The Shishi Manual

for version 0.0.2, 17 August 2003

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Table of Contents

1 Introduction

Shishi implements the RFC 1510 network security system, also known as Kerberos 5.

1.1 Getting Started

This manual documents the Shishi application and library programming interface. All commands, functions and data types provided by Shishi are explained.

The reader is assumed to possess basic familiarity with network security and the RFC 1510 security system.

This manual can be used in several ways. If read from the beginning to the end, it gives a good introduction into the library and how it can be used in an application. Forward references are included where necessary. Later on, the manual can be used as a reference manual to get just the information needed about any particular interface of the library. Experienced programmers might want to start looking at the examples at the end of the manual, and then only read up those parts of the interface which are unclear.

1.2 Features and Status

Shishi might have a couple of advantages over other packages doing a similar job.

It's Free Software
: Anybody can use, modify, and redistribute it under the terms of the GNU General Public License (see Appendix B [Copying], page 88).

It's thread-safe
: The library uses no global variables.

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

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

Shishi is far from feature complete, it is not even a full RFC 1510 implementation yet. However, some basic functionality is implemented. A few implemented feature are mentioned below.

- Initial authentication (AS) from raw key or password. This step is typically used to acquire a ticket granting ticket and, less commonly, a server ticket.
- Subsequent authentication (TGS). This step is typically used to acquire a server ticket, by authenticating yourself using the ticket granting ticket.
- Client-Server authentication (AP). This step is used by clients and servers to prove to each other who they are, using negotiated tickets.
- Integrity protected communication (SAFE). This step is used by clients and servers to exchange integrity protected data with each other. The key is typically agreed on using the Client-Server authentication step.

- Ticket cache, supporting multiple principals and realms. As tickets have a life time of typically several hours, they are managed in disk files. There can be multiple ticket caches, and each ticket cache can store tickets for multiple clients (users), servers, encryption types, etc. Functionality is provided for locating the proper ticket for every use.
- Most standard cryptographic primitives. The believed most secure algorithms are supported (see Section 1.4 [Cryptographic Overview], page 4).
- Telnet client and server. This is used to remotely login to other machines, after authenticating yourself with a ticket.
- PAM module. This is used to login locally on a machine.
- KDC addresses located using DNS SRV RRs.

The following table summarize what the current objectives are (i.e., the todo list) and an estimate on how long it will take to implement the feature. If you like to start working on anything, please let me know so work duplication can be avoided.

- Cross-realm support (week).
- Session keys in AP (week).
- PKINIT (use libksba, weeks)
- Finish GSSAPI support via GPL GSS (weeks) Shishi will not support GSS, but a separate project "GPL GSS" is under way to produce a generic GSS implementation, and it will use Shishi to implement the Kerberos 5 mechanism.
- Port to cyclone (cyclone need to mature first)
- Modularize ASN.1 library so it can be replaced (days)
- Modularize Crypto library so it can be replaced (days)
- KDC (initiated, weeks)
- PAM module (week) Finished.
- Set/Change password protocol (weeks?)
- Port applications to use Shishi (indefinite)
- Improve documentation
- Improve internationalization
- Add AP-REQ reply cache (week).

1.3 Overview

This section describes RFC 1510 from a protocol point of view[1].

Kerberos provides a means of verifying the identities of principals, (e.g., a workstation user or a network server) on an open (unprotected) network. This is accomplished without relying on authentication by the host operating system, without basing trust on host addresses, without requiring physical security of all the hosts on the network, and under the assumption that packets traveling along the network can be read, modified, and inserted at

[1] The text is a lightly adapted version of the introduction section from RFC 1510 by J. Kohl and C. Neuman, September 1993, unclear copyrights, but presumably owned by The Internet Society.

will. (Note, however, that many applications use Kerberos' functions only upon the initiation of a stream-based network connection, and assume the absence of any "hijackers" who might subvert such a connection. Such use implicitly trusts the host addresses involved.) Kerberos performs authentication under these conditions as a trusted third- party authentication service by using conventional cryptography, i.e., shared secret key. (shared secret key - Secret and private are often used interchangeably in the literature. In our usage, it takes two (or more) to share a secret, thus a shared DES key is a secret key. Something is only private when no one but its owner knows it. Thus, in public key cryptosystems, one has a public and a private key.)

The authentication process proceeds as follows: A client sends a request to the authentication server (AS) requesting "credentials" for a given server. The AS responds with these credentials, encrypted in the client's key. The credentials consist of 1) a "ticket" for the server and 2) a temporary encryption key (often called a "session key"). The client transmits the ticket (which contains the client's identity and a copy of the session key, all encrypted in the server's key) to the server. The session key (now shared by the client and server) is used to authenticate the client, and may optionally be used to authenticate the server. It may also be used to encrypt further communication between the two parties or to exchange a separate sub-session key to be used to encrypt further communication.

The implementation consists of one or more authentication servers running on physically secure hosts. The authentication servers maintain a database of principals (i.e., users and servers) and their secret keys. Code libraries provide encryption and implement the Kerberos protocol. In order to add authentication to its transactions, a typical network application adds one or two calls to the Kerberos library, which results in the transmission of the necessary messages to achieve authentication.

The Kerberos protocol consists of several sub-protocols (or exchanges). There are two methods by which a client can ask a Kerberos server for credentials. In the first approach, the client sends a cleartext request for a ticket for the desired server to the AS. The reply is sent encrypted in the client's secret key. Usually this request is for a ticket-granting ticket (TGT) which can later be used with the ticket-granting server (TGS). In the second method, the client sends a request to the TGS. The client sends the TGT to the TGS in the same manner as if it were contacting any other application server which requires Kerberos credentials. The reply is encrypted in the session key from the TGT.

Once obtained, credentials may be used to verify the identity of the principals in a transaction, to ensure the integrity of messages exchanged between them, or to preserve privacy of the messages. The application is free to choose whatever protection may be necessary.

To verify the identities of the principals in a transaction, the client transmits the ticket to the server. Since the ticket is sent "in the clear" (parts of it are encrypted, but this encryption doesn't thwart replay) and might be intercepted and reused by an attacker, additional information is sent to prove that the message was originated by the principal to whom the ticket was issued. This information (called the authenticator) is encrypted in the session key, and includes a timestamp. The timestamp proves that the message was recently generated and is not a replay. Encrypting the authenticator in the session key proves that it was generated by a party possessing the session key. Since no one except the requesting principal and the server know the session key (it is never sent over the network in the clear) this guarantees the identity of the client.

The integrity of the messages exchanged between principals can also be guaranteed using the session key (passed in the ticket and contained in the credentials). This approach provides detection of both replay attacks and message stream modification attacks. It is accomplished by generating and transmitting a collision-proof checksum (elsewhere called a hash or digest function) of the client's message, keyed with the session key. Privacy and integrity of the messages exchanged between principals can be secured by encrypting the data to be passed using the session key passed in the ticket, and contained in the credentials.

1.4 Cryptographic Overview

Shishi implements several of the standard cryptographic primitives. Here are the names of the supported encryption suites, with some notes on their status and there associated checksum suite. They are ordered by increased security as perceived by the author.

`NULL`

> `NULL` is a dummy encryption suite for debugging. Encryption and decryption are identity functions. No integrity protection. It is weak. It is associated with the `NULL` checksum.

`des-cbc-crc`

> `des-cbc-crc` is DES encryption and decryption with 56 bit keys and 8 byte blocks in CBC mode. The keys can be derived from passwords by an obscure application specific algorithm. Data is integrity protected with an unkeyed but encrypted `CRC32`-like checksum. It is weak. It is associated with the `rsa-md5-des` checksum.

`des-cbc-md4`

> `des-cbc-md4` is DES encryption and decryption with 56 bit keys and 8 byte blocks in CBC mode. The keys can be derived from passwords by an obscure application specific algorithm. Data is integrity protected with an unkeyed but encrypted MD4 hash. It is weak. It is associated with the `rsa-md4-des` checksum.

`des-cbc-md5`

> `des-cbc-md5` is DES encryption and decryption with 56 bit keys and 8 byte blocks in CBC mode. The keys can be derived from passwords by an obscure application specific algorithm. Data is integrity protected with an unkeyed but encrypted MD5 hash. It is weak. It is associated with the `rsa-md5-des` checksum. This is the strongest RFC 1510 interoperable mechanism.

`des3-cbc-sha1-kd`

> `des3-cbc-sha1-kd` is DES encryption and decryption with three 56 bit keys (effective key size 112 bits) and 8 byte blocks in CBC mode. The keys can be derived from passwords by a algorithm based on the paper "A Better Key Schedule For DES-like Ciphers"[2] by Uri Blumenthal and Steven M. Bellovin (it is not clear if the algorithm, and the way it is used, is used by any other protocols, although it seems unlikely). Data is integrity protected with a keyed

[2] `http://www.research.att.com/~smb/papers/ides.pdf`

(HMAC) SHA1 hash. It has no security proof, but is assumed to provide adequate security in the sense that knowledge on how to crack it is not known to the public. It is associated with the `hmac-sha1-des3-kd` checksum.

`aes128-cts-hmac-sha1-96`
`aes256-cts-hmac-sha1-96.`

`aes128-cts-hmac-sha1-96` and `aes256-cts-hmac-sha1-96` is AES encryption and decryption with 128 bit and 256 bit key, respectively, and 16 byte blocks in CBC mode with Cipher Text Stealing. Cipher Text Stealing means data length of encrypted data is preserved (pure CBC add up to 7 pad characters). The keys can be derived from passwords with RSA Laboratories PKCS#5 Password Based Key Derivation Function 2[3], which is allegedly provably secure in a random oracle model. Data is integrity protected with a keyed (HMAC) SHA1 hash truncated to 96 bits. There is no security proof, but the schemes are assumed to provide good security, but has, as AES itself, yet to receive the test of time. It is associated with the `hmac-sha1-96-aes128` and `hmac-sha1-96-aes256` checksums, respectively.

The protocol do not include any way to negotiate which checksum mechanisms to use, so in most cases the associated checksum will be used. However, checksum mechanisms can be used with other encryption mechanisms, as long as they are compatible in terms of key format etc. Here are the names of the supported checksum mechanisms, with some notes on their status and the compatible encryption mechanisms. They are ordered by increased security as perceived by the author.

`NULL`

`NULL` is a dummy checksum suite for debugging. It provides no integrity. It is weak. It is compatible with the `NULL` encryption mechanism.

`rsa-md4-des`

`rsa-md4-des` is a DES CBC encryption of one block of random data and a unkeyed MD4 hash computed over the random data and the message to integrity protect. The key used is derived from the base protocol key by XOR with a constant. It is weak. It is compatible with the `des-cbc-crc`, `des-cbc-md4`, `des-cbc-md5` encryption mechanisms.

`rsa-md5-des`

`rsa-md5-des` is a DES CBC encryption of one block of random data and a unkeyed MD5 hash computed over the random data and the message to integrity protect. The key used is derived from the base protocol key by XOR with a constant. It is weak. It is compatible with the `des-cbc-crc`, `des-cbc-md4`, `des-cbc-md5` encryption mechanisms.

`hmac-sha1-des3-kd`

`hmac-sha1-des3-kd` is a keyed (HMAC) SHA1 hash computed over the message. The key is derived from the base protocol by the simplified key derivation function (similar to the password key derivation functions of `des3-cbc-sha1-kd`). It has no security proof, but is assumed to provide good security. It is compatible with the `des3-cbc-sha1-kd` encryption mechanism.

[3] `http://www.rsasecurity.com/rsalabs/pkcs/pkcs-5/`

`hmac-sha1-96-aes128`
`hmac-sha1-96-aes256`

`hmac-sha1-96-aes*` are keyed (HMAC) SHA1 hashes computed over the message and then truncated to 96 bits. The key is derived from the base protocol by the simplified key derivation function (similar to the password key derivation functions of `des3-cbc-sha1-kd`). It has no security proof, but is assumed to provide good security. It is compatible with the `des3-cbc-sha1-kd` encryption mechanism.

1.5 Supported Platforms

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

1. Debian GNU/Linux 3.0r0 (Woody)

   GCC 2.95.4 and GNU Make. alphaev67-unknown-linux-gnu, alphaev6-unknown-linux-gnu, hppa64-unknown-linux-gnu, i686-pc-linux-gnu, ia64-unknown-linux-gnu.

2. Tru64 UNIX

   Tru64 UNIX C compiler and Tru64 Make. alphaev68-dec-osf5.1.

3. SuSE Linux 7.1

   GCC 2.96 and GNU Make. alphaev67-unknown-linux-gnu.

4. SuSE Linux 7.2a

   GCC 3.0 and GNU Make. ia64-unknown-linux-gnu.

5. RedHat Linux 7.2

   GCC 2.96 and GNU Make. i686-pc-linux-gnu.

6. RedHat Linux 8.0

   GCC 3.2 and GNU Make. i686-pc-linux-gnu.

7. Red Hat Advanced Server 2.1

   GCC 2.96 and GNU Make. ia64-unknown-linux-gnu (Intel Madison).

8. SUN Solaris 2.8

   Sun WorkShop Compiler C 6.0 and SUN Make. sparc-sun-solaris2.8.

9. NetBSD 1.6

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

10. OpenBSD 3.1

    GCC 2.95.3 and GNU Make. i386-unknown-openbsd3.1.

11. FreeBSD 4.7

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

If you use Shishi on, or port Shishi to, a new platform please report it to the author (see Section 1.6 [Bug Reports], page 7).

1.6 Bug Reports

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

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

2 User Manual

Usually Shishi interacts with you to get some initial authentication information like a password, and then contacts a server to receive a so called ticket granting ticket. From now on, you rarely interacts with Shishi directly. Applications that needs security services instruct the Shishi library to use the ticket granting ticket to get new tickets for various servers. An example could be if you log on to a host remotely via '`telnet`'. The host usually requires authentication before permitting you in. The '`telnet`' client uses the ticket granting ticket to get a ticket for the server, and then use this ticket to authenticate you against the server (typically the server is also authenticated to you). You perform the initial authentication by typing `shishi` at the prompt. Sometimes it is necessary to supply options telling Shishi what your principal name (user name in the Kerberos realm) or realm is. In the example, I specify the client name `simon@JOSEFSSON.ORG`.

```
$ shishi simon@JOSEFSSON.ORG
Enter password for 'jas@JOSEFSSON.ORG':
jas@JOSEFSSON.ORG:
Authtime:       Fri Aug 15 04:44:49 2003
Endtime:        Fri Aug 15 05:01:29 2003
Server:         krbtgt/JOSEFSSON.ORG key des3-cbc-sha1-kd (16)
Ticket key:     des3-cbc-sha1-kd (16) protected by des3-cbc-sha1-kd (16)
Ticket flags:   INITIAL (512)
$
```

As you can see, Shishi also prints a short description of the ticket received.

A logical next step is to display all tickets you have received (by the way, the tickets are usually stored as text in '`~/.shishi/tickets`'). This is achieved by typing `shishi --list`.

```
$ shishi --list
Tickets in `/home/jas/.shishi/tickets':

jas@JOSEFSSON.ORG:
Authtime:       Fri Aug 15 04:49:46 2003
Endtime:        Fri Aug 15 05:06:26 2003
Server:         krbtgt/JOSEFSSON.ORG key des-cbc-md5 (3)
Ticket key:     des-cbc-md5 (3) protected by des-cbc-md5 (3)
Ticket flags:   INITIAL (512)

jas@JOSEFSSON.ORG:
Authtime:       Fri Aug 15 04:49:46 2003
Starttime:      Fri Aug 15 04:49:49 2003
Endtime:        Fri Aug 15 05:06:26 2003
Server:         host/latte.josefsson.org key des-cbc-md5 (3)
Ticket key:     des-cbc-md5 (3) protected by des-cbc-md5 (3)

2 tickets found.
$
```

As you can see, I had a ticket for the server '`host/latte.josefsson.org`' which was generated by '`telnet`':ing to that host.

If, for some reason, you want to manually get a ticket for a specific server, you can use the `shishi --server-name` command. Normally, however, the application that uses Shishi will take care of getting a ticket for the appropriate server, so you normally wouldn't need this command.

```
$ shishi --server-name=user/billg --encryption-type=des-cbc-md4
jas@JOSEFSSON.ORG:
Authtime:       Fri Aug 15 04:49:46 2003
Starttime:      Fri Aug 15 04:54:33 2003
Endtime:        Fri Aug 15 05:06:26 2003
Server:         user/billg key des-cbc-md4 (2)
Ticket key:     des-cbc-md4 (2) protected by des-cbc-md5 (3)
$
```

As you can see, I acquired a ticket for '`user/billg`' with a '`des-cbc-md4`' (see Section 1.4 [Cryptographic Overview], page 4) encryption key specified with the '`--encryption-type`' parameter.

To wrap up this introduction, lets see how you can remove tickets. You may want to do this if you leave your terminal for lunch or similar, and don't want someone to be able to copy the file and then use your credentials. Note that this only destroy the tickets locally, it does not contact any server and tell it that these credentials are no longer valid. So if someone stole your ticket file, you must contact your administrator and have them reset your account, simply using this parameter is not sufficient.

```
$ shishi --server-name=imap/latte.josefsson.org --destroy
1 ticket removed.
$ shishi --server-name=foobar --destroy
No tickets removed.
$ shishi --destroy
3 tickets removed.
$
```

Below follows a list of all parameters.

Mandatory or optional arguments to long options are also mandatory or optional for any corresponding short options.

```
      --client-name=NAME     Client name. Default is login username. Only for
                             AS.
      --destroy              Destroy tickets in local cache, subject to
                             --server-name limiting.
  -e, --encryption-type=ETYPE,[ETYPE...]
                             Encryption types to use.  ETYPE is either
                             registered name or integer.
      --force-as             Force AS mode. Default is to use TGS iff a TGT is
                             found.
      --force-tgs            Force TGS mode. Default is to use TGS iff a TGT is
                             found.
      --key-value=KEY        Cipher key to decrypt response (discouraged).
      --list                 List tickets in local cache, subject to
                             --server-name limiting.
      --password=PASSWORD    Password to decrypt response (discouraged).  Only
                             for AS.
  -r, --realm=REALM          Realm of server. Default is DNS domain of local
                             host. For AS, this also indicates realm of client.

      --server=HOST          Send request to HOST. Default uses address from
                             configuration file.
      --server-name=NAME     Server name. Default is "krbtgt/REALM" where REALM
                             is server realm (see --realm).
      --ticket-granter=NAME  Service name in ticket to use for authenticating
                             request. Only for TGS. Defaults to
                             "krbtgt/REALM@REALM" where REALM is server realm
                             (see --realm).

 Options for low-level cryptography (CRYPTO-OPTIONS):
      --algorithm=ALGORITHM  Cipher algorithm, expressed either as the etype
                             integer or the registered name.
      --client-name=NAME     Username. Default is login name.
      --decrypt              Decrypt data.
```

```
      --encrypt               Encrypt data.
      --key-usage=KEYUSAGE    Encrypt or decrypt using specified key usage.
                              Default is 0, which means no key derivation are
                              performed.
      --key-value=KEY         Base64 encoded key value.
      --key-version=INTEGER   Version number of key.
      --parameter=STRING      String-to-key parameter to use when --password is
                              specified. This data is specific for each
                              encryption algorithm and rarely needed.
      --password=PASSWORD     Password used to generate key.  --client-name and
                              --realm also modify the computed key value.
      --random                Generate key from random data.
      --read-data-file=[TYPE,]FILE
                              Read data from FILE in TYPE, BASE64, HEX or BINARY
                              (default).
      --read-key-file=FILE    Read cipher key from FILE
      --realm=REALM           Realm of principal. Defaults to DNS domain of
                              local host.
      --salt=SALT             Salt to use when --password is specified. Defaults
                              to using theusername (--client-name) and realm
                              (--realm).
      --write-data-file=[TYPE,]FILE
                              Write data to FILE in TYPE, BASE64, HEX or BINARY
                              (default).
      --write-key-file=FILE   Append cipher key to FILE

Other options:
 -c, --configuration-file=FILE   Read user configuration from file.  Default
                              is ~/.shishi/config.
 -o, --library-options=STRING   Parse STRING as a configuration file
                              statement.
 -q, --quiet, --silent       Don't produce any output.
 -s, --system-configuration-file=FILE
                              Read system wide configuration from file.  Default
                              is /usr/local/etc/shishi.conf.
 -t, --ticket-file=FILE      Read tickets from FILE. Default is
                              $HOME/.shishi/tickets.
 -v, --verbose               Produce verbose output.
     --verbose-library       Produce verbose output in the library.
 -w, --ticket-write-file=FILE   Write tickets to FILE.  Default is to write
                              them back to ticket file.
 NAME                        Set client name and realm from NAME.  The
                              --client-name and --realm can be used to override
                              part of NAME.

 -?, --help                  Give this help list
     --usage                 Give a short usage message
```

```
-V, --version              Print program version
```

3 Administration Manual

TBW.

4 Programming Manual

This chapter describes all the publicly available functions in the library.

4.1 Preparation

To use 'Libshishi', you have to perform some changes to your sources and the build system. The necessary changes are small and explained in the following sections. At the end of this chapter, it is described how the library is initialized, and how the requirements of the library are verified.

A faster way to find out how to adapt your application for use with 'Libshishi' may be to look at the examples at the end of this manual (see Section 4.15 [Examples], page 78).

4.1.1 Header

All interfaces (data types and functions) of the library are defined in the header file 'shishi.h'. You must include this in all programs using the library, either directly or through some other header file, like this:

```
#include <shishi.h>
```

The name space of 'Libshishi' is `shishi_*` for function names, `Shishi*` for data types and `SHISHI_*` for other symbols. In addition the same name prefixes with one prepended underscore are reserved for internal use and should never be used by an application.

4.1.2 Initialization

'Libshishi' must be initialized before it can be used. The library is initialized by calling `shishi_init()` (see Section 4.2 [Initialization Functions], page 15). The resources allocated by the initialization process can be released if the application no longer has a need to call 'Libshishi' functions, this is done by calling `shishi_done()`.

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

4.1.3 Version Check

It is often desirable to check that the version of 'Libshishi' used is indeed one which fits all requirements. Even with binary compatibility new features may have been introduced but due to problem with the dynamic linker an old version is actually used. So you may want to check that the version is okay right after program startup.

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

req_version: version string to compare with, or NULL

Check that the the version of the library is at minimum the one given as a string in `req_version` and return the actual version string of the library; return NULL if the condition is not met. If *NULL* is passed to this function no check is done and

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

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

```
if (!shishi_check_version (SHISHI_VERSION))
  {
    printf ("shishi_check_version() failed:\n"
            "Header file incompatible with shared library.\n");
    exit(1);
  }
```

4.1.4 Building the source

If you want to compile a source file including the 'shishi.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, 'Libshishi' uses the external package `pkg-config` that knows the path to the include file and other configuration options. The options that need to be added to the compiler invocation at compile time are output by the '`--cflags`' option to `pkg-config shishi`. The following example shows how it can be used at the command line:

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

Adding the output of '`pkg-config shishi --cflags`' to the compilers command line will ensure that the compiler can find the 'Libshishi' header file.

A similar problem occurs when linking the program with the library. Again, the compiler has to find the library files. For this to work, the path to the library files has to be added to the library search path (via the '`-L`' option). For this, the option '`--libs`' to `pkg-config shishi` can be used. For convenience, this option also outputs all other options that are required to link the program with the 'Libshishi' libararies (in particular, the '`-lshishi`' option). The example shows how to link '`foo.o`' with the 'Libshishi' library to a program `foo`.

```
gcc -o foo foo.o `pkg-config shishi --libs`
```

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

```
gcc -o foo foo.c `pkg-config shishi --cflags --libs`
```

4.2 Initialization Functions

Shishi * shishi (*void*) [Function]

Initializes the Shishi library. If this function fails, it may print diagnostic errors to stderr.

Returns Shishi library handle, or *NULL* on error.

`int` **shishi_init** (`Shishi ** handle`) [Function]

handle: pointer to handle to be created.

Create a Shishi library handle and read the system configuration file, user configuration file and user tickets from the default paths. The paths to the system configuration file is decided at compile time, and is $sysconfdir/shishi.conf. The user configuration file is $HOME/.shishi/config, and the user ticket file is $HOME/.shishi/ticket. The handle is allocated regardless of return values, except for SHISHI_HANDLE_ERROR which indicates a problem allocating the handle. (The other error conditions comes from reading the files.)

Returns SHISHI_OK iff successful.

`int` **shishi_init_with_paths** (`Shishi ** handle, const char * tktsfile, const char * systemcfgfile, const char * usercfgfile`) [Function]

handle: pointer to handle to be created.

tktsfile: Filename of ticket file, or NULL.

systemcfgfile: Filename of system configuration, or NULL.

usercfgfile: Filename of user configuration, or NULL.

Like `shishi_init()` but use explicit paths. Like `shishi_init()`, the handle is allocated regardless of return values, except for SHISHI_HANDLE_ERROR which indicates a problem allocating the handle. (The other error conditions comes from reading the files.)

Returns SHISHI_OK iff successful.

`int` **shishi_init_server** (`Shishi ** handle`) [Function]

handle: pointer to handle to be created.

Like `shishi_init()` but only read the system configuration file. Like `shishi_init()`, the handle is allocated regardless of return values, except for SHISHI_HANDLE_ERROR which indicates a problem allocating the handle. (The other error conditions comes from reading the configuration file.)

Returns SHISHI_OK iff successful.

`int` **shishi_init_server_with_paths** (`Shishi ** handle, const char * systemcfgfile`) [Function]

handle: pointer to handle to be created.

systemcfgfile: Filename of system configuration, or NULL.

Like `shishi_init()` but only read the system configuration file from specified location. Like `shishi_init()`, the handle is allocated regardless of return values, except for SHISHI_HANDLE_ERROR which indicates a problem allocating the handle. (The other error conditions comes from reading the configuration file.)

Returns SHISHI_OK iff successful.

`void` **shishi_done** (`Shishi * handle`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

Deallocates the shishi library handle. The handle must not be used in any calls to shishi functions after this. If there is a default tkts, it is written to the default tkts file

(call `shishi_tkts_default_file_set()` to change the default tkts file). If you do not wish to write the default tkts file, close the default tkts with shishi_tkts_done(handle, NULL) before calling this function.

`int` **shishi_cfg** (`Shishi * handle, char * option`) [Function]

option: string with shishi library option.

Configure shishi library with given option.

Returns SHISHI_OK if option was valid.

`int` **shishi_cfg_from_file** (`Shishi * handle, const char * cfg`) [Function]

cfg: filename to read configuration from.

Configure shishi library using configuration file.

Returns SHISHI_OK iff succesful.

`int` **shishi_cfg_print** (`Shishi * handle, FILE * fh`) [Function]

handle: Shishi library handle create by `shishi_init()`.

fh: file descriptor opened for writing.

Print library configuration status, mostly for debugging purposes.

Returns SHISHI_OK.

`const char *` **shishi_cfg_default_systemfile** (`Shishi * handle`) [Function]

handle: Shishi library handle create by `shishi_init()`.

Return system configuration filename.

`const char *` **shishi_cfg_default_userdirectory** (`Shishi * handle`) [Function]

handle: Shishi library handle create by `shishi_init()`.

Return directory with configuration files etc.

`const char *` **shishi_cfg_default_userfile** (`Shishi * handle`) [Function]

handle: Shishi library handle create by `shishi_init()`.

Return user configuration filename.

`int` **shishi_cfg_clientkdcetype** (`Shishi * handle, int32_t ** etypes`) [Function]

handle: Shishi library handle create by `shishi_init()`.

etypes: output array with encryption types.

Set the etypes variable to the array of preferred client etypes.

Return the number of encryption types in the array, 0 means none.

`int` **shishi_cfg_clientkdcetype_set** (`Shishi * handle, char * value`) [Function]

handle: Shishi library handle create by `shishi_init()`.

value: string with encryption types.

Set the "client-kdc-etypes" configuration option from given string. The string contains encryption types (integer or names) separated by comma or whitespace, e.g. "aes256-cts-hmac-sha1-96 des3-cbc-sha1-kd des-cbc-md5".

Return SHISHI_OK iff successful.

4.3 Ticket Set Functions

A "ticket set" is, as the name implies, a collection of tickets. Functions are provided to read tickets from file into a ticket set, to query number of tickets in the set, to extract a given ticket from the set, to search the ticket set for tickets matching certain criterium, to write the ticket set to a file, etc. High level functions for performing a initial authentication (see Section 4.7 [AS Functions], page 39) or subsequent authentication (see Section 4.8 [TGS Functions], page 43) and storing the new ticket in the ticket set are also provided.

To manipulate each individual ticket, See Section 4.6 [Ticket Functions], page 38. For low-level ASN.1 manipulation see See Section 4.9 [Ticket (ASN.1) Functions], page 47.

`char * shishi_tkts_default_file_guess ( void)` [Function]

Guesses the default ticket filename; it is $HOME/.shishi/tickets.

Returns default tkts filename as a string that has to be deallocated with `free()` by the caller.

`const char * shishi_tkts_default_file (Shishi * handle)` [Function]

handle: Shishi library handle create by `shishi_init()`.

Returns the default ticket set filename used in the library. (Not a copy of it, so don't modify or deallocate it.)

`void shishi_tkts_default_file_set (Shishi * handle, const char * tktsfile)` [Function]

handle: Shishi library handle create by `shishi_init()`.

tktsfile: string with new default tkts file name, or NULL to reset to default.

Set the default ticket set filename used in the library. The string is copied into the library, so you can dispose of the variable immediately after calling this function.

`Shishi_tkts * shishi_tkts_default (Shishi * handle)` [Function]

handle: Shishi library handle create by `shishi_init()`.

Return the handle global ticket set.

`int shishi_tkts (Shishi * handle, Shishi_tkts ** tkts)` [Function]

handle: shishi handle as allocated by `shishi_init()`.

tkts: output pointer to newly allocated tkts handle.

Returns *SHISHI_OK* iff successful.

`void shishi_tkts_done (Shishi_tkts ** tkts)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

Deallocates all resources associated with ticket set. The ticket set handle must not be used in calls to other shishi_tkts_*() functions after this.

`int shishi_tkts_size (Shishi_tkts * tkts)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

Returns number of tickets stored in ticket set.

`Shishi_tkt * shishi_tkts_nth (Shishi_tkts * tkts, int ticketno)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

ticketno: integer indicating requested ticket in ticket set.

Returns a ticket handle to the ticketno:th ticket in the ticket set, or NULL if ticket set is invalid or ticketno is out of bounds. The first ticket is ticketno 0, the second ticketno 1, and so on.

`int shishi_tkts_remove (Shishi_tkts * tkts, int ticketno)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

Returns SHISHI_OK if succesful or if ticketno larger than size of ticket set.

`int shishi_tkts_add (Shishi_tkts * tkts, Shishi_tkt * tkt)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

Returns SHISHI_OK iff succesful.

`int shishi_tkts_new (Shishi_tkts * tkts, Shishi_asn1 ticket, Shishi_asn1 enckdcreppart, Shishi_asn1 kdcrep)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

ticket: input ticket variable.

enckdcreppart: input ticket detail variable.

kdcrep: input KDC-REP variable.

Allocate a new ticket and add it to the ticket set.

Returns SHISHI_OK iff succesful.

`int shishi_tkts_read (Shishi_tkts * tkts, FILE * fh)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

fh: file descriptor to read from.

Read tickets from file descriptor and add them to the ticket set.

Returns SHISHI_OK iff succesful.

`int shishi_tkts_from_file (Shishi_tkts * tkts, const char * filename)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

filename: filename to read tickets from.

Read tickets from file and add them to the ticket set.

Returns SHISHI_OK iff succesful.

`int shishi_tkts_write (Shishi_tkts * tkts, FILE * fh)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

Write tickets in set to file descriptor.

Returns SHISHI_OK iff succesful.

`int shishi_tkts_expire (Shishi_tkts * tkts)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

Remove expired tickets from ticket set.

Returns SHISHI_OK iff succesful.

`int` **shishi_tkts_to_file** (`Shishi_tkts * tkts, const char * filename`) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

filename: filename to write tickets to.

Write tickets in set to file.

Returns SHISHI_OK iff succesful.

`int` **shishi_tkts_print_for_service** (`Shishi_tkts * tkts, FILE * fh, const char * service`) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

fh: file descriptor to print to.

service: service to limit tickets printed to, or NULL. Print description of tickets for specified service to file descriptor. If service is NULL, all tickets are printed.

Returns SHISHI_OK iff succesful.

`int` **shishi_tkts_print** (`Shishi_tkts * tkts, FILE * fh`) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

fh: file descriptor to print to.

Print description of all tickets to file descriptor.

Returns SHISHI_OK iff succesful.

`int` **shishi_tkt_match_p** (`Shishi_tkt * tkt, Shishi_tkts_hint * hint`) [Function]

tkt: ticket to test hints on.

hint: structure with characteristics of ticket to be found.

Returns 0 iff ticket fails to match given criteria.

`Shishi_tkt *` **shishi_tkts_find** (`Shishi_tkts * tkts, Shishi_tkts_hint * hint`) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

hint: structure with characteristics of ticket to be found.

Search the ticketset sequentially (from ticket number 0 through all tickets in the set) for a ticket that fits the given characteristics. If a ticket is found, the hint->startpos field is updated to point to the next ticket in the set, so this function can be called repeatedly with the same hint argument in order to find all tickets matching a certain criterium. Note that if tickets are added to, or removed from, the ticketset during a query with the same hint argument, the hint->startpos field must be updated appropriately.

Shishi_tkts_hint hint;

Shishi_tkt tkt;

...

memset(`hint`, 0, sizeof(hint));

hint.server = "imap/mail.example.org";

tkt = shishi_tkts_find (shishi_tkts_default(handle), `hint`);

```
if (!tkt)
printf("No ticket found...\n");
else
...do something with ticket
```

Returns a ticket if found, or NULL if no further matching tickets could be found.

`Shishi_tkt *` **shishi_tkts_find_for_clientserver** (`Shishi_tkts *` *tkts*, `const char *` *client*, `const char *` *server*) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

client: client name to find ticket for.

server: server name to find ticket for.

Short-hand function for searching the ticket set for a ticket for the given client and server. See `shishi_tkts_find()`.

Returns a ticket if found, or NULL.

`Shishi_tkt *` **shishi_tkts_find_for_server** (`Shishi_tkts *` *tkts*, `const char *` *server*) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

server: server name to find ticket for.

Short-hand function for searching the ticket set for a ticket for the given server using the default client principal. See `shishi_tkts_find_for_clientserver()` and `shishi_tkts_find()`.

Returns a ticket if found, or NULL.

`Shishi_tkt *` **shishi_tkts_get** (`Shishi_tkts *` *tkts*, `Shishi_tkts_hint *` *hint*) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

hint: structure with characteristics of ticket to begot.

Get a ticket matching given characteristics. This function first looks in the ticket set for the ticket, then tries to find a TGT for the realm (possibly by using an AS exchange) and then use the TGT in a TGS exchange to get the ticket. Currently this function do not implement cross realm logic.

Returns a ticket if found, or NULL if this function is unable to get the ticket.

`Shishi_tkt *` **shishi_tkts_get_for_clientserver** (`Shishi_tkts *` *tkts*, `const char *` *client*, `const char *` *server*) [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

client: client name to get ticket for.

server: server name to get ticket for.

Short-hand function for getting a ticket for the given client and server. See `shishi_tkts_get()`.

Returns a ticket if found, or NULL.

`Shishi_tkt * shishi_tkts_get_for_server (Shishi_tkts * tkts, const char * server)` [Function]

tkts: ticket set handle as allocated by `shishi_tkts()`.

server: server name to get ticket for.

Short-hand function for getting a ticket for the given server and the default principal client. See `shishi_tkts_get()`.

Returns a ticket if found, or NULL.

4.4 AP-REQ and AP-REP Functions

The "AP-REQ" and "AP-REP" are ASN.1 structures used by application client and servers to prove to each other who they are. The structures contain auxilliary information, together with an authenticator (see Section 4.11 [Authenticator Functions], page 60) which is the real cryptographic proof. The following illustrates the AP-REQ and AP-REP ASN.1 structures.

```
AP-REQ          ::= [APPLICATION 14] SEQUENCE {
        pvno            [0] INTEGER (5),
        msg-type        [1] INTEGER (14),
        ap-options      [2] APOptions,
        ticket          [3] Ticket,
        authenticator   [4] EncryptedData {Authenticator,
                                { keyuse-pa-TGSReq-authenticator
                                  | keyuse-APReq-authenticator }}
}

AP-REP          ::= [APPLICATION 15] SEQUENCE {
        pvno            [0] INTEGER (5),
        msg-type        [1] INTEGER (15),
        enc-part        [2] EncryptedData {EncAPRepPart,
                                { keyuse-EncAPRepPart }}
}

EncAPRepPart    ::= [APPLICATION 27] SEQUENCE {
        ctime           [0] KerberosTime,
        cusec           [1] Microseconds,
        subkey          [2] EncryptionKey OPTIONAL,
        seq-number      [3] UInt32 OPTIONAL
}
```

`int shishi_ap (Shishi * handle, Shishi_ap ** ap)` [Function]

handle: shishi handle as allocated by `shishi_init()`.

ap: pointer to new structure that holds information about AP exchange

Create a new AP exchange.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_set_tktoptions** (`Shishi_ap * ap, Shishi_tkt * tkt, int options`) [Function]

ap: structure that holds information about AP exchange

tkt: ticket to set in AP.

options: AP-REQ options to set in AP.

Set the ticket (see `shishi_ap_tkt_set()`) and set the AP-REQ apoptions (see `shishi_apreq_options_set()`).

Returns SHISHI_OK iff successful.

`int` **shishi_ap_set_tktoptionsdata** (`Shishi_ap * ap, Shishi_tkt * tkt, int options, char * data, int len`) [Function]

ap: structure that holds information about AP exchange

tkt: ticket to set in AP.

options: AP-REQ options to set in AP.

data: input array with data to checksum in Authenticator.

len: length of input array with data to checksum in Authenticator.

Set the ticket (see `shishi_ap_tkt_set()`) and set the AP-REQ apoptions (see `shishi_apreq_options_set()`) and set the Authenticator checksum data.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_set_tktoptionsasn1usage** (`Shishi_ap * ap, Shishi_tkt * tkt, int options, Shishi_asn1 node, char * field, int authenticatorcksumkeyusage, int authenticatorkeyusage`) [Function]

ap: structure that holds information about AP exchange

tkt: ticket to set in AP.

options: AP-REQ options to set in AP.

node: input ASN.1 structure to store as authenticator checksum data.

Set ticket, options and authenticator checksum data using `shishi_ap_set_tktoptionsdata()`. The authenticator checksum data is the DER encoding of the ASN.1 structure provided.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_tktoptions** (`Shishi * handle, Shishi_ap ** ap, Shishi_tkt * tkt, int options`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ap: pointer to new structure that holds information about AP exchange

tkt: ticket to set in newly created AP.

options: AP-REQ options to set in newly created AP.

Create a new AP exchange using `shishi_ap()`, and set the ticket and AP-REQ apoptions using `shishi_ap_set_tktoption()`.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_tktoptionsdata** (`Shishi * handle, Shishi_ap ** ap, Shishi_tkt * tkt, int options, char * data, int len`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ap: pointer to new structure that holds information about AP exchange

tkt: ticket to set in newly created AP.

options: AP-REQ options to set in newly created AP.

data: input array with data to checksum in Authenticator.

len: length of input array with data to checksum in Authenticator.

Create a new AP exchange using `shishi_ap()`, and set the ticket, AP-REQ apoptions and the Authenticator checksum data using `shishi_ap_set_tktoptionsdata()`.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_tktoptionsasn1usage** (`Shishi * handle, Shishi_ap ** ap, Shishi_tkt * tkt, int options, Shishi_asn1 node, char * field, int authenticatorcksumkeyusage, int authenticatorkeyusage`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ap: pointer to new structure that holds information about AP exchange

tkt: ticket to set in newly created AP.

options: AP-REQ options to set in newly created AP.

node: input ASN.1 structure to store as authenticator checksum data.

Create a new AP exchange using `shishi_ap()`, and set ticket, options and authenticator checksum data from the DER encoding of the ASN.1 field using `shishi_ap_set_tktoptionsasn1usage()`.

Returns SHISHI_OK iff successful.

`Shishi_tkt *` **shishi_ap_tkt** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Returns the ticket from the AP exchange, or NULL if not yet set or an error occured.

`void` **shishi_ap_tkt_set** (`Shishi_ap * ap, Shishi_tkt * tkt`) [Function]

ap: structure that holds information about AP exchange

tkt: ticket to store in AP.

Set the Ticket in the AP exchange.

`int` **shishi_ap_authenticator_cksumdata** (`Shishi_ap * ap, char * out, int * len`) [Function]

ap: structure that holds information about AP exchange

out: output array that holds authenticator checksum data.

len: on input, maximum length of output array that holds authenticator checksum data, on output actual length of output array that holds authenticator checksum data.

Returns SHISHI_OK if successful, or SHISHI_TOO_SMALL_BUFFER if buffer provided was too small.

`void` **shishi_ap_authenticator_cksumdata_set** (`Shishi_ap * ap, char * authenticatorcksumdata, int authenticatorcksumdatalen`) [Function]

ap: structure that holds information about AP exchange

authenticatorcksumdata: length of input array with authenticator checksum data to use in AP.

Set the Authenticator Checksum Data in the AP exchange.

`Shishi_asn1` **shishi_ap_authenticator** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Returns the Authenticator from the AP exchange, or NULL if not yet set or an error occured.

`void` **shishi_ap_authenticator_set** (`Shishi_ap * ap, Shishi_asn1 authenticator`) [Function]

ap: structure that holds information about AP exchange

authenticator: authenticator to store in AP.

Set the Authenticator in the AP exchange.

`Shishi_asn1` **shishi_ap_req** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Returns the AP-REQ from the AP exchange, or NULL if not yet set or an error occured.

`void` **shishi_ap_req_set** (`Shishi_ap * ap, Shishi_asn1 apreq`) [Function]

ap: structure that holds information about AP exchange

apreq: apreq to store in AP.

Set the AP-REQ in the AP exchange.

`int` **shishi_ap_req_der** (`Shishi_ap * ap, char * out, int * outlen`) [Function]

ap: structure that holds information about AP exchange

out: output array with der encoding of AP-REQ.

outlen: length of output array with der encoding of AP-REQ.

Build AP-REQ using `shishi_ap_req_build()` and DER encode it.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_req_der_new** (`Shishi_ap * ap, char ** out, int * outlen`) [Function]

ap: structure that holds information about AP exchange

out: pointer to output array with der encoding of AP-REQ.

outlen: pointer to length of output array with der encoding of AP-REQ.

Build AP-REQ using `shishi_ap_req_build()` and DER encode it. `out` is allocated by this function, and it is the responsibility of caller to deallocate it.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_req_der_set** (`Shishi_ap * ap, char * der, size_t derlen`) [Function]

ap: structure that holds information about AP exchange

der: input array with DER encoded AP-REQ.

derlen: length of input array with DER encoded AP-REQ.

DER decode AP-REQ and set it AP exchange. If decoding fails, the AP-REQ in the AP exchange is lost.

Returns SHISHI_OK.

`int` **shishi_ap_req_build** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Checksum data in authenticator and add ticket and authenticator to AP-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_req_process** (`Shishi_ap * ap, Shishi_key * key`) [Function]

ap: structure that holds information about AP exchange

Decrypt ticket in AP-REQ using supplied key and decrypt Authenticator in AP-REQ using key in decrypted ticket, and on success set the Ticket and Authenticator fields in the AP exchange.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_req_asn1** (`Shishi_ap * ap, Shishi_asn1 * apreq`) [Function]

ap: structure that holds information about AP exchange

apreq: output AP-REQ variable.

Build AP-REQ using `shishi_ap_req_build()` and return it.

Returns SHISHI_OK iff successful.

`Shishi_asn1` **shishi_ap_rep** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Returns the AP-REP from the AP exchange, or NULL if not yet set or an error occured.

`void` **shishi_ap_rep_set** (`Shishi_ap * ap, Shishi_asn1 aprep`) [Function]

ap: structure that holds information about AP exchange

aprep: aprep to store in AP.

Set the AP-REP in the AP exchange.

`int` **shishi_ap_rep_der** (`Shishi_ap * ap, char * out, size_t * outlen`) [Function]

ap: structure that holds information about AP exchange

out: output array with der encoding of AP-REP.

outlen: length of output array with der encoding of AP-REP.

Build AP-REP using `shishi_ap_rep_build()` and DER encode it.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_rep_der_set** (`Shishi_ap * ap, char * der, size_t derlen`) [Function]

ap: structure that holds information about AP exchange

der: input array with DER encoded AP-REP.

derlen: length of input array with DER encoded AP-REP.

DER decode AP-REP and set it AP exchange. If decoding fails, the AP-REP in the AP exchange remains.

Returns SHISHI_OK.

`int` **shishi_ap_rep_build** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Checksum data in authenticator and add ticket and authenticator to AP-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_rep_asn1** (`Shishi_ap * ap, Shishi_asn1 * aprep`) [Function]

ap: structure that holds information about AP exchange

Build AP-REP using `shishi_ap_rep_build()` and return it.

Returns SHISHI_OK iff successful.

`int` **shishi_ap_rep_verify** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Verify AP-REP compared to Authenticator.

Returns SHISHI_OK, SHISHI_APREP_VERIFY_FAILED or an error.

`int` **shishi_ap_rep_verify_der** (`Shishi_ap * ap, char * der, size_t derlen`) [Function]

ap: structure that holds information about AP exchange

der: input array with DER encoded AP-REP.

derlen: length of input array with DER encoded AP-REP.

DER decode AP-REP and set it in AP exchange using `shishi_ap_rep_der_set()` and verify it using `shishi_ap_rep_verify()`.

Returns SHISHI_OK, SHISHI_APREP_VERIFY_FAILED or an error.

`int` **shishi_ap_rep_verify_asn1** (`Shishi_ap * ap, Shishi_asn1 aprep`) [Function]

ap: structure that holds information about AP exchange

aprep: input AP-REP.

Set the AP-REP in the AP exchange using `shishi_ap_rep_set()` and verify it using `shishi_ap_rep_verify()`.

Returns SHISHI_OK, SHISHI_APREP_VERIFY_FAILED or an error.

`Shishi_asn1` **shishi_ap_encapreppart** (`Shishi_ap * ap`) [Function]

ap: structure that holds information about AP exchange

Returns the EncAPREPPart from the AP exchange, or NULL if not yet set or an error occured.

`void` **shishi_ap_encapreppart_set** (`Shishi_ap * ap, Shishi_asn1 encapreppart`) [Function]

ap: structure that holds information about AP exchange

encapreppart: EncAPRepPart to store in AP.

Set the EncAPRepPart in the AP exchange.

`Shishi_asn1` **shishi_apreq** (`Shishi * handle`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

This function creates a new AP-REQ, populated with some default values.

Returns the AP-REQ or NULL on failure.

`int` **shishi_apreq_print** (`Shishi * handle, FILE * fh, Shishi_asn1 apreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

apreq: AP-REQ to print.

Print ASCII armored DER encoding of AP-REQ to file.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_save** (`Shishi * handle, FILE * fh, Shishi_asn1 apreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

apreq: AP-REQ to save.

Save DER encoding of AP-REQ to file.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_to_file** (`Shishi * handle, Shishi_asn1 apreq, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

apreq: AP-REQ to save.

filetype: input variable specifying type of file to be written, see Shishi_filetype.

filename: input variable with filename to write to.

Write AP-REQ to file in specified TYPE. The file will be truncated if it exists.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_parse** (`Shishi * handle, FILE * fh, Shishi_asn1 * apreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

apreq: output variable with newly allocated AP-REQ.

Read ASCII armored DER encoded AP-REQ from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_read** (`Shishi * handle, FILE * fh, Shishi_asn1 * apreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

apreq: output variable with newly allocated AP-REQ.

Read DER encoded AP-REQ from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_from_file** (`Shishi * handle, Shishi_asn1 * apreq, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

apreq: output variable with newly allocated AP-REQ.

filetype: input variable specifying type of file to be read, see Shishi_filetype.

filename: input variable with filename to read from.

Read AP-REQ from file in specified TYPE.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_set_authenticator** (`Shishi * handle, Shishi_asn1 apreq, int32_t etype, char * buf, int buflen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

apreq: AP-REQ to add authenticator field to.

etype: encryption type used to encrypt authenticator.

buf: input array with encrypted authenticator.

buflen: size of input array with encrypted authenticator.

Set the encrypted authenticator field in the AP-REP. The encrypted data is usually created by calling `shishi_encrypt()` on the DER encoded authenticator. To save time, you may want to use `shishi_apreq_add_authenticator()` instead, which calculates the encrypted data and calls this function in one step.

`int` **shishi_apreq_add_authenticator** (`Shishi * handle, Shishi_asn1 apreq, Shishi_key * key, int keyusage, Shishi_asn1 authenticator`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

apreq: AP-REQ to add authenticator field to.

authenticator: authenticator as allocated by `shishi_authenticator()`.

Encrypts DER encoded authenticator using key from ticket and store it in the AP-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_set_ticket** (`Shishi * handle, Shishi_asn1 apreq, Shishi_asn1 ticket`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

apreq: AP-REQ to add ticket field to.

ticket: input ticket to copy into AP-REQ ticket field.

Copy ticket into AP-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_get_authenticator_etype** (`Shishi * handle, Shishi_asn1 apreq, int32_t * etype`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

etype: output variable that holds the value.

Extract KDC-REP.enc-part.etype.

Returns SHISHI_OK iff successful.

`int` **shishi_apreq_get_ticket** (`Shishi * handle, Shishi_asn1 apreq, Shishi_asn1 * ticket`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ticket: output variable to hold extracted ticket.

Extract ticket from AP-REQ.

Returns SHISHI_OK iff successful.

`Shishi_asn1` **shishi_aprep** (`Shishi * handle`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

This function creates a new AP-REP, populated with some default values.

Returns the authenticator or NULL on failure.

`int` **shishi_aprep_print** (`Shishi * handle, FILE * fh, Shishi_asn1 aprep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

aprep: AP-REP to print.

Print ASCII armored DER encoding of AP-REP to file.

Returns SHISHI_OK iff successful.

`int` **shishi_aprep_save** (`Shishi * handle, FILE * fh, Shishi_asn1 aprep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

aprep: AP-REP to save.

Save DER encoding of AP-REP to file.

Returns SHISHI_OK iff successful.

`int` **shishi_aprep_to_file** (`Shishi * handle, Shishi_asn1 aprep, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

aprep: AP-REP to save.

filetype: input variable specifying type of file to be written, see Shishi_filetype.

filename: input variable with filename to write to.

Write AP-REP to file in specified TYPE. The file will be truncated if it exists.

Returns SHISHI_OK iff successful.

`int` **shishi_aprep_parse** (`Shishi * handle, FILE * fh, Shishi_asn1 * aprep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

aprep: output variable with newly allocated AP-REP.

Read ASCII armored DER encoded AP-REP from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_aprep_read** (`Shishi * handle, FILE * fh, Shishi_asn1 * aprep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

aprep: output variable with newly allocated AP-REP.

Read DER encoded AP-REP from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_aprep_from_file** (`Shishi * handle, Shishi_asn1 * aprep, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

aprep: output variable with newly allocated AP-REP.

filetype: input variable specifying type of file to be read, see Shishi_filetype.

filename: input variable with filename to read from.

Read AP-REP from file in specified TYPE.

Returns SHISHI_OK iff successful.

`int` **shishi_aprep_get_enc_part_etype** (`Shishi * handle, Shishi_asn1 aprep, int32_t * etype`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

aprep: AP-REP variable to get value from.

etype: output variable that holds the value.

Extract AP-REP.enc-part.etype.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_print** (`Shishi * handle, FILE * fh, Shishi_asn1 encapreppart`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

encapreppart: EncAPRepPart to print.

Print ASCII armored DER encoding of EncAPRepPart to file.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_save** (`Shishi * handle, FILE * fh, Shishi_asn1 encapreppart`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

encapreppart: EncAPRepPart to save.

Save DER encoding of EncAPRepPart to file.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_to_file** (`Shishi * handle, Shishi_asn1 encapreppart, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encapreppart: EncAPRepPart to save.

filetype: input variable specifying type of file to be written, see Shishi_filetype.

filename: input variable with filename to write to.

Write EncAPRepPart to file in specified TYPE. The file will be truncated if it exists.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_parse** (`Shishi * handle, FILE * fh, Shishi_asn1 * encapreppart`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

encapreppart: output variable with newly allocated EncAPRepPart.

Read ASCII armored DER encoded EncAPRepPart from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_read** (`Shishi * handle, FILE * fh, Shishi_asn1 * encapreppart`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

encapreppart: output variable with newly allocated EncAPRepPart.

Read DER encoded EncAPRepPart from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_from_file** (`Shishi * handle, Shishi_asn1 * encapreppart, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encapreppart: output variable with newly allocated EncAPRepPart.

filetype: input variable specifying type of file to be read, see Shishi_filetype.

filename: input variable with filename to read from.

Read EncAPRepPart from file in specified TYPE.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_get_key** (`Shishi * handle, Shishi_asn1 encapreppart, int32_t * keytype, char * keyvalue, size_t * keyvalue_len`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encapreppart: input EncAPRepPart variable.

keytype: output variable that holds key type.

keyvalue: output array with key.

keyvalue_len: on input, maximum size of output array with key, on output, holds the actual size of output array with key.

Extract the subkey from the encrypted AP-REP part.

Returns SHISHI_OK iff succesful.

`int` **shishi_encapreppart_ctime_set** (`Shishi * handle, Shishi_asn1 encapreppart, char * ctime`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encapreppart: EncAPRepPart as allocated by `shishi_encapreppart()`.

ctime: string with generalized time value to store in EncAPRepPart.

Store client time in EncAPRepPart.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_cusec_get** (`Shishi * handle, Shishi_asn1 encapreppart, int * cusec`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encapreppart: EncAPRepPart as allocated by `shishi_encapreppart()`.

cusec: output integer with client microseconds field.

Extract client microseconds field from EncAPRepPart.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_cusec_set** (`Shishi * handle, Shishi_asn1 encapreppart, int cusec`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encapreppart: EncAPRepPart as allocated by `shishi_encapreppart()`.

cusec: client microseconds to set in authenticator, 0-999999.

Set the cusec field in the Authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_encapreppart_seqnumber_get** (`Shishi * handle, Shishi_asn1 encapreppart, uint32_t * seqnumber`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encapreppart: EncAPRepPart as allocated by `shishi_encapreppart()`.

seqnumber: output integer with sequence number field.

Extract sequence number field from EncAPRepPart.

Returns SHISHI_OK iff successful.

4.5 SAFE and PRIV Functions

The "KRB-SAFE" is an ASN.1 structure used by application client and servers to exchange integrity protected data. The integrity protection is keyed, usually with a key agreed on via the AP exchange (see Section 4.4 [AP-REQ and AP-REP Functions], page 22). The following illustrates the KRB-SAFE ASN.1 structure.

```
KRB-SAFE        ::= [APPLICATION 20] SEQUENCE {
        pvno            [0] INTEGER (5),
        msg-type        [1] INTEGER (20),
        safe-body       [2] KRB-SAFE-BODY,
        cksum           [3] Checksum
}

KRB-SAFE-BODY   ::= SEQUENCE {
        user-data       [0] OCTET STRING,
        timestamp       [1] KerberosTime OPTIONAL,
        usec            [2] Microseconds OPTIONAL,
        seq-number      [3] UInt32 OPTIONAL,
        s-address       [4] HostAddress,
        r-address       [5] HostAddress OPTIONAL
}
```

`int` **shishi_safe** (`Shishi *` *handle*, `Shishi_safe **` *safe*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

safe: pointer to new structure that holds information about SAFE exchange

Create a new SAFE exchange.

Returns SHISHI_OK iff successful.

`Shishi_key *` **shishi_safe_key** (`Shishi_safe *` *safe*) [Function]

Returns the key used in the SAFE exchange, or NULL if not yet set or an error occured.

`void` **shishi_safe_key_set** (`Shishi_safe *` *safe*, `Shishi_key *` *key*) [Function]

safe: structure that holds information about SAFE exchange

key: key to store in SAFE.

Set the Key in the SAFE exchange.

`Shishi_asn1` **shishi_safe_safe** (`Shishi_safe *` *safe*) [Function]

Returns the ASN.1 safe in the SAFE exchange, or NULL if not yet set or an error occured.

`void` **shishi_safe_safe_set** (`Shishi_safe *` *safe*, `Shishi_asn1` *asn1safe*) [Function]

safe: KRB-SAFE to store in SAFE exchange.

Set the KRB-SAFE in the SAFE exchange.

`int` **shishi_safe_safe_der** (`Shishi_safe * safe, char * out, int * outlen`) [Function]

safe: safe as allocated by `shishi_safe()`.

out: output array with der encoding of SAFE.

outlen: length of output array with der encoding of SAFE.

DER encode SAFE structure. Typically `shishi_safe_build()` is used instead to build the SAFE structure first.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_safe_der_set** (`Shishi_safe * safe, char * der, size_t derlen`) [Function]

safe: safe as allocated by `shishi_safe()`.

der: input array with DER encoded KRB-SAFE.

derlen: length of input array with DER encoded KRB-SAFE.

DER decode KRB-SAFE and set it SAFE exchange. If decoding fails, the KRB-SAFE in the SAFE exchange remains.

Returns SHISHI_OK.

`int` **shishi_safe_print** (`Shishi * handle, FILE * fh, Shishi_asn1 safe`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

safe: SAFE to print.

Print ASCII armored DER encoding of SAFE to file.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_save** (`Shishi * handle, FILE * fh, Shishi_asn1 safe`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

safe: SAFE to save.

Save DER encoding of SAFE to file.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_to_file** (`Shishi * handle, Shishi_asn1 safe, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

safe: SAFE to save.

filetype: input variable specifying type of file to be written, see Shishi_filetype.

filename: input variable with filename to write to.

Write SAFE to file in specified TYPE. The file will be truncated if it exists.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_parse** (`Shishi * handle, FILE * fh, Shishi_asn1 * safe`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

safe: output variable with newly allocated SAFE.

Read ASCII armored DER encoded SAFE from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_read** (`Shishi * handle, FILE * fh, Shishi_asn1 * safe`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

safe: output variable with newly allocated SAFE.

Read DER encoded SAFE from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_from_file** (`Shishi * handle, Shishi_asn1 * safe, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

safe: output variable with newly allocated SAFE.

filetype: input variable specifying type of file to be read, see Shishi_filetype.

filename: input variable with filename to read from.

Read SAFE from file in specified TYPE.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_cksum** (`Shishi * handle, Shishi_asn1 safe, int32_t * cksumtype, char * cksum, size_t * cksumlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

safe: safe as allocated by `shishi_safe()`.

cksumtype: output checksum type.

cksum: output checksum data from SAFE.

cksumlen: on input, maximum size of output checksum data buffer, on output, actual size of output checksum data buffer.

Read checksum value from KRB-SAFE.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_set_cksum** (`Shishi * handle, Shishi_asn1 safe, int32_t cksumtype, char * cksum, size_t cksumlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

safe: safe as allocated by `shishi_safe()`.

cksumtype: input checksum type to store in SAFE.

cksum: input checksum data to store in SAFE.

cksumlen: size of input checksum data to store in SAFE.

Store checksum value in SAFE. A checksum is usually created by calling `shishi_checksum()` on some application specific data using the key from the ticket that is being used. To save time, you may want to use `shishi_safe_build()` instead, which calculates the checksum and calls this function in one step.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_user_data** (`Shishi * handle, Shishi_asn1 safe, char * userdata, size_t * userdatalen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

safe: safe as allocated by `shishi_safe()`.

userdata: output user data from KRB-SAFE.

userdatalen: on input, maximum size of output user data buffer, on output, actual size of output user data buffer.

Read user data value from KRB-SAFE.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_set_user_data** (`Shishi * handle, Shishi_asn1 safe, char * userdata, size_t userdatalen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

safe: safe as allocated by `shishi_safe()`.

userdata: input user application to store in SAFE.

userdatalen: size of input user application to store in SAFE.

Set the application data in SAFE.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_build** (`Shishi_safe * safe, Shishi_key * key`) [Function]

safe: safe as allocated by `shishi_safe()`.

key: key for session, used to compute checksum.

Build checksum and set it in KRB-SAFE. Note that this follows RFC 1510bis and is incompatible with RFC 1510, although presumably few implementations use the RFC1510 algorithm.

Returns SHISHI_OK iff successful.

`int` **shishi_safe_verify** (`Shishi_safe * safe, Shishi_key * key`) [Function]

safe: safe as allocated by `shishi_safe()`.

key: key for session, used to verify checksum.

Verify checksum in KRB-SAFE. Note that this follows RFC 1510bis and is incompatible with RFC 1510, although presumably few implementations use the RFC1510 algorithm.

Returns SHISHI_OK iff successful, SHISHI_SAFE_BAD_KEYTYPE if an incompatible key type is used, or SHISHI_SAFE_VERIFY_FAILED if the actual verification failed.

The "KRB-PRIV" is an ASN.1 structure used by application client and servers to exchange confidential data. The confidentiality is keyed, usually with a key agreed on via the AP exchange (see Section 4.4 [AP-REQ and AP-REP Functions], page 22). The following illustrates the KRB-PRIV ASN.1 structure.

```
KRB-PRIV        ::= [APPLICATION 21] SEQUENCE {
        pvno            [0] INTEGER (5),
        msg-type        [1] INTEGER (21),
                        -- NOTE: there is no [2] tag
        enc-part        [3] EncryptedData -- EncKrbPrivPart
}

EncKrbPrivPart  ::= [APPLICATION 28] SEQUENCE {
        user-data       [0] OCTET STRING,
        timestamp       [1] KerberosTime OPTIONAL,
        usec            [2] Microseconds OPTIONAL,
        seq-number      [3] UInt32 OPTIONAL,
        s-address       [4] HostAddress -- sender's addr --,
        r-address       [5] HostAddress OPTIONAL -- recip's addr
}
```

4.6 Ticket Functions

`int` **shishi_tkt_client** (`Shishi_tkt *` *tkt*, `char *` *client*, `int *` *clientlen*) [Function]

client: output buffer that holds client name of ticket.

clientlen: on input, maximum size of output buffer, on output, actual size of output buffer.

Returns client principal of ticket.

`Shishi_asn1` **shishi_tkt_ticket** (`Shishi_tkt *` *tkt*) [Function]

tkt: input variable with ticket info.

Returns actual ticket.

`Shishi_asn1` **shishi_tkt_enckdcreppart** (`Shishi_tkt *` *tkt*) [Function]

tkt: input variable with ticket info.

Returns auxilliary ticket information.

`void` **shishi_tkt_enckdcreppart_set** (`Shishi_tkt *` *tkt*, `Shishi_asn1` *enckdcreppart*) [Function]

enckdcreppart: EncKDCRepPart to store in Ticket.

Set the EncKDCRepPart in the Ticket.

`Shishi_asn1` **shishi_tkt_kdcrep** (`Shishi_tkt *` *tkt*) [Function]

tkt: input variable with ticket info.

Returns KDC-REP information.

`Shishi_asn1` **shishi_tkt_encticketpart** (`Shishi_tkt * tkt`) [Function]
tkt: input variable with ticket info.
Returns EncTicketPart information.

`void` **shishi_tkt_encticketpart_set** (`Shishi_tkt * tkt, Shishi_asn1 encticketpart`) [Function]
tkt: input variable with ticket info.
encticketpart: encticketpart to store in ticket.
Set the EncTicketPart in the Ticket.

`Shishi_key *` **shishi_tkt_key** (`Shishi_tkt * tkt`) [Function]
tkt: input variable with ticket info.
Returns key extracted from enckdcreppart.

`int` **shishi_tkt_key_set** (`Shishi_tkt * tkt, Shishi_key * key`) [Function]
tkt: input variable with ticket info.
key: key to store in ticket.
Set the key in the EncTicketPart.
Returns SHISHI_OK iff successful.

`Shishi_tkt *` **shishi_tkt2** (`Shishi * handle, Shishi_asn1 ticket, Shishi_asn1 enckdcreppart, Shishi_asn1 kdcrep`) [Function]
handle: shishi handle as allocated by `shishi_init()`.
ticket: input variable with ticket.
enckdcreppart: input variable with auxilliary ticket information.
kdcrep: input variable with KDC-REP ticket information.
Create a new ticket handle.
Returns new ticket handle, or *NULL* on error.

`int` **shishi_tkt** (`Shishi * handle, Shishi_tkt ** tkt`) [Function]
handle: shishi handle as allocated by `shishi_init()`.
tkt: output variable with newly allocated ticket.
Create a new ticket handle.
Returns SHISHI_OK iff successful.

4.7 AS Functions

The Authentication Service (AS) is used to get an initial ticket using e.g. your password. The following illustrates the AS-REQ and AS-REP ASN.1 structures.

```
-- Request --

AS-REQ          ::= KDC-REQ {10}

KDC-REQ {INTEGER:tagnum}        ::= [APPLICATION tagnum] SEQUENCE {
```

```
        pvno            [1] INTEGER (5) -- first tag is [1], not [0] --,
        msg-type        [2] INTEGER (tagnum),
        padata          [3] SEQUENCE OF PA-DATA OPTIONAL,
        req-body        [4] KDC-REQ-BODY
}

KDC-REQ-BODY    ::= SEQUENCE {
        kdc-options             [0] KDCOptions,
        cname                   [1] PrincipalName OPTIONAL
                                    -- Used only in AS-REQ --,
        realm                   [2] Realm
                                    -- Server's realm
                                    -- Also client's in AS-REQ --,
        sname                   [3] PrincipalName OPTIONAL,
        from                    [4] KerberosTime OPTIONAL,
        till                    [5] KerberosTime,
        rtime                   [6] KerberosTime OPTIONAL,
        nonce                   [7] UInt32,
        etype                   [8] SEQUENCE OF Int32 -- EncryptionType
                                    -- in preference order --,
        addresses               [9] HostAddresses OPTIONAL,
        enc-authorization-data  [10] EncryptedData {
                                        AuthorizationData,
                                        { keyuse-TGSReqAuthData-sesskey
                                          | keyuse-TGSReqAuthData-subkey }
                                    } OPTIONAL,
        additional-tickets      [11] SEQUENCE OF Ticket OPTIONAL
}

-- Reply --

AS-REP          ::= KDC-REP {11, EncASRepPart, {keyuse-EncASRepPart}}

KDC-REP {INTEGER:tagnum,
         TypeToEncrypt,
         UInt32:KeyUsages}      ::= [APPLICATION tagnum] SEQUENCE {
        pvno            [0] INTEGER (5),
        msg-type        [1] INTEGER (tagnum),
        padata          [2] SEQUENCE OF PA-DATA OPTIONAL,
        crealm          [3] Realm,
        cname           [4] PrincipalName,
        ticket          [5] Ticket,
        enc-part        [6] EncryptedData {TypeToEncrypt, KeyUsages}
}

EncASRepPart    ::= [APPLICATION 25] EncKDCRepPart
```

```
EncKDCRepPart   ::= SEQUENCE {
        key             [0] EncryptionKey,
        last-req        [1] LastReq,
        nonce           [2] UInt32,
        key-expiration  [3] KerberosTime OPTIONAL,
        flags           [4] TicketFlags,
        authtime        [5] KerberosTime,
        starttime       [6] KerberosTime OPTIONAL,
        endtime         [7] KerberosTime,
        renew-till      [8] KerberosTime OPTIONAL,
        srealm          [9] Realm,
        sname           [10] PrincipalName,
        caddr           [11] HostAddresses OPTIONAL
}
```

`int` **shishi_as** (`Shishi * handle, Shishi_as ** as`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

as: holds pointer to newly allocate Shishi_as structure.

Allocate a new AS exchange variable.

Returns SHISHI_OK iff successful.

`Shishi_asn1` **shishi_as_req** (`Shishi_as * as`) [Function]

as: structure that holds information about AS exchange

Returns the generated AS-REQ packet from the AS exchange, or NULL if not yet set or an error occured.

`int` **shishi_as_req_build** (`Shishi_as * as`) [Function]

as: structure that holds information about AS exchange

Possibly remove unset fields (e.g., rtime).

Returns SHISHI_OK iff successful.

`void` **shishi_as_req_set** (`Shishi_as * as, Shishi_asn1 asreq`) [Function]

as: structure that holds information about AS exchange

asreq: asreq to store in AS.

Set the AS-REQ in the AP exchange.

`int` **shishi_as_req_der** (`Shishi_as * as, char * out, int * outlen`) [Function]

as: structure that holds information about AS exchange

out: output array with der encoding of AS-REQ.

outlen: length of output array with der encoding of AS-REQ.

DER encode AS-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_as_req_der_set** (`Shishi_as * as, char * der, size_t derlen`) [Function]

as: structure that holds information about AS exchange

der: input array with DER encoded AP-REQ.

derlen: length of input array with DER encoded AP-REQ.

DER decode AS-REQ and set it AS exchange. If decoding fails, the AS-REQ in the AS exchange remains.

Returns SHISHI_OK.

`Shishi_asn1` **shishi_as_rep** (`Shishi_as * as`) [Function]

as: structure that holds information about AS exchange

Returns the received AS-REP packet from the AS exchange, or NULL if not yet set or an error occured.

`int` **shishi_as_rep_process** (`Shishi_as * as, Shishi_key * key, const char * password`) [Function]

as: structure that holds information about AS exchange

Process new AS-REP and set ticket. The key is used to decrypt the AP-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_as_rep_build** (`Shishi_as * as, Shishi_key * key`) [Function]

as: structure that holds information about AS exchange

key: user's key, used to encrypt the encrypted part of the AS-REP.

Build AS-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_as_rep_der** (`Shishi_as * as, char * out, int * outlen`) [Function]

as: structure that holds information about AS exchange

out: output array with der encoding of AS-REP.

outlen: length of output array with der encoding of AS-REP.

DER encode AS-REP.

Returns SHISHI_OK iff successful.

`void` **shishi_as_rep_set** (`Shishi_as * as, Shishi_asn1 asrep`) [Function]

as: structure that holds information about AS exchange

asrep: asrep to store in AS.

Set the AS-REP in the AP exchange.

`int` **shishi_as_rep_der_set** (`Shishi_as * as, char * der, size_t derlen`) [Function]

as: structure that holds information about AS exchange

der: input array with DER encoded AP-REP.

derlen: length of input array with DER encoded AP-REP.

DER decode AS-REP and set it AS exchange. If decoding fails, the AS-REP in the AS exchange remains.

Returns SHISHI_OK.

`Shishi_asn1` **shishi_as_krberror** (`Shishi_as * as`) [Function]

as: structure that holds information about AS exchange

Returns the received KRB-ERROR packet from the AS exchange, or NULL if not yet set or an error occured.

`int` **shishi_as_krberror_der** (`Shishi_as * as, char * out, int * outlen`) [Function]

as: structure that holds information about AS exchange

out: output array with der encoding of KRB-ERROR.

outlen: length of output array with der encoding of KRB-ERROR.

DER encode KRB-ERROR.

Returns SHISHI_OK iff successful.

`void` **shishi_as_krberror_set** (`Shishi_as * as, Shishi_asn1 krberror`) [Function]

as: structure that holds information about AS exchange

krberror: krberror to store in AS.

Set the KRB-ERROR in the AP exchange.

`Shishi_tkt *` **shishi_as_tkt** (`Shishi_as * as`) [Function]

as: structure that holds information about AS exchange

Returns the newly aquired tkt from the AS exchange, or NULL if not yet set or an error occured.

`void` **shishi_as_tkt_set** (`Shishi_as * as, Shishi_tkt * tkt`) [Function]

as: structure that holds information about AS exchange

tkt: tkt to store in AS.

Set the Tkt in the AP exchange.

`int` **shishi_as_sendrecv** (`Shishi_as * as`) [Function]

as: structure that holds information about AS exchange

Send AS-REQ and receive AS-REP or KRB-ERROR. This is the initial authentication, usually used to acquire a Ticket Granting Ticket.

Returns SHISHI_OK iff successful.

4.8 TGS Functions

The Ticket Granting Service (TGS) is used to get subsequent tickets, authenticated by other tickets (so called ticket granting tickets). The following illustrates the TGS-REQ and TGS-REP ASN.1 structures.

```
-- Request --

TGS-REQ          ::= KDC-REQ {12}

KDC-REQ {INTEGER:tagnum}         ::= [APPLICATION tagnum] SEQUENCE {
```

```
        pvno            [1] INTEGER (5) -- first tag is [1], not [0] --,
        msg-type        [2] INTEGER (tagnum),
        padata          [3] SEQUENCE OF PA-DATA OPTIONAL,
        req-body        [4] KDC-REQ-BODY
}

KDC-REQ-BODY    ::= SEQUENCE {
        kdc-options             [0] KDCOptions,
        cname                   [1] PrincipalName OPTIONAL
                                    -- Used only in AS-REQ --,
        realm                   [2] Realm
                                    -- Server's realm
                                    -- Also client's in AS-REQ --,
        sname                   [3] PrincipalName OPTIONAL,
        from                    [4] KerberosTime OPTIONAL,
        till                    [5] KerberosTime,
        rtime                   [6] KerberosTime OPTIONAL,
        nonce                   [7] UInt32,
        etype                   [8] SEQUENCE OF Int32 -- EncryptionType
                                    -- in preference order --,
        addresses               [9] HostAddresses OPTIONAL,
        enc-authorization-data  [10] EncryptedData {
                                        AuthorizationData,
                                        { keyuse-TGSReqAuthData-sesskey
                                          | keyuse-TGSReqAuthData-subkey }
                                    } OPTIONAL,
        additional-tickets      [11] SEQUENCE OF Ticket OPTIONAL
}

-- Reply --

TGS-REP         ::= KDC-REP {13, EncTGSRepPart,
                        { keyuse-EncTGSRepPart-sesskey
                          | keyuse-EncTGSRepPart-subkey }}

KDC-REP {INTEGER:tagnum,
         TypeToEncrypt,
         UInt32:KeyUsages}      ::= [APPLICATION tagnum] SEQUENCE {
        pvno            [0] INTEGER (5),
        msg-type        [1] INTEGER (tagnum),
        padata          [2] SEQUENCE OF PA-DATA OPTIONAL,
        crealm          [3] Realm,
        cname           [4] PrincipalName,
        ticket          [5] Ticket,
        enc-part        [6] EncryptedData {TypeToEncrypt, KeyUsages}
}
```

```
EncTGSRepPart   ::= [APPLICATION 26] EncKDCRepPart

EncKDCRepPart   ::= SEQUENCE {
        key             [0] EncryptionKey,
        last-req        [1] LastReq,
        nonce           [2] UInt32,
        key-expiration  [3] KerberosTime OPTIONAL,
        flags           [4] TicketFlags,
        authtime        [5] KerberosTime,
        starttime       [6] KerberosTime OPTIONAL,
        endtime         [7] KerberosTime,
        renew-till      [8] KerberosTime OPTIONAL,
        srealm          [9] Realm,
        sname           [10] PrincipalName,
        caddr           [11] HostAddresses OPTIONAL
}
```

`int` **shishi_tgs** (`Shishi *` *handle*, `Shishi_tgs **` *tgs*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

tgs: holds pointer to newly allocate Shishi_tgs structure.

Allocate a new TGS exchange variable.

Returns SHISHI_OK iff successful.

`Shishi_tkt *` **shishi_tgs_tgtkt** (`Shishi_tgs *` *tgs*) [Function]

tgs: structure that holds information about TGS exchange

Returns the ticket-granting-ticket used in the TGS exchange, or NULL if not yet set or an error occured.

`void` **shishi_tgs_tgtkt_set** (`Shishi_tgs *` *tgs*, `Shishi_tkt *` *tgtkt*) [Function]

tgs: structure that holds information about TGS exchange

tgtkt: ticket granting ticket to store in TGS.

Set the Ticket in the AP exchange.

`Shishi_ap *` **shishi_tgs_ap** (`Shishi_tgs *` *tgs*) [Function]

tgs: structure that holds information about TGS exchange

Returns the AP exchange (part of TGS-REQ) from the TGS exchange, or NULL if not yet set or an error occured.

`Shishi_asn1` **shishi_tgs_req** (`Shishi_tgs *` *tgs*) [Function]

tgs: structure that holds information about TGS exchange

Returns the generated TGS-REQ from the TGS exchange, or NULL if not yet set or an error occured.

`int` **shishi_tgs_req_build** (`Shishi_tgs *` *tgs*) [Function]

tgs: structure that holds information about TGS exchange

Checksum data in authenticator and add ticket and authenticator to TGS-REQ.

Returns SHISHI_OK iff successful.

`Shishi_asn1` **shishi_tgs_rep** (`Shishi_tgs * tgs`) [Function]
tgs: structure that holds information about TGS exchange

Returns the received TGS-REP from the TGS exchange, or NULL if not yet set or an error occured.

`int` **shishi_tgs_rep_process** (`Shishi_tgs * tgs`) [Function]
tgs: structure that holds information about TGS exchange

Process new TGS-REP and set ticket. The key to decrypt the TGS-REP is taken from the EncKDCRepPart of the TGS tgticket.

Returns SHISHI_OK iff successful.

`Shishi_asn1` **shishi_tgs_krberror** (`Shishi_tgs * tgs`) [Function]
tgs: structure that holds information about TGS exchange

Returns the received TGS-REP from the TGS exchange, or NULL if not yet set or an error occured.

`Shishi_tkt *` **shishi_tgs_tkt** (`Shishi_tgs * tgs`) [Function]
tgs: structure that holds information about TGS exchange

Returns the newly aquired ticket from the TGS exchange, or NULL if not yet set or an error occured.

`void` **shishi_tgs_tkt_set** (`Shishi_tgs * tgs, Shishi_tkt * tkt`) [Function]
tgs: structure that holds information about TGS exchange

tkt: ticket to store in TGS.

Set the Ticket in the AP exchange.

`int` **shishi_tgs_sendrecv** (`Shishi_tgs * tgs`) [Function]
tgs: structure that holds information about TGS exchange

Send TGS-REQ and receive TGS-REP or KRB-ERROR. This is the subsequent authentication, usually used to acquire server tickets.

Returns SHISHI_OK iff successful.

`int` **shishi_tgs_set_server** (`Shishi_tgs * tgs, const char * server`) [Function]
tgs: structure that holds information about TGS exchange

server: indicates the server to acquire ticket for.

Set the server in the TGS-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_tgs_set_realm** (`Shishi_tgs * tgs, const char * realm`) [Function]
tgs: structure that holds information about TGS exchange

realm: indicates the realm to acquire ticket for.

Set the server in the TGS-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_tgs_set_realmserver** (`Shishi_tgs * tgs, const char * realm, const char * server`) [Function]

tgs: structure that holds information about TGS exchange

realm: indicates the realm to acquire ticket for.

server: indicates the server to acquire ticket for.

Set the realm and server in the TGS-REQ.

Returns SHISHI_OK iff successful.

4.9 Ticket (ASN.1) Functions

`int` **shishi_ticket_realm_set** (`Shishi * handle, Shishi_asn1 ticket, const char * realm`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ticket: input variable with ticket info.

realm: input array with name of realm.

Set the realm field in the Ticket.

Returns SHISHI_OK iff successful.

`int` **shishi_ticket_sname_set** (`Shishi * handle, Shishi_asn1 ticket, Shishi_name_type name_type, char * sname[]`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ticket: Ticket variable to set server name field in.

name_type: type of principial, see Shishi_name_type, usually SHISHI_NT_UNKNOWN.

Set the server name field in the Ticket.

Returns SHISHI_OK iff successful.

`int` **shishi_ticket_get_enc_part_etype** (`Shishi * handle, Shishi_asn1 ticket, int32_t * etype`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

etype: output variable that holds the value.

Extract Ticket.enc-part.etype.

Returns SHISHI_OK iff successful.

`int` **shishi_ticket_set_enc_part** (`Shishi * handle, Shishi_asn1 ticket, int etype, int kvno, char * buf, size_t buflen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ticket: Ticket to add enc-part field to.

etype: encryption type used to encrypt enc-part.

kvno: key version number.

buf: input array with encrypted enc-part.

buflen: size of input array with encrypted enc-part.

Set the encrypted enc-part field in the Ticket. The encrypted data is usually created by calling `shishi_encrypt()` on the DER encoded enc-part. To save time, you may

want to use `shishi_ticket_add_enc_part()` instead, which calculates the encrypted data and calls this function in one step.

Returns SHISHI_OK iff successful.

`int` **shishi_ticket_add_enc_part** (`Shishi *` *handle*, `Shishi_asn1` *ticket*, `Shishi_key *` *key*, `Shishi_asn1` *encticketpart*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

ticket: Ticket to add enc-part field to.

key: key used to encrypt enc-part.

encticketpart: EncTicketPart to add.

Encrypts DER encoded EncTicketPart using key and stores it in the Ticket.

Returns SHISHI_OK iff successful.

4.10 AS/TGS Functions

The Authentication Service (AS) is used to get an initial ticket using e.g. your password. The Ticket Granting Service (TGS) is used to get subsequent tickets using other tickets. Protocol wise the procedures are very similar, which is the reason they are described together. The following illustrates the AS-REQ, TGS-REQ and AS-REP, TGS-REP ASN.1 structures. Most of the functions use the mnemonic "KDC" instead of either AS or TGS, which means the function operates on both AS and TGS types. Only where the distinction between AS and TGS is important are the AS and TGS names used. Remember, these are low-level functions, and normal applications will likely be satisfied with the AS (see Section 4.7 [AS Functions], page 39) and TGS (see Section 4.8 [TGS Functions], page 43) interfaces, or the even more high-level Ticket Set (see Section 4.3 [Ticket Set Functions], page 18) interface.

```
-- Request --

AS-REQ          ::= KDC-REQ {10}
TGS-REQ         ::= KDC-REQ {12}

KDC-REQ {INTEGER:tagnum}        ::= [APPLICATION tagnum] SEQUENCE {
        pvno            [1] INTEGER (5) -- first tag is [1], not [0] --,
        msg-type        [2] INTEGER (tagnum),
        padata          [3] SEQUENCE OF PA-DATA OPTIONAL,
        req-body        [4] KDC-REQ-BODY
}

KDC-REQ-BODY    ::= SEQUENCE {
        kdc-options             [0] KDCOptions,
        cname                   [1] PrincipalName OPTIONAL
                                    -- Used only in AS-REQ --,
        realm                   [2] Realm
                                    -- Server's realm
                                    -- Also client's in AS-REQ --,
```

```
        sname                   [3] PrincipalName OPTIONAL,
        from                    [4] KerberosTime OPTIONAL,
        till                    [5] KerberosTime,
        rtime                   [6] KerberosTime OPTIONAL,
        nonce                   [7] UInt32,
        etype                   [8] SEQUENCE OF Int32 -- EncryptionType
                                    -- in preference order --,
        addresses               [9] HostAddresses OPTIONAL,
        enc-authorization-data  [10] EncryptedData {
                                        AuthorizationData,
                                        { keyuse-TGSReqAuthData-sesskey
                                          | keyuse-TGSReqAuthData-subkey }
                                     } OPTIONAL,
        additional-tickets      [11] SEQUENCE OF Ticket OPTIONAL
}

-- Reply --

AS-REP          ::= KDC-REP {11, EncASRepPart, {keyuse-EncASRepPart}}
TGS-REP         ::= KDC-REP {13, EncTGSRepPart,
                        { keyuse-EncTGSRepPart-sesskey
                          | keyuse-EncTGSRepPart-subkey }}

KDC-REP {INTEGER:tagnum,
         TypeToEncrypt,
         UInt32:KeyUsages}      ::= [APPLICATION tagnum] SEQUENCE {
        pvno            [0] INTEGER (5),
        msg-type        [1] INTEGER (tagnum),
        padata          [2] SEQUENCE OF PA-DATA OPTIONAL,
        crealm          [3] Realm,
        cname           [4] PrincipalName,
        ticket          [5] Ticket,
        enc-part        [6] EncryptedData {TypeToEncrypt, KeyUsages}
}

EncASRepPart    ::= [APPLICATION 25] EncKDCRepPart
EncTGSRepPart   ::= [APPLICATION 26] EncKDCRepPart

EncKDCRepPart   ::= SEQUENCE {
        key             [0] EncryptionKey,
        last-req        [1] LastReq,
        nonce           [2] UInt32,
        key-expiration  [3] KerberosTime OPTIONAL,
        flags           [4] TicketFlags,
        authtime        [5] KerberosTime,
        starttime       [6] KerberosTime OPTIONAL,
        endtime         [7] KerberosTime,
```

```
        renew-till      [8] KerberosTime OPTIONAL,
        srealm          [9] Realm,
        sname           [10] PrincipalName,
        caddr           [11] HostAddresses OPTIONAL
}
```

`int` **shishi_as_derive_salt** (`Shishi *` *handle*, `Shishi_asn1` *asreq*, `Shishi_asn1` *asrep*, `char *` *salt*, `size_t *` *saltlen*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

asrep: input AS-REP variable.

salt: output array with salt.

saltlen: on input, maximum size of output array with salt, on output, holds actual size of output array with salt.

Derive the salt that should be used when deriving a key via `shishi_string_to_key()` for an AS exchange. Currently this searches for PA-DATA of type SHISHI_PA_PW_SALT in the AS-REP and returns it if found, otherwise the salt is derived from the client name and realm in AS-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_kdc_copy_crealm** (`Shishi *` *handle*, `Shishi_asn1` *kdcrep*, `Shishi_asn1` *encticketpart*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encticketpart: EncTicketPart to set crealm in.

Set crealm in KDC-REP to value in EncTicketPart.

Returns SHISHI_OK if successful.

`int` **shishi_as_check_crealm** (`Shishi *` *handle*, `Shishi_asn1` *asreq*, `Shishi_asn1` *asrep*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

Verify that AS-REQ.req-body.realm and AS-REP.crealm fields matches. This is one of the steps that has to be performed when processing a AS-REQ and AS-REP exchange, see `shishi_kdc_process()`.

Returns SHISHI_OK if successful, SHISHI_REALM_MISMATCH if the values differ, or an error code.

`int` **shishi_kdc_copy_cname** (`Shishi *` *handle*, `Shishi_asn1` *kdcrep*, `Shishi_asn1` *encticketpart*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

encticketpart: EncTicketPart to set cname in.

Set cname in KDC-REP to value in EncTicketPart.

Returns SHISHI_OK if successful.

`int` **shishi_as_check_cname** (`Shishi *` *handle*, `Shishi_asn1` *asreq*, `Shishi_asn1` *asrep*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

Verify that AS-REQ.req-body.realm and AS-REP.crealm fields matches. This is one of the steps that has to be performed when processing a AS-REQ and AS-REP exchange, see `shishi_kdc_process()`.

Returns SHISHI_OK if successful, SHISHI_CNAME_MISMATCH if the values differ, or an error code.

`int` **shishi_kdc_copy_nonce** (`Shishi *` *handle*, `Shishi_asn1` *kdcreq*, `Shishi_asn1` *enckdcreppart*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ to read nonce from.

enckdcreppart: EncKDCRepPart to set nonce in.

Set nonce in EncKDCRepPart to value in KDC-REQ.

Returns SHISHI_OK if successful.

`int` **shishi_kdc_check_nonce** (`Shishi *` *handle*, `Shishi_asn1` *kdcreq*, `Shishi_asn1` *enckdcreppart*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ to compare nonce field in.

enckdcreppart: Encrypted KDC-REP part to compare nonce field in.

Verify that KDC-REQ.req-body.nonce and EncKDCRepPart.nonce fields matches. This is one of the steps that has to be performed when processing a KDC-REQ and KDC-REP exchange.

Returns SHISHI_OK if successful, SHISHI_NONCE_LENGTH_MISMATCH if the nonces have different lengths (usually indicates that buggy server truncated nonce to 4 bytes), SHISHI_NONCE_MISMATCH if the values differ, or an error code.

`int` **shishi_tgs_process** (`Shishi *` *handle*, `Shishi_asn1` *tgsreq*, `Shishi_asn1` *tgsrep*, `Shishi_asn1` *oldenckdcreppart*, `Shishi_asn1 *` *enckdcreppart*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

oldenckdcreppart: input variable with EncKDCRepPart used in request.

enckdcreppart: output variable that holds new EncKDCRepPart.

Process a TGS client exchange and output decrypted EncKDCRepPart which holds details for the new ticket received. This function simply derives the encryption key from the ticket used to construct the TGS request and calls `shishi_kdc_process()`, which see.

Returns SHISHI_OK iff the TGS client exchange was successful.

`int` **shishi_as_process** (`Shishi *` *handle*, `Shishi_asn1` *asreq*, `Shishi_asn1` *asrep*, `const char *` *string*, `Shishi_asn1 *` *enckdcreppart*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

string: input variable with zero terminated password.

enckdcreppart: output variable that holds new EncKDCRepPart.

Process an AS client exchange and output decrypted EncKDCRepPart which holds details for the new ticket received. This function simply derives the encryption key from the password and calls `shishi_kdc_process()`, which see.

Returns SHISHI_OK iff the AS client exchange was successful.

`int` **shishi_kdc_process** (`Shishi * handle, Shishi_asn1 kdcreq, Shishi_asn1 kdcrep, Shishi_key * key, int keyusage, Shishi_asn1 * enckdcreppart`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: input variable that holds the sent KDC-REQ.

kdcrep: input variable that holds the received KDC-REP.

key: input array with key to decrypt encrypted part of KDC-REP with.

enckdcreppart: output variable that holds new EncKDCRepPart.

Process a KDC client exchange and output decrypted EncKDCRepPart which holds details for the new ticket received. Use `shishi_kdcrep_get_ticket()` to extract the ticket. This function verifies the various conditions that must hold if the response is to be considered valid, specifically it compares nonces (`shishi_check_nonces()`) and if the exchange was a AS exchange, it also compares cname and crealm (`shishi_check_cname()` and `shishi_check_crealm()`).

Usually the `shishi_as_process()` and `shishi_tgs_process()` functions should be used instead, since they simplify the decryption key computation.

Returns SHISHI_OK iff the KDC client exchange was successful.

`Shishi_asn1` **shishi_asreq** (`Shishi * handle`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

This function creates a new AS-REQ, populated with some default values.

Returns the AS-REQ or NULL on failure.

`Shishi_asn1` **shishi_tgsreq** (`Shishi * handle`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

This function creates a new TGS-REQ, populated with some default values.

Returns the TGS-REQ or NULL on failure.

`int` **shishi_kdcreq_print** (`Shishi * handle, FILE * fh, Shishi_asn1 kdcreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

kdcreq: KDC-REQ to print.

Print ASCII armored DER encoding of KDC-REQ to file.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_save** (`Shishi * handle, FILE * fh, Shishi_asn1 kdcreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

kdcreq: KDC-REQ to save.

Print DER encoding of KDC-REQ to file.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_to_file** (`Shishi * handle, Shishi_asn1 kdcreq, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ to save.

filetype: input variable specifying type of file to be written, see Shishi_filetype.

filename: input variable with filename to write to.

Write KDC-REQ to file in specified TYPE. The file will be truncated if it exists.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_parse** (`Shishi * handle, FILE * fh, Shishi_asn1 * kdcreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

kdcreq: output variable with newly allocated KDC-REQ.

Read ASCII armored DER encoded KDC-REQ from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_read** (`Shishi * handle, FILE * fh, Shishi_asn1 * kdcreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

kdcreq: output variable with newly allocated KDC-REQ.

Read DER encoded KDC-REQ from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_from_file** (`Shishi * handle, Shishi_asn1 * kdcreq, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: output variable with newly allocated KDC-REQ.

filetype: input variable specifying type of file to be read, see Shishi_filetype.

filename: input variable with filename to read from.

Read KDC-REQ from file in specified TYPE.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_set_cname** (`Shishi * handle, Shishi_asn1 kdcreq, Shishi_name_type name_type, const char * principal`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ variable to set client name field in.

name_type: type of principial, see Shishi_name_type, usually SHISHI_NT_UNKNOWN.

principal: input array with principal name.

Set the client name field in the KDC-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_set_realm** (`Shishi * handle, Shishi_asn1 kdcreq, const char * realm`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ variable to set realm field in.

realm: input array with name of realm.

Set the realm field in the KDC-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_set_sname** (`Shishi * handle, Shishi_asn1 kdcreq, Shishi_name_type name_type, const char * sname[]`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ variable to set server name field in.

name_type: type of principial, see Shishi_name_type, usually SHISHI_NT_UNKNOWN.

Set the server name field in the KDC-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_etype** (`Shishi * handle, Shishi_asn1 kdcreq, int32_t * etype, int netype`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ variable to get etype field from.

etype: output encryption type.

netype: element number to return.

th encryption type from KDC-REQ. The first etype is number 1.

Returns SHISHI_OK iff etype successful set.

`int` **shishi_kdcreq_set_etype** (`Shishi * handle, Shishi_asn1 kdcreq, int32_t * etype, int netype`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ variable to set etype field in.

etype: input array with encryption types.

netype: number of elements in input array with encryption types.

Set the list of supported or wanted encryption types in the request. The list should be sorted in priority order.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_clear_padata** (`Shishi * handle, Shishi_asn1 kdcreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ to remove PA-DATA from.

Remove the padata field from KDC-REQ.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_add_padata** (`Shishi * handle, Shishi_asn1 kdcreq, int padatatype, char * data, int datalen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ to add PA-DATA to.

padatatype: type of PA-DATA, see Shishi_padata_type.

data: input array with PA-DATA value.

datalen: size of input array with PA-DATA value.

Add new pre authentication data (PA-DATA) to KDC-REQ. This is used to pass various information to KDC, such as in case of a SHISHI_PA_TGS_REQ padatatype the AP-REQ that authenticates the user to get the ticket. (But also see `shishi_kdcreq_add_padata_tgs()` which takes an AP-REQ directly.)

Returns SHISHI_OK iff successful.

`int` **shishi_kdcreq_add_padata_tgs** (`Shishi * handle, Shishi_asn1 kdcreq, Shishi_asn1 apreq`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcreq: KDC-REQ to add PA-DATA to.

apreq: AP-REQ to add as PA-DATA.

Add TGS pre-authentication data to KDC-REQ. The data is an AP-REQ that authenticates the request. This functions simply DER encodes the AP-REQ and calls `shishi_kdcreq_add_padata()` with a SHISHI_PA_TGS_REQ padatatype.

Returns SHISHI_OK iff successful.

`Shishi_asn1` **shishi_asrep** (`Shishi * handle`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

This function creates a new AS-REP, populated with some default values.

Returns the AS-REP or NULL on failure.

`Shishi_asn1` **shishi_tgsrep** (`Shishi * handle`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

This function creates a new TGS-REP, populated with some default values.

Returns the TGS-REP or NULL on failure.

`int` **shishi_kdcrep_print** (`Shishi * handle, FILE * fh, Shishi_asn1 kdcrep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

kdcrep: KDC-REP to print.

Print ASCII armored DER encoding of KDC-REP to file.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_save** (`Shishi * handle, FILE * fh, Shishi_asn1 kdcrep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

kdcrep: KDC-REP to save.

Print DER encoding of KDC-REP to file.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_to_file** (`Shishi * handle, Shishi_asn1 kdcrep, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: KDC-REP to save.

filetype: input variable specifying type of file to be written, see Shishi_filetype.

filename: input variable with filename to write to.

Write KDC-REP to file in specified TYPE. The file will be truncated if it exists.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_parse** (`Shishi * handle, FILE * fh, Shishi_asn1 * kdcrep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

kdcrep: output variable with newly allocated KDC-REP.

Read ASCII armored DER encoded KDC-REP from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_read** (`Shishi * handle, FILE * fh, Shishi_asn1 * kdcrep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

kdcrep: output variable with newly allocated KDC-REP.

Read DER encoded KDC-REP from file and populate given variable.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_from_file** (`Shishi * handle, Shishi_asn1 * kdcrep, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: output variable with newly allocated KDC-REP.

filetype: input variable specifying type of file to be read, see Shishi_filetype.

filename: input variable with filename to read from.

Read KDC-REP from file in specified TYPE.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_crealm_set** (`Shishi * handle, Shishi_asn1 kdcrep, const char * crealm`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: Kdcrep variable to set realm field in.

crealm: input array with name of realm.

Set the client realm field in the KDC-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_cname_set** (`Shishi * handle, Shishi_asn1 kdcrep, Shishi_name_type name_type, const char * cname[]`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: Kdcrep variable to set server name field in.

name_type: type of principial, see Shishi_name_type, usually SHISHI_NT_UNKNOWN.

Set the server name field in the KDC-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_client_set** (`Shishi * handle, Shishi_asn1 kdcrep, const char * client`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: Kdcrep variable to set server name field in.

Set the client name field in the KDC-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_get_enc_part_etype** (`Shishi * handle, Shishi_asn1 kdcrep, int32_t * etype`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: KDC-REP variable to get value from.

etype: output variable that holds the value.

Extract KDC-REP.enc-part.etype.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_get_ticket** (`Shishi * handle, Shishi_asn1 kdcrep, Shishi_asn1 * ticket`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: KDC-REP variable to get ticket from.

ticket: output variable to hold extracted ticket.

Extract ticket from KDC-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_set_ticket** (`Shishi * handle, Shishi_asn1 kdcrep, Shishi_asn1 ticket`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: KDC-REP to add ticket field to.

ticket: input ticket to copy into KDC-REP ticket field.

Copy ticket into KDC-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_set_enc_part** (`Shishi * handle, Shishi_asn1 kdcrep, int etype, int kvno, char * buf, int buflen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: KDC-REP to add enc-part field to.

etype: encryption type used to encrypt enc-part.

kvno: key version number.

buf: input array with encrypted enc-part.

buflen: size of input array with encrypted enc-part.

Set the encrypted enc-part field in the KDC-REP. The encrypted data is usually created by calling `shishi_encrypt()` on the DER encoded enc-part. To save time, you may want to use `shishi_kdcrep_add_enc_part()` instead, which calculates the encrypted data and calls this function in one step.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_add_enc_part** (`Shishi * handle, Shishi_asn1 kdcrep, Shishi_key * key, int keyusage, Shishi_asn1 enckdcreppart`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: KDC-REP to add enc-part field to.

key: key used to encrypt enc-part.

keyusage: key usage to use, normally SHISHI_KEYUSAGE_ENCASREPPART, SHISHI_KEYUSAGE_ENCTGSREPPART_SESSION_KEY or SHISHI_KEYUSAGE_ENCTGSREPPA

enckdcreppart: EncKDCRepPart to add.

Encrypts DER encoded EncKDCRepPart using key and stores it in the KDC-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_kdcrep_clear_padata** (`Shishi * handle, Shishi_asn1 kdcrep`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

kdcrep: KDC-REP to remove PA-DATA from.

Remove the padata field from KDC-REP.

Returns SHISHI_OK iff successful.

`int` **shishi_enckdcreppart_get_key** (`Shishi * handle, Shishi_asn1 enckdcreppart, Shishi_key ** key`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

enckdcreppart: input EncKDCRepPart variable.

Extract the key to use with the ticket sent in the KDC-REP associated with the EndKDCRepPart input variable.

Returns SHISHI_OK iff succesful.

`int` **shishi_enckdcreppart_key_set** (`Shishi * handle, Shishi_asn1 enckdcreppart, Shishi_key * key`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

enckdcreppart: input EncKDCRepPart variable.

key: key handle with information to store in enckdcreppart.

Set the EncKDCRepPart.key field to key type and value of supplied key.

Returns SHISHI_OK iff succesful.

`int` **shishi_enckdcreppart_nonce_set** (`Shishi * handle, Shishi_asn1 enckdcreppart, uint32_t nonce`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

enckdcreppart: input EncKDCRepPart variable.

nonce: nonce to set in EncKDCRepPart.

Set the EncKDCRepPart.nonce field.

Returns SHISHI_OK iff succesful.

`int` **shishi_enckdcreppart_flags_set** (`Shishi * handle, Shishi_asn1 enckdcreppart, int flags`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

enckdcreppart: input EncKDCRepPart variable.

flags: flags to set in EncKDCRepPart.

Set the EncKDCRepPart.flags field.

Returns SHISHI_OK iff succesful.

`int` **shishi_enckdcreppart_populate_encticketpart** (`Shishi * handle, Shishi_asn1 enckdcreppart, Shishi_asn1 encticketpart`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

enckdcreppart: input EncKDCRepPart variable.

encticketpart: input EncTicketPart variable.

Set the flags, authtime, starttime, endtime, renew-till and caddr fields of the EncKDCRepPart to the corresponding values in the EncTicketPart.

Returns SHISHI_OK iff succesful.

`int` **shishi_enckdcreppart_srealm_set** (`Shishi * handle, Shishi_asn1 enckdcreppart, const char * srealm`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

enckdcreppart: EncKDCRepPart variable to set realm field in.

srealm: input array with name of realm.

Set the server realm field in the EncKDCRepPart.

Returns SHISHI_OK iff successful.

`int` **shishi_enckdcreppart_sname_set** (`Shishi * handle, Shishi_asn1 enckdcreppart, Shishi_name_type name_type, char * sname[]`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

enckdcreppart: EncKDCRepPart variable to set server name field in.

name_type: type of principial, see Shishi_name_type, usually SHISHI_NT_UNKNOWN.

Set the server name field in the EncKDCRepPart.

Returns SHISHI_OK iff successful.

4.11 Authenticator Functions

An "Authenticator" is a ASN.1 structure that work as a proof that an entity owns a ticket. It is usually embedded in the AP-REQ structure (see Section 4.4 [AP-REQ and AP-REP Functions], page 22), and you most likely want to use an AP-REQ instead of a Authenticator in normal applications. The following illustrates the Authenticator ASN.1 structure.

```
Authenticator   ::= [APPLICATION 2] SEQUENCE  {
        authenticator-vno       [0] INTEGER (5),
        crealm                  [1] Realm,
        cname                   [2] PrincipalName,
        cksum                   [3] Checksum OPTIONAL,
        cusec                   [4] Microseconds,
        ctime                   [5] KerberosTime,
        subkey                  [6] EncryptionKey OPTIONAL,
        seq-number              [7] UInt32 OPTIONAL,
        authorization-data      [8] AuthorizationData OPTIONAL
}
```

`Shishi_asn1` **shishi_authenticator** (`Shishi *` *handle*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

This function creates a new Authenticator, populated with some default values. It uses the current time as returned by the system for the ctime and cusec fields.

Returns the authenticator or NULL on failure.

`int` **shishi_authenticator_print** (`Shishi *` *handle*, `FILE *` *fh*, `Shishi_asn1` *authenticator*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

authenticator: authenticator as allocated by `shishi_authenticator()`.

Print ASCII armored DER encoding of authenticator to file.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_save** (`Shishi *` *handle*, `FILE *` *fh*, `Shishi_asn1` *authenticator*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for writing.

authenticator: authenticator as allocated by `shishi_authenticator()`.

Save DER encoding of authenticator to file.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_to_file** (`Shishi *` *handle*, `Shishi_asn1` *authenticator*, `int` *filetype*, `char *` *filename*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: Authenticator to save.

filetype: input variable specifying type of file to be written, see Shishi_filetype.

filename: input variable with filename to write to.

Write Authenticator to file in specified TYPE. The file will be truncated if it exists.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_parse** (`Shishi * handle, FILE * fh, Shishi_asn1 * authenticator`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

authenticator: output variable with newly allocated authenticator.

Read ASCII armored DER encoded authenticator from file and populate given authenticator variable.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_read** (`Shishi * handle, FILE * fh, Shishi_asn1 * authenticator`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

fh: file handle open for reading.

authenticator: output variable with newly allocated authenticator.

Read DER encoded authenticator from file and populate given authenticator variable.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_from_file** (`Shishi * handle, Shishi_asn1 * authenticator, int filetype, char * filename`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: output variable with newly allocated Authenticator.

filetype: input variable specifying type of file to be read, see Shishi_filetype.

filename: input variable with filename to read from.

Read Authenticator from file in specified TYPE.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_set_crealm** (`Shishi * handle, Shishi_asn1 authenticator, const char * crealm`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

crealm: input array with realm.

Set realm field in authenticator to specified value.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_set_cname** (`Shishi * handle, Shishi_asn1 authenticator, Shishi_name_type name_type, const char * cname[]`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

name_type: type of principial, see Shishi_name_type, usually SHISHI_NT_UNKNOWN.

Set principal field in authenticator to specified value.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_client_set** (`Shishi * handle, Shishi_asn1 authenticator, const char * client`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

Set the client name field in the Authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_ctime_set** (`Shishi * handle, Shishi_asn1 authenticator, char * ctime`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: Authenticator as allocated by `shishi_authenticator()`.

ctime: string with generalized time value to store in Authenticator.

Store client time in Authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_cusec_get** (`Shishi * handle, Shishi_asn1 authenticator, int * cusec`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: Authenticator as allocated by `shishi_authenticator()`.

cusec: output integer with client microseconds field.

Extract client microseconds field from Authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_cusec_set** (`Shishi * handle, Shishi_asn1 authenticator, int cusec`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

cusec: client microseconds to set in authenticator, 0-999999.

Set the cusec field in the Authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_cksum** (`Shishi * handle, Shishi_asn1 authenticator, int32_t * cksumtype, char * cksum, size_t * cksumlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

cksumtype: output checksum type.

cksum: output checksum data from authenticator.

cksumlen: on input, maximum size of output checksum data buffer, on output, actual size of output checksum data buffer.

Read checksum value from authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_set_cksum** (`Shishi * handle, Shishi_asn1 authenticator, int32_t cksumtype, char * cksum, size_t cksumlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

cksumtype: input checksum type to store in authenticator.

cksum: input checksum data to store in authenticator.

cksumlen: size of input checksum data to store in authenticator.

Store checksum value in authenticator. A checksum is usually created by calling `shishi_checksum()` on some application specific data using the key from the ticket that is being used. To save time, you may want to use `shishi_authenticator_add_cksum()` instead, which calculates the checksum and calls this function in one step.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_add_cksum** (`Shishi * handle, Shishi_asn1 authenticator, Shishi_key * key, int keyusage, char * data, int datalen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

data: input array with data to calculate checksum on.

datalen: size of input array with data to calculate checksum on.

Calculate checksum for data and store it in the authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_clear_authorizationdata** (`Shishi * handle, Shishi_asn1 authenticator`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: Authenticator as allocated by `shishi_authenticator()`.

Remove the authorization-data field from Authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_add_authorizationdata** (`Shishi * handle, Shishi_asn1 authenticator, int adtype, char * addata, int addatalen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

adtype: input authorization data type to add.

addata: input authorization data to add.

addatalen: size of input authorization data to add.

Add authorization data to authenticator.

Returns SHISHI_OK iff successful.

`int` **shishi_authenticator_authorizationdata** (`Shishi * handle, Shishi_asn1 authenticator, int * adtype, char * addata, int * addatalen, int nth`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

authenticator: authenticator as allocated by `shishi_authenticator()`.

adtype: output authorization data type.

addata: output authorization data.

addatalen: on input, maximum size of output authorization data,

nth: element number of authorization-data to extract.

th authorization data from authenticator. The first field is 1.

Returns SHISHI_OK iff successful.

4.12 Cryptographic Functions

Underneath the high-level functions described earlier, cryptographic operations are happening. If you need to access these cryptographic primitives directly, this section describes the functions available.

Most cryptographic operations need keying material, and cryptographic keys have been isolated into it's own data structure `Shishi_key`. The following illustrates it's contents, but note that you cannot access it's elements directly but must use the accessor functions described below.

```
struct Shishi_key
{
  int type;    /* RFC 1510 encryption integer type */
  char *value; /* Cryptographic key data */
  int version; /* RFC 1510 ``kvno'' */
};
```

All functions that operate on this data structure are described now.

`const char *` **shishi_key_principal** (`Shishi_key * key`) [Function]

key: structure that holds key information

Returns the principal owning the key. (Not a copy of it, so don't modify or deallocate it.)

`void` **shishi_key_principal_set** (`Shishi_key * key, const char * principal`) [Function]

key: structure that holds key information

principal: string with new principal name.

Set the principal owning the key. The string is copied into the key, so you can dispose of the variable immediately after calling this function.

`const char *` **shishi_key_realm** (`Shishi_key * key`) [Function]

key: structure that holds key information

Returns the realm for the principal owning the key. (Not a copy of it, so don't modify or deallocate it.)

`void` **shishi_key_realm_set** (`Shishi_key * key, const char * realm`) [Function]
key: structure that holds key information
realm: string with new realm name.
Set the realm for the principal owning the key. The string is copied into the key, so you can dispose of the variable immediately after calling this function.

`int` **shishi_key_type** (`Shishi_key * key`) [Function]
key: structure that holds key information
Returns the type of key as an integer as described in the standard.

`void` **shishi_key_type_set** (`Shishi_key * key, int32_t type`) [Function]
key: structure that holds key information
Set the type of key in key structure.

`char *` **shishi_key_value** (`Shishi_key * key`) [Function]
key: structure that holds key information
Returns the key value as a pointer which is valid throughout the lifetime of the key structure.

`void` **shishi_key_value_set** (`Shishi_key * key, const char * value`) [Function]
key: structure that holds key information
value: input array with key data.
Set the key value and length in key structure.

`int` **shishi_key_version** (`Shishi_key * key`) [Function]
key: structure that holds key information
Returns the version of key ("kvno").

`void` **shishi_key_version_set** (`Shishi_key * key, int version`) [Function]
key: structure that holds key information
version: new version integer.
Set the version of key ("kvno") in key structure.

`const char *` **shishi_key_name** (`Shishi_key * key`) [Function]
key: structure that holds key information
Calls shishi_cipher_name for key type.
Return name of key.

`size_t` **shishi_key_length** (`Shishi_key * key`) [Function]
key: structure that holds key information
Calls shishi_cipher_keylen for key type.
Returns the length of the key value.

`int` **shishi_key** (`Shishi * handle, Shishi_key ** key`) [Function]
handle: Shishi library handle create by `shishi_init()`.
key: pointer to structure that will hold newly created key information
Create a new Key information structure.
Returns SHISHI_MALLOC_ERROR on memory allocation errors, and SHISHI_OK on success.

`void` **shishi_key_done** (`Shishi_key ** key`) [Function]

key: pointer to structure that holds key information.

Deallocates key information structure and set key handle to NULL.

`void` **shishi_key_copy** (`Shishi_key * dstkey, Shishi_key * srckey`) [Function]

dstkey: structure that holds destination key information

srckey: structure that holds source key information

Copies source key into existing allocated destination key.

`int` **shishi_key_from_value** (`Shishi * handle, int32_t type, char * value, Shishi_key ** key`) [Function]

handle: Shishi library handle create by `shishi_init()`.

type: type of key.

value: input array with key value, or NULL.

key: pointer to structure that will hold newly created key information

Create a new Key information structure, and set the key type and key value. KEY contains a newly allocated structure only if this function is successful.

Returns SHISHI_MALLOC_ERROR on memory allocation errors, and SHISHI_OK on success.

`int` **shishi_key_from_base64** (`Shishi * handle, int32_t type, char * value, Shishi_key ** key`) [Function]

handle: Shishi library handle create by `shishi_init()`.

type: type of key.

value: input string with base64 encoded key value, or NULL.

key: pointer to structure that will hold newly created key information

Create a new Key information structure, and set the key type and key value. KEY contains a newly allocated structure only if this function is successful.

Returns SHISHI_MALLOC_ERROR on memory allocation errors, SHISHI_INVALID_KEY if the base64 encoded key length doesn't match the key type, and SHISHI_OK on success.

`int` **shishi_key_random** (`Shishi * handle, int32_t type, Shishi_key ** key`) [Function]

handle: Shishi library handle create by `shishi_init()`.

type: type of key.

Create a new Key information structure for the key type and some random data. KEY contains a newly allocated structure only if this function is successful.

Returns SHISHI_OK iff successful.

`int` **shishi_key_from_random** (`Shishi * handle, int32_t type, char * random, size_t randomlen, Shishi_key ** key`) [Function]

handle: Shishi library handle create by `shishi_init()`.

type: type of key.

random: random data.

randomlen: length of random data.

Create a new Key information structure, and set the key type and key value using `shishi_random_to_key()`. KEY contains a newly allocated structure only if this function is successful.

Returns SHISHI_MALLOC_ERROR on memory allocation errors, and SHISHI_OK on success.

`int` **shishi_key_from_string** (`Shishi * handle, int32_t type, const char * password, size_t passwordlen, const char * salt, size_t saltlen, const char * parameter, Shishi_key ** key`) [Function]

handle: Shishi library handle create by `shishi_init()`.

type: type of key.

password: input array containing password.

passwordlen: length of input array containing password.

salt: input array containing salt.

saltlen: length of input array containing salt.

parameter: input array with opaque encryption type specific information.

Create a new Key information structure, and set the key type and key value using `shishi_string_to_key()`. KEY contains a newly allocated structure only if this function is successful.

Returns SHISHI_MALLOC_ERROR on memory allocation errors, and SHISHI_OK on success.

Applications that run uninteractively may need keying material. In these cases, the keys are stored in a file, a file that is normally stored on the local host. The file should be protected from unauthorized access. The file is in ASCII format and contains keys as outputed by `shishi_key_print()`. All functions that handle these keys sets are described now.

`Shishi_key *` **shishi_keys_for_serverrealm_in_file** (`Shishi * handle, const char * filename, const char * server, const char * realm`) [Function]

handle: Shishi library handle create by `shishi_init()`.

filename: file to read keys from.

server: server name to get key for.

realm: realm of server to get key for.

Returns the key for specific server and realm, read from the indicated file, or NULL if no key could be found or an error encountered.

`Shishi_key *` **shishi_keys_for_server_in_file** (`Shishi * handle, const char * filename, const char * server`) [Function]

handle: Shishi library handle create by `shishi_init()`.

filename: file to read keys from.

server: server name to get key for.

Returns the key for specific server, read from the indicated file, or NULL if no key could be found or an error encountered.

`Shishi_key *` **shishi_keys_for_localservicerealm_in_file** (`Shishi * handle, const char * filename, const char * service, const char * realm`) [Function]

handle: Shishi library handle create by `shishi_init()`.

filename: file to read keys from.

service: service to get key for.

realm: realm of server to get key for, or NULL for default realm.

Returns the key for the server "SERVICE/HOSTNAMEREALM" (where HOSTNAME is the current system's hostname), read from the default host keys file (see `shishi_hostkeys_default_file()`), or NULL if no key could be found or an error encountered.

The previous functions require that the filename is known. For some applications, servers, it makes sense to provide a system default. These key sets used by server applications are known as "hostkeys". Here are the functions that operate on hostkeys (they are mostly wrappers around generic key sets).

`const char *` **shishi_hostkeys_default_file** (`Shishi * handle`) [Function]

handle: Shishi library handle create by `shishi_init()`.

Returns the default host key filename used in the library. (Not a copy of it, so don't modify or deallocate it.)

`void` **shishi_hostkeys_default_file_set** (`Shishi * handle, const char * hostkeysfile`) [Function]

handle: Shishi library handle create by `shishi_init()`.

hostkeysfile: string with new default hostkeys file name, or NULL to reset to default.

Set the default host key filename used in the library. The string is copied into the library, so you can dispose of the variable immediately after calling this function.

`Shishi_key *` **shishi_hostkeys_for_server** (`Shishi * handle, const char * server`) [Function]

handle: Shishi library handle create by `shishi_init()`.

server: server name to get key for

Returns the key for specific server, read from the default host keys file (see `shishi_hostkeys_default_file()`), or NULL if no key could be found or an error encountered.

`Shishi_key *` **shishi_hostkeys_for_serverrealm** (`Shishi * handle, const char * server, const char * realm`) [Function]

handle: Shishi library handle create by `shishi_init()`.

server: server name to get key for

realm: realm of server to get key for.

Returns the key for specific server and realm, read from the default host keys file (see `shishi_hostkeys_default_file()`), or NULL if no key could be found or an error encountered.

`Shishi_key * shishi_hostkeys_for_localservicerealm (Shishi * handle, const char * service, const char * realm)` [Function]

handle: Shishi library handle create by `shishi_init()`.

service: service to get key for.

realm: realm of server to get key for, or NULL for default realm.

Returns the key for the server "SERVICE/HOSTNAMEREALM" (where HOSTNAME is the current system's hostname), read from the default host keys file (see `shishi_hostkeys_default_file()`), or NULL if no key could be found or an error encountered.

`Shishi_key * shishi_hostkeys_for_localservice (Shishi * handle, const char * service)` [Function]

handle: Shishi library handle create by `shishi_init()`.

service: service to get key for.

Returns the key for the server "SERVICE/HOSTNAME" (where HOSTNAME is the current system's hostname), read from the default host keys file (see `shishi_hostkeys_default_file()`), or NULL if no key could be found or an error encountered.

After creating the key structure, it can be used to encrypt and decrypt data, calculate checksum on data etc. All available functions are described now.

`int shishi_cipher_supported_p (int32_t type)` [Function]

type: encryption type, see Shishi_etype.

Return 0 iff cipher is unsupported.

`const char * shishi_cipher_name (int32_t type)` [Function]

type: encryption type, see Shishi_etype.

Return name of encryption type, e.g. "des3-cbc-sha1-kd", as defined in the standards.

`int shishi_cipher_blocksize (int32_t type)` [Function]

type: encryption type, see Shishi_etype.

Return block size for encryption type, as defined in the standards.

`int shishi_cipher_minpadsize (int32_t type)` [Function]

type: encryption type, see Shishi_etype.

Return the minimum pad size for encryption type, as defined in the standards.

`int shishi_cipher_confoundersize (int32_t type)` [Function]

type: encryption type, see Shishi_etype.

Returns the size of the confounder (random data) for encryption type, as defined in the standards.

`size_t shishi_cipher_keylen (int32_t type)` [Function]

type: encryption type, see Shishi_etype.

Return length of key used for the encryption type, as defined in the standards.

`size_t` **shishi_cipher_randomlen** (`int32_t` *type*) [Function]

type: encryption type, see Shishi_etype.

Return length of random used for the encryption type, as defined in the standards.

`int` **shishi_cipher_defaultcksumtype** (`int32_t` *type*) [Function]

type: encryption type, see Shishi_etype.

Return associated checksum mechanism for the encryption type, as defined in the standards.

`int` **shishi_cipher_parse** (`const char *` *cipher*) [Function]

cipher: name of encryption type, e.g. "des3-cbc-sha1-kd".

Return encryption type corresponding to a string.

`int` **shishi_checksum_supported_p** (`int32_t` *type*) [Function]

type: encryption type, see Shishi_etype.

Return 0 iff checksum is unsupported.

`const char *` **shishi_checksum_name** (`int32_t` *type*) [Function]

type: encryption type, see Shishi_etype.

Return name of checksum type, e.g. "hmac-sha1-96-aes256", as defined in the standards.

`size_t` **shishi_checksum_cksumlen** (`int32_t` *type*) [Function]

type: encryption type, see Shishi_etype.

Return length of checksum used for the encryption type, as defined in the standards.

`int` **shishi_checksum_parse** (`const char *` *checksum*) [Function]

checksum: name of checksum type, e.g. "hmac-sha1-96-aes256".

Return checksum type corresponding to a string.

`int` **shishi_string_to_key** (`Shishi *` *handle*, `int32_t` *keytype*, `const char *` *password*, `size_t` *passwordlen*, `const char *` *salt*, `size_t` *saltlen*, `const char *` *parameter*, `Shishi_key *` *outkey*) [Function]

handle: shishi handle as allocated by `shishi_init()`.

keytype: cryptographic encryption type, see Shishi_etype.

password: input array with password.

passwordlen: length of input array with password.

salt: input array with salt.

saltlen: length of input array with salt.

parameter: input array with opaque encryption type specific information.

outkey: allocated key handle that will contain new key.

Derive key from a string (password) and salt (commonly concatenation of realm and principal) for specified key type, and set the type and value in the given key to the computed values. The parameter value is specific for each keytype, and can be set if the parameter information is not available.

Returns *SHISHI_OK* iff successful.

`int` **shishi_random_to_key** (`Shishi * handle, int32_t keytype, char * random, size_t randomlen, Shishi_key * outkey`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

keytype: cryptographic encryption type, see Shishi_etype.

random: input array with random data.

randomlen: length of input array with random data.

outkey: allocated key handle that will contain new key.

Derive key from random data for specified key type, and set the type and value in the given key to the computed values.

Returns *SHISHI_OK* iff successful.

`int` **shishi_checksum** (`Shishi * handle, Shishi_key * key, int keyusage, int cksumtype, char * in, size_t inlen, char ** out, size_t * outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: key to encrypt with.

keyusage: integer specifying what this key is encrypting.

cksumtype: the checksum algorithm to use.

in: input array with data to integrity protect.

inlen: size of input array with data to integrity protect.

out: output array with integrity protected data.

outlen: on input, holds maximum size of output array, on output, holds actual size of output array.

Integrity protect data using key, possibly altered by supplied key usage. If key usage is 0, no key derivation is used.

If OUT is NULL, this functions only set OUTLEN. This usage may be used by the caller to allocate the proper buffer size.

Returns *SHISHI_OK* iff successful.

`int` **shishi_encrypt_iv_etype** (`Shishi * handle, Shishi_key * key, int keyusage, int32_t etype, char * iv, size_t ivlen, char * in, size_t inlen, char ** out, size_t * outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: key to encrypt with.

keyusage: integer specifying what this key is encrypting.

etype: integer specifying what decryption method to use.

iv: input array with initialization vector.

ivlen: size of input array with initialization vector.

in: input array with data to encrypt.

inlen: size of input array with data to encrypt.

out: output array with encrypted data.

outlen: on input, holds maximum size of output array, on output, holds actual size of output array.

Encrypts data using key, possibly altered by supplied key usage. If key usage is 0, no key derivation is used.

If OUT is NULL, this functions only set OUTLEN. This usage may be used by the caller to allocate the proper buffer size.

Returns *SHISHI_OK* iff successful.

`int` **shishi_encrypt_iv** (`Shishi * handle, Shishi_key * key, int keyusage, char * iv, size_t ivlen, char * in, size_t inlen, char ** out, size_t * outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: key to encrypt with.

keyusage: integer specifying what this key is encrypting.

in: input array with data to encrypt.

inlen: size of input array with data to encrypt.

out: output array with encrypted data.

outlen: on input, holds maximum size of output array, on output, holds actual size of output array.

Encrypts data using key, possibly altered by supplied key usage. If key usage is 0, no key derivation is used.

If OUT is NULL, this functions only set OUTLEN. This usage may be used by the caller to allocate the proper buffer size.

Returns *SHISHI_OK* iff successful.

`int` **shishi_encrypt** (`Shishi * handle, Shishi_key * key, int keyusage, char * in, size_t inlen, char ** out, size_t * outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: key to encrypt with.

keyusage: integer specifying what this key is encrypting.

in: input array with data to encrypt.

inlen: size of input array with data to encrypt.

out: output array with encrypted data.

outlen: on input, holds maximum size of output array, on output, holds actual size of output array.

Encrypts data using key, possibly altered by supplied key usage. If key usage is 0, no key derivation is used.

If OUT is NULL, this functions only set OUTLEN. This usage may be used by the caller to allocate the proper buffer size.

Returns *SHISHI_OK* iff successful.

`int` **shishi_decrypt_iv_etype** (`Shishi * handle, Shishi_key * key, int keyusage, int32_t etype, char * iv, size_t ivlen, char * in, size_t inlen, char ** out, size_t * outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: key to decrypt with.

keyusage: integer specifying what this key is decrypting.

etype: integer specifying what decryption method to use.

iv: input array with initialization vector.

ivlen: size of input array with initialization vector.

in: input array with data to decrypt.

inlen: size of input array with data to decrypt.

out: output array with decrypted data.

outlen: on input, holds maximum size of output array, on output, holds actual size of output array.

Decrypts data using key, possibly altered by supplied key usage. If key usage is 0, no key derivation is used.

If OUT is NULL, this functions only set OUTLEN. This usage may be used by the caller to allocate the proper buffer size.

Returns *SHISHI_OK* iff successful.

`int` **shishi_decrypt_iv** (`Shishi * handle, Shishi_key * key, int keyusage, char * iv, size_t ivlen, char * in, size_t inlen, char ** out, size_t * outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: key to decrypt with.

keyusage: integer specifying what this key is decrypting.

iv: input array with initialization vector.

ivlen: size of input array with initialization vector.

in: input array with data to decrypt.

inlen: size of input array with data to decrypt.

out: output array with decrypted data.

outlen: on input, holds maximum size of output array, on output, holds actual size of output array.

Decrypts data using key, possibly altered by supplied key usage. If key usage is 0, no key derivation is used.

If OUT is NULL, this functions only set OUTLEN. This usage may be used by the caller to allocate the proper buffer size.

Returns *SHISHI_OK* iff successful.

`int` **shishi_decrypt** (`Shishi * handle, Shishi_key * key, int keyusage, char * in, size_t inlen, char ** out, size_t * outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: key to decrypt with.

keyusage: integer specifying what this key is decrypting.

in: input array with data to decrypt.

inlen: size of input array with data to decrypt.

out: output array with decrypted data.

outlen: on input, holds maximum size of output array, on output, holds actual size of output array.

Decrypts data using key, possibly altered by supplied key usage. If key usage is 0, no key derivation is used.

If OUT is NULL, this functions only set OUTLEN. This usage may be used by the caller to allocate the proper buffer size.

Returns *SHISHI_OK* iff successful.

`int` **shishi_randomize** (`Shishi * handle, char * data, size_t datalen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

data: output array to be filled with random data.

datalen: size of output array.

Store cryptographically strong random data of given size in the provided buffer.

Returns *SHISHI_OK* iff successful.

`int` **shishi_n_fold** (`Shishi * handle, char * in, size_t inlen, char * out, size_t outlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

in: input array with data to decrypt.

inlen: size of input array with data to decrypt ("M").

out: output array with decrypted data.

outlen: size of output array ("N").

Fold data into a fixed length output array, with the intent to give each input bit approximately equal weight in determining the value of each output bit.

The algorithm is from "A Better Key Schedule For DES-like Ciphers" by Uri Blumenthal and Steven M. Bellovin, <URL:http://www.research.att.com/~smb/papers/ides.pdf>, although the sample vectors provided by the paper are incorrect.

Returns *SHISHI_OK* iff successful.

`int` **shishi_dr** (`Shishi * handle, Shishi_key * key, char * constant, size_t constantlen, char * derivedrandom, size_t derivedrandomlen`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: input array with cryptographic key to use.

constant: input array with the constant string.

constantlen: size of input array with the constant string.

derivedrandom: output array with derived random data.

derivedrandomlen: size of output array with derived random data.

Derive "random" data from a key and a constant thusly: DR(KEY, CONSTANT) = TRUNCATE(DERIVEDRANDOMLEN, SHISHI_ENCRYPT(KEY, CONSTANT)).

Returns *SHISHI_OK* iff successful.

`int` **shishi_dk** (`Shishi * handle, Shishi_key * key, char * constant, int constantlen, Shishi_key * derivedkey`) [Function]

handle: shishi handle as allocated by `shishi_init()`.

key: input array with cryptographic key to use.

constant: input array with the constant string.

constantlen: size of input array with the constant string.

derivedkey: output array with derived key.

DK(KEY, CONSTANT) = SHISHI_RANDOM-TO-KEY(SHISHI_DR(KEY, CONSTANT)).

Returns *SHISHI_OK* iff successful.

4.13 Utility Functions

`char *` **shishi_realm_default_guess** (`void`) [Function]

Guesses a realm based on `getdomainname()` (which really is NIS/YP domain, but if it is set it might be a good guess), or if it fails, based on `gethostname()`, or if it fails, the string "could-not-guess-default-realm". Note that the hostname is not trimmed off of the data returned by `gethostname()` to get the domain name and use that as the realm.

Returns guessed realm for host as a string that has to be deallocated with `free()` by the caller.

`const char *` **shishi_realm_default** (`Shishi * handle`) [Function]

handle: Shishi library handle create by `shishi_init()`.

Returns the default realm used in the library. (Not a copy of it, so don't modify or deallocate it.)

`void` **shishi_realm_default_set** (`Shishi * handle, const char * realm`) [Function]

handle: Shishi library handle create by `shishi_init()`.

realm: string with new default realm name, or NULL to reset to default.

Set the default realm used in the library. The string is copied into the library, so you can dispose of the variable immediately after calling this function.

`char *` **shishi_principal_default_guess** (`void`) [Function]

Guesses a principal using getpwuid(getuid)), or if it fails, the string "user".

Returns guessed default principal for user as a string that has to be deallocated with `free()` by the caller.

`const char * shishi_principal_default (Shishi * handle)` [Function]

handle: Shishi library handle create by `shishi_init()`.

Returns the default principal name used in the library. (Not a copy of it, so don't modify or deallocate it.)

`void shishi_principal_default_set (Shishi * handle, const char * principal)` [Function]

handle: Shishi library handle create by `shishi_init()`.

principal: string with new default principal name, or NULL to reset to default.

Set the default realm used in the library. The string is copied into the library, so you can dispose of the variable immediately after calling this function.

`int shishi_principal_name_set (Shishi * handle, Shishi_asn1 namenode, const char * namefield, Shishi_name_type name_type, const char * name[])` [Function]

handle: shishi handle as allocated by `shishi_init()`.

namenode: ASN.1 structure with principal in `namefield`.

namefield: name of field in namenode containing principal name.

name_type: type of principial, see Shishi_name_type, usually SHISHI_NT_UNKNOWN.

Set the given principal name field to given name.

Returns SHISHI_OK iff successful.

`int shishi_principal_set (Shishi * handle, Shishi_asn1 namenode, const char * namefield, const char * name)` [Function]

namenode: ASN.1 structure with principal in `namefield`.

namefield: name of field in namenode containing principal name.

name: zero-terminated string with principal name on RFC 1964 form.

Set principal name field in ASN.1 structure to given name.

Returns SHISHI_OK iff successful.

4.14 Error Handling

Most functions in 'Libshishi' are returning an error if they fail. For this reason, the application should always catch the error condition and take appropriate measures, for example by releasing the resources and passing the error up to the caller, or by displaying a descriptive message to the user and cancelling the operation.

Some error values do not indicate a system error or an error in the operation, but the result of an operation that failed properly.

4.14.1 Error values

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

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

`SHISHI_MALLOC_ERROR`
: Memory allocation error in shishi library.

`SHISHI_BASE64_ERROR`
: Base64 encoding or decoding failed. This usually means the data is corrupt.

`SHISHI_FOPEN_ERROR`
: Could not open file.

`SHISHI_FCLOSE_ERROR`
: Could not close file.

`SHISHI_CRYPTO_INTERNAL_ERROR`
: Internal error in low-level crypto routines.

`SHISHI_NONCE_MISMATCH`
: Replay protection value (nonce) differ between request and reply.

`SHISHI_REALM_MISMATCH`
: Client realm value differ between request and reply.

`SHISHI_CNAME_MISMATCH`
: Client name value differ between request and reply.

`SHISHI_ASN1_ERROR`
: Error in ASN.1 data, probably due to corrupt data.

`SHISHI_CRYPTO_ERROR`
: Low-level cryptographic primitive failed. This usually indicates bad password or data corruption.

`SHISHI_KDC_TIMEOUT`
: Timedout talking to KDC. This usually indicates a network or KDC address problem.

`SHISHI_KDC_NOT_KNOWN_FOR_REALM`
: No KDC for realm known.

`SHISHI_SOCKET_ERROR`
: The system call socket() failed. This usually indicates that your system does not support the socket type.

`SHISHI_BIND_ERROR`
: The system call bind() failed. This usually indicates insufficient permissions.

`SHISHI_SENDTO_ERROR`
: The system call sendto() failed.

`SHISHI_CLOSE_ERROR`
: The system call close() failed.

`SHISHI_GOT_KRBERROR`
: Server replied with an error message to request.

`SHISHI_INVALID_TKTS`
: Ticketset not initialized. This usually indicates an internal application error.

`SHISHI_TICKET_BAD_KEYTYPE`
: Keytype used to encrypt ticket doesn't match provided key. This usually indicates an internal application error.

`SHISHI_APREQ_DECRYPT_FAILED`
: Could not decrypt AP-REQ using provided key. This usually indicates an internal application error.

`SHISHI_TICKET_DECRYPT_FAILED`
: Could not decrypt Ticket using provided key. This usually indicates an internal application error.

4.14.2 Error strings

`const char *` **shishi_strerror** (`int` *err*) [Function]

err: shishi error code

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

4.15 Examples

This section will be extended to contain walk-throughs of example code that demonstrate how 'Shishi' is used to write your own applications that support Kerberos 5. The rest of the current section consists of some crude hints for the example client/server applications that is part of Shishi, taken from an email but saved here for lack of a better place to put it.

There are two programs: 'client' and 'server' in src/.

The client output an AP-REQ, waits for an AP-REP, and then simply reads data from stdin.

The server waits for an AP-REQ, parses it and prints an AP-REP, and then read data from stdin.

Both programs accept a Kerberos server name as the first command line argument. Your KDC must know this server, since the client tries to get a ticket for it (first it gets a ticket granting ticket for the default username), and you must write the key for the server into /usr/local/etc/shishi.keys on the Shishi format, e.g.:

```
-----BEGIN SHISHI KEY-----
Keytype: 16 (des3-cbc-sha1-kd)
Principal: sample/latte.josefsson.org
Realm: JOSEFSSON.ORG

8W0VrQQBpxlACPQEqN91EHxbvFFo2ltt
-----END SHISHI KEY-----
```

You must extract the proper encryption key from the KDC in some way. (This part will be easier when Shishi include a KDC, a basic one isn't far away, give me a week or to.)

The intention is that the data read, after the authentication phase, should be protected using KRB_SAFE (see RFC) but I haven't added this yet.

4.16 Generic Security Service

As an alternative to the native Shishi programming API, it is possible to program Shishi through the Generic Security Services (GSS) API. The advantage of using GSS-API in your security application, instead of the native Shishi API, is that it will be easier to port your application between different Kerberos 5 implementations, and even beyond Kerberos 5 to different security systems, that support GSS-API. In the free software world, however, the only widely used security system that supports GSS-API is Kerberos 5, so the last advantage is somewhat academic. But if you are porting applications using GSS-API for other Kerberos 5 implementations, or want a more mature and stable API than the native Shishi API, you may find using Shishi's GSS-API interface compelling. Note that GSS-API only offer basic services, for more advanced uses you must use the native API.

Since the GSS is not specific to Shishi, it is distributed independently from Shishi. Further information on the GSS project can be found at `http://josefsson.org/gss/`.

5 Acknowledgements

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Several people reported bugs, sent patches or suggested improvements, see the file THANKS.

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Concept Index

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Short Contents

Table of Contents