GnuTLS-Guile

Guile binding for GNU TLS
for version 3.0.5, 13 September 2011

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1 Preface

This manual 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 Function reference, of the C API reference.

At this stage, not all the C functions are available from Scheme, but a large subset thereof is available.

2 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>
```

To check that you got the intended GnuTLS library version, you may print the version number of the loaded library as follows:

```
$ guile
guile> (use-modules (gnutls))
guile> (gnutls-version)
"3.0.5"
guile>
```

3 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.

3.1 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.

3.2 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.

3.3 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 4.3 [Importing OpenPGP Keys Guile Example], page 9.

3.4 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.

3.5 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 3.1 [Enumerates and Constants], page 3). 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.

4 Guile Examples

This chapter provides examples that illustrate common use cases.

4.1 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!

4.2 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 4.3 [Importing OpenPGP Keys Guile Example], page 9).

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 5.1 [Core Interface], page 11).

4.3 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 5.2 [Extra Interface], page 19).

5 Guile Reference

This chapter documents GnuTLS Scheme procedures available to Guile programmers.

5.1 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-priorities!` *session priorities* [Scheme Procedure]
Have *session* use the given *priorities* for the ciphers, key exchange methods, MACs and compression methods. *priorities* must be a string (see Priority Strings). When *priorities* cannot be parsed, an `error/invalid-request` error is raised, with an extra argument indication the position of the error.

`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.

5.2 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`.

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