GnuTLS-Guile

Guile binding for GNU TLS
for version 3.5.14, 4 July 2017

This manual is last updated 4 July 2017 for version 3.5.14 of GnuTLS.

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1 Preface

This manual describes the GNU Guile Scheme programming interface to GnuTLS, which is distributed as part of 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 available for Guile's 2.0 stable series, as well as the forthcoming 2.2 series and the legacy 1.8 series.

By default they are installed under the GnuTLS installation directory, typically `/usr/local/share/guile/site/`). Normally Guile will not find the module there without help. You may experience something like this:

```
$ guile
...
scheme@(guile-user)> (use-modules (gnutls))
ERROR: no code for module (gnutls)
```

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
scheme@(guile-user)> (use-modules (gnutls))
scheme@(guile-user)>
```

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 `guile-gnutls-v-2` similar to:

```
gnutls.scm:361:1: In procedure dynamic-link in expression (load-extension "guile-gnutl
gnutls.scm:361:1: file: "guile-gnutls-v-2", message: "guile-gnutls-v-2.so: cannot open
```

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
scheme@(guile-user)> (use-modules (gnutls))
scheme@(guile-user)>
```

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

```
$ guile
scheme@(guile-user)> (use-modules (gnutls))
scheme@(guile-user)> (gnutls-version)
"3.5.14"
scheme@(guile-user)>
```

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)` module. 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_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
```

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.

Binary data is represented on the Scheme side using bytevectors (see Section "Bytevectors" in *The GNU Guile Reference Manual*). Homogeneous vectors such as SRFI-4 `u8vectors` can also be used[1].

As an example, generating and then exporting Diffie-Hellman parameters in the PEM format can be done as follows:

```
(let* ((dh  (make-dh-parameters 1024))
       (pem (pkcs3-export-dh-parameters dh
                                        x509-certificate-format/pem)))
  (call-with-output-file "some-file.pem"
    (lambda (port)
      (uniform-vector-write pem port))))
```

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

[1] Historically, SRFI-4 `u8vectors` are the closest thing to bytevectors that Guile 1.8 and earlier supported.

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)))
    (display "Hello peer!" i/o)
    (let ((greetings (read i/o)))

      ;; ...

      (bye session close-request/rdwr))))
```

Note that each write to the session record port leads to the transmission of an encrypted TLS "Application Data" packet. In the above example, we create an Application Data packet for the 11 bytes for the string that we write. This is not efficient both in terms of CPU usage and bandwidth (each packet adds at least 5 bytes of overhead and can lead to one `write` system call), so we recommend that applications do their own buffering.

A lower-level I/O API is provided by `record-send` and `record-receive!` which take a bytevector (or a SRFI-4 vector) to represent the data sent or received. While it might improve performance, it is much less convenient than the session record port 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 4). 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!

5 Guile Reference

This chapter lists the GnuTLS Scheme procedures exported by the `(gnutls)` module (see Section "The Guile module system" in *The GNU Guile Reference Manual*).

(Guile not available, documentation not generated.)

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