the length of the fingerprint.

Get the fingerprint of the OpenPGP key. Depends on the algorithm, the fingerprint can be 16 or 20 bytes.

Returns: On success, 0 is returned, or an error code.

Since: 2.4.0

gnutls_openpgp_privkey_get_key_id

`int gnutls_openpgp_privkey_get_key_id (`*gnutls_openpgp_privkey_t* `key`*, gnutls_openpgp_keyid_t* `keyid`*)* [Function]

key: the structure that contains the OpenPGP secret key.

keyid: the buffer to save the keyid.

Get key-id.

Returns: the 64-bit keyID of the OpenPGP key.

Since: 2.4.0

gnutls_openpgp_privkey_get_pk_algorithm

`gnutls_pk_algorithm_t` [Function]
`gnutls_openpgp_privkey_get_pk_algorithm` (*gnutls_openpgp_privkey_t* `key`, *unsigned int* * `bits`)

key: is an OpenPGP key

bits: if bits is non null it will hold the size of the parameters' in bits

This function will return the public key algorithm of an OpenPGP certificate.

If bits is non null, it should have enough size to hold the parameters size in bits. For RSA the bits returned is the modulus. For DSA the bits returned are of the public exponent.

Returns: a member of the `gnutls_pk_algorithm_t` enumeration on success, or a negative value on error.

Since: 2.4.0

gnutls_openpgp_privkey_get_preferred_key_id

`int gnutls_openpgp_privkey_get_preferred_key_id` [Function]
(*gnutls_openpgp_privkey_t* `key`, *gnutls_openpgp_keyid_t* `keyid`)

key: the structure that contains the OpenPGP public key.

keyid: the struct to save the keyid.

Get the preferred key-id for the key.

Returns: the 64-bit preferred keyID of the OpenPGP key, or if it hasn't been set it returns `GNUTLS_E_INVALID_REQUEST`.

gnutls_openpgp_privkey_get_revoked_status

`int gnutls_openpgp_privkey_get_revoked_status` [Function]
(*gnutls_openpgp_privkey_t* `key`)

key: the structure that contains the OpenPGP private key.

Get revocation status of key.

Returns: true (1) if the key has been revoked, or false (0) if it has not, or a negative value indicates an error.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_count

`int gnutls_openpgp_privkey_get_subkey_count` [Function]
(*gnutls_openpgp_privkey_t* `key`)

key: is an OpenPGP key

This function will return the number of subkeys present in the given OpenPGP certificate.

Returns: the number of subkeys, or a negative value on error.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_creation_time

`time_t gnutls_openpgp_privkey_get_subkey_creation_time` [Function]
(*gnutls_openpgp_privkey_t* `key`, *unsigned int* `idx`)

key: the structure that contains the OpenPGP private key.

idx: the subkey index

Get subkey creation time.

Returns: the timestamp when the OpenPGP key was created.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_expiration_time

`time_t gnutls_openpgp_privkey_get_subkey_expiration_time` [Function]
(*gnutls_openpgp_privkey_t* `key`, *unsigned int* `idx`)

key: the structure that contains the OpenPGP private key.

idx: the subkey index

Get subkey expiration time. A value of '0' means that the key doesn't expire at all.

Returns: the time when the OpenPGP key expires.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_fingerprint

`int gnutls_openpgp_privkey_get_subkey_fingerprint` [Function]
(*gnutls_openpgp_privkey_t* `key`, *unsigned int* `idx`, *void ** `fpr`, *size_t ** `fprlen`)

key: the raw data that contains the OpenPGP secret key.

idx: the subkey index

fpr: the buffer to save the fingerprint, must hold at least 20 bytes.

fprlen: the integer to save the length of the fingerprint.

Get the fingerprint of an OpenPGP subkey. Depends on the algorithm, the fingerprint can be 16 or 20 bytes.

Returns: On success, 0 is returned, or an error code.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_idx

`int gnutls_openpgp_privkey_get_subkey_idx` [Function]
(*gnutls_openpgp_privkey_t* `key`, *const gnutls_openpgp_keyid_t* `keyid`)

key: the structure that contains the OpenPGP private key.

keyid: the keyid.

Get index of subkey.

Returns: the index of the subkey or a negative error value.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_id

`int gnutls_openpgp_privkey_get_subkey_id` [Function]
(*gnutls_openpgp_privkey_t* `key`, *unsigned int* `idx`, *gnutls_openpgp_keyid_t* `keyid`)

key: the structure that contains the OpenPGP secret key.

idx: the subkey index

keyid: the buffer to save the keyid.

Get the key-id for the subkey.

Returns: the 64-bit keyID of the OpenPGP key.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_pk_algorithm

`gnutls_pk_algorithm_t` [Function]
`gnutls_openpgp_privkey_get_subkey_pk_algorithm`
(*gnutls_openpgp_privkey_t* `key`, *unsigned int* `idx`, *unsigned int* * `bits`)

key: is an OpenPGP key

idx: is the subkey index

bits: if bits is non null it will hold the size of the parameters' in bits

This function will return the public key algorithm of a subkey of an OpenPGP certificate.

If bits is non null, it should have enough size to hold the parameters size in bits. For RSA the bits returned is the modulus. For DSA the bits returned are of the public exponent.

Returns: a member of the `gnutls_pk_algorithm_t` enumeration on success, or a negative value on error.

Since: 2.4.0

gnutls_openpgp_privkey_get_subkey_revoked_status

`int gnutls_openpgp_privkey_get_subkey_revoked_status` [Function]
(*gnutls_openpgp_privkey_t* `key`, *unsigned int* `idx`)

key: the structure that contains the OpenPGP private key.

idx: is the subkey index

Get revocation status of key.

Returns: true (1) if the key has been revoked, or false (0) if it has not, or a negative value indicates an error.

Since: 2.4.0

gnutls_openpgp_privkey_import

`int gnutls_openpgp_privkey_import` (*gnutls_openpgp_privkey_t* [Function]
`key`, *const gnutls_datum_t* * `data`, *gnutls_openpgp_crt_fmt_t* `format`, *const char* * `password`, *unsigned int* `flags`)

key: The structure to store the parsed key.

data: The RAW or BASE64 encoded key.

format: One of gnutls_openpgp_crt_fmt_t elements.

password: (unused for now)

flags: should be zero

This function will convert the given RAW or Base64 encoded key to the native gnutls_openpgp_privkey_t format. The output will be stored in 'key'.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_privkey_init

`int gnutls_openpgp_privkey_init` (*gnutls_openpgp_privkey_t * **key***) [Function]

key: The structure to be initialized

This function will initialize an OpenPGP key structure.

Returns: `GNUTLS_E_SUCCESS` on success, or an error code.

gnutls_openpgp_privkey_set_preferred_key_id

`int gnutls_openpgp_privkey_set_preferred_key_id` [Function]
(*gnutls_openpgp_privkey_t **key**, const gnutls_openpgp_keyid_t **keyid***)

key: the structure that contains the OpenPGP public key.

keyid: the selected keyid

This allows setting a preferred key id for the given certificate. This key will be used by functions that involve key handling.

Returns: On success, 0 is returned, or an error code.

gnutls_openpgp_privkey_sign_hash

`int gnutls_openpgp_privkey_sign_hash` (*gnutls_openpgp_privkey_t **key**, const gnutls_datum_t * **hash**, gnutls_datum_t * **signature***) [Function]

key: Holds the key

hash: holds the data to be signed

signature: will contain newly allocated signature

This function will sign the given hash using the private key. You should use `gnutls_openpgp_privkey_set_subkey()` before calling this function to set the subkey to use.

Returns: On success, `GNUTLS_E_SUCCESS` is returned, otherwise a negative error value.

gnutls_openpgp_set_recv_key_function

`void gnutls_openpgp_set_recv_key_function` (*gnutls_session_t **session**, gnutls_openpgp_recv_key_func **func***) [Function]

session: a TLS session

func: the callback

This funtion will set a key retrieval function for OpenPGP keys. This callback is only useful in server side, and will be used if the peer sent a key fingerprint instead of a full key.

9.5 TLS Inner Application (TLS/IA) Functions

The following functions are used for TLS Inner Application (TLS/IA). Their prototypes lie in 'gnutls/extra.h'. You need to link with 'libgnutls-extra' to be able to use these functions (see Section 9.3 [GnuTLS-extra functions], page 231).

The typical control flow in an TLS/IA client (that would not require an Application Phase for resumed sessions) would be similar to the following:

```
int client_avp (gnuls_session_t *session, void *ptr,
                const char *last, size_t lastlen,
char **new, size_t *newlen)
{
...
}
...
int main ()
{
  gnutls_ia_client_credentials_t iacred;
...
  gnutls_init (&session, GNUTLS_CLIENT);
...
  /* Enable TLS/IA. */
  gnutls_ia_allocate_client_credentials(&iacred);
  gnutls_ia_set_client_avp_function(iacred, client_avp);
  gnutls_credentials_set (session, GNUTLS_CRD_IA, iacred);
...
  ret = gnutls_handshake (session);
  // Error handling...
...
  if (gnutls_ia_handshake_p (session))
    {
      ret = gnutls_ia_handshake (session);
      // Error handling...
...
```

See below for detailed descriptions of all the functions used above.

The function `client_avp` would have to be implemented by your application. The function is responsible for handling the AVP data. See `gnutls_ia_set_client_avp_function` below for more information on how that function should be implemented.

The control flow in a typical server is similar to the above, use `gnutls_ia_server_credentials_t` instead of `gnutls_ia_client_credentials_t`, and replace the call to the client functions with the corresponding server functions.

gnutls_ia_allocate_client_credentials

`int gnutls_ia_allocate_client_credentials` [Function]
(*gnutls_ia_client_credentials_t* * *sc*)

sc: is a pointer to an `gnutls_ia_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Adding this credential to a session will enable TLS/IA, and will require an Application Phase after the TLS handshake (if the server support TLS/IA). Use `gnutls_ia_require_inner_phase()` to toggle the TLS/IA mode.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_ia_allocate_server_credentials

`int gnutls_ia_allocate_server_credentials` [Function]
(*gnutls_ia_server_credentials_t* * `sc`)

sc: is a pointer to an `gnutls_ia_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to allocate it.

Adding this credential to a session will enable TLS/IA, and will require an Application Phase after the TLS handshake (if the client support TLS/IA). Use `gnutls_ia_require_inner_phase()` to toggle the TLS/IA mode.

Returns: On success, `GNUTLS_E_SUCCESS` (0) is returned, otherwise an error code is returned.

gnutls_ia_enable

`void gnutls_ia_enable` (*gnutls_session_t* `session`, *int* `allow_skip_on_resume`) [Function]

session: is a `gnutls_session_t` structure.

allow_skip_on_resume: non-zero if local party allows to skip the TLS/IA application phases for a resumed session.

Specify whether we must advertise support for the TLS/IA extension during the handshake.

At the client side, we always advertise TLS/IA if gnutls_ia_enable was called before the handshake; at the server side, we also require that the client has advertised that it wants to run TLS/IA before including the advertisement, as required by the protocol.

Similarly, at the client side we always advertise that we allow TLS/IA to be skipped for resumed sessions if `allow_skip_on_resume` is non-zero; at the server side, we also require that the session is indeed resumable and that the client has also advertised that it allows TLS/IA to be skipped for resumed sessions.

After the TLS handshake, call `gnutls_ia_handshake_p()` to find out whether both parties agreed to do a TLS/IA handshake, before calling `gnutls_ia_handshake()` or one of the lower level gnutls_ia_* functions.

gnutls_ia_endphase_send

`int gnutls_ia_endphase_send` (*gnutls_session_t* `session`, *int* `final_p`) [Function]

session: is a `gnutls_session_t` structure.

final_p: Set iff this should signal the final phase.

Send a TLS/IA end phase message.

In the client, this should only be used to acknowledge an end phase message sent by the server.

In the server, this can be called instead of `gnutls_ia_send()` if the server wishes to end an application phase.

Return value: Return 0 on success, or an error code.

gnutls_ia_extract_inner_secret

`void gnutls_ia_extract_inner_secret (`*gnutls_session_t* **`session`**`,` [Function]
*char * * **`buffer`**`)`

session: is a `gnutls_session_t` structure.

buffer: pre-allocated buffer to hold 48 bytes of inner secret.

Copy the 48 bytes large inner secret into the specified buffer

This function is typically used after the TLS/IA handshake has concluded. The TLS/IA inner secret can be used as input to a PRF to derive session keys. Do not use the inner secret directly as a session key, because for a resumed session that does not include an application phase, the inner secret will be identical to the inner secret in the original session. It is important to include, for example, the client and server randomness when deriving a sesssion key from the inner secret.

gnutls_ia_free_client_credentials

`void gnutls_ia_free_client_credentials` [Function]
`(`*gnutls_ia_client_credentials_t* **`sc`**`)`

sc: is an `gnutls_ia_client_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_ia_free_server_credentials

`void gnutls_ia_free_server_credentials` [Function]
`(`*gnutls_ia_server_credentials_t* **`sc`**`)`

sc: is an `gnutls_ia_server_credentials_t` structure.

This structure is complex enough to manipulate directly thus this helper function is provided in order to free (deallocate) it.

gnutls_ia_generate_challenge

`int gnutls_ia_generate_challenge (`*gnutls_session_t* **`session`**`,` [Function]
size_t **`buffer_size`**`,` *char * * **`buffer`**`)`

session: is a `gnutls_session_t` structure.

buffer_size: size of output buffer.

buffer: pre-allocated buffer to contain `buffer_size` bytes of output.

Generate an application challenge that the client cannot control or predict, based on the TLS/IA inner secret.

Return value: Returns 0 on success, or an negative error code.

gnutls_ia_get_client_avp_ptr

`void * gnutls_ia_get_client_avp_ptr` [Function]
(*gnutls_ia_client_credentials_t* `cred`)

cred: is a `gnutls_ia_client_credentials_t` structure.

Returns the pointer that will be provided to the TLS/IA callback function as the first argument.

Returns: The client callback data pointer.

gnutls_ia_get_server_avp_ptr

`void * gnutls_ia_get_server_avp_ptr` [Function]
(*gnutls_ia_server_credentials_t* `cred`)

cred: is a `gnutls_ia_client_credentials_t` structure.

Returns the pointer that will be provided to the TLS/IA callback function as the first argument.

Returns: The server callback data pointer.

gnutls_ia_handshake_p

`int gnutls_ia_handshake_p` (*gnutls_session_t* `session`) [Function]

session: is a `gnutls_session_t` structure.

Predicate to be used after `gnutls_handshake()` to decide whether to invoke `gnutls_ia_handshake()`. Usable by both clients and servers.

Return value: non-zero if TLS/IA handshake is expected, zero otherwise.

gnutls_ia_handshake

`int gnutls_ia_handshake` (*gnutls_session_t* `session`) [Function]

session: is a `gnutls_session_t` structure.

Perform a TLS/IA handshake. This should be called after `gnutls_handshake()` iff `gnutls_ia_handshake_p()`.

Return 0 on success, or an error code.

gnutls_ia_permute_inner_secret

`int gnutls_ia_permute_inner_secret` (*gnutls_session_t* `session`, [Function]
size_t `session_keys_size`, *const char ** `session_keys`)

session: is a `gnutls_session_t` structure.

session_keys_size: Size of generated session keys (0 if none).

session_keys: Generated session keys, used to permute inner secret (NULL if none).

Permute the inner secret using the generated session keys.

This can be called in the TLS/IA AVP callback to mix any generated session keys with the TLS/IA inner secret.

Return value: Return zero on success, or a negative error code.

gnutls_ia_recv

`ssize_t gnutls_ia_recv (`*gnutls_session_t* ***session***`, char *` ***data***`, size_t` ***sizeofdata***`)` [Function]

session: is a `gnutls_session_t` structure.

data: the buffer that the data will be read into, must hold >= 12 bytes.

sizeofdata: the number of requested bytes, must be >= 12.

Receive TLS/IA data. This function has the similar semantics with `recv()`. The only difference is that is accepts a GNUTLS session, and uses different error codes.

If the server attempt to finish an application phase, this function will return `GNUTLS_E_WARNING_IA_IPHF_RECEIVED` or `GNUTLS_E_WARNING_IA_FPHF_RECEIVED`. The caller should then invoke `gnutls_ia_verify_endphase()`, and if it runs the client side, also send an endphase message of its own using gnutls_ia_endphase_send.

If EINTR is returned by the internal push function (the default is `code{recv()}`) then GNUTLS_E_INTERRUPTED will be returned. If GNUTLS_E_INTERRUPTED or GNUTLS_E_AGAIN is returned, you must call this function again, with the same parameters; alternatively you could provide a NULL pointer for data, and 0 for size.

Returns: The number of bytes received. A negative error code is returned in case of an error. The `GNUTLS_E_WARNING_IA_IPHF_RECEIVED` and `GNUTLS_E_WARNING_IA_FPHF_RECEIVED` errors are returned when an application phase finished message has been sent by the server.

gnutls_ia_send

`ssize_t gnutls_ia_send (`*gnutls_session_t* ***session***`, const char *` ***data***`, size_t` ***sizeofdata***`)` [Function]

session: is a `gnutls_session_t` structure.

data: contains the data to send

sizeofdata: is the length of the data

Send TLS/IA application payload data. This function has the similar semantics with `send()`. The only difference is that is accepts a GNUTLS session, and uses different error codes.

The TLS/IA protocol is synchronous, so you cannot send more than one packet at a time. The client always send the first packet.

To finish an application phase in the server, use `gnutls_ia_endphase_send()`. The client cannot end an application phase unilaterally; rather, a client is required to respond with an endphase of its own if gnutls_ia_recv indicates that the server has sent one.

If the EINTR is returned by the internal push function (the default is `send()}` then `GNUTLS_E_INTERRUPTED` will be returned. If `GNUTLS_E_INTERRUPTED` or `GNUTLS_E_AGAIN` is returned, you must call this function again, with the same parameters; alternatively you could provide a `NULL` pointer for data, and 0 for size.

Returns: The number of bytes sent, or a negative error code.

gnutls_ia_set_client_avp_function

`void gnutls_ia_set_client_avp_function` [Function]
(*gnutls_ia_client_credentials_t* `cred`, *gnutls_ia_avp_func* `avp_func`)

cred: is a `gnutls_ia_client_credentials_t` structure.

avp_func: is the callback function

Set the TLS/IA AVP callback handler used for the session.

The AVP callback is called to process AVPs received from the server, and to get a new AVP to send to the server.

The callback's function form is: int (*avp_func) (gnutls_session_t session, void *ptr, const char *last, size_t lastlen, char **next, size_t *nextlen);

The `session` parameter is the `gnutls_session_t` structure corresponding to the current session. The `ptr` parameter is the application hook pointer, set through `gnutls_ia_set_client_avp_ptr()`. The AVP received from the server is present in `last` of `lastlen` size, which will be `NULL` on the first invocation. The newly allocated output AVP to send to the server should be placed in *`next` of *`nextlen` size.

The callback may invoke `gnutls_ia_permute_inner_secret()` to mix any generated session keys with the TLS/IA inner secret.

Return 0 (`GNUTLS_IA_APPLICATION_PAYLOAD`) on success, or a negative error code to abort the TLS/IA handshake.

Note that the callback must use allocate the `next` parameter using `gnutls_malloc()`, because it is released via `gnutls_free()` by the TLS/IA handshake function.

gnutls_ia_set_client_avp_ptr

`void gnutls_ia_set_client_avp_ptr` (*gnutls_ia_client_credentials_t* `cred`, *void * ptr*) [Function]

cred: is a `gnutls_ia_client_credentials_t` structure.

ptr: is the pointer

Sets the pointer that will be provided to the TLS/IA callback function as the first argument.

gnutls_ia_set_server_avp_function

`void gnutls_ia_set_server_avp_function` [Function]
(*gnutls_ia_server_credentials_t* `cred`, *gnutls_ia_avp_func* `avp_func`)

cred: is a `gnutls_ia_server_credentials_t` structure.

Set the TLS/IA AVP callback handler used for the session.

The callback's function form is: int (*avp_func) (gnutls_session_t session, void *ptr, const char *last, size_t lastlen, char **next, size_t *nextlen);

The `session` parameter is the `gnutls_session_t` structure corresponding to the current session. The `ptr` parameter is the application hook pointer, set through `gnutls_ia_set_server_avp_ptr()`. The AVP received from the client is present in

`last` of `lastlen` size. The newly allocated output AVP to send to the client should be placed in *`next` of *`nextlen` size.

The AVP callback is called to process incoming AVPs from the client, and to get a new AVP to send to the client. It can also be used to instruct the TLS/IA handshake to do go into the Intermediate or Final phases. It return a negative error code, or an `gnutls_ia_apptype_t` message type.

The callback may invoke `gnutls_ia_permute_inner_secret()` to mix any generated session keys with the TLS/IA inner secret.

Specifically, return `GNUTLS_IA_APPLICATION_PAYLOAD` (0) to send another AVP to the client, return `GNUTLS_IA_INTERMEDIATE_PHASE_FINISHED` (1) to indicate that an IntermediatePhaseFinished message should be sent, and return `GNUTLS_IA_FINAL_PHASE_FINISHED` (2) to indicate that an FinalPhaseFinished message should be sent. In the last two cases, the contents of the `next` and `nextlen` parameter is not used.

Note that the callback must use allocate the `next` parameter using `gnutls_malloc()`, because it is released via `gnutls_free()` by the TLS/IA handshake function.

gnutls_ia_set_server_avp_ptr

`void gnutls_ia_set_server_avp_ptr (`*gnutls_ia_server_credentials_t* `cred`, *void ** `ptr``)` [Function]

cred: is a `gnutls_ia_client_credentials_t` structure.

ptr: is the pointer

Sets the pointer that will be provided to the TLS/IA callback function as the first argument.

gnutls_ia_verify_endphase

`int gnutls_ia_verify_endphase (`*gnutls_session_t* `session`, *const char ** `checksum``)` [Function]

session: is a `gnutls_session_t` structure.

checksum: 12-byte checksum data, received from `gnutls_ia_recv()`.

Verify TLS/IA end phase checksum data. If verification fails, the `GNUTLS_A_INNER_APPLICATION_VERIFICATION` alert is sent to the other sie.

This function is called when `gnutls_ia_recv()` return `GNUTLS_E_WARNING_IA_IPHF_RECEIVED` or `GNUTLS_E_WARNING_IA_FPHF_RECEIVED`.

Return value: Return 0 on successful verification, or an error code. If the checksum verification of the end phase message fails, `GNUTLS_E_IA_VERIFY_FAILED` is returned.

9.6 Error Codes and Descriptions

The error codes used throughout the library are described below. The return code `GNUTLS_E_SUCCESS` indicate successful operation, and is guaranteed to have the value 0, so you can use it in logical expressions.

`GNUTLS_E_AGAIN:`
: Function was interrupted.

`GNUTLS_E_ASN1_DER_ERROR:`
ASN1 parser: Error in DER parsing.

`GNUTLS_E_ASN1_DER_OVERFLOW:`
ASN1 parser: Overflow in DER parsing.

`GNUTLS_E_ASN1_ELEMENT_NOT_FOUND:`
ASN1 parser: Element was not found.

`GNUTLS_E_ASN1_GENERIC_ERROR:`
ASN1 parser: Generic parsing error.

`GNUTLS_E_ASN1_IDENTIFIER_NOT_FOUND:`
ASN1 parser: Identifier was not found

`GNUTLS_E_ASN1_SYNTAX_ERROR:`
ASN1 parser: Syntax error.

`GNUTLS_E_ASN1_TAG_ERROR:`
ASN1 parser: Error in TAG.

`GNUTLS_E_ASN1_TAG_IMPLICIT:`
ASN1 parser: error in implicit tag

`GNUTLS_E_ASN1_TYPE_ANY_ERROR:`
ASN1 parser: Error in type 'ANY'.

`GNUTLS_E_ASN1_VALUE_NOT_FOUND:`
ASN1 parser: Value was not found.

`GNUTLS_E_ASN1_VALUE_NOT_VALID:`
ASN1 parser: Value is not valid.

`GNUTLS_E_BASE64_DECODING_ERROR:`
Base64 decoding error.

`GNUTLS_E_BASE64_ENCODING_ERROR:`
Base64 encoding error.

`GNUTLS_E_BASE64_UNEXPECTED_HEADER_ERROR:`
Base64 unexpected header error.

`GNUTLS_E_CERTIFICATE_ERROR:`
Error in the certificate.

`GNUTLS_E_CERTIFICATE_KEY_MISMATCH:`
The certificate and the given key do not match.

`GNUTLS_E_COMPRESSION_FAILED:`
Compression of the TLS record packet has failed.

`GNUTLS_E_CONSTRAINT_ERROR:`
Some constraint limits were reached.

`GNUTLS_E_CRYPTO_ALREADY_REGISTERED:`
There is already a crypto algorithm with lower priority.

`GNUTLS_E_DB_ERROR:`
Error in Database backend.

`GNUTLS_E_DECOMPRESSION_FAILED:`
Decompression of the TLS record packet has failed.

`GNUTLS_E_DECRYPTION_FAILED:`
Decryption has failed.

`GNUTLS_E_DH_PRIME_UNACCEPTABLE:`
The Diffie Hellman prime sent by the server is not acceptable (not long enough).

`GNUTLS_E_ENCRYPTION_FAILED:`
Encryption has failed.

`GNUTLS_E_ERROR_IN_FINISHED_PACKET:`
An error was encountered at the TLS Finished packet calculation.

`GNUTLS_E_EXPIRED:`
The requested session has expired.

`GNUTLS_E_FATAL_ALERT_RECEIVED:`
A TLS fatal alert has been received.

`GNUTLS_E_FILE_ERROR:`
Error while reading file.

`GNUTLS_E_GOT_APPLICATION_DATA:`
TLS Application data were received, while expecting handshake data.

`GNUTLS_E_HANDSHAKE_TOO_LARGE:`
The handshake data size is too large (DoS?), check gnutls_handshake_set_max_packet_length().

`GNUTLS_E_HASH_FAILED:`
Hashing has failed.

`GNUTLS_E_IA_VERIFY_FAILED:`
Verifying TLS/IA phase checksum failed

`GNUTLS_E_ILLEGAL_SRP_USERNAME:`
The SRP username supplied is illegal.

`GNUTLS_E_INCOMPATIBLE_GCRYPT_LIBRARY:`
The gcrypt library version is too old.

`GNUTLS_E_INCOMPATIBLE_LIBTASN1_LIBRARY:`
The tasn1 library version is too old.

`GNUTLS_E_INIT_LIBEXTRA:`
The initialization of GnuTLS-extra has failed.

`GNUTLS_E_INSUFFICIENT_CREDENTIALS:`
Insufficient credentials for that request.

`GNUTLS_E_INTERNAL_ERROR:`
GnuTLS internal error.

`GNUTLS_E_INTERRUPTED:`
: Function was interrupted.

`GNUTLS_E_INVALID_PASSWORD:`
: The given password contains invalid characters.

`GNUTLS_E_INVALID_REQUEST:`
: The request is invalid.

`GNUTLS_E_INVALID_SESSION:`
: The specified session has been invalidated for some reason.

`GNUTLS_E_KEY_USAGE_VIOLATION:`
: Key usage violation in certificate has been detected.

`GNUTLS_E_LARGE_PACKET:`
: A large TLS record packet was received.

`GNUTLS_E_LIBRARY_VERSION_MISMATCH:`
: The GnuTLS library version does not match the GnuTLS-extra library version.

`GNUTLS_E_LZO_INIT_FAILED:`
: The initialization of LZO has failed.

`GNUTLS_E_MAC_VERIFY_FAILED:`
: The Message Authentication Code verification failed.

`GNUTLS_E_MEMORY_ERROR:`
: Internal error in memory allocation.

`GNUTLS_E_MPI_PRINT_FAILED:`
: Could not export a large integer.

`GNUTLS_E_MPI_SCAN_FAILED:`
: The scanning of a large integer has failed.

`GNUTLS_E_NO_CERTIFICATE_FOUND:`
: The peer did not send any certificate.

`GNUTLS_E_NO_CIPHER_SUITES:`
: No supported cipher suites have been found.

`GNUTLS_E_NO_COMPRESSION_ALGORITHMS:`
: No supported compression algorithms have been found.

`GNUTLS_E_NO_TEMPORARY_DH_PARAMS:`
: No temporary DH parameters were found.

`GNUTLS_E_NO_TEMPORARY_RSA_PARAMS:`
: No temporary RSA parameters were found.

`GNUTLS_E_OPENPGP_FINGERPRINT_UNSUPPORTED:`
: The OpenPGP fingerprint is not supported.

`GNUTLS_E_OPENPGP_GETKEY_FAILED:`
: Could not get OpenPGP key.

`GNUTLS_E_OPENPGP_KEYRING_ERROR:`
Error loading the keyring.

`GNUTLS_E_OPENPGP_SUBKEY_ERROR:`
Could not find OpenPGP subkey.

`GNUTLS_E_OPENPGP_UID_REVOKED:`
The OpenPGP User ID is revoked.

`GNUTLS_E_PKCS1_WRONG_PAD:`
Wrong padding in PKCS1 packet.

`GNUTLS_E_PK_DECRYPTION_FAILED:`
Public key decryption has failed.

`GNUTLS_E_PK_ENCRYPTION_FAILED:`
Public key encryption has failed.

`GNUTLS_E_PK_SIGN_FAILED:`
Public key signing has failed.

`GNUTLS_E_PK_SIG_VERIFY_FAILED:`
Public key signature verification has failed.

`GNUTLS_E_PULL_ERROR:`
Error in the pull function.

`GNUTLS_E_PUSH_ERROR:`
Error in the push function.

`GNUTLS_E_RANDOM_FAILED:`
Failed to acquire random data.

`GNUTLS_E_RECEIVED_ILLEGAL_EXTENSION:`
An illegal TLS extension was received.

`GNUTLS_E_RECEIVED_ILLEGAL_PARAMETER:`
An illegal parameter has been received.

`GNUTLS_E_RECORD_LIMIT_REACHED:`
The upper limit of record packet sequence numbers has been reached. Wow!

`GNUTLS_E_REHANDSHAKE:`
Rehandshake was requested by the peer.

`GNUTLS_E_REQUESTED_DATA_NOT_AVAILABLE:`
The requested data were not available.

`GNUTLS_E_SHORT_MEMORY_BUFFER:`
The given memory buffer is too short to hold parameters.

`GNUTLS_E_SRP_PWD_ERROR:`
Error in password file.

`GNUTLS_E_SRP_PWD_PARSING_ERROR:`
Parsing error in password file.

`GNUTLS_E_SUCCESS:`
: Success.

`GNUTLS_E_TOO_MANY_EMPTY_PACKETS:`
: Too many empty record packets have been received.

`GNUTLS_E_UNEXPECTED_HANDSHAKE_PACKET:`
: An unexpected TLS handshake packet was received.

`GNUTLS_E_UNEXPECTED_PACKET:`
: An unexpected TLS packet was received.

`GNUTLS_E_UNEXPECTED_PACKET_LENGTH:`
: A TLS packet with unexpected length was received.

`GNUTLS_E_UNKNOWN_ALGORITHM:`
: The specified algorithm or protocol is unknown.

`GNUTLS_E_UNKNOWN_CIPHER_SUITE:`
: Could not negotiate a supported cipher suite.

`GNUTLS_E_UNKNOWN_CIPHER_TYPE:`
: The cipher type is unsupported.

`GNUTLS_E_UNKNOWN_COMPRESSION_ALGORITHM:`
: Could not negotiate a supported compression method.

`GNUTLS_E_UNKNOWN_HASH_ALGORITHM:`
: The hash algorithm is unknown.

`GNUTLS_E_UNKNOWN_PKCS_BAG_TYPE:`
: The PKCS structure's bag type is unknown.

`GNUTLS_E_UNKNOWN_PKCS_CONTENT_TYPE:`
: The PKCS structure's content type is unknown.

`GNUTLS_E_UNKNOWN_PK_ALGORITHM:`
: An unknown public key algorithm was encountered.

`GNUTLS_E_UNSUPPORTED_CERTIFICATE_TYPE:`
: The certificate type is not supported.

`GNUTLS_E_UNSUPPORTED_VERSION_PACKET:`
: A record packet with illegal version was received.

`GNUTLS_E_UNWANTED_ALGORITHM:`
: An algorithm that is not enabled was negotiated.

`GNUTLS_E_WARNING_ALERT_RECEIVED:`
: A TLS warning alert has been received.

`GNUTLS_E_WARNING_IA_FPHF_RECEIVED:`
: Received a TLS/IA Final Phase Finished message

`GNUTLS_E_WARNING_IA_IPHF_RECEIVED:`
: Received a TLS/IA Intermediate Phase Finished message

`GNUTLS_E_X509_UNKNOWN_SAN:`
: Unknown Subject Alternative name in X.509 certificate.

`GNUTLS_E_X509_UNSUPPORTED_ATTRIBUTE:`
: The certificate has unsupported attributes.

`GNUTLS_E_X509_UNSUPPORTED_CRITICAL_EXTENSION:`
: Unsupported critical extension in X.509 certificate.

`GNUTLS_E_X509_UNSUPPORTED_OID:`
: The OID is not supported.

10 All the Supported Ciphersuites in GnuTLS

Available cipher suites:

TLS_ANON_DH_ARCFOUR_MD5	0x00 0x18	SSL3.0
TLS_ANON_DH_3DES_EDE_CBC_SHA1	0x00 0x1b	SSL3.0
TLS_ANON_DH_AES_128_CBC_SHA1	0x00 0x34	SSL3.0
TLS_ANON_DH_AES_256_CBC_SHA1	0x00 0x3a	SSL3.0
TLS_ANON_DH_CAMELLIA_128_CBC_SHA1	0x00 0x46	TLS1.0
TLS_ANON_DH_CAMELLIA_256_CBC_SHA1	0x00 0x89	TLS1.0
TLS_PSK_SHA_ARCFOUR_SHA1	0x00 0x8a	TLS1.0
TLS_PSK_SHA_3DES_EDE_CBC_SHA1	0x00 0x8b	TLS1.0
TLS_PSK_SHA_AES_128_CBC_SHA1	0x00 0x8c	TLS1.0
TLS_PSK_SHA_AES_256_CBC_SHA1	0x00 0x8d	TLS1.0
TLS_DHE_PSK_SHA_ARCFOUR_SHA1	0x00 0x8e	TLS1.0
TLS_DHE_PSK_SHA_3DES_EDE_CBC_SHA1	0x00 0x8f	TLS1.0
TLS_DHE_PSK_SHA_AES_128_CBC_SHA1	0x00 0x90	TLS1.0
TLS_DHE_PSK_SHA_AES_256_CBC_SHA1	0x00 0x91	TLS1.0
TLS_SRP_SHA_3DES_EDE_CBC_SHA1	0xc0 0x1a	TLS1.0
TLS_SRP_SHA_AES_128_CBC_SHA1	0xc0 0x1d	TLS1.0
TLS_SRP_SHA_AES_256_CBC_SHA1	0xc0 0x20	TLS1.0
TLS_SRP_SHA_DSS_3DES_EDE_CBC_SHA1	0xc0 0x1c	TLS1.0
TLS_SRP_SHA_RSA_3DES_EDE_CBC_SHA1	0xc0 0x1b	TLS1.0
TLS_SRP_SHA_DSS_AES_128_CBC_SHA1	0xc0 0x1f	TLS1.0
TLS_SRP_SHA_RSA_AES_128_CBC_SHA1	0xc0 0x1e	TLS1.0
TLS_SRP_SHA_DSS_AES_256_CBC_SHA1	0xc0 0x22	TLS1.0
TLS_SRP_SHA_RSA_AES_256_CBC_SHA1	0xc0 0x21	TLS1.0
TLS_DHE_DSS_ARCFOUR_SHA1	0x00 0x66	TLS1.0
TLS_DHE_DSS_3DES_EDE_CBC_SHA1	0x00 0x13	SSL3.0
TLS_DHE_DSS_AES_128_CBC_SHA1	0x00 0x32	SSL3.0
TLS_DHE_DSS_AES_256_CBC_SHA1	0x00 0x38	SSL3.0
TLS_DHE_DSS_CAMELLIA_128_CBC_SHA1	0x00 0x44	TLS1.0
TLS_DHE_DSS_CAMELLIA_256_CBC_SHA1	0x00 0x87	TLS1.0
TLS_DHE_RSA_3DES_EDE_CBC_SHA1	0x00 0x16	SSL3.0
TLS_DHE_RSA_AES_128_CBC_SHA1	0x00 0x33	SSL3.0
TLS_DHE_RSA_AES_256_CBC_SHA1	0x00 0x39	SSL3.0
TLS_DHE_RSA_CAMELLIA_128_CBC_SHA1	0x00 0x45	TLS1.0
TLS_DHE_RSA_CAMELLIA_256_CBC_SHA1	0x00 0x88	TLS1.0
TLS_RSA_NULL_MD5	0x00 0x01	SSL3.0
TLS_RSA_EXPORT_ARCFOUR_40_MD5	0x00 0x03	SSL3.0
TLS_RSA_ARCFOUR_SHA1	0x00 0x05	SSL3.0
TLS_RSA_ARCFOUR_MD5	0x00 0x04	SSL3.0
TLS_RSA_3DES_EDE_CBC_SHA1	0x00 0x0a	SSL3.0
TLS_RSA_AES_128_CBC_SHA1	0x00 0x2f	SSL3.0
TLS_RSA_AES_256_CBC_SHA1	0x00 0x35	SSL3.0
TLS_RSA_CAMELLIA_128_CBC_SHA1	0x00 0x41	TLS1.0
TLS_RSA_CAMELLIA_256_CBC_SHA1	0x00 0x84	TLS1.0

Available certificate types:

- X.509
- OPENPGP

Available protocols:

- SSL3.0
- TLS1.0
- TLS1.1
- TLS1.2

Available ciphers:

- AES-256-CBC
- AES-128-CBC
- 3DES-CBC
- DES-CBC
- ARCFOUR-128
- ARCFOUR-40
- RC2-40
- CAMELLIA-256-CBC
- CAMELLIA-128-CBC
- NULL

Available MAC algorithms:

- SHA1
- MD5
- SHA256
- SHA384
- SHA512
- MD2
- RIPEMD160
- NULL

Available key exchange methods:

- ANON-DH
- RSA
- RSA-EXPORT
- DHE-RSA
- DHE-DSS
- SRP-DSS
- SRP-RSA
- SRP
- PSK

- DHE-PSK

Available public key algorithms:

- RSA
- DSA

Available public key signature algorithms:

- RSA-SHA
- RSA-SHA256
- RSA-SHA384
- RSA-SHA512
- RSA-RMD160
- DSA-SHA
- RSA-MD5
- RSA-MD2

Available compression methods:

- DEFLATE
- NULL

Some additional information regarding some of the algorithms:

`RSA` RSA is public key cryptosystem designed by Ronald Rivest, Adi Shamir and Leonard Adleman. It can be used with any hash functions.

`DSA` DSA is the USA's Digital Signature Standard. It uses only the SHA-1 hash algorithm.

`MD2` MD2 is a cryptographic hash algorithm designed by Ron Rivest. It is optimized for 8-bit processors. Outputs 128 bits of data. There are no known weaknesses of this algorithm but since this algorithm is rarely used and not really studied it should not be used today.

`MD5` MD5 is a cryptographic hash algorithm designed by Ron Rivest. Outputs 128 bits of data. It is considered to be broken.

`SHA-1` SHA is a cryptographic hash algorithm designed by NSA. Outputs 160 bits of data. It is also considered to be broken, though no practical attacks have been found.

`RMD160` RIPEMD is a cryptographic hash algorithm developed in the framework of the EU project RIPE. Outputs 160 bits of data.

11 Guile Bindings

This chapter describes the GNU Guile Scheme programming interface to GnuTLS. The reader is assumed to have basic knowledge of the protocol and library. Details missing from this chapter may be found in Chapter 9 [Function reference], page 116.

At this stage, not all the C functions are available from Scheme, but a large subset thereof is available.

11.1 Guile Preparations

The GnuTLS Guile bindings are by default installed under the GnuTLS installation directory (e.g., typically '`/usr/local/share/guile/site/`'). Normally Guile will not find the module there without help. You may experience something like this:

```
$ guile
guile> (use-modules (gnutls))
<unnamed port>: no code for module (gnutls)
guile>
```

There are two ways to solve this. The first is to make sure that when building GnuTLS, the Guile bindings will be installed in the same place where Guile looks. You may do this by using the `--with-guile-site-dir` parameter as follows:

```
$ ./configure --with-guile-site-dir=no
```

This will instruct GnuTLS to attempt to install the Guile bindings where Guile will look for them. It will use `guile-config info pkgdatadir` to learn the path to use.

If Guile was installed into `/usr`, you may also install GnuTLS using the same prefix:

```
$ ./configure --prefix=/usr
```

If you want to specify the path to install the Guile bindings you can also specify the path directly:

```
$ ./configure --with-guile-site-dir=/opt/guile/share/guile/site
```

The second solution requires some more work but may be easier to use if you do not have system administrator rights to your machine. You need to instruct Guile so that it finds the GnuTLS Guile bindings. Either use the `GUILE_LOAD_PATH` environment variable as follows:

```
$ GUILE_LOAD_PATH="/usr/local/share/guile/site:$GUILE_LOAD_PATH" guile
guile> (use-modules (gnutls))
guile>
```

Alternatively, you can modify Guile's `%load-path` variable (see Section "Build Config" in *The GNU Guile Reference Manual*).

At this point, you might get an error regarding '`libguile-gnutls-v-0`' similar to:

```
gnutls.scm:361:1: In procedure dynamic-link in expression (load-extension "libguile-gn
gnutls.scm:361:1: file: "libguile-gnutls-v-0", message: "libguile-gnutls-v-0.so: canno
```

In this case, you will need to modify the run-time linker path, for example as follows:

```
$ LD_LIBRARY_PATH=/usr/local/lib GUILE_LOAD_PATH=/usr/local/share/guile/site guile
guile> (use-modules (gnutls))
guile>
```

11.2 Guile API Conventions

This chapter details the conventions used by Guile API, as well as specificities of the mapping of the C API to Scheme.

11.2.1 Enumerates and Constants

Lots of enumerates and constants are used in the GnuTLS C API. For each C enumerate type, a disjoint Scheme type is used—thus, enumerate values and constants are not represented by Scheme symbols nor by integers. This makes it impossible to use an enumerate value of the wrong type on the Scheme side: such errors are automatically detected by type-checking.

The enumerate values are bound to variables exported by the `(gnutls)` and `(gnutls extra)` modules. These variables are named according to the following convention:

- All variable names are lower-case; the underscore `_` character used in the C API is replaced by hyphen `-`.
- All variable names are prepended by the name of the enumerate type and the slash `/` character.
- In some cases, the variable name is made more explicit than the one of the C API, e.g., by avoid abbreviations.

Consider for instance this C-side enumerate:

```
typedef enum
{
  GNUTLS_CRD_CERTIFICATE = 1,
  GNUTLS_CRD_ANON,
  GNUTLS_CRD_SRP,
  GNUTLS_CRD_PSK,
  GNUTLS_CRD_IA
} gnutls_credentials_type_t;
```

The corresponding Scheme values are bound to the following variables exported by the `(gnutls)` module:

```
credentials/certificate
credentials/anonymous
credentials/srp
credentials/psk
credentials/ia
```

Hopefully, most variable names can be deduced from this convention.

Scheme-side "enumerate" values can be compared using `eq?` (see Section "Equality" in *The GNU Guile Reference Manual*). Consider the following example:

```
(let ((session (make-session connection-end/client)))

  ;;
  ;; ...
  ;;

  ;; Check the ciphering algorithm currently used by SESSION.
```

```
(if (eq? cipher/arcfour (session-cipher session))
    (format #t "We're using the ARCFOUR algorithm")))
```

In addition, all enumerate values can be converted to a human-readable string, in a type-specific way. For instance, `(cipher->string cipher/arcfour)` yields `"ARCFOUR 128"`, while `(key-usage->string key-usage/digital-signature)` yields `"digital-signature"`. Note that these strings may not be sufficient for use in a user interface since they are fairly concise and not internationalized.

11.2.2 Procedure Names

Unlike C functions in GnuTLS, the corresponding Scheme procedures are named in a way that is close to natural English. Abbreviations are also avoided. For instance, the Scheme procedure corresponding to `gnutls_certificate_set_dh_params` is named `set-certificate-credentials-dh-parameters!`. The `gnutls_` prefix is always omitted from variable names since a similar effect can be achieved using Guile's nifty binding renaming facilities, should it be needed (see Section "Using Guile Modules" in *The GNU Guile Reference Manual*).

Often Scheme procedure names differ from C function names in a way that makes it clearer what objects they operate on. For example, the Scheme procedure named `set-session-transport-port!` corresponds to `gnutls_transport_set_ptr`, making it clear that this procedure applies to session.

11.2.3 Representation of Binary Data

Many procedures operate on binary data. For instance, `pkcs3-import-dh-parameters` expects binary data as input and, similarly, procedures like `pkcs1-export-rsa-parameters` return binary data.

Binary data is represented on the Scheme side using SRFI-4 homogeneous vectors (see Section "SRFI-4" in *The GNU Guile Reference Manual*). Although any type of homogeneous vector may be used, `u8vectors` (i.e., vectors of bytes) are highly recommended.

As an example, generating and then exporting RSA parameters in the PEM format can be done as follows:

```
(let* ((rsa-params (make-rsa-parameters 1024))
       (raw-data
        (pkcs1-export-rsa-parameters rsa-params
                                     x509-certificate-format/pem)))
  (uniform-vector-write raw-data (open-output-file "some-file.pem")))
```

For an example of OpenPGP key import from a file, see Section 11.3.3 [Importing OpenPGP Keys Guile Example], page 274.

11.2.4 Input and Output

The underlying transport of a TLS session can be any Scheme input/output port (see Section "Ports and File Descriptors" in *The GNU Guile Reference Manual*). This has to be specified using `set-session-transport-port!`.

However, for better performance, a raw file descriptor can be specified, using `set-session-transport-fd!`. For instance, if the transport layer is a socket port over an OS-provided socket, you can use the `port->fdes` or `fileno` procedure to obtain the underlying file

descriptor and pass it to `set-session-transport-fd!` (see Section "Ports and File Descriptors" in *The GNU Guile Reference Manual*). This would work as follows:

```
(let ((socket (socket PF_INET SOCK_STREAM 0))
      (session (make-session connection-end/client)))

  ;;
  ;; Establish a TCP connection...
  ;;

  ;; Use the file descriptor that underlies SOCKET.
  (set-session-transport-fd! session (fileno socket)))
```

Once a TLS session is established, data can be communicated through it (i.e., *via* the TLS record layer) using the port returned by `session-record-port`:

```
(let ((session (make-session connection-end/client)))

  ;;
  ;; Initialize the various parameters of SESSION, set up
  ;; a network connection, etc...
  ;;

  (let ((i/o (session-record-port session)))
    (write "Hello peer!" i/o)
    (let ((greetings (read i/o)))

      ;; ...

      (bye session close-request/rdwr))))
```

A lower-level I/O API is provided by `record-send` and `record-receive!` which take an SRFI-4 vector to represent the data sent or received. While it might improve performance, it is much less convenient than the above and should rarely be needed.

11.2.5 Exception Handling

GnuTLS errors are implemented as Scheme exceptions (see Section "Exceptions" in *The GNU Guile Reference Manual*). Each time a GnuTLS function returns an error, an exception with key `gnutls-error` is raised. The additional arguments that are thrown include an error code and the name of the GnuTLS procedure that raised the exception. The error code is pretty much like an enumerate value: it is one of the `error/` variables exported by the `(gnutls)` module (see Section 11.2.1 [Enumerates and Constants], page 268). Exceptions can be turned into error messages using the `error->string` procedure.

The following examples illustrates how GnuTLS exceptions can be handled:

```
(let ((session (make-session connection-end/server)))

  ;;
  ;; ...
  ;;
```

```
(catch 'gnutls-error
  (lambda ()
    (handshake session))
  (lambda (key err function . currently-unused)
    (format (current-error-port)
            "a GnuTLS error was raised by `~a': ~a~%"
            function (error->string err)))))
```

Again, error values can be compared using `eq?`:

```
;; `gnutls-error' handler.
(lambda (key err function . currently-unused)
  (if (eq? err error/fatal-alert-received)
      (format (current-error-port)
              "a fatal alert was caught!~%")
      (format (current-error-port)
              "something bad happened: ~a~%"
              (error->string err))))
```

Note that the `catch` handler is currently passed only 3 arguments but future versions might provide it with additional arguments. Thus, it must be prepared to handle more than 3 arguments, as in this example.

11.3 Guile Examples

This chapter provides examples that illustrate common use cases.

11.3.1 Anonymous Authentication Guile Example

Anonymous authentication is very easy to use. No certificates are needed by the communicating parties. Yet, it allows them to benefit from end-to-end encryption and integrity checks.

The client-side code would look like this (assuming *some-socket* is bound to an open socket port):

```
;; Client-side.

(let ((client (make-session connection-end/client)))
  ;; Use the default settings.
  (set-session-default-priority! client)

  ;; Don't use certificate-based authentication.
  (set-session-certificate-type-priority! client '())

  ;; Request the "anonymous Diffie-Hellman" key exchange method.
  (set-session-kx-priority! client (list kx/anon-dh))

  ;; Specify the underlying socket.
  (set-session-transport-fd! client (fileno some-socket))
```

```
;; Create anonymous credentials.
(set-session-credentials! client
                          (make-anonymous-client-credentials))

;; Perform the TLS handshake with the server.
(handshake client)

;; Send data over the TLS record layer.
(write "hello, world!" (session-record-port client))

;; Terminate the TLS session.
(bye client close-request/rdwr))
```

The corresponding server would look like this (again, assuming *some-socket* is bound to a socket port):

```
;; Server-side.

(let ((server (make-session connection-end/server)))
  (set-session-default-priority! server)
  (set-session-certificate-type-priority! server '())
  (set-session-kx-priority! server (list kx/anon-dh))

  ;; Specify the underlying transport socket.
  (set-session-transport-fd! server (fileno some-socket))

  ;; Create anonymous credentials.
  (let ((cred (make-anonymous-server-credentials))
        (dh-params (make-dh-parameters 1024)))
    ;; Note: DH parameter generation can take some time.
    (set-anonymous-server-dh-parameters! cred dh-params)
    (set-session-credentials! server cred))

  ;; Perform the TLS handshake with the client.
  (handshake server)

  ;; Receive data over the TLS record layer.
  (let ((message (read (session-record-port server))))
    (format #t "received the following message: ~a~%"
            message)

    (bye server close-request/rdwr)))
```

This is it!

11.3.2 OpenPGP Authentication Guile Example

GnuTLS allows users to authenticate using OpenPGP certificates. The relevant procedures are provided by the `(gnutls extra)` module. Using OpenPGP-based authentication is not more complicated than using anonymous authentication. It requires a bit of extra work,

though, to import the OpenPGP public and private key of the client/server. Key import is omitted here and is left as an exercise to the reader (see Section 11.3.3 [Importing OpenPGP Keys Guile Example], page 274).

Assuming *some-socket* is bound to an open socket port and *pub* and *sec* are bound to the client's OpenPGP public and secret key, respectively, client-side code would look like this:

```
;; Client-side.

(define %certs (list certificate-type/openpgp))

(let ((client (make-session connection-end/client))
      (cred   (make-certificate-credentials)))
  (set-session-default-priority! client)

  ;; Choose OpenPGP certificates.
  (set-session-certificate-type-priority! client %certs)

  ;; Prepare appropriate client credentials.
  (set-certificate-credentials-openpgp-keys! cred pub sec)
  (set-session-credentials! client cred)

  ;; Specify the underlying transport socket.
  (set-session-transport-fd! client (fileno some-socket))

  (handshake client)
  (write "hello, world!" (session-record-port client))
  (bye client close-request/rdwr))
```

Similarly, server-side code would be along these lines:

```
;; Server-side.

(define %certs (list certificate-type/openpgp))

(let ((server (make-session connection-end/server))
      (rsa    (make-rsa-parameters 1024))
      (dh     (make-dh-parameters 1024)))
  (set-session-default-priority! server)

  ;; Choose OpenPGP certificates.
  (set-session-certificate-type-priority! server %certs)

  (let ((cred (make-certificate-credentials)))
    ;; Prepare credentials with RSA and Diffie-Hellman parameters.
    (set-certificate-credentials-dh-parameters! cred dh)
    (set-certificate-credentials-rsa-export-parameters! cred rsa)
    (set-certificate-credentials-openpgp-keys! cred pub sec)
    (set-session-credentials! server cred))
```

```
  (set-session-transport-fd! server (fileno some-socket))

  (handshake server)
  (let ((msg (read (session-record-port server))))
    (format #t "received: ~a~%" msg)

    (bye server close-request/rdwr)))
```

In practice, generating RSA parameters (and Diffie-Hellman parameters) can time a long time. Thus, you may want to generate them once and store them in a file for future re-use (see Section 11.4.1 [Core Interface], page 275).

11.3.3 Importing OpenPGP Keys Guile Example

The following example provides a simple way of importing "ASCII-armored" OpenPGP keys from files, using the `import-openpgp-certificate` and `import-openpgp-private-key` procedures provided by the `(gnutls extra)` module.

```
(use-modules (srfi srfi-4)
             (gnutls extra))

(define (import-key-from-file import-proc file)
  ;; Import OpenPGP key from FILE using IMPORT-PROC.

  ;; Prepare a u8vector large enough to hold the raw
  ;; key contents.
  (let* ((size (stat:size (stat path)))
         (raw  (make-u8vector size)))

    ;; Fill in the u8vector with the contents of FILE.
    (uniform-vector-read! raw (open-input-file file))

    ;; Pass the u8vector to the import procedure.
    (import-proc raw openpgp-certificate-format/base64)))


(define (import-public-key-from-file file)
  (import-key-from-file import-openpgp-certificate file))

(define (import-private-key-from-file file)
  (import-key-from-file import-openpgp-private-key file))
```

The procedures `import-public-key-from-file` and `import-private-key-from-file` can be passed a file name. They return an OpenPGP public key and private key object, respectively (see Section 11.4.2 [Extra Interface], page 282).

11.4 Guile Reference

This chapter documents GnuTLS Scheme procedures available to Guile programmers.

11.4.1 Core Interface

This section lists the Scheme procedures exported by the `(gnutls)` module (see Section "The Guile module system" in *The GNU Guile Reference Manual*). This module is licenced under the GNU Lesser General Public Licence, version 2.1 or later.

`set-log-level!` *level* [Scheme Procedure]
Enable GnuTLS logging up to *level* (an integer).

`set-log-procedure!` *proc* [Scheme Procedure]
Use *proc* (a two-argument procedure) as the global GnuTLS log procedure.

`x509-certificate-subject-alternative-name` *cert index* [Scheme Procedure]
Return two values: the alternative name type for *cert* (i.e., one of the `x509-subject-alternative-name/` values) and the actual subject alternative name (a string) at *index*. Both values are `#f` if no alternative name is available at *index*.

`x509-certificate-subject-key-id` *cert* [Scheme Procedure]
Return the subject key ID (a u8vector) for *cert*.

`x509-certificate-authority-key-id` *cert* [Scheme Procedure]
Return the key ID (a u8vector) of the X.509 certificate authority of *cert*.

`x509-certificate-key-id` *cert* [Scheme Procedure]
Return a statistically unique ID (a u8vector) for *cert* that depends on its public key parameters. This is normally a 20-byte SHA-1 hash.

`x509-certificate-version` *cert* [Scheme Procedure]
Return the version of *cert*.

`x509-certificate-key-usage` *cert* [Scheme Procedure]
Return the key usage of *cert* (i.e., a list of `key-usage/` values), or the empty list if *cert* does not contain such information.

`x509-certificate-public-key-algorithm` *cert* [Scheme Procedure]
Return two values: the public key algorithm (i.e., one of the `pk-algorithm/` values) of *cert* and the number of bits used.

`x509-certificate-signature-algorithm` *cert* [Scheme Procedure]
Return the signature algorithm used by *cert* (i.e., one of the `sign-algorithm/` values).

`x509-certificate-matches-hostname?` *cert hostname* [Scheme Procedure]
Return true if *cert* matches *hostname*, a string denoting a DNS host name. This is the basic implementation of RFC 2818 (aka. HTTPS).

`x509-certificate-issuer-dn-oid` *cert index* [Scheme Procedure]
Return the OID (a string) at *index* from *cert*'s issuer DN. Return `#f` if no OID is available at *index*.

`x509-certificate-dn-oid` *cert index* [Scheme Procedure]
Return OID (a string) at *index* from *cert*. Return `#f` if no OID is available at *index*.

`x509-certificate-issuer-dn` *cert* [Scheme Procedure]
Return the distinguished name (DN) of X.509 certificate *cert*.

`x509-certificate-dn` *cert* [Scheme Procedure]
Return the distinguished name (DN) of X.509 certificate *cert*. The form of the DN is as described in RFC 2253.

`pkcs8-import-x509-private-key` *data format* [*pass* [*encrypted*]] [Scheme Procedure]
Return a new X.509 private key object resulting from the import of *data* (a uniform array) according to *format*. Optionally, if *pass* is not `#f`, it should be a string denoting a passphrase. *encrypted* tells whether the private key is encrypted (`#t` by default).

`import-x509-private-key` *data format* [Scheme Procedure]
Return a new X.509 private key object resulting from the import of *data* (a uniform array) according to *format*.

`import-x509-certificate` *data format* [Scheme Procedure]
Return a new X.509 certificate object resulting from the import of *data* (a uniform array) according to *format*.

`server-session-psk-username` *session* [Scheme Procedure]
Return the username associated with PSK server session *session*.

`set-psk-client-credentials!` *cred username key key-format* [Scheme Procedure]
Set the client credentials for *cred*, a PSK client credentials object.

`make-psk-client-credentials` [Scheme Procedure]
Return a new PSK client credentials object.

`set-psk-server-credentials-file!` *cred file* [Scheme Procedure]
Use *file* as the password file for PSK server credentials *cred*.

`make-psk-server-credentials` [Scheme Procedure]
Return new PSK server credentials.

`peer-certificate-status` *session* [Scheme Procedure]
Verify the peer certificate for *session* and return a list of `certificate-status` values (such as `certificate-status/revoked`), or the empty list if the certificate is valid.

`set-certificate-credentials-verify-flags!` *cred* [*flags...*] [Scheme Procedure]
Set the certificate verification flags to *flags*, a series of `certificate-verify` values.

`set-certificate-credentials-verify-limits!` *cred max-bits max-depth* [Scheme Procedure]
Set the verification limits of `peer-certificate-status` for certificate credentials *cred* to *max_bits* bits for an acceptable certificate and *max_depth* as the maximum depth of a certificate chain.

`set-certificate-credentials-x509-keys!` *cred certs privkey* [Scheme Procedure]

Have certificate credentials *cred* use the X.509 certificates listed in *certs* and X.509 private key *privkey*.

`set-certificate-credentials-x509-key-data!` *cred cert key format* [Scheme Procedure]

Use X.509 certificate *cert* and private key *key*, both uniform arrays containing the X.509 certificate and key in format *format*, for certificate credentials *cred*.

`set-certificate-credentials-x509-crl-data!` *cred data format* [Scheme Procedure]

Use *data* (a uniform array) as the X.509 CRL (certificate revocation list) database for *cred*. On success, return the number of CRLs processed.

`set-certificate-credentials-x509-trust-data!` *cred data format* [Scheme Procedure]

Use *data* (a uniform array) as the X.509 trust database for *cred*. On success, return the number of certificates processed.

`set-certificate-credentials-x509-crl-file!` *cred file format* [Scheme Procedure]

Use *file* as the X.509 CRL (certificate revocation list) file for certificate credentials *cred*. On success, return the number of CRLs processed.

`set-certificate-credentials-x509-trust-file!` *cred file format* [Scheme Procedure]

Use *file* as the X.509 trust file for certificate credentials *cred*. On success, return the number of certificates processed.

`set-certificate-credentials-x509-key-files!` *cred cert-file key-file format* [Scheme Procedure]

Use *file* as the password file for PSK server credentials *cred*.

`set-certificate-credentials-rsa-export-parameters!` *cred rsa-params* [Scheme Procedure]

Use RSA parameters *rsa_params* for certificate credentials *cred*.

`set-certificate-credentials-dh-parameters!` *cred dh-params* [Scheme Procedure]

Use Diffie-Hellman parameters *dh_params* for certificate credentials *cred*.

`make-certificate-credentials` [Scheme Procedure]

Return new certificate credentials (i.e., for use with either X.509 or OpenPGP certificates.

`pkcs1-export-rsa-parameters` *rsa-params format* [Scheme Procedure]

Export Diffie-Hellman parameters *rsa_params* in PKCS1 format according for *format* (an `x509-certificate-format` value). Return a `u8vector` containing the result.

`pkcs1-import-rsa-parameters` *array format* [Scheme Procedure]
Import Diffie-Hellman parameters in PKCS1 format (further specified by *format*, an `x509-certificate-format` value) from *array* (a homogeneous array) and return a new `rsa-params` object.

`make-rsa-parameters` *bits* [Scheme Procedure]
Return new RSA parameters.

`set-anonymous-server-dh-parameters!` *cred dh-params* [Scheme Procedure]
Set the Diffie-Hellman parameters of anonymous server credentials *cred*.

`make-anonymous-client-credentials` [Scheme Procedure]
Return anonymous client credentials.

`make-anonymous-server-credentials` [Scheme Procedure]
Return anonymous server credentials.

`set-session-dh-prime-bits!` *session bits* [Scheme Procedure]
Use *bits* DH prime bits for *session*.

`pkcs3-export-dh-parameters` *dh-params format* [Scheme Procedure]
Export Diffie-Hellman parameters *dh_params* in PKCS3 format according for *format* (an `x509-certificate-format` value). Return a `u8vector` containing the result.

`pkcs3-import-dh-parameters` *array format* [Scheme Procedure]
Import Diffie-Hellman parameters in PKCS3 format (further specified by *format*, an `x509-certificate-format` value) from *array* (a homogeneous array) and return a new `dh-params` object.

`make-dh-parameters` *bits* [Scheme Procedure]
Return new Diffie-Hellman parameters.

`set-session-transport-port!` *session port* [Scheme Procedure]
Use *port* as the input/output port for *session*.

`set-session-transport-fd!` *session fd* [Scheme Procedure]
Use file descriptor *fd* as the underlying transport for *session*.

`session-record-port` *session* [Scheme Procedure]
Return a read-write port that may be used to communicate over *session*. All invocations of `session-port` on a given session return the same object (in the sense of `eq?`).

`record-receive!` *session array* [Scheme Procedure]
Receive data from *session* into *array*, a uniform homogeneous array. Return the number of bytes actually received.

`record-send` *session array* [Scheme Procedure]
Send the record constituted by *array* through *session*.

`set-session-credentials!` *session cred* [Scheme Procedure]
Use *cred* as *session*'s credentials.

`cipher-suite->string` *kx cipher mac* [Scheme Procedure]
Return the name of the given cipher suite.

`set-session-default-export-priority!` *session* [Scheme Procedure]
Have *session* use the default export priorities.

`set-session-default-priority!` *session* [Scheme Procedure]
Have *session* use the default priorities.

`set-session-certificate-type-priority!` *session items* [Scheme Procedure]
Use *items* (a list) as the list of preferred certificate-type for *session*.

`set-session-protocol-priority!` *session items* [Scheme Procedure]
Use *items* (a list) as the list of preferred protocol for *session*.

`set-session-kx-priority!` *session items* [Scheme Procedure]
Use *items* (a list) as the list of preferred kx for *session*.

`set-session-compression-method-priority!` *session items* [Scheme Procedure]
Use *items* (a list) as the list of preferred compression-method for *session*.

`set-session-mac-priority!` *session items* [Scheme Procedure]
Use *items* (a list) as the list of preferred mac for *session*.

`set-session-cipher-priority!` *session items* [Scheme Procedure]
Use *items* (a list) as the list of preferred cipher for *session*.

`set-server-session-certificate-request!` *session request* [Scheme Procedure]
Tell how *session*, a server-side session, should deal with certificate requests. *request* should be either `certificate-request/request` or `certificate-request/require`.

`session-our-certificate-chain` *session* [Scheme Procedure]
Return our certificate chain for *session* (as sent to the peer) in raw format (a u8vector). In the case of OpenPGP there is exactly one certificate. Return the empty list if no certificate was used.

`session-peer-certificate-chain` *session* [Scheme Procedure]
Return the a list of certificates in raw format (u8vectors) where the first one is the peer's certificate. In the case of OpenPGP, there is always exactly one certificate. In the case of X.509, subsequent certificates indicate form a certificate chain. Return the empty list if no certificate was sent.

`session-client-authentication-type` *session* [Scheme Procedure]
Return the client authentication type (a `credential-type` value) used in *session*.

`session-server-authentication-type` *session* [Scheme Procedure]
Return the server authentication type (a `credential-type` value) used in *session*.

`session-authentication-type` *session* [Scheme Procedure]
Return the authentication type (a `credential-type` value) used by *session*.

`session-protocol` *session* [Scheme Procedure]
Return the protocol used by *session*.

`session-certificate-type` *session* [Scheme Procedure]
Return *session*'s certificate type.

`session-compression-method` *session* [Scheme Procedure]
Return *session*'s compression method.

`session-mac` *session* [Scheme Procedure]
Return *session*'s MAC.

`session-kx` *session* [Scheme Procedure]
Return *session*'s kx.

`session-cipher` *session* [Scheme Procedure]
Return *session*'s cipher.

`alert-send` *session level alert* [Scheme Procedure]
Send *alert* via *session*.

`alert-get` *session* [Scheme Procedure]
Get an aleter from *session*.

`rehandshake` *session* [Scheme Procedure]
Perform a re-handshaking for *session*.

`handshake` *session* [Scheme Procedure]
Perform a handshake for *session*.

`bye` *session how* [Scheme Procedure]
Close *session* according to *how*.

`make-session` *end* [Scheme Procedure]
Return a new session for connection end *end*, either `connection-end/server` or `connection-end/client`.

`gnutls-version` [Scheme Procedure]
Return a string denoting the version number of the underlying GnuTLS library, e.g., `"1.7.2"`.

`x509-private-key?` *obj* [Scheme Procedure]
Return true if *obj* is of type `x509-private-key`.

`x509-certificate?` *obj* [Scheme Procedure]
Return true if *obj* is of type `x509-certificate`.

`psk-client-credentials?` *obj* [Scheme Procedure]
Return true if *obj* is of type `psk-client-credentials`.

`psk-server-credentials?` *obj* [Scheme Procedure]
Return true if *obj* is of type `psk-server-credentials`.

`srp-client-credentials?` *obj* [Scheme Procedure]
Return true if *obj* is of type `srp-client-credentials`.

`srp-server-credentials?` *obj* [Scheme Procedure]
Return true if *obj* is of type `srp-server-credentials`.

`certificate-credentials?` *obj* [Scheme Procedure]
Return true if *obj* is of type `certificate-credentials`.

`rsa-parameters?` *obj* [Scheme Procedure]
Return true if *obj* is of type `rsa-parameters`.

`dh-parameters?` *obj* [Scheme Procedure]
Return true if *obj* is of type `dh-parameters`.

`anonymous-server-credentials?` *obj* [Scheme Procedure]
Return true if *obj* is of type `anonymous-server-credentials`.

`anonymous-client-credentials?` *obj* [Scheme Procedure]
Return true if *obj* is of type `anonymous-client-credentials`.

`session?` *obj* [Scheme Procedure]
Return true if *obj* is of type `session`.

`error->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `error` value.

`certificate-verify->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `certificate-verify` value.

`key-usage->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `key-usage` value.

`psk-key-format->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `psk-key-format` value.

`sign-algorithm->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `sign-algorithm` value.

`pk-algorithm->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `pk-algorithm` value.

`x509-subject-alternative-name->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `x509-subject-alternative-name` value.

`x509-certificate-format->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `x509-certificate-format` value.

`certificate-type->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `certificate-type` value.

`protocol->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `protocol` value.

`close-request->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `close-request` value.

`certificate-request->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `certificate-request` value.

`certificate-status->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `certificate-status` value.

`handshake-description->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `handshake-description` value.

`alert-description->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `alert-description` value.

`alert-level->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `alert-level` value.

`connection-end->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `connection-end` value.

`compression-method->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `compression-method` value.

`digest->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `digest` value.

`mac->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `mac` value.

`credentials->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `credentials` value.

`params->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `params` value.

`kx->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `kx` value.

`cipher->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `cipher` value.

11.4.2 Extra Interface

This section lists the Scheme procedures exported by the `(gnutls extra)` module. This module is licenced under the GNU General Public Licence, version 3 or later.

`set-certificate-credentials-openpgp-keys!` *cred pub sec* [Scheme Procedure]
Use certificate *pub* and secret key *sec* in certificate credentials *cred*.

`openpgp-keyring-contains-key-id?` *keyring id* [Scheme Procedure]
Return `#f` if key ID *id* is in *keyring*, `#f` otherwise.

`import-openpgp-keyring` *data format* [Scheme Procedure]
Import *data* (a u8vector) according to *format* and return the imported keyring.

`openpgp-certificate-usage` *key* [Scheme Procedure]
Return a list of values denoting the key usage of *key*.

`openpgp-certificate-version` *key* [Scheme Procedure]
Return the version of the OpenPGP message format (RFC2440) honored by *key*.

`openpgp-certificate-algorithm` *key* [Scheme Procedure]
Return two values: the certificate algorithm used by *key* and the number of bits used.

`openpgp-certificate-names` *key* [Scheme Procedure]
Return the list of names for *key*.

`openpgp-certificate-name` *key index* [Scheme Procedure]
Return the *index*th name of *key*.

`openpgp-certificate-fingerprint` *key* [Scheme Procedure]
Return a new u8vector denoting the fingerprint of *key*.

`openpgp-certificate-fingerprint!` *key fpr* [Scheme Procedure]
Store in *fpr* (a u8vector) the fingerprint of *key*. Return the number of bytes stored in *fpr*.

`openpgp-certificate-id!` *key id* [Scheme Procedure]
Store the ID (an 8 byte sequence) of certificate *key* in *id* (a u8vector).

`openpgp-certificate-id` *key* [Scheme Procedure]
Return the ID (an 8-element u8vector) of certificate *key*.

`import-openpgp-private-key` *data format* [*pass*] [Scheme Procedure]
Return a new OpenPGP private key object resulting from the import of *data* (a uniform array) according to *format*. Optionally, a passphrase may be provided.

`import-openpgp-certificate` *data format* [Scheme Procedure]
Return a new OpenPGP certificate object resulting from the import of *data* (a uniform array) according to *format*.

`openpgp-certificate-format->string` *enumval* [Scheme Procedure]
Return a string describing *enumval*, a `openpgp-certificate-format` value.

`openpgp-keyring?` *obj* [Scheme Procedure]
Return true if *obj* is of type `openpgp-keyring`.

`openpgp-private-key?` *obj* [Scheme Procedure]
Return true if *obj* is of type `openpgp-private-key`.

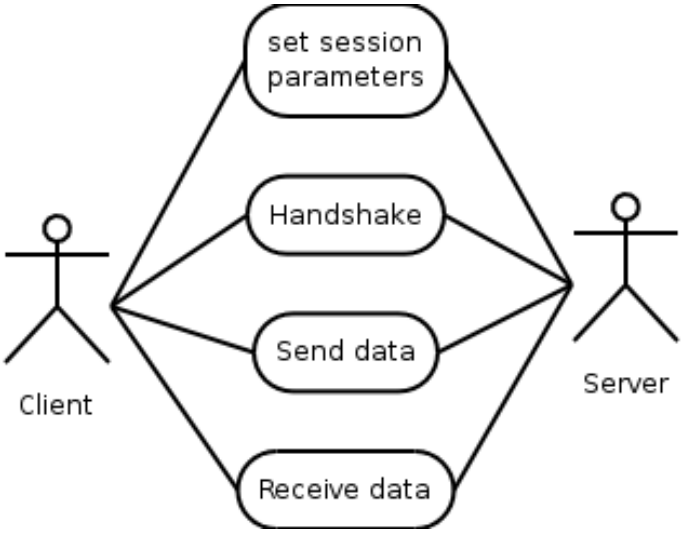
`openpgp-certificate?` *obj* [Scheme Procedure]
Return true if *obj* is of type `openpgp-certificate`.

12 Internal Architecture of GnuTLS

This chapter is to give a brief description of the way GnuTLS works. The focus is to give an idea to potential developers and those who want to know what happens inside the black box.

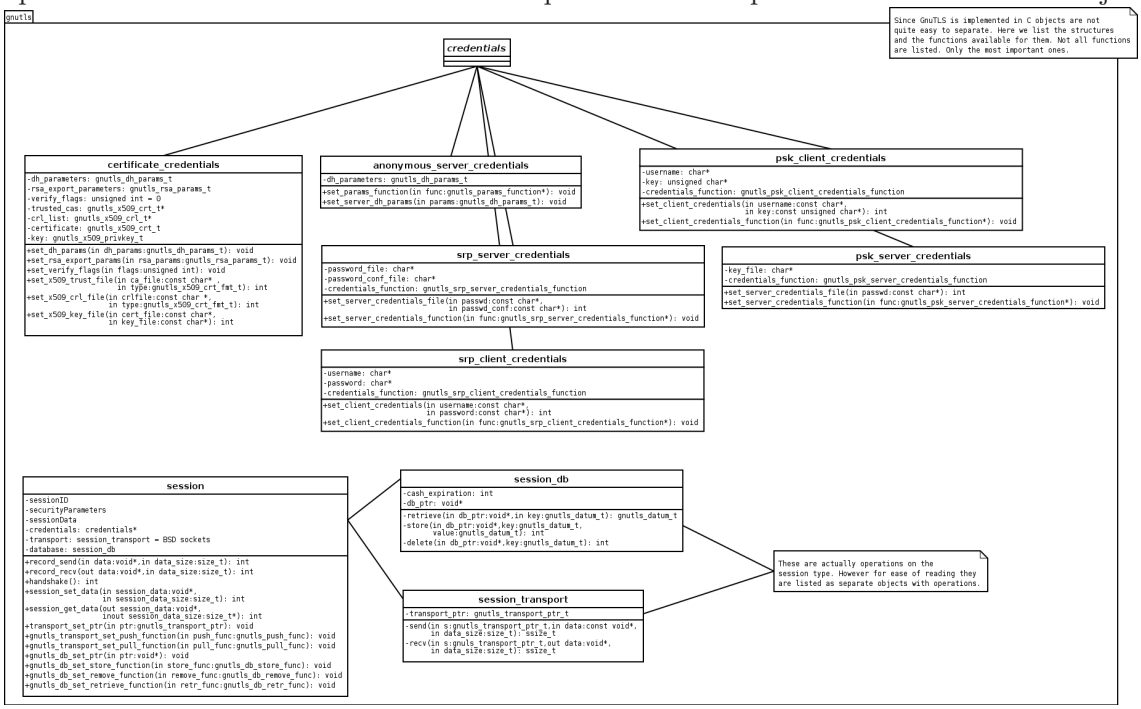
12.1 The TLS Protocol

The main needs for the TLS protocol to be used are shown in the image below.



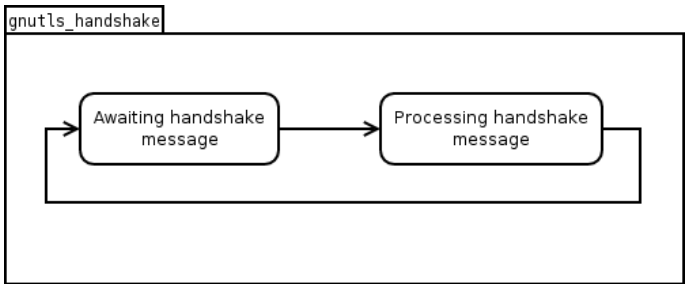
This is being accomplished by the following object diagram. Note that since GnuTLS is being developed in C object are just structures with attributes. The

operations listed are functions that require the first parameter to be that object.



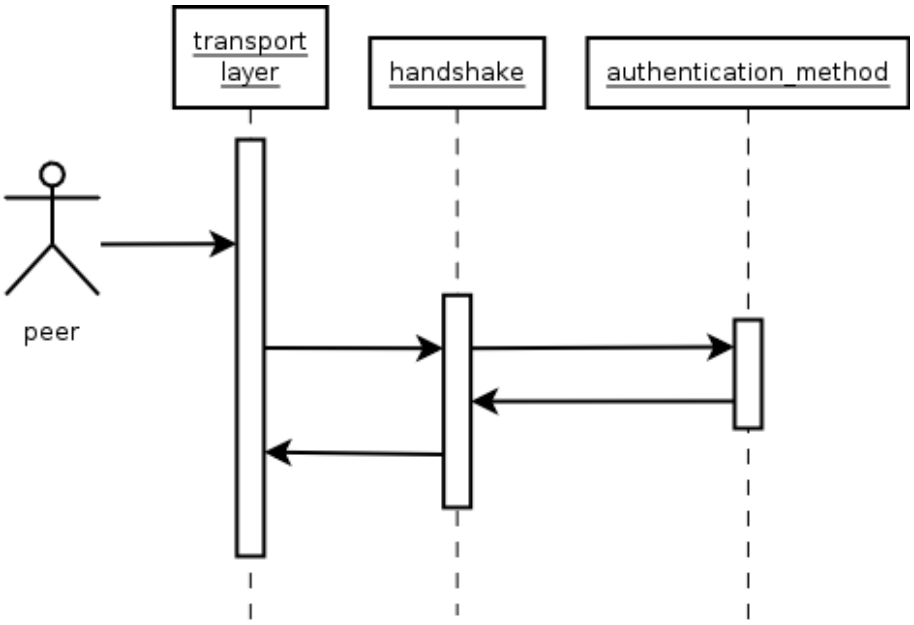
12.2 TLS Handshake Protocol

The GnuTLS handshake protocol is implemented as a state machine that waits for input or returns immediately when the non-blocking transport layer functions are used. The main idea is shown in the following figure.



Also the way the input is processed varies per ciphersuite. Several implementations of the internal handlers are available and [gnutls_handshake], page 148 only multiplexes the input

to the appropriate handler. For example a PSK ciphersuite has a different implementation of the `process_client_key_exchange` than a certificate ciphersuite.



12.3 TLS Authentication Methods

In GnuTLS authentication methods can be implemented quite easily. Since the required changes to add a new authentication method affect only the handshake protocol, a simple interface is used. An authentication method needs only to implement the functions as seen in the figure below.

mod_auth_st

```
generate_server_certificate(in session:gnutls_session_t,out data:opaque**): int
generate_client_certificate(in session:gnutls_session_t,out data:opaque**): int
generate_server_kx(in session:gnutls_session_t,out data:opaque**): int
generate_client_kx(in session:gnutls_session_t,out data:opaque**): int
generate_client_cert_vrfy(in session:gnutls_session_t,out data:opaque**): int
generate_server_certificate_request(in session:gnutls_session_t,
                                    out data:opaque**): int
process_server_certificate(in session:gnutls_session_t,in data:opaque*,
                           in data_size:size_t): int
process_client_certificate(in session:gnutls_session_t,in data:opaque*,
                           in data_size:size_t): int
process_server_kx(in session:gnutls_session_t,in data:opaque*,
                  in data_size:size_t): int
process_client_kx(in session:gnutls_session_t,in data:opaque*,
                  in data_size:size_t): int
process_client_cert_vrfy(in session:gnutls_session_t,in data:opaque*,
                         in data_size:size_t): int
process_server_certificate_request(in session:gnutls_session_t,
                                   in data:opaque*,in data_size:size_t): int
```

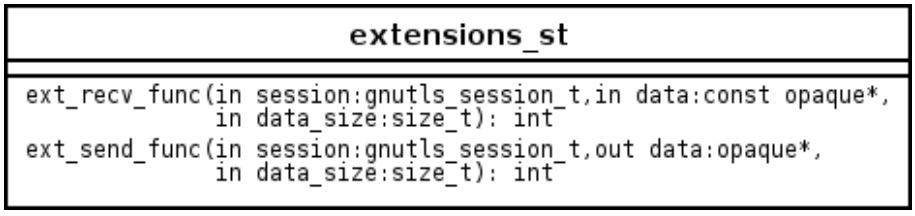
The functions that need to be implemented are the ones responsible for interpreting the handshake protocol messages. It is common for such functions to read data from one or

more `credentials_t` structures[1] and write data, such as certificates, usernames etc. to `auth_info_t` structures.

Simple examples of existing authentication methods can be seen in `auth_psk.c` for PSK ciphersuites and `auth_srp.c` for SRP ciphersuites. After implementing these functions the structure holding its pointers has to be registered in `gnutls_algorithms.c` in the `_gnutls_kx_algorithms` structure.

12.4 TLS Extension Handling

As with authentication methods, the TLS extensions handlers can be implemented using the following interface.



Here there are two functions, one for receiving the extension data and one for sending. These functions have to check internally whether they operate in client or server side.

A simple example of an extension handler can be seen in `ext_srp.c` After implementing these functions, together with the extension number they handle, they have to be registered in `gnutls_extensions.c` in the `_gnutls_extensions` structure.

12.4.1 Adding a New TLS Extension

Adding support for a new TLS extension is done from time to time, and the process to do so is not difficult. Here are the steps you need to follow if you wish to do this yourself. For sake of discussion, let's consider adding support for the hypothetical TLS extension `foobar`.

1. Modify `configure.in` to add `--enable-foobar` or `--disable-foobar`.

   Which to chose depends on whether you intend to make the extension be enabled by default. Look at existing checks (i.e., SRP, authz) for how to model the code. For example:

```
AC_MSG_CHECKING([whether to disable foobar support])
AC_ARG_ENABLE(foobar,
AS_HELP_STRING([--disable-foobar],
[disable foobar support]),
ac_enable_foobar=no)
if test x$ac_enable_foobar != xno; then
 AC_MSG_RESULT(no)
 AC_DEFINE(ENABLE_FOOBAR, 1, [enable foobar])
else
 ac_full=0
 AC_MSG_RESULT(yes)
fi
```

[1] such as the `gnutls_certificate_credentials_t` structures

```
AM_CONDITIONAL(ENABLE_FOOBAR, test "$ac_enable_foobar" != "no")
```

2. Add IANA extension value to `extensions_t` in `gnutls_int.h`.

   A good name for the value would be GNUTLS_EXTENSION_FOOBAR. Check with http://www.iana.org/assignments/tls-extensiontype-values for allocated values. For experiments, you could pick a number but remember that some consider it a bad idea to deploy such modified version since it will lead to interoperability problems in the future when the IANA allocates that number to someone else, or when the foobar protocol is allocated another number.

3. Add an entry to `_gnutls_extensions` in `gnutls_extensions.c`.

   A typical entry would be:

```
#if ENABLE_FOOBAR
  GNUTLS_EXTENSION_ENTRY (GNUTLS_EXTENSION_FOOBAR,
  _gnutls_foobar_recv_params,
  _gnutls_foobar_send_params),
#endif
```

   The GNUTLS_EXTENSION_FOOBAR is the integer value you added to `gnutls_int.h` earlier. The two functions are new functions that you will need to implement, most likely you'll need to add an `#include "ext_foobar.h"` as well.

4. Add new files `ext_foobar.c` and `ext_foobar.h` that implements the extension.

   The functions you are responsible to add are those mentioned in the previous step. As a starter, you could add this:

```
int
_gnutls_foobar_recv_params (gnutls_session_t session,
                            const opaque * data,
                            size_t data_size)
{
  return 0;
}

int
_gnutls_foobar_send_params (gnutls_session_t session,
                            opaque * data,
                            size_t _data_size)
{
  return 0;
}
```

   The `_gnutls_foobar_recv_params` function is responsible for parsing incoming extension data (both in the client and server).

   The `_gnutls_foobar_send_params` function is responsible for sending extension data (both in the client and server).

   If you receive length fields that doesn't match, return `GNUTLS_E_UNEXPECTED_PACKET_LENGTH`. If you receive invalid data, return `GNUTLS_E_RECEIVED_ILLEGAL_PARAMETER`. You can use other error codes too. Return 0 on success.

The function typically store some information in the `session` variable for later usage. If you need to add new fields there, check `tls_ext_st` in `gnutls_int.h` and compare with existing TLS extension specific variables.

Recall that both the client and server both send and receives parameters, and your code most likely will need to do different things depending on which mode it is in. It may be useful to make this distinction explicit in the code. Thus, for example, a better template than above would be:

```
int
_gnutls_foobar_recv_params (gnutls_session_t session,
                            const opaque * data,
                            size_t data_size)
{
  if (session->security_parameters.entity == GNUTLS_CLIENT)
    return foobar_recv_client (session, data, data_size);
  else
    return foobar_recv_server (session, data, data_size);
}

int
_gnutls_foobar_send_params (gnutls_session_t session,
                            opaque * data,
                            size_t data_size)
{
  if (session->security_parameters.entity == GNUTLS_CLIENT)
    return foobar_send_client (session, data, data_size);
  else
    return foobar_send_server (session, data, data_size);
}
```

The functions used would be declared as `static` functions, of the appropriate prototype, in the same file.

When adding the files, you'll need to add them to `Makefile.am` as well, for example:

```
if ENABLE_FOOBAR
COBJECTS += ext_foobar.c
HFILES += ext_foobar.h
endif
```

5. Add API functions to enable/disable the extension.

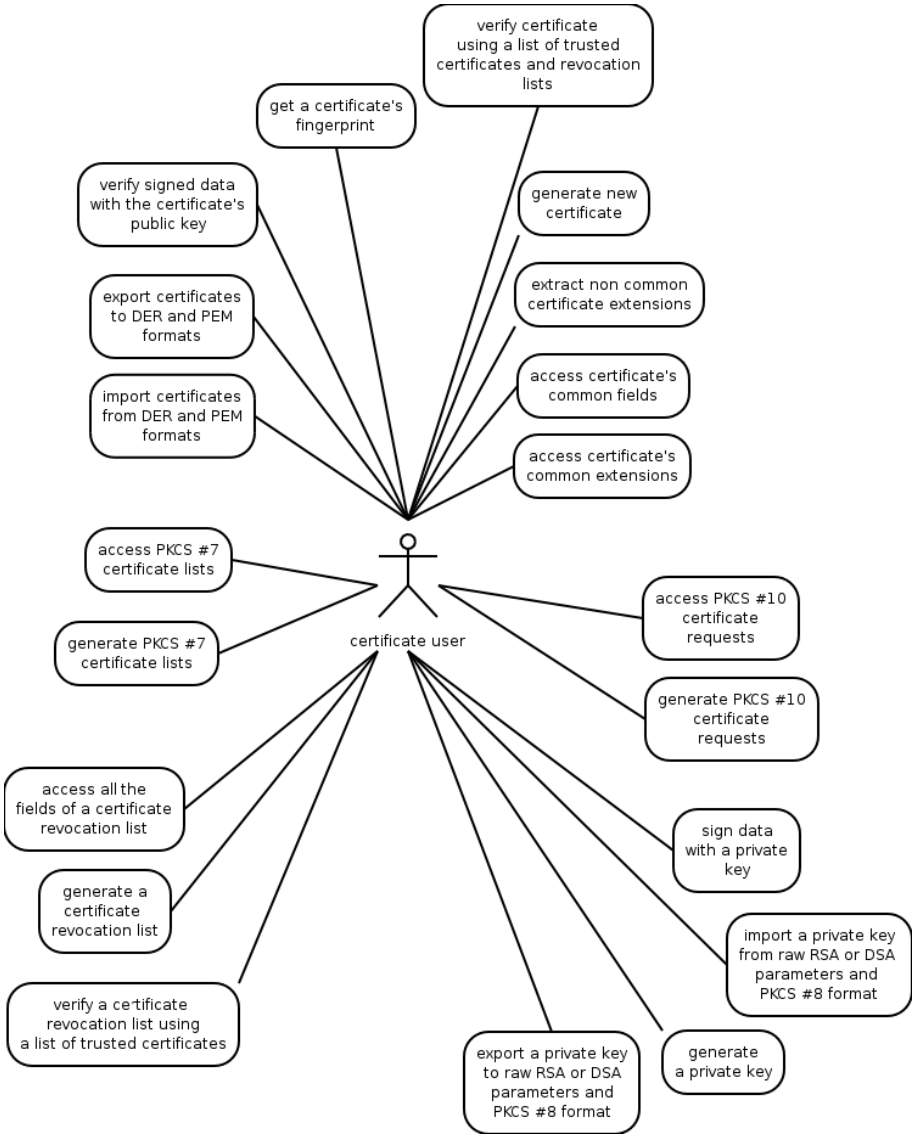
   Normally the client will have one API to request use of the extension, and setting some extension specific data. The server will have one API to let the library know that it is willing to accept the extension, often this is implemented through a callback but it doesn't have to.

   The APIs need to be added to `includes/gnutls/gnutls.h` or `includes/gnutls/extra.h` as appropriate. It is recommended that if you don't have a requirement to use the LGPLv2.1+ license for your extension, that you place your work under the GPLv3+ license and thus in the libgnutls-extra library.

You can implement the API function in the `ext_foobar.c` file, or if that file ends up becoming rather larger, add a `gnutls_foobar.c` file.

12.5 Certificate Handling

What is provided by the certificate handling functions is summarized in the following diagram.



12.6 Cryptographic Backend

Several new systems provide hardware assisted cryptographic algorithm implementations that offer implementations some orders of magnitude faster than the software. For this reason in current releases of GnuTLS it is possible to override parts of the crypto backend or the whole. It is possible to override them both at runtime and compile time, however

here we will discuss the runtime possibility. The API available for this functionality is in `gnutls/crypto.h` header file.

12.6.1 Override specific algorithms

When an optimized implementation of a single algorithm is available, say a hardware assisted version of AES-CBC then the following functions can be used to register those algorithms.

- [gnutls_crypto_single_cipher_register2], page 137 To register a cipher algorithm.
- [gnutls_crypto_single_mac_register2], page 138 To register a MAC algorithm.

  [gnutls_crypto_single_digest_register2], page 137 To register a digest (hash) algorithm.

Those registration functions will only replace the specified algorithm and leave the rest of subsystem intact.

12.6.2 Override parts of the backend

In some systems, such as embedded ones, it might be desirable to override big parts of the cryptographic backend, or even all of them. For this reason the following functions are provided.

- [gnutls_crypto_cipher_register2], page 135 To override the cryptographic algorithms backend.
- [gnutls_crypto_mac_register2], page 136 To override the MAC algorithms backend.
- [gnutls_crypto_digest_register2], page 135 To override the digest algorithms backend.
- [gnutls_crypto_rnd_register2], page 136 To override the random number generator backend.
- [gnutls_crypto_bigint_register2], page 134 To override the big number number operations backend.
- [gnutls_crypto_pk_register2], page 136 To override the public key encryption backend. This is tight to the big number operations so either both of them should be updated or care must be taken to use the same format.

If all of them are used then GnuTLS will no longer use libgcrypt.

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Version 1.2, November 2002

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Although the Lesser General Public License is Less protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

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   "Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

   Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

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(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

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   This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

   However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

   When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

   If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

   Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

   You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

   a. Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

b. Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

c. Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

d. If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

e. Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

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That's all there is to it!

A.3 GNU General Public License

Version 3, 29 June 2007

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The precise terms and conditions for copying, distribution and modification follow.

TERMS AND CONDITIONS

0. Definitions.

   "This License" refers to version 3 of the GNU General Public License.

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1. Source Code.

   The "source code" for a work means the preferred form of the work for making modifications to it. "Object code" means any non-source form of a work.

   A "Standard Interface" means an interface that either is an official standard defined by a recognized standards body, or, in the case of interfaces specified for a particular programming language, one that is widely used among developers working in that language.

   The "System Libraries" of an executable work include anything, other than the work as a whole, that (a) is included in the normal form of packaging a Major Component, but which is not part of that Major Component, and (b) serves only to enable use of the work with that Major Component, or to implement a Standard Interface for which an implementation is available to the public in source code form. A "Major Component", in this context, means a major essential component (kernel, window system, and so on) of the specific operating system (if any) on which the executable work runs, or a compiler used to produce the work, or an object code interpreter used to run it.

   The "Corresponding Source" for a work in object code form means all the source code needed to generate, install, and (for an executable work) run the object code and to modify the work, including scripts to control those activities. However, it does not include the work's System Libraries, or general-purpose tools or generally available free programs which are used unmodified in performing those activities but which are not part of the work. For example, Corresponding Source includes interface definition

files associated with source files for the work, and the source code for shared libraries and dynamically linked subprograms that the work is specifically designed to require, such as by intimate data communication or control flow between those subprograms and other parts of the work.

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d. Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.

e. Convey the object code using peer-to-peer transmission, provided you inform other peers where the object code and Corresponding Source of the work are being offered to the general public at no charge under subsection 6d.

A separable portion of the object code, whose source code is excluded from the Corresponding Source as a System Library, need not be included in conveying the object code work.

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