GNU Serveez

A server framework
Edition 0.2.2, 9 November 2013

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GNU Serveez

This manual documents GNU Serveez 0.2.2, released 9 November 2013.

GNU Serveez is a server framework. It provides routines and help for implementing IP-based servers (currently TCP, UDP and ICMP). It supports named pipes for all connection-oriented protocols.

We think it is worth the effort because many people need server functionality within their applications. However, many people experience problems with select(2) or poll(2) loops, and with non-blocking operations.

GNU Serveez demonstrates various aspects of advanced network programming in a portable manner. It is known to compile and run on GNU/Linux systems, as well as on other 32-bit and 64-bit flavours of Unix and on Microsoft Windows (9x/ME/NT/2000/XP).

You can use it for implementing your own servers or for understanding how certain network services and operations work.

The package includes a number of servers that work already: an HTTP server, an IRC server, a Gnutella spider and some others. One of the highlights is that you can run all protocols on the same port. The application itself is single threaded but it uses helper processes for concurrent name resolution and ident lookups.
Chapter 1: Using Serveez

1 Using Serveez

We know, you usually don’t read the documentation. Who does. But please, read at the very least this chapter. It contains information on the basic concepts. Larger parts of the manual can be used as a reference manual for the various servers.

1.1 Building and installing

1.1.1 Rebuild the package from the sources

You can skip this section if you are familiar with the GNU’ish way of configuring, compiling and installing a GNU package.

1.1.1.1 Getting the source

Serveez can be found on http://ftp.gnu.org/gnu/serveez/, on one of the mirrors (http://www.gnu.org/prep/ftp.html) or at its original location http://www.lkcc.org/~ela/download/.

1.1.1.2 Requirements

Serveez needs GNU Guile (Ubiquitous Intelligent Language for Extensions). The current version of Serveez is known to work with Guile 1.3 and later. Guile can be downloaded at http://ftp.gnu.org/gnu/guile/.

When installing Guile, consider specifying to its configure script options along the lines of:

--enable-static --disable-shared
--disable-debug-freelist
--disable-debug-malloc
--disable-guile-debug
--disable-arrays --disable-posix
--enable-networking --disable-regex
--without-threads --enable-ltdl-convenience

This option set is tuned for Guile 1.4 and may or may not work for your particular installation; you may need to experiment a bit. Most important is that the program ‘guile-config’ be findable in a directory named in the PATH environment variable. If not, configuration will fail with message “Guile not found”.

1.1.1.3 Installation

Unpack the distribution tarball:

sleepless ~> gzip -cd serveez-0.2.2.tar.gz | tar xvf -

Change into the source directory:

sleepless ~> cd serveez-0.2.2

Configure the source package for your system:

Normally, this is done by running the configure script in the top-level directory. GNU Serveez needs a reasonably conformant C99 compiler to build. If the configure script is not able to automatically find and enable such a compiler, you can specify it directly using the ‘CC’ command-line option. For example:
sleepless ~> ./configure --prefix /gnu CC=’/gnu/bin/gcc’

Note that in this example you can achieve the same results by making sure /gnu/bin is in the PATH env var.

In previous Serveez releases, the configure script had some builtin compiler flags for warnings and optimizations, conveniently exposed via command-line options. These are no longer available; instead, you can use CFLAGS for such purposes (see below). Here is a complete list of the configure script options. The list of known options can the obtained via ’./configure --help’.

‘--enable-debug’
All of the debug messages (debug: some annoying crap text) can be suppressed by setting the debug level (-v). If you do not want these messages built in at all then disable this feature.

‘--enable-controlproto’
If you enable this feature the control protocol will be supported by Serveez. This protocol is for remote control of the server.

‘--enable-ircproto’
Enabling this feature tells the software package to support the IRC (Internet Relay Chat) protocol.

‘--enable-irc-ts’
This feature is only available if you enabled the IRC protocol. If you enabled both of them then Serveez will support the so called TimeStamp protocol, which is an EFNet extension of the original IRC protocol. In order to connect to EFNet you MUST use this option.

‘--enable-httpproto’
When using Serveez as part of the textSure (C) chat system you will will have need of an additional web server. This option makes Serveez support a simple HTTP protocol.

‘--enable-flood’
If you enable this feature Serveez will support a simple built-in flood protection. It is always useful to protect the software from flood clients.

‘--without-mingw=DIR’
When compiling under M$-Windows the DIR argument specifies the path to the extra MinGW32 library and header files. If you want the final executable to use the Cygwin project’s cygwin1.dll instead, you have to disable this option by passing the configure script ‘--without-mingw’ or ‘--with-mingw=no’.

‘--enable-sntpproto’
This option enables support for a simple network time protocol server.
If the target system supports `poll` and this feature is enabled the
main file descriptor loop is done via `poll`. This helps to work
around the (g)libc's file descriptor limit. Otherwise Serveez always
falls back to the `select` system call.

`--enable-sendfile`
This option enables the use of the `sendfile` system call. Disabling
it using `--disable-sendfile` provides a work-around for bogus
implementations of `sendfile`.

`--enable-gnutella`
If you do *not* want the Gnutella spider client compiled in you
need to *disable* this option.

`--enable-crypt`
This option tells Serveez to process any passwords as `crypt`ed.

`--enable-tunnel`
If you enable this feature the port forwarder will be included.
This is useful if you plan to use Serveez as a gateway or firewall
workaround.

`--enable-fakeident`
By enabling this you will get a fake ident server included in the
binary executable.

`--enable-guile-server`
If you enable this feature the user is able to write servers using
Guile.

`--enable-passthrough`
This includes the program passthrough server in the Serveez binary.
The server provides basic inetd functionality.

`--enable-iflist`
If Serveez is unable to detect the correct list of local network in-
terfaces (`serveez -i`) you can disable this option and setup them
manually in the configuration file.

`--enable-heap-count`
This option depends on `--enable-debug`. With the debugging
option disabled there is also no support for heap counters. The
heap counters are used to detect memory leaks in Serveez.

`--enable-libserveez-install`
This causes `make install` to also copy libserveez and its header
files to `$libdir` and `$includedir`, respectively. While Serveez
is in alpha (version less than `0.8.0`), this option is disabled by
default.

For maximum flexibility and reproducibility, we recommend enabling warn-
ings and optimizations specifying `CFLAGS` as a command-line option to the
configure script. For reference, here is the collected set of flags built into previous Serveez releases:

(warnings)
- W -fullwarn -pedantic -ansi
- Wall -Wcast-align -Wstrict-prototypes
- Wformat -Wno-unused -Wno-long-long

(optimizations)
- O2 -fomit-frame-pointer -fstrength-reduce
- funroll-loops -finline-functions
- fexpensive-optimizations -fcaller-saves
- frerun-loop-opt -foptimize-register-move
- ffunction-cse -fpeephole -momit-leaf-frame-pointer
- fschedule-insns2 -m486 -march=pentiumpro -O3

Note that not all flags may be compatible with your compiler or even each other. That’s one of the reasons we no longer take this approach. See Section “Defining Variables” in The Autoconf Manual.

sleepless ~/serveez-0.2.2> ./configure \
CFLAGS='g -O3 -Wall -Wextra'

Now compile the package:

sleepless ~/serveez-0.2.2> make

Install serveez:

You must have root privileges if you want to install the package in the standard location /usr/local or in any location that is only writable by root.

sleepless ~/serveez-0.2.2> make install

If you have problems building the package out of the box this is due to GNU libtool’s inability to handle dynamic linking in most cases. That is why we recommend to try to configure the package with ‘--disable-shared’.

1.2 Environment variables

When using the serveezopt package or playing around with the dynamic server module loader of Serveez you can tell the core API of Serveez (which is the libserveez.[so|dll] library) to use an additional load path to find these server modules. The environment variable ‘SERVEEZ_LOAD_PATH’ holds this information. You can set it up via:

on Unices
sleepless ~> export SERVEEZ_LOAD_PATH=/home/lib:/usr/local/lib

or on Windows
C:\HOME> set SERVEEZ_LOAD_PATH=C:\HOME\LIB;C:\USR\LOCAL\LIB

1.3 Starting Serveez

When Serveez is started it reads its configuration from a file called serveez.cfg in the current directory and runs the server loop afterwards. Press ‘^C’ to abort the execution
of this program. Serveez is not interactive and does not automatically detach from the terminal.

1.4 Command line options

- **h, --help**
  Display this help and exit.

- **V, --version**
  Display version information and exit.

- **L, --list-servers**
  Display prefix and description of each builtin server, one per line, and exit. If Serveez was configured to include the Guile server (see Section 1.1 [Build and install], page 2), the output includes an additional line:
  
  (dynamic) (servers defined in scheme)

- **i, --iflist**
  List local network interfaces and exit.

- **f, --cfg-file=FILENAME**
  File to use as configuration file (serveez.cfg).

- **v, --verbose=LEVEL**
  Set level of logging verbosity.

- **l, --log-file=FILENAME**
  Use FILENAME for logging (default is stderr).

- **P, --password=STRING**
  Set the password for control connections. This option is available only if the control protocol is enabled. See Section 3.4.3 [Control Protocol Server], page 43.

- **m, --max-sockets=COUNT**
  Set the maximum number of socket descriptors.

- **d, --daemon**
  Start as daemon in background.

- **c, --stdin**
  Use standard input as configuration file.

- **s, --solitary**
  Do not start any builtin coserver instances.

1.5 Configuring Serveez

As noted above Serveez is configured via a configuration file which is by default serveez.cfg and can be set by passing the `--f` command line argument. When you pipe a file into Serveez or pass the `--c` argument on the command line the input stream will be used as configuration file no matter whether you passed a `--f` command line switch or not.

To make configuring more fun we did not invent yet another configuration file format. Instead we use a dialect of the Scheme programming language called GNU Guile (http://
www.gnu.org/software/guile/). There is no need to be worried if you are not a programmer. What you have to do is really simple and this document shows you everything you need to know. We also provide many examples. However there are some simple concepts you have to understand. The following paragraphs will explain them.

The idea of the configuration file is this: Serveez starts, runs the configuration file (other applications usually just read them and remember the settings) and finally enters its main loop doing the things you wanted it to.

There are three things you have to do in the configuration file.

1.5.1 Define ports
A port (in Serveez) is a transport endpoint. You might know them from other TCP or UDP server applications. For example: web servers (HTTP) usually listen on TCP port 80. However, there is more than TCP ports: we have UDP, ICMP and named pipes each with different options to set. Every port has a unique name you assign to it. The name of the port is later used to bind servers to it.

The following examples show how you setup different types of port configurations. You start to define such a port using the procedure `define-port!`. The first argument specifies the name of the port configuration. The remaining argument describes the port in detail.

1.5.1.1 Port configuration items
This table describes each configuration item for a port in Serveez. Note that not each item applies to every kind of port configuration.

<table>
<thead>
<tr>
<th>Configuration Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>proto (string)</td>
<td>This is the main configuration item for a port configuration setting up the type of port. Valid values are ‘tcp’, ‘udp’, ‘icmp’, ‘raw’ and ‘pipe’. This configuration item decides which of the remaining configuration items apply and which do not.</td>
</tr>
<tr>
<td>port (integer in the range 0..65535)</td>
<td>The port item determines the network port number on which TCP and UDP servers will listen. Thus it does not make sense for ICMP and named pipes. If you pass ‘0’ Serveez will determine a free port in the range between 1 and 65535.</td>
</tr>
<tr>
<td>recv (string or associative list)</td>
<td>This item describes the receiving (listening) end of a named pipe connection, i.e., the filename of a fifo node to which a client can connect by opening it for writing. Both the recv and send item apply to named pipes only. The value can either be an associative list or a simple filename. Using a simple filename leaves additional options to use default values. They deal mainly with file permissions and are described below.</td>
</tr>
<tr>
<td>send (string or associative list)</td>
<td>This item is the sending end of a named pipe connection. It is used to send data when the receiving (listening) end has detected a connection. The following table enumerates the additional options you can setup if you pass an associative list and not a simple filename.</td>
</tr>
</tbody>
</table>
name (string)
The filename of the named pipe. On Windows systems you can also specify the hostname on which the pipe should be created in the format '\hostname\pipe\name'. By default (if you leave the leading '\hostname\pipe\' part) the pipe will be created on '\\.\pipe\name' which refers to a pipe on the local machine.

permission (octal integer)
This specifies the file permissions a named pipe should be created with. The given number is interpreted in a Unix’ish style (e.g., ‘#0666’ is a permission field for reading and writing for the creating user, all users in the same group and all other users).

user (string)
The file owner (username) of the named pipe in textual form.

group (string)
The file owner group (groupname) of the named pipe in textual form. If this item is left it defaults to the file owner’s primary group.

uid (integer)
The file owner of the named pipe as a user id. You are meant to specify either the uid item or the user item. Serveez will complain about conflicting values.

gid (integer)
The file owner group of the named pipe as a group id. This item defaults to the file owner’s primary group id. You are meant to specify either the gid item or the group item. Serveez will croak about conflicting values.

ipaddr (string)
This configuration item specifies the IP address (either in dotted decimal form e.g., ‘192.168.2.1’ or as a device description which can be obtained via ‘serveez -i’) to which a server is bound to. The ‘*’ keyword for all known IP addresses and the ‘any’ keyword for any IP address are also valid values. The default value is ‘*’. The configuration item applies to network ports (TCP, UDP and ICMP) only.

device (string)
The device configuration item also refers to the IP address a server can be bound to. It overrides the ipaddr item. Valid values are network device descriptions (probably no aliases and no loopback devices). It applies to network ports (TCP, UDP and ICMP) only.

A note on device bindings: Device bindings are based on the SO_BINDTODEVICE socket layer option. This option is not available on all systems. We only tested it on GNU/Linux (2.2.18 and 2.4.17 as of this writing). Device bindings are very restrictive: only root can do it and only physical devices are possible. The loopback device cannot be used and no interface alias (i.e., ‘eth0:0’). A device binding can only be reached from the physical outside but it includes all aliases
for the device. So if you bind to device ‘eth0’ even ‘eth0:0’ (and all other
aliases) are used. The connection has to be made from a remote machine. The
advantage of this kind of binding is that it survives changes of IP addresses.
This is tested for ethernet networks (i.e., eth*) and isdn dialups (i.e., ippp*).
It does not work for modem dialups (i.e., ppp*) (at least for Stefan’s PCMCIA
modem). The problem seems to be the dialup logic actually destroying ppp*.
Other opinions are welcome. Device bindings always win: If you bind to ‘*’
(or an individual IP address) and to the corresponding device, connections are
made with the device binding. The order of the bind-server! statements do
not matter. This feature is not thoroughly tested.

backlog (integer)
The backlog parameter defines the maximum length the queue of pending
connections may grow to. If a connection request arrives with the queue full
the client may receive an error. This parameter applies to TCP ports only.

type (integer in the range 0..255)
This item applies to ICMP ports only. It defines the message type identifier
used to send ICMP packets (e.g., ‘8’ is an echo message i.e., PING).

send-buffer-size (integer)
The send-buffer-size configuration item defines the maximum number of
bytes the send queue of a client is allowed to grow to. The item influences
the “send buffer overrun error condition”. For packet oriented protocols (UDP
and ICMP) you need to specify at least the maximum number of bytes a single
packets can have. For UDP and ICMP this is 64 KByte. The value specified
here is an initial value. It is used unless the server bound to this port changes
it.

recv-buffer-size (integer)
The recv-buffer-size configuration item defines the maximum number of
bytes the receive queue of a client is allowed to grow to. The item influences
the “receive buffer underrun error condition”. The value specified here is an
initial value. It is used unless the server bound to this port changes it.

connect-frequency (integer)
This item determines the maximum number of connections per second the port
will accept. It is a kind of “hammer protection”. The item is evaluated for each
remote client machine separately. It applies to TCP ports.

allow (list of strings)
Both the allow and deny lists are lists of IP addresses in dotted decimal form
(e.g., ‘192.168.2.1’). The allow list defines the remote machines which are
allowed to connect to the port. It applies to TCP ports.

deny (list of strings)
The deny list defines the remote machines which are not allowed to connect to
the port. Each connection from one of these IP addresses will be refused and
shut down immediately. It applies to TCP ports.
1.5.1.2 TCP port definition

Definition of a TCP port configuration with the name `foo-tcp-port`. The enhanced settings are all optional including the `ipaddr` property which defaults to `'*'`. The `ipaddr` item can contain any form of a dotted decimal internet address, a `'*'`, `'any'` or an interface description which you can obtain by running `serveez -i`.

```scheme
(define-port! 'foo-tcp-port '(
  ;; usual settings
  (proto . tcp)    ;; protocol is tcp
  (port . 42421)  ;; network port 42421
  (ipaddr . *)    ;; bind to all known interfaces
  (device . eth0) ;; bind to network card

  ;; enhanced settings
  (backlog . 5)    ;; enqueue max. 5 connections
  (connect-frequency . 1) ;; allow 1 connect per second
  (send-buffer-size . 1024) ;; initial send buffer size in bytes
  (recv-buffer-size . 1024) ;; initial receive buffer size in bytes

  ;; allow connections from these ip addresses
  (allow . (127.0.0.1 127.0.0.2))

  ;; refuse connections from this ip address
  (deny . (192.168.2.7))
))
```

1.5.1.3 Pipe port definition

Definition of a pipe port configuration with the name `foo-pipe-port`. When bound to a server it creates the receiving end and listens on that. If some client accesses this named pipe the server opens the sending end which the client has to open for reading previously.

The only mandatory item is the file name of each pipe. If you want to specify a user creating the named pipe (file ownership) use either the `user` or the `uid` setting. Same goes for the items `group` and `gid`.

```scheme
(define-port! 'foo-pipe-port '(
  ;; protocol is named pipe

  ;; specify the receiving endpoint
  (recv . ((name . "./foo-receive") ;; name of the pipe
    (permissions . #o0666) ;; create it with these permissions
    (user . "calvin") ;; as user "calvin"
    (uid . 50) ;; with the user id 50
    (group . "heros") ;; which is in the group "heros"
    (gid . 100))) ;; with the group id 100

  ;; specify the sending endpoint
  (send . ((name . "./foo-send")
    (permissions . #o0666)

```
1.5.1.4 ICMP port definition
Define an ICMP port configuration which will accept connections from the network interface '
127.0.0.1' only and communicates via the message type 8 as described in the Section 3.4.7
[Tunnel Server], page 47 chapter. The name of this port configuration is foo-icmp-port. When
you are going to bind some server to this kind of port you have to ensure root (or Administrator
under Windows) privileges.

(define-port! 'foo-icmp-port '((proto . icmp)
   (ipaddr . 127.0.0.1)
   (type . 8)))

1.5.1.5 UDP port definition
Simple definition of a UDP port configuration with the name foo-udp-port.

(define-port! 'foo-udp-port '((proto . udp)
   (port . 27952)))

1.5.2 Define servers
A server (in Serveez) is a snippet of code that implements some protocol. There are many
servers built into Serveez but you can implement your own, too. For example we provide
a webserver implementing the Hypertext Transfer Protocol (HTTP). Each server has a
different set of options you can change. You can have many instances of every server, each
with a different set of options. For example: You can create a webserver on TCP port 42420
publishing the Serveez documentation and also have another webserver on a different port
publishing something else. Every server has a unique name you assign to it. The name of
the server is later used to bind it to a port.

The following example instantiates a server with the short name “foo”. Each server in
Serveez has got a short name. See Section 3.4 [Existing servers], page 37, for the details.
This example demonstrates everything which is possible in server configurations. You start a
definition of a server with the procedure define-server!. The following argument specifies
the name of the server instance (in this case foo-server) which starts with the short name.
The second argument describes the server in detail. Each configuration item is setup with a
(key . value) pair where key is the name of the configuration item and value is the value
which depends on the type of the item. See Section 3.3 [Configuring servers], page 36, for
a detailed description of each type of value.

(define-server! 'foo-server '(;
   (bar . 100) ;; number
   (reply . "Booo") ;; character string
   (messages . ;; list of strings
      ("Welcome to the foo test server."
       "This one echos your lines."))
   (ports . (5 6 7 8 9))) ;; list of numbers
Serveez provides a number of server types. Each of them has a short name. The name 
of the server instance has to begin with this short name followed by a dash (-). You can
append any suffix then. In the example above “foo” is the short name and foo-server
the name of the server instance.

1.5.3 Bind servers to ports

Finally you can bind servers to ports. When you do so the server you created listens on
the port, accepts connections and serves clients. It does so as soon as Serveez enters its
main loop right after running the configuration file. Serveez won’t stop until you interrupt
it (e.g., by pressing ^C in the terminal you started it in).

This example binds the server foo-server (s.a.) to the port foo-tcp-port which was
described above. Therefore you need to call the procedure bind-server! which takes two
arguments specifying the name of a port configuration and a server instance. Both need to
be defined before you can write this statement.

(bind-server! 'foo-tcp-port 'foo-server)

One of the main features of Serveez is that you can bind multiple servers to the same
port. This for example is useful to pass braindead firewall configurations or proxy servers.
It is also possible to bind servers to ports they are actually not designed for. This might be
used for debugging servers or other funny things (again, think about the firewall). This is
the point we have to warn you: Some protocols cannot share the same port (e.g., the tunnel
server) and some protocols simply won’t work on ‘wrong’ ports. Additionally, you will not
get error messages when that happens. The server just will not work then.

1.5.4 Additional configuration possibilities

The three procedures define-port!, define-server! and bind-server! return #t on
success and #f on failure. For your convenience we provide some more built-in procedures,
some of which are based upon those above.

1.5.4.1 output

fs s [args...]  [Scheme Procedure]
Return a string made by applying simple-format #f to s and args. For example:
(fs "~A-~S" 'foo 42)
⇒ "foo-42"

println [object...]  [Scheme Procedure]
Do display on each object. Then, output a newline.

printsln spacer [object...]  [Scheme Procedure]
For each object, do display on it and on spacer, as well. Then, output a newline.
1.5.4.2 augmenting

interface-add! *interface*  [Scheme Procedure]
Add *interface* to the list of known network interfaces. You can get the list of known interfaces by running the shell command `serveez -i`. The *interface* argument must be in dotted decimal form (e.g., `127.0.0.1`). Serveez provides this procedure for systems where it is unable to detect the list of network interface automatically.

loadpath-add! *dir...*  [Scheme Procedure]
Append *dir...* to the server modules load path.

serveez-load *filename*  [Scheme Procedure]
Try to load *filename* (via primitive-load). If *filename* is not absolute, search for it in the list of directories returned by serveez-loadpath. Return #t if successful, #f otherwise.

1.5.4.3 abstractions

bind-servers! *args...*  [Scheme Procedure]
Bind all servers and ports in *args* to each other. This is a cross-product operation; given *s* servers, and *p* ports, *s* * p bindings will be created.

create-tcp-port! *basename* *port*  [Scheme Procedure]
Define a new TCP port named by concatenating *basename* and *port*. Return the new name.

bind-tcp-port-range! *from* to *to* *servers...*  [Scheme Procedure]
Bind the list of *servers* to simple TCP port configurations whose network ports range between *from* and *to* both inclusive.

create-udp-port! *basename* *port*  [Scheme Procedure]
Define a new UDP port named by concatenating *basename* and *port*. Return the new name.

bind-udp-port-range! *from* to *to* *servers...*  [Scheme Procedure]
Bind the list of *servers* to simple UDP port configurations whose network ports range between *from* and *to* both inclusive.

1.5.4.4 rpc

getrpcent  [Scheme Procedure]
Return the next RPC entry as a vector of the form: #$(*name* *aliases* *program-number*). *name* is a symbol, *aliases* is a list (possibly empty) of symbols, and *program-number* is an integer. If the list is exhausted, return #f.

getrpcbyname *name*  [Scheme Procedure]
Return the RPC entry for *name*, a string. (FIXME: Should be able to handle a symbol, too.) If no such service exists, signal error.

getrpcbynumber *number*  [Scheme Procedure]
Return the RPC entry for *number*, an integer. If no such service exists, signal error.
**setrpcent** [stayopen] 

Open and rewind the file `/etc/rpc`. If optional arg `stayopen` (an integer) is non-zero, the database will not be closed after each call to `getrpc` (or its derivatives `getrpcent`, `getrpcbyname`, `getrpcbynumber`).

**endrpcent**

Close the file `/etc/rpc`.

1.5.4.5 misc

**serveez-verbosity** [level]

Return the verbosity level (an integer). Optional arg `level` means set it to that level, instead. This setting is overridden by the command-line `-v` option.

**serveez-maxsockets** [max]

Return the maximum number of open sockets permitted (an integer). Optional arg `max` means set it to that number, instead. This setting is overridden by the command-line `-m` option.

**serveez-passwd** [pw]

Return the control password (a string). Optional arg `pw` sets it to that, instead. This effectively does nothing if the control protocol is not enabled.

We now have a closer look at the internals of Serveez. If you are not interested in that have a look at the existing servers (See Section 3.4 [Existing servers], page 37.).
2 Concept

2.1 Overall concept

The primary functionality Serveez provides is a framework for Internet services. It can act as a kind of server collection and may even replace super-servers such as the inetd daemon. Its key features and benefits are:

- support for packet and connection oriented protocols
  Serveez currently supports two server types. TCP and named pipe servers are connection oriented servers. This type of server accepts a client’s connection request and communicates with it using a dedicated connection. The format of the incoming and outgoing data streams are irrelevant to Serveez. Packet oriented servers (like UDP and ICMP) receive data packets and respond to the sender with data packets. A server in Serveez can detect whether it is bound to a packet or connection oriented port configuration and thus can act as the expected type.

- server and client functionality
  Besides a wide variety of server capabilities, Serveez also contains some client functionality. This may be necessary when a server is meant to establish a connection to another server in response to an incoming request. For example, imagine a protocol where a client tells the server, “Let me be the server. Please connect to this host at this port”. You are also able to implement pure clients.

- platform portability
  When writing this software the authors were always mindful of platform portability. Serveez compiles and runs on various Unix platforms as well as on Windows systems. See Chapter 6 [Porting issues], page 83, for details. Most of the routines in the core library can be used without regard to the platform on which you are programming or the details of its underlying system calls. Exceptions are noted in the documentation. Platform portability also means that the server code you write will run on other systems, too.

- powerful configuration capabilities
  Server configuration has always been a complicated but very important issue. When Serveez starts up it runs the configuration file using the programming language Guile. In contradiction, other (server) applications just read their configuration files and remember the settings in it. This makes them powerful enough to adapt the Serveez settings dynamically. Using the Guile interpreter also means that you can split your configuration into separate files and load these, perhaps conditionally, from the main configuration file.

- easy server implementation
  Serveez is a server framework. When implementing a new server the programmer need pay little or no attention to the networking code but is free to direct his attention to the protocol the server is meant to support. That protocol may be an established one such as HTTP, or may be a custom protocol fitting the specific application’s requirements. The Section 3.2 [Writing servers], page 19 section describes this process in detail.

- code reusability
  The Serveez package comes along with a core library (depending on the system this
is a static library, shared library or a DLL) and its API which contains most of the functionality necessary to write an Internet server. Most probably, a programmer can also use the library for other (network programming related) purposes.

- server instantiation and network port sharing
  Once you have written a protocol server and integrated into Serveez’s concept of servers the user can instantiate (multiply) the server. At the first glimpse this sounds silly, but with different server configurations it does not. If, for example, an administrator wishes to run multiple HTTP servers with different document roots, Serveez will handle them all in a single process. Also if the same administrator wants to run a HTTP server and some other server on the same network port this is possible with Serveez. You can run a single server on different network ports, too.

### 2.2 I/O Strategy

Serveez’s I/O strategy is the traditional select method. It is serving many clients in a single server thread. This is done by setting all network handles to non-blocking mode. We then use select to tell which network handles have data waiting. This is the traditional Unix style multiplexing.

An important bottleneck in this method is that a `read` or `sendfile` from disk blocks if the data is not in core at the moment. Setting non-blocking mode on a disk file handle has no effect. The same thing applies to memory-mapped disk files. The first time a server needs disk I/O, its process blocks, all clients have to wait, and raw non-threaded performance may go to waste.

Unfortunately, `select` is limited to the number of FD_SETSIZE handles. This limit is compiled into the standard library, user programs and sometimes the kernel. Nevertheless, Serveez is able to serve about one thousand and more clients on GNU/Linux, a hundred on Win95 and more on later Windows systems.

We chose this method anyway because it seems to be the most portable.

An alternative method to multiplex client network connections is `poll`. It is automatically used when `configure` finds `poll` to be available. This will work around the builtin (g)libc’s `select` file descriptor limit.

#### 2.2.1 Limits on open filehandles

**Any Unix**  The limits set by `ulimit` or `setrlimit`.

**Solaris**  See the Solaris FAQ, question 3.45.

**FreeBSD**  Use `sysctl -w kern.maxfiles=nnnn` to raise limit.

**GNU/Linux**

See Bodo Bauer’s /proc documentation. On current 2.2.x kernels,

```bash
echo 32768 > /proc/sys/fs/file-max
```

increases the system limit on open files, and

```bash
ulimit -n 32768
```

increases the current process’ limit. We verified that a process on Linux kernel 2.2.5 (plus patches) can open at least 31000 file descriptors this way. It has also been verified that a process on 2.2.12 can open at least 90000 file descriptors
this way (with appropriate limits). The upper bound seems to be available memory.

Windows 9x/ME
On Win9x machines, there is quite a low limit imposed by the kernel: 100 connections system wide (!). You can increase this limit by editing the registry key HKLM\System\CurrentControlSet\Services\VxD\MSTCP\MaxConnections. On Windows 95, the key is a DWORD; on Windows 98, it’s a string. We have seen some reports of instability when this value is increased to more than a few times its default value.

Windows NT/2000
More than 2000 connections tested. It seems like the limit is due to available physical memory.

2.3 Alternatives to Serveez’s I/O strategy
One of the problems with the traditional select method with non-blocking file descriptors occurs when passing a large number of descriptors to the select system call. The server loop then goes through all the descriptors, decides which has pending data, then reads and handles this data. For a large number of connections (say, 90000) this results in temporary CPU load peaks even if there is no network traffic.

Along with this behaviour comes the problem of “starving” connections. Connections which reside at the beginning of the select set are processed immediately while those at the end are processed significantly later and may possibly die because of buffer overruns. This is the reason why Serveez features priority connection: it serves listening sockets first and rolls the order of the remaining connections. In this way, non-priority connections are handled in a “round robin” fashion.

Other server implementations solve these problems differently. Some start a new process for each connection (fully-threaded server) or split the select set into pieces and let different processes handle them (threaded server). This method shifts the priority scheduling to the underlying operating system. Another method is the use of asynchronous I/O based upon signals where the server process receives a signal when data arrives for a connection. The signal handler queues these events in order of arrival and the main server loop continuously processes this queue.
3 Server

3.1 Introduction to servers

Serveez is a kind of server server. It allows different protocol servers to listen on various TCP/UDP ports, on ICMP sockets and on named pipes. Servers are instantiated with a certain configuration. It is possible to run multiple different servers on the same port.

This chapter covers all questions about how to write your own Internet protocol server with this package. Most of the common tasks of such a server have got a generic solution (default routines) which could be “overridden” by your own routines. There are some examples within this package. They are showing the possibilities with this package and how to implement servers.

The ‘foo’ server does not do anything at all and is of no actual use but could be a basis for a new protocol server. We are now going to describe how this specific server works. Eventually the reader might get an impression of what is going on.

For better understanding the text below we will use the following terminology:

server definition
A server definition is a \texttt{svz\_servertype\_t} structure which contains server specific members like its name, different callbacks, a single default configuration and a list of configuration items which determines what can be configured.

server configuration
A server configuration can be any kind of structure. The default server configuration must be specified within the server definition (see above). When instantiating a server (which is done via the configuration file) the configuration items specified in the server definition get processed and are put into a copy of the default configuration. Thus we get an instance.

server instance
A server instance is a copy of the server definition including the modified server configuration. A server gets instantiated by the configuration file parser. The concept of server instances has been introduced because we wanted Serveez to have the following features. A single server can have multiple instances with different behaviour due to different server configurations. A server instance can be bound to multiple port configurations. Different server instances (of the same and/or different server type) can share the same port configuration.

port configuration
A port configuration in Serveez is represented by the \texttt{svz\_portcfg\_t} structure. Depending on a shared flag it contains different type of information specifying a transport endpoint. See Section 1.5.1 [Define ports], page 7, for more on this topic. It also can be a special configuration item within a server configuration. This is necessary if a server needs for some reason a remote transport endpoint. A server instance does not usually need to know about the port configuration it is bound to.
3.2 Writing servers

Serveez is meant to be a server framework. That is why it supports various ways to implement Internet servers. First of all there are some servers already included in the main serveez package (see Section 3.4 [Existing servers], page 37). These are called ‘Builtin servers’. Another possibility to add a new server are ‘Embedded servers’ which are shared libraries (or DLL’s) containing the server implementation. These can be dynamically loaded by Serveez at runtime. This kind of server is also called ‘Server modules’. A third possibility are the ‘Guile servers’ which allow even unexperienced schemers to write an Internet server.

This section describes each of the above possibilities in detail.

3.2.1 Embedded servers

The core library of Serveez can be used to write standalone server modules. Serveez defines a certain interface for shared libraries which contain such server modules. If Serveez detects an unknown server type (server type which is not builtin) in its configuration file it tries to load a shared library containing this server type during startup.

3.2.1.1 Prerequisites

In order to implement a server module you need an existing installation of Serveez. This can be achieved issuing the following commands:

```
$ ./configure --enable-shared --prefix=/usr/local
$ make
$ make install
```

After successful installation you are able to compile and link against the Serveez core API. The headers should be available in `/usr/local/include` and the library itself (`libserveez.so` or `libserveez.dll`) is located in `/usr/local/lib` if you passed the configure script ‘--prefix=/usr/local’.

3.2.1.2 Server definition

The interface mentioned in the introduction is defined via the extern declaration of the server type in the shared library of the server module. Imagine you want to implement a server type called ‘foo’. This requires the external symbol `foo_server_definition` in the shared library. You can achieve this inserting the following lines into your header file:

```
/* Either Unices. */
extern svz_servertype_t foo_server_definition;

/* Or Windows. */
__declspec(dllexport) extern svz_servertype_t foo_server_definition;
```

The data symbol `foo_server_definition` must be statically filled with the proper content (See Section 3.2.3 [Builtin servers], page 32.)

3.2.2 Guile servers

This section describes the Guile interface to Serveez which provides the ability to write servers with Guile. Of course, you could do this without any help from Serveez, but it
makes the task a lot easier. This interface reduces the Guile implementation of an Internet server to a simple data processor.

3.2.2.1 Underlying libserveez

libserveez-features

Return a list of symbols representing the features of the underlying libserveez. For details, See Section 5.2.1 [Library features], page 57.

3.2.2.2 Special Data Types

Serveez extends Guile by various new data types which represent internal data structures of Serveez’s core API.

- #<svz-server-type> represents a server type.
- #<svz-server> represents a server (an instance of a server type).
- #<svz-socket> represents a socket structure.

3.2.2.3 Passing Binary Data

The new binary data type (#<svz-binary>) provides access to any kind of unstructured data. It manages the data exchange between Guile and Serveez. There are some conversion procedures for strings and lists which help to process this binary data in a more complex (guile’ish) way.

binary->string binary

Convert the given binary smob binary into a string. Return the string itself.

string->binary string

Convert the given string into a binary smob. The data pointer of the binary smob is marked as garbage which must be free’d in the sweep phase of the garbage collector.

binary? obj

Return #t if obj is an instance of the binary smob type.

list->binary list

Convert the scheme list list into a binary smob. Each of the elements of list is checked for validity. The elements can be either exact numbers in a byte’s range or characters.

binary->list binary

Convert the given binary smob binary into a scheme list. The list is empty if the size of binary is zero.

binary-search binary needle

Search through the binary smob binary for needle, which can be an exact number, character, string or another binary smob. Return #f if the needle could not be found, or a positive number indicating the position of the first occurrence of needle in the binary smob binary.

binary-set! binary index value

Set the byte at position index of the binary smob binary to the value given in value which can be either a character or an exact number.
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binary-ref binary index [Scheme Procedure]
Obtain the byte at position index of the binary smob binary.

binary-length binary [Scheme Procedure]
Return the size in bytes of the binary smob binary.

binary-concat! binary append [Scheme Procedure]
Append either the binary smob or string append onto the binary smob binary. If binary has been a simple data pointer reference it is then a standalone binary smob as returned by string->binary.

binary-subset binary start [end] [Scheme Procedure]
Create a subset binary smob from the given binary smob binary. The range of this subset is specified by start and end both inclusive (thus the resulting size is end - start + 1). With a single exception: If end is not given or specified with -1, return all data until the end of binary.

binary-reverse binary [Scheme Procedure]
Return a new binary smob with the reverse byte order of the given binary smob binary.

binary-reverse! binary [Scheme Procedure]
Perform an in-place reversal of the given binary smob binary and return it.

binary-long-ref binary index [Scheme Procedure]
Return the long value of the binary smob binary at the array index index.

binary-long-set! binary index value [Scheme Procedure]
Set the long value of the binary smob binary at the array index index to the given value value. Return the previous (overridden) value.

binary-int-ref binary index [Scheme Procedure]
Return the int value of the binary smob binary at the array index index.

binary-int-set! binary index value [Scheme Procedure]
Set the int value of the binary smob binary at the array index index to the given value value. Return the previous (overridden) value.

binary-short-ref binary index [Scheme Procedure]
Return the short value of the binary smob binary at the array index index.

binary-short-set! binary index value [Scheme Procedure]
Set the short value of the binary smob binary at the array index index to the given value value. Return the previous (overridden) value.

binary-char-ref binary index [Scheme Procedure]
Return the char value of the binary smob binary at the array index index.

binary-char-set! binary index value [Scheme Procedure]
Set the char value of the binary smob binary at the array index index to the given value value. Return the previous (overridden) value.
3.2.2.4 Server Definition

In order to set up a new server type, you use the procedure `define-servertype!`. This procedure takes one argument which must be an associative list specifying the server type in detail. There are optional and mandatory elements you can set up in this alist.

The following example shows the overall syntax of this procedure:

```
(define-servertype! '(
    ;; Mandatory: server type prefix for later use in (define-server!)
    (prefix . "foo")

    ;; Mandatory: server type description
    (description . "guile foo server")

    ;; Mandatory for TCP and PIPE servers: protocol detection
    (detect-proto . foo-detect-proto)

    ;; Optional: global server type initialisation
    (global-init . foo-global-init)

    ;; Optional: server instance initialisation
    (init . foo-init)

    ;; Optional: server instance finalisation
    (finalize . foo-finalize)

    ;; Optional: global server type finalisation
    (global-finalize . foo-global-finalize)

    ;; Mandatory for TCP and PIPE servers: socket connection
    (connect-socket . foo-connect-socket)

    ;; Optional: server instance info
    (info-server . foo-info-server)

    ;; Optional: client info
    (info-client . foo-info-client)

    ;; Optional: server instance reset callback
    (reset . foo-reset)

    ;; Optional: server instance notifier
    (notify . foo-notify)

    ;; Mandatory for UDP and ICMP servers: packet handler
    (handle-request . foo-handle-request)
)
```
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;; Mandatory: server type configuration (may be an empty list)
/configuration . (  

;; The server configuration is an alist (associative list) again.
;; Each item consists of an item name and a list describing the
;; item itself.
;; Syntax: (key . (type defaultable default))
(foo-integer . (integer #t 0))
(foo-integer-array . (intarray #t (1 2 3 4 5)))
(foo-string . (string #t "default-foo-string"))
(foo-string-array . (strarray #t ("guile" "foo" "server")))
(foo-hash . (hash #t ("foo" . "bar")))
(foo-port . (portcfg #t foo-port))
(foo-boolean . (boolean #t #t))
))

**define-servertype! args**  
[Scheme Procedure]  
Define a new server type based on args. (If everything works fine you have a freshly
registered server type afterwards.) Return #t on success.

#### 3.2.2.5 Predefined Procedures

The following subset of procedures may be used to implement a Guile server. They should
be used within the callbacks defined in the define-servertype! procedure. Each of these
callbacks gets passed the appropriate arguments needed to stuff into the following proce-
dures. Please have a look at the example Guile servers for the details.

**svz:sock? sock**  
[Scheme Procedure]  
Return #t if the given cell sock is an instance of a valid #<svz-socket>, otherwise
#f.

**svz:sock:check-request sock [proc]**  
[Scheme Procedure]  
Set the check-request member of the socket structure sock to proc. Return the
previously handler if there is any.

**svz:sock:check-oob-request sock [proc]**  
[Scheme Procedure]  
Set the check-oob-request callback of the given socket structure sock to proc, re-
turning the previous callback (if there was any set before). The callback is run
whenever urgent data (out-of-band) has been detected on the socket.

**svz:sock:send-oob sock oob**  
[Scheme Procedure]  
Send byte oob as urgent (out-of-band) data through the underlying TCP stream of
TCP sock. Return #t on successful completion and otherwise (either it failed to send
the byte or the passed socket is not a TCP socket) #f.

**svz:sock:handle-request sock [proc]**  
[Scheme Procedure]  
Set the handle-request member of the socket structure sock to proc. Return the
previously set handler if there is any.
**svz:sock:boundary** sock boundary

Set up the packet boundary of the socket `sock`. The given string value `boundary` can contain any kind of data. If `boundary` is an exact number, set up the socket to parse fixed sized packets. More precisely, set the check-request callback of the given socket structure `sock` to an internal routine which runs the socket's handle-request callback when it detects a complete packet specified by `boundary`.

For instance, you can arrange for Serveez to pass the handle-request to pass the boundary to the socket by calling `(svz:sock:boundary sock "\n")`.

**svz:sock:floodprotect** sock [flag]

Set or unset the flood protection bit of the given socket `sock`. Return the previous value of this bit (`#t` or `#f`). The flag argument must be either boolean or an exact number and is optional.

**svz:sock:print** sock buffer

Write `buffer` (string or binary smob) to the socket `sock`. Return `#t` on success and `#f` on failure.

**svz:sock:final-print** sock

Schedule the socket `sock` for shutdown after all data within the send buffer queue has been sent. You should call this right before the last call to `svz:sock:print`.

**svz:sock:no-delay** sock [enable]

Turn the Nagle algorithm for the TCP socket `sock` on or off depending on the optional `enable` argument. Return the previous state of this flag (`#f` if Nagle is active, `#t` otherwise). By default this flag is switched off. This socket option is useful when dealing with small packet transfer in order to disable unnecessary delays.

**svz:sock:send-buffer** sock

Return the send buffer of the socket `sock` as a binary smob.

**svz:sock:send-buffer-size** sock [size]

Return the current send buffer size and fill status in bytes of the socket `sock` as a pair of exact numbers. If the optional argument `size` is given, set the send buffer to the specified size in bytes.

**svz:sock:receive-buffer** sock

Return the receive buffer of the socket `sock` as a binary smob.

**svz:sock:receive-buffer-size** sock [size]

Return the current receive buffer size and fill status in bytes of the socket `sock` as a pair of exact numbers. If the optional argument `size` is given, set the receive buffer to the specified size in bytes.

**svz:sock:receive-buffer-reduce** sock [length]

Dequeue `length` bytes from the receive buffer of the socket `sock`, or all bytes if `length` is omitted. Return the number of bytes actually shuffled away.
svz:sock:connect host proto [port]

Establish a network connection to the given host [port]. If proto equals PROTO_ICMP the port argument is ignored. Valid identifiers for proto are PROTO_TCP, PROTO_UDP and PROTO_ICMP. The host argument must be either a string in dotted decimal form, a valid hostname or an exact number in host byte order. When giving a hostname this operation might block. The port argument must be an exact number in the range from 0 to 65535, also in host byte order. Return a valid #<svz-socket> or #f on failure.

svz:sock:disconnected sock [proc]

Set the disconnected-socket member of the socket structure sock to proc. The given callback runs whenever the socket is lost for some external reason. Return the previously set handler if there is one.

svz:sock:kicked sock [proc]

Set the kicked-socket callback of the given socket structure sock to proc and return any previously set procedure. This callback gets called whenever the socket gets closed by Serveez intentionally.

svz:sock:trigger sock [proc]

Set the trigger callback of the socket structure sock to proc and return any previously set procedure. The callback is run when the trigger-condition callback returns #t.

svz:sock:trigger-condition sock [proc]

Set the trigger-condition callback for the socket structure sock to proc. Return the previously set procedure if available. The callback is run once every server loop indicating whether the trigger callback should be run or not.

svz:sock:idle sock [proc]

Set the idle callback of the socket structure sock to proc. Return any previously set procedure. The callback is run by the periodic task scheduler when the idle-counter of the socket structure drops to zero. If this counter is not zero it gets decremented once a second. The idle callback can reset idle-counter to some value and thus can re-schedule itself for a later task.

svz:sock:idle-counter sock [counter]

Return the socket structure sock’s current idle-counter value. If the optional argument counter is given, the set the idle-counter. Please have a look at the svz:sock:idle procedure for the exact meaning of this value.

svz:sock:parent sock [parent]

Return the given socket’s sock parent and optionally set it to the socket parent. Return either a valid #<svz-socket> object or an empty list.

svz:sock:referrer sock [referrer]

Return the given socket’s sock referrer and optionally set it to the socket referrer. Return either a valid #<svz-socket> or an empty list.
svz:sock:server sock [server] [Scheme Procedure]
Return the #<svz-server> object associated with the given argument sock. The optional argument server can be used to redefine this association and must be a valid #<svz-server> object. For a usual socket callback like connect-socket or handle-request, the association is already in place. But for sockets created by svz:sock:connect, you can use it in order to make the returned socket object part of a server.

svz:sock:local-address sock [address] [Scheme Procedure]
Return the current local address as a pair like (host . port) with both entries in network byte order. If you pass the optional argument address, you can set the local address of the socket sock.

svz:sock:remote-address sock [address] [Scheme Procedure]
Return the current remote address as a pair like (host . port) with both entries in network byte order. If you pass the optional argument address, you can set the remote address of the socket sock.

svz:sock:find ident [Scheme Procedure]
Return the #<svz-socket> specified by ident, a pair of integers in the form (identification . version). If that socket no longer exists, return #f.

svz:sock:ident sock [Scheme Procedure]
Return a pair of numbers identifying the given #<svz-socket> sock, which can be passed to svz:sock:find. This may be necessary when you are passing a #<svz-socket> through coserver callback arguments in order to verify that the passed #<svz-socket> is still valid when the coserver callback runs.

svz:sock:protocol sock [Scheme Procedure]
Return one of the PROTO_TCP, PROTO_UDP, PROTO_ICMP, PROTO_RAW or PROTO_PIPE constants indicating the type of the socket structure sock. If there is no protocol information available, return #f.

svz:read-file port size [Scheme Procedure]
Return either a binary smob containing a data block read from the open input port port with a maximum number of size bytes, or the end-of-file object if the underlying ports end has been reached. The size of the returned binary smob may be less than the requested size size if it exceed the current size of the given port port. Throw an exception if an error occurred while reading from the port.

svz:server? server [Scheme Procedure]
Return #t if the given cell server is an instance of a valid #<svz-server>, otherwise #f.

svz:server:listeners server [Scheme Procedure]
Return a list of listening #<svz-socket> smobs to which the given server instance server is currently bound, or an empty list if there is no such binding yet.

svz:server:clients server [Scheme Procedure]
Return a list of #<svz-socket> client smobs associated with the given server instance server in arbitrary order, or an empty list if there is no such client.
svz:server:config-ref server key  [Scheme Procedure]
Return the configuration item specified by key of the given server instance server. You can pass this procedure a socket, too, in which case the appropriate server instance is looked up. If the given string key is invalid (not defined in the configuration alist in define-servertype!), then return an empty list.

serveez-port? name  [Scheme Procedure]
Return #t if the given string name corresponds with a registered port configuration, otherwise #f.

serveez-server? name  [Scheme Procedure]
Check whether the given string name corresponds with an instantiated server name and return #t if so.

serveez-servertype? name  [Scheme Procedure]
Check whether the given string name is a valid server type prefix known in Serveez and return #t if so. Otherwise return #f.

serveez-exceptions [enable]  [Scheme Procedure]
Control the use of exception handlers for the Guile procedure calls of Guile server callbacks. If the optional argument enable is #t, enable exception handling; if #f, disable it. Return the current (boolean) setting.

serveez-nuke [exit-value]  [Scheme Procedure]
Shutdown all network connections and terminate after the next event loop. You should use this instead of calling quit. Optional arg exit-value specifies an exit value for the serveez program. It is mapped to a number via scm_exit_value.

serveez-loadpath [args]  [Scheme Procedure]
Make the search path for the Serveez core library accessible to Scheme. Return a list a each path as previously defined. If args is specified, override the current definition of this load path with it. The load path is used to tell Serveez where it can find additional server modules.

serveez-interfaces [args]  [Scheme Procedure]
Make the list of local interfaces accessible to Scheme. Return the local interfaces as a list of ip addresses in dotted decimal form. If args are specified, they are added as additional local interfaces.

getrpc [arg]  [Scheme Procedure]
Lookup a network rpc service arg (name or service number), and return a network rpc service object. If given no arguments, it behave like getrpcent.

setrpc [stayopen]  [Scheme Procedure]
Open and rewind the file /etc/rpc. If the stayopen flag is non-zero, the net data base will not be closed after each call to getrpc. If stayopen is omitted, this is equivalent to calling endrpcent. Otherwise it is equivalent to calling setrpcent with arg 1.

portmap prognum versnum [protocol [port]]  [Scheme Procedure]
Establish a (portmap service) mapping between the triple [prognum, versnum, protocol] and port on the machine’s portmap service. The value of protocol is most likely
IPPROTO_UDP or IPPROTO_TCP. If instead protocol and port are omitted, destroy all mapping between the triple [prognum,versnum,*] and ports on the machine’s portmap service.

**portmap-list** [address]  
[Scheme Procedure]  
Return a list of the current RPC program-to-port mappings on the host located at IP address address, which defaults to the local machine’s IP address. Return an empty list if either there is no such list available or an error occurred while fetching the list.

**svz:coserver:dns** host callback  
[Scheme Procedure]  
Enqueue the host string argument into the internal DNS coserver queue. When the coserver responds, the procedure callback is run as (callback addr). The addr argument passed to the callback is a string representing the appropriate IP address for the given hostname host.

**svz:coserver:reverse-dns** addr callback  
[Scheme Procedure]  
Enqueue the given addr argument, which must be an IP address in network byte order, into the internal reverse DNS coserver queue. When the coserver responds, the procedure callback is run as (callback host) where host is the hostname of the requested IP address addr.

**svz:coserver:ident** sock callback  
[Scheme Procedure]  
Enqueue the given #<svz-socket> sock into the internal ident coserver queue. When the coserver responds, it runs the procedure callback as (callback user), where user is the corresponding username for the client connection sock.

### 3.2.2.6 Callback Prototypes

The Guile interface of Serveez is completely callback driven. Callbacks can be set up in the associative list passed to **define-servertype!**, or by using the predefined procedures described in the previous section. Each of the callbacks is passed certain arguments and is meant to return specific values to indicate success or failure. This section describes each of these callbacks.

**global-init** servertype  
[Scheme Procedure]  
This callback is invoked once for every type of server right after the **define-servertype!** statement. Here you can initialise resources shared between all instances of your server type. The callback is optional and can be set up in **define-servertype!**. It should return zero to indicate success and non-zero to indicate failure. If the global initialiser fails, Serveez will refuse to register the server type.

**global-finalize** servertype  
[Scheme Procedure]  
If you want to free shared resources, which were possibly allocated within the global initialiser, you can do so here. The callback is invoked when Serveez shuts down (issued by **serveez-nuke**) or the server type gets unregistered for some reason. It should return zero to signal success. The callback can be set up in **define-servertype!** and is optional.
init server

Within this callback you can initialise everything you might need for a single instance of your server. The callback is invoked for each server instance which has been created by define-server! and should return zero to indicate success, otherwise Serveez rejects the server instance. The callback can be set up in define-servertype! and is optional.

finalize server

The server instance finaliser gets its instance representation passed as argument. You need to free all resources used by this server instance which might have been allocated within the server instance initialiser or consumed while running. You can set this callback in the define-servertype! statement. The callback is optional and should return zero to indicate success.

detect,proto server socket

Connection oriented protocols like TCP and PIPE allow more than one server to be listening on the same network port. Therefore, it is necessary to be able to detect the type of client connecting to a port.

This callback takes two arguments; the first is the server instance and the second is the client socket object containing the client connection information. You can set up this callback in the define-servertype! statement.

Serveez may invoke this callback several times as data becomes available from the client until one of the servers recognises it. The servers can retrieve the data received so far using the svz:sock:receive-buffer call.

To indicate successful client detection, you need to return a non-zero value. (Note that for historical reasons, this is inconsistent with other procedures which return zero on successful completion.) Once the server has indicated success, Serveez invokes any further callbacks for the connection only on that server.

If no server has recognised the client after the first 16 bytes, Serveez will close the connection. The connection will also be closed if the client has not sent enough data for a server to recognise it within 30 seconds of connecting.

If multiple servers are listening on the same network port, Serveez invokes this callback for each of them in an arbitrary order. Only one server at most should indicate successful detection.

This callback is mandatory for servers which get bound to connection oriented protocol (TCP and PIPE) port configurations by bind-server!.

connect-socket server socket

If the client detection signalled success, this callback is invoked to assign the client connection to a server instance. The arguments are the same as the detection callback. In this callback you can assign all the connection specific callbacks for your server and perform some initial tasks. Basically you should specify the handle-request and/or check-request callback. This can be achieved by calling svz:sock:handle-request and svz:sock:check-request. The connect-socket callback is also mandatory for connection oriented protocols and must be defined in define-servertype!. On success you should return zero, otherwise the connection will be shutdown by Serveez.
**info-server** server

This callback gets invoked when requested by the builtin Section 3.4.3 [Control Protocol Server], page 43. The callback is optional and can be set up in `define-servertype!`. The returned character string can be multiple lines separated by \r\n (but without a trailing separator). Usually you will return information about the server instance configuration and/or state.

**info-client** server socket

This callback is optional. You can set it up in the `define-servertype!` procedure. It is meant to provide socket structure specific information. (The socket structure is a client/child of the given server instance.) You need to return a single line character string without trailing newlines. The information provided can be requested by the builtin Section 3.4.3 [Control Protocol Server], page 43.

**notify** server

The server instance notifier callback will be invoked whenever there is idle time available. In practice, it is run approximately once a second. A server instance can use it to perform periodic tasks. The callback is optional and can be set up in `define-servertype!`.

**reset** server

This callback is invoked when the Serveez process receives a SIGHUP signal which can be issued via `killall -HUP serveez` from user land. If the underlying operating system does not provide SIGHUP there is no use for this callback. It provides the possibility to perform asynchronous tasks scheduled from outside Serveez. You can optionally set it up in the `define-servertype!` procedure.

**handle-request** socket binary size

This callback is invoked whenever a complete packet has been detected in the receive buffer. The packet data is passed to the callback as a `#<svz-binary>`. The `size` argument is passed for convenience and specifies the length of the packet in bytes.

The detection, and therefore the invocation, can be made in one of two ways. When Serveez can determine itself when a packet is complete, the callback will be invoked directly. Serveez can make this determination for connections with packet oriented protocols such as UDP and ICMP, or if you tell Serveez how to parse the packet using `svz:sock:boundary sock delimiter` or `svz:sock:boundary sock size` and do not specify a `check-request` callback.

Whenever you specify a `check-request` callback to determine when a packet is complete, it becomes the responsibility of that callback to invoke `handle-request` itself. Serveez recognises two different return value meanings. For connection oriented protocols (TCP and PIPE), zero indicates success and non-zero failure; on failure, Serveez will shutdown the connection. For packet oriented protocols (UDP and ICMP), a non-zero return value indicates that your server was able to process the passed packet data, otherwise (zero return value) the packet can be passed to other servers listening on the same port configuration.

This callback must be specified in `define-servertype!` for packet oriented protocols (UDP and ICMP) but is optional otherwise. You can modify the callback by calling `svz:sock:handle-request`. 
check-request socket

This callback is invoked whenever new data has arrived in the receive buffer. The receive buffer of the given `<svz-socket>` can be obtained using `svz:sock:receive-buffer`. The callback is initially not set and can be set up with `svz:sock:check-request`. Its purpose is to check whether a complete request was received. If so, it should be handled (by running the `handle-request` callback) and removed from the receive buffer (using `svz:sock:receive-buffer-reduce`). The callback is for connection oriented protocols (TCP and PIPE) only. You should return zero to indicate success and non-zero to indicate failure. On failure Serveez shuts the connection down.

disconnected socket

The `disconnected` callback gets invoked whenever the socket is lost for some external reason and is going to be shutdown by Serveez. It can be set up with `svz:sock:disconnected`.

kicked socket reason

This callback gets invoked whenever the socket gets closed by Serveez intentionally. It can be set up with `svz:sock:kicked`. The `reason` argument can be either `KICK_FLOOD`, indicating the socket is a victim of the builtin flood protection, or `KICK_QUEUE` which indicates a send buffer overflow.

idle socket

The `idle` callback gets invoked from the periodic task scheduler, which maintains an `idle-counter` for each socket structure. This counter is decremented whenever Serveez becomes idle and the callback is invoked when it drops to zero. The `idle` callback can set its socket’s `idle-counter` to some value with the procedure `svz:sock:idle-counter` and thus re-schedule itself for a later task. You can set up this callback with `svz:sock:idle`.

trigger-condition socket

This callback is invoked once every server loop for the socket structure. If you return `#f` nothing else is happening. Otherwise the `trigger` callback will be invoked immediately. You can set up the callback using the procedure `svz:sock:trigger-condition`.

trigger socket

The `trigger` callback is invoked when the `trigger-condition` returns `#t`. The callback can be set up with the procedure `svz:sock:trigger`. Returning a non-zero value shuts the connection down. A zero return value indicates success. This callback can be used to perform connection related updates, e.g., you can ensure a certain send buffer fill.

check-oob-request socket oob-byte

This callback is invoked whenever urgent data (out-of-band) has been detected on a socket. Initially this event is ignored and the callback can be set up with the procedure `svz:sock:check-oob-request`. The `oob-byte` argument is a number containing the received out-of-band data byte ranging from 0 to 255. If the callback returns non-zero
the connection will be shutdown. A zero return value indicates success. You can use `svz:sock:send-oob` to send a single out-of-band data byte.

**Please note:** The urgent data is not supported by all operating systems. Also it does not work for all types of network protocols. We verified it to be working for TCP streams on GNU/Linux 2.x.x and Windows 95; let us know if/how it works on other platforms.

### 3.2.3 Built-in servers

All of the servers listed in Section 3.4 [Existing servers], page 37 are built-in servers. The following sections describe in detail how to setup a new built-in server type. This kind of server will be part of the Serveez executable. That is why you should make it configurable in the configure script via a `--enable-xxxserver` argument.

#### 3.2.3.1 Making and configuring preparations

Serveez is configured and built via automake and autoconf. That is why you are not supposed to write your own Makefiles but simplified `Makefile.am` files. Automake will automatically generate dependencies and compiler/linker command lines. Here are the steps you basically need to follow:

- Change to the `src/` directory in the source tree.
- Edit the `Makefile.am`. Add your sub directory name and library name which you are going to create.
- Now create the sub directory and change into it.
- You need to create a new `Makefile.am` therein. If you want to have this file configured you need to add a further line to the `AC_OUTPUT` statement in `configure.ac` which is in the top level directory. You have to put at least the following into the newly created `Makefile.am`:

```plaintext
noinst_LIBRARIES = libfoo.a
libfoo_a_SOURCES = fooproto.h fooproto.c
INCLUDES = $(SERVEEZ_CFLAGS) -I$(top_srcdir)/src
CLEANFILES = *~
MAINTAINERCLEANFILES = Makefile.in
```
- Just have a look at all the other server directories. For more information about automake read the info pages.

#### 3.2.3.2 Server header file `fooproto.h`

This file contains at least your server’s `extern` declaration of your server definition which must be available from the outside. The `foo` server implements all kinds of configuration items which can be integers, integer arrays, strings, string arrays, port configurations, booleans and hash maps. Every item of the server configuration can later be manipulated from the configuration file.

#### 3.2.3.3 Server implementation file `fooproto.c`

If you want to define default values for your configuration you have to define them somewhere and put them into the default configuration structure. This structure will be used to instantiate your server. For this example we simply called it simply `foo_config`. 
In order to associate the configuration items in a server configuration to keywords within the configuration file you have to define an array of key-value-pairs. This is done in the `foo_config_prototype` field. There are several macros which make different associations. These are the `SVZ_REGISTER_*` macros which take three arguments. The first argument is the keyword which will occur in the configuration file, the second is the associated item in your default configuration structure and the last argument specifies if this item is defaultable or not.

### 3.2.3.4 Server definition

The server definition is in a way the ‘class’ of your server. Together with the default values (`foo_config_prototype`) it serves as a template for newly instantiated servers. The structure contains a long and a short description of your server. The short name is used as the prefix for all server instances of this specific type. The long description is used in the control protocol (See Section 3.4.3 [Control Protocol Server], page 43). The server definition also contains the callbacks your server (mandatorily) provides.

### 3.2.3.5 Server callbacks

There are several callback routines, which get called in order to instantiate the server and for describing the actual behaviour of your server. Here are the description of all of these callbacks. Some of them have to be implemented. Others have reasonable default values.

- **global initializer (optional)**
  
  This callback is executed once for every type of server. Here you can initialize data or whatever is shared between all instances of your server. For instance the HTTP server initializes its file cache here.

- **global finalizer (optional)**
  
  If you want to free shared resources which were possibly allocated within the global initializer you can do so here. The `foo` server frees its default hash previously allocated in the global initializer.

- **instance initializer (mandatory)**
  
  Within this routine you can initialize everything you might need for one instance of your server. The `foo` server does not do anything in this callback.

- **instance finalizer (optional)**
  
  The server instance finalizer gets its instance representation as argument. You have to free all resources used by this server instance.

- **protocol detection (mandatory)**
  
  Because it is possible to have more than one server listening on one network port we need to detect the type of client which is connecting to this port. The `foo` server checks if the first five bytes the client was sending is identifying it as a `foo` client. This routine is getting two arguments where the first one is a pointer to this servers instance and the second is the client socket object containing all information of the client connection. This structure is described a bit later. Be patient. For successful client detection return non-zero value.

- **socket connection (mandatory)**
  
  If the client detection signaled success this routine is called to assign the client connection to the server instance. The arguments are just the same as in the
detection routine. In this callback you can assign all the connection specific callbacks for your server and do some initial things. The foo server sets the check_request callback to the default svz_sock_check_request which is using the packet delimiter information to find whole packets. When a client sent such a packet the handle_request callback is executed. That is why the foo server assigns the handle_request method.

client info (optional)
If this callback is given the control protocol (See Section 3.4.3 [Control Protocol Server], page 43.) can give information about a specific client if requested with ‘stat id NUM’. The first argument given is the server instance and the second one the client’s socket structure. You have to return a static single line character string.

server info (optional)
This function is called when listing the server instances via ‘stat all’ from the control protocol (See Section 3.4.3 [Control Protocol Server], page 43.). The returned character string might be multilined separated by \r\n (no trailing separator). Usually you will return all the server configuration information.

notifier (optional)
If this callback is not NULL it is called whenever there is some time left. It gets the server instance itself as argument. Actually it gets called every second.

handle request (mandatory for UDP and ICMP servers)
The arguments to this callback are the client’s socket structure, the address of the packet data and its length. When implementing a UDP or ICMP server you need to return non-zero if your server could process the packet. Thus it is possible that there are multiple UDP servers on a single port.

3.2.3.6 Make your server available
You distribute your server by editing the cfgfile.c file in the src/ directory. There you have to include the servers header file and add the server definition by calling svz_servertype_add

3.2.3.7 More detailed description of the callback system and structures
The client connection information is stored within the svz_socket_t object. All of the client connection specific callbacks get this object as first argument. Following is a description of the most important elements of this object.

int id
The socket id is a unique id for a client connection.

int version
This item validates this socket structure. If you pass the id and version to a coserver you can check if the delivered socket structure is the original or not within the coserver callback.

int proto
The proto flag determines a server sockets protocol type which can be PROTO_PIPE, PROTO_TCP, PROTO_UDP, PROTO_ICMP or PROTO_RAW.
**int flags**  The flag field of the client connection contains informations about the state of this connection. See `socket.h` in the `src/libserveez/` directory for more information. Basically this bitfield specifies how this object is handled by the main server loop.

**int userflags**  This bitfield could be used for protocol specific information. You can use it for any information.

**char *boundary, int boundary_size**  If you are going to write a packet oriented protocol server you can use the `svz_sock_check_request` method to parse packets. These two properties describe the packet delimiter.

**char *send_buffer, int send_buffer_size, int send_buffer_fill**  This is the outgoing data for a client connection object.

**char *recv_buffer, int recv_buffer_size, int recv_buffer_fill**  Within the receive buffer all incoming data for a connection object is stored. This buffer is at least used for the client detection callback.

**int read_socket (svz_socket_t)**  This callback gets called whenever data is available on the socket. Normally, this is set to a default function which reads all available data from the socket and feeds it to `check_request`, but specific sockets may need other policies.

**int write_socket (svz_socket_t)**  This routine is called when data is is valid in the output buffer and the socket gets available for writing. You normally leave this callback untouched. It simply writes as much data as possible to the socket and removes the data from the send buffer.

**int disconnected_socket (svz_socket_t)**  This gets called whenever the socket is lost for some external reason.

**int connected_socket (svz_socket_t)**  If some piece of code tries to connect to another host via `svz_tcp_connect` this connection might be established some time later. This callback gets called when the socket is finally connected.

**int kicked_socket (svz_socket_t, int)**  We call this whenever the socket gets closed by us. The second argument specifies a reason.

**int check_request (svz_socket_t)**  This gets called whenever data was read from the socket. Its purpose is to check whether a complete request was read, and if it was, it should be handled and removed from the input buffer.

**int handle_request (svz_socket_t, char *, int)**  This gets called when the `check_request` got a valid packet. The request arguments contains the actual packet and the second argument is the length of this packet including the packet delimiter.
int idle_func (svz_socket_t)
    This callback gets called from the periodic task scheduler. Whenever idle_counter (see below) is non-zero, it is decremented and idle_func gets called when it drops to zero. idle_func can reset idle_counter to some value and thus can re-schedule itself for a later task.

int idle_counter
    Counter for calls to idle_func.

void *data
    Miscellaneous field. Listener keeps array of server instances here. This array is NULL terminated. Some servers store server specific information here.

void *cfg
    When the final protocol detection has been done cfg should contain a pointer to the actual configuration hash map taken from the server instance object.

3.2.3.8 Using coservers
Coservers are designed to complete blocking tasks. Each coserver runs in its own thread/process. There are several coservers implemented: the dns, reverse dns and ident coserver. You need to implement the callback which gets called when a coserver completed its task. This routine must be a svz_coserver_handle_result_t. The first argument is the actual coserver result which might be NULL if the request could not be fulfilled and the latter two arguments are the arguments you specified yourself when issuing the request. To invoke a coserver you use one of the svz_coserver_* macros. The foo server uses the reverse dns coserver to identify the host name of the remote client.

3.3 Some words about server configuration
If you define a server you basically pass an instance name and a list of items to the define-server! procedure. Each item has a name and a value. A value has a type. We provide several types: integers (numbers), integer arrays, strings, string arrays, booleans (yes/no-values), hashes (associations) and port configurations.

The following table shows how each kind of value is set up in the configuration file. item is the name of the item to be configured.

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integer</td>
<td>(item . 42)</td>
</tr>
<tr>
<td>Integer array</td>
<td>(item . (0 1 2 3))</td>
</tr>
<tr>
<td>String</td>
<td>(item . &quot;a character string&quot;)</td>
</tr>
<tr>
<td>String array</td>
<td>(&quot;abc&quot; &quot;cba&quot; &quot;bca&quot; &quot;acb&quot;)</td>
</tr>
<tr>
<td>Boolean</td>
<td>#t or #f</td>
</tr>
</tbody>
</table>

A normal boolean in guile is represented by #t or #f. But the configuration
file parser additional understand some bare words and numbers.
Example: (item . #f)

Hash
Hash maps associate keys with values. Both must be character strings.
Example: (item . (key1 . "value1") (key2 . "value2"))

Port configuration
See Section 1.5.1 [Define ports], page 7, for more information on this. When configuring a port configuration you need to define it via `define-port!` previously and put its symbolic name into the configuration.
Example: (item . foo-tcp-port)

The next chapter describes the servers currently implemented using Serveez. The configuration items used by each of them are described in the following format:

`NameOfTheItem (Type, default: DefaultValue, Comments)`
Description of the configuration item named `NameOfTheItem` (case sensitive). `Type` can be either `integer`, `integer array`, `string`, `string array`, `boolean`, `hash` or `port configuration`. The `Comments` is an optional text.

The example configuration file `data/serveez.cfg` contains an example definition of each server already implemented. You can copy and modify the example for an easy start.

## 3.4 Existing servers

### 3.4.1 HTTP Server

#### 3.4.1.1 General description
The integrated HTTP server was originally meant to be a simple but fast document server. But now it can even execute CGI scripts. The GET, HEAD and POST methods are fully functional. Additionally Serveez produces directory listings when no standard document file (e.g., `index.html`) has been found at the requested document node (directory). Furthermore it implements a file cache for speeding up repetitive HTTP request.

In comparison to other web server projects like Apache and Roxen this web server is really fast. Comparative benchmarks will follow. The benchmark system is a 233 MHz Mobile Pentium MMX. Both the server and the client (http_load - multiprocessing http test client) ran on the same computer.

**Small files**
The small-file test load consists of 1000 files, each 1KB long, requested randomly.

<table>
<thead>
<tr>
<th>concurrent fetches</th>
<th>1</th>
<th>10</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>500</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>hits/second</td>
<td>501</td>
<td>520</td>
<td>481</td>
<td>475</td>
<td>420</td>
<td>390</td>
<td>295</td>
</tr>
</tbody>
</table>

**CGI**
The CGI test load consists of a trivial “hello world” C program. I noticed GNU/Linux (2.2.17 in this case, probably others too) to throw “Resource temporarily unavailable” errors when `forking` very fast. This limits the test to about 200 concurrent fetches on the test system.
Large files
The large-file test load consists of 100 files, each 1MB long, requested randomly. Also, each connection is throttled to simulate a 33.6Kbps modem. Note that 1000 33.6Kbps connections is 3/4 of a T3. There was no problem to get 1000+ concurrent fetches.

3.4.1.2 Configuration
The following options can be set from the configuration file.

indexfile (string, default: index.html)
The indexfile parameter is the default file served by the HTTP server when the user does not specify a file but a document node (e.g., http://www.lkcc.org/).

docs (string, default: ../show)
The docs parameter is the document root where the server finds its web documents.

userdir (string, default: public_html)
Each ‘~user’ request gets converted into the given user’s home directory. The string will be appended to this directory. Its default value is ‘public_html’.

cgi-url (string, default: /cgi-bin)
This parameter is the first part of the URL the HTTP server identifies a CGI request. For instance if you specify here /cgi-bin and the user requests http://www.lkcc.org/cgi-bin/test.pl then the HTTP server tries to execute the program test.pl within the cgi-dir (see below) and pipes its output to the user.

cgi-dir (string, default: ./cgibin)
The cgi-dir is the CGI document root (on the server).

cgi-application (hash, default: empty)
Within the MinGW32 port you can use this hash to associate certain file suffices with applications on your computer (e.g., .pl with perl). This is necessary because there is no possibility to check whether a file is executable on Win32.

cache-size (integer, default: 200 kb)
This specifies the size of the document cache in bytes for each cache entry.

cache-entries (integer, default: 64)
This parameter specifies the maximum number of HTTP file cache entries (files). When you instantiate more than one HTTP server the biggest value wins. The HTTP file cache is shared by all HTTP servers. Please note: If your harddrive/filesystem combination proves to be faster than the HTTP file cache you should disable it by setting both cache-size and cache-entries to zero.

timeout (integer, default: 15)
The timeout value is the amount of time in seconds after which a keep-alive connection (this is a HTTP/1.1 feature) will be closed when it has been idle.
keepalive (integer, default: 10)
On one keep-alive connection can be served the number of keepalive documents at all. Then the connection will be closed. Both this and the timeout value are just to be on the safe side. They protect against idle and high traffic connections.

default-type (string, default: text/plain)
The default-type is the default content type the HTTP server assumes if it can not identify a served file by the types hash and the type-file (see below).

type-file (string, default: /etc/mime.types)
This should be a file like the /etc/mime.types on Unix systems. It associates file suffices with MIME types.

types (hash, default: empty)
If you want to specify special content types do it here. This parameter is a hash map associating file suffices with HTTP content types (MIME types).

admin (string, default: root@localhost)
Your address, where problems with the server should be e-mailed. This address appears on some server-generated pages, such as error documents.

host (string, default: localhost)
This is the host name of your web server. Sometimes the server has to send back its own name to the client. It will use this value. Be aware that you cannot invent such a name.

nslookup (boolean, default: false)
If this is true the HTTP server invokes a reverse DNS lookup for each client connection in order to replace the remote ip address with the remote host name in the access logfile.

ident (boolean, default: false)
If this is true the HTTP server processes identd requests for each client connection for logging purposes.

logfile (string, default: http-access.log)
The location of the access logfile. For each HTTP request a line gets appended to this file.

logformat (string, default: CLF)
The format of the access logfile. There are special placeholders for different kinds of logging information. The default log format is the Common Log Format (CLF). It contains a separate line for each request. A line is composed of several tokens separated by spaces.

CLF = host ident authuser date request status bytes
If a token does not have a value then it is represented by a hyphen (-). The meanings and values of these tokens are as follows:

%h (host) The fully-qualified domain name of the client, or its IP number if the name is not available.
This is the identity information reported by the client. Not active, so we will see a hyphen (-).

If the request was for an password protected document, then this is the userid used in the request.

The date and time of the request, in the following format:

date = [day/month/year:hour:minute:second zone]
day = 2*digit
month = 3*letter
year = 4*digit
hour = 2*digit
minute = 2*digit
second = 2*digit
zone = (‘+’ | ‘-’) 4*digit

The request line from the client, enclosed in double quotes (").

Which document referred to this document.

What kind of web browser did the remote client use.

The three digit status code returned to the client.

The number of bytes in the object returned to the client, not including any headers.

3.4.2 IRC Server

3.4.2.1 General description

Internet Relay Chat. The mother of all chat systems. The integrated IRC server is intended to be compatible with the EFNet. There are no good possibilities to test this in real life, so it is still under heavy construction. But it can be used as a standalone server anyway.

IRC itself is a teleconferencing system, which (through the use of the client-server model) is well-suited for running on many machines in a distributed fashion. A typical setup involves a single process (the server) forming a central point for clients (or other servers) to connect to, performing the required message delivery/multiplexing and other functions.

The server forms the backbone of IRC, providing a point for clients and servers to connect to. Clients connect to talk to each other. Servers connect to build up a network of servers. IRC server connections have to build up a spanning tree. Loops are not allowed. Each server acts as a central node for the rest of the network it sees.
3.4.2.2 Configuration

The following table shows the configuration keys provided. Most of the configuration items are similar to those of an Hybrid IRC server. They seem archaic at first sight but IRC operators are used to it. Refer to the Hybrid documentation for further information. It can be found on the EFNet web page.

**MOTD-file** (string, default: ../data/irc-MOTD.txt)
When a user initially joins it will get this file’s content as the message of the day comment. When changing on disk the server will notice that and reload the file automatically.

**INFO-file** (string, default: no file)
The INFO-files content gets displayed when the user issues the /INFO command.

**tsdelta** (integer, default: 0)
This value is the timestamp delta value to UTC (Coordinated Universal Time) in seconds.

**channels-per-user** (integer, default: 10)
Configures the maximum number of channels a single local user can join.

**admininfo** (string, no default)
Some administrative information delivered on the /ADMIN command.

**M-line** (string, no default, mandatory)
The TCP level configuration of this IRC server. The server info field is sometimes given to the client for informational use. The server will croak about if the settings do not correspond with the actual bindings. The format of this line is:

```
"\::" virtual hostname
"\::" optional bind address (real hostname)
"\::" server info: "World’s best IRC server"
"\::" port
```

**A-line** (string, no default, mandatory)
The administrative info, printed by the /ADMIN command.

```
"\::" administrative info (department, university)
"\::" the server’s geographical location
"\::" email address for a person responsible for the IRC server
```

**Y-lines** (string array, no default, suggested)
The connection classes. They are used in other parameters (e.g., I-lines). A Y-line describes a group of connections. You usually have at least two Y-lines: One for server connections and one for client connections. Format of each line is:

```
"\::" class number (higher numbers refer to a higher priority)
"\::" ping frequency (in seconds)
"\::" connect frequency in seconds for servers, 0 for client classes
```
I-lines (string array, no default, mandatory)
Authorization of clients, wildcards permitted, a valid client is matched user@ip
OR user@host.
  ":" user@ip, you can specify ‘NOMATCH’ here to force matching user@host
  ":" password (optional)
  ":" user@host
  ":" password (optional)
  ":" connection class number (YLine)

O-lines (string array, no default, optional)
Authorize operator, wildcards allowed.
  ":" user@host, user@ forces checking ident
  ":" password
  ":" nick

O-lines (string array, no default, optional)
Authorize local operator.
  ":" user@host, user@ forces checking ident
  ":" password
  ":" nick

C-lines (string array, no default, networked)
List of servers to connect to. Note: C and N lines can also use the user@ combination in order to check specific users (ident) starting servers. C and N lines are usually given in pairs.
  ":" host name
  ":" password
  ":" server name (virtual)
  ":" port (if not given we will not connect)
  ":" connection class number (YLine)

N-lines (string array, no default, networked)
Servers which may connect.
  ":" host name
  ":" password
  ":" server name (virtual host name)
  ":" password
  ":" how many components of your own server’s name to strip off the front and be replaced with a ‘*’.
  ":" connection class number (YLine)

K-lines (string array, no default, optional)
Kill user, wildcards allowed.
  ":" host
  ":" time of day
  ":" user
3.4.3 Control Protocol Server

If the GNU Serveez package is configured with the control protocol enabled, running ‘serveez --help’ will show the option -P and the following documentation applies. Otherwise, feel free to skip to the next section.

3.4.3.1 General description

Serveez implements something like a telnet protocol for administrative purposes. You just need to start a telnet session like:

$ telnet www.lkcc.org 42420

After pressing RET you will be asked for a password which you might setup passing Serveez the -P argument. See Chapter 1 [Using Serveez], page 2. The next section describes the interactive commands available.

3.4.3.2 Using the Control Protocol

‘help’      This command will give you a very short help screen of all available commands.
‘quit’      This command closes the connection to Serveez.
‘restart ident’
            Restarts the internal ident coserver. This is useful if you just want to start a new one if the old one died or is otherwise unusable.
‘restart dns’
            Restarts the internal dns lookup server.
‘restart reverse dns’
            Restarts the internal reverse dns lookup server.
‘killall’   This might be useful if Serveez seems to be unstable but you do not want to restart it. With ‘killall’ you disconnect all client network connections except the control protocol connections.
‘kill id NUM’
            Disconnects a specific connection identified by its ID. These IDs will be stated when you type ‘stat con’ (see below).
‘stat’      General statistics about Serveez. This will show you some useful information about the computer Serveez is running on and about the state of Serveez in general.
‘stat coserver’
            Statistics about all running coserver instances.
‘stat SERVER’
            This command is for selecting certain server instances to be listed. SERVER is one of server names you specified in the configuration file.
‘stat id NUM’
            Show statistics about a specific connection. This will give you all available information about every connection you specified. See Section 3.2 [Writing servers], page 19, for more information about how to provide these information.
Chapter 3: Server

`stat con` Connection statistics. This will give a list of all socket structures within Serveez.
If you want more detailed information about specific connections, coservers or
servers you need to request these information with `stat id NUM` or `stat all`.

`stat all` Server and coserver instance statistics. This command lists all the information
about instantiated servers and coservers. See Section 3.2 [Writing servers],
page 19, for more information about how to provide these information.

`stat cache` HTTP cache statistics. This command produces an output something like the
following where `File` is the short name of the cache entry, `Size` the cache
size, `Usage` the amount of connections currently using this entry, `Hits` the
amount of cache hits, `Recent` the cache strategy flag (newer entries have larger
numbers) and `Ready` is the current state of the cache entry.

<table>
<thead>
<tr>
<th>File</th>
<th>Size</th>
<th>Usage</th>
<th>Hits</th>
<th>Recent</th>
<th>Ready</th>
</tr>
</thead>
<tbody>
<tr>
<td>zlib-1.1.3-20000531.zip</td>
<td>45393</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>texinfo.tex</td>
<td>200531</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>shayne.txt</td>
<td>2534</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Total : 248458 byte in 3 cache entries

`kill cache`
Reinitialize the HTTP file cache. Flushes all files from the cache.

3.4.3.3 Configuration
There is nothing to be configured yet.

3.4.4 Foo Server

3.4.4.1 General description
The Foo Server is a simple example on how to write Internet protocol servers with Serveez.
See Section 3.2 [Writing servers], page 19.

3.4.4.2 Configuration
There are all kinds of configuration items. They are used to explain the implementation of
servers. A complete list will follow.

`port` (port configuration, default: tcp, 42421, *)
Sets up the TCP port and local address.

`bar` (integer, no default)
Some integer value. Printed as server information.

`reply` (string, default: Default reply)
Some string. Printed as server information.

`messages` (string array, default: ...)
Some string array which is actually a list of strings. Also printed as server
information.

`ports` (integer array, default: 1, 2, 3, 4)
Some array of integer numbers. Printed as server information.
assoc (hash, default: default: ...)
   An hash map associating keys with values. Printed as server information.

truth (boolean, default: true)
   Some boolean value. Printed as server information.

3.4.5 SNTP Server

3.4.5.1 General
The SNTP server can be queried with the `netdate` command. It is used to synchronize time and dates between Internet hosts. The protocol is described in the ARPA Internet RFC 868. Thus it is not really an SNTP server as described by RFC 2030 (Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI). It is rather an excellent example on how to implement a UDP server in Serveez.

This protocol provides a site-independent, machine readable date and time. The Time service sends back time in seconds since midnight on January first 1900.

One motivation arises from the fact that not all systems have a date/time clock, and all are subject to occasional human or machine error. The use of time-servers makes it possible to quickly confirm or correct a system’s idea of the time, by making a brief poll of several independent sites on the network.

3.4.5.2 Configuration
The configuration of this server does not require any item.

3.4.6 Gnutella Spider

3.4.6.1 What is it?
The Gnutella net is a peer-to-peer network which is based on client programs only. There are no servers. The network itself is formed by client connections only. Generally the Gnutella network is for sharing files of any kind.

This Gnutella spider is for seeking the needle in the haystack. Once connected to the network it regularly tries to find certain files in there. It keeps track of all connected clients and tries to reconnect them if the current connections are lost.

Gnutella, however has nothing to do with the GNU project. The original client is just a free (as in free beer) piece of software. With Serveez you have a free (as in freedom) way to use it. Have a look at the Gnutella page for further information.

3.4.6.2 Configuration
The Gnutella spider knows the following configurations items.

net-url (string, default: gnutella-net)
   If you want to see the host catcher list of this Gnutella spider you can connect to this port with any WWW browser at http://host:port/net-url. The host:port combinations depend on the bindings.

hosts (string array, no default)
   This is the start of the haystack, the initial host list of the clients the spider tries to connect to. Each list item should be of the format ip:port (e.g.,
You can also pass Internet host names. If the port information is left blank it defaults to 6346. If you need some entry point for the Gnutella network have a look at http://www.gnutellahosts.com/ or http://www.gnutellanet.com/.

search (string array, default: Puppe3000, Meret Becker)
This is the needle. Each search line is either a set of space delimited tokens where every token must match. Or a kind of wildcard expression including '?' and '*'. Search lines are always matched case insensitive.

search-limit (integer, default: 30)
This limits how many results the Gnutella spider returns to other people searching your files. This is for protection against * search requests.

max-ttl (integer, default: 5)
Every Gnutella packet has got a TTL. This is the maximum TTL allowed for outgoing packets. When a packet comes in it gets its TTL value decremented and is forwarded to its destination. If however an incoming packet has a TTL larger than max-ttl the ttl value is set to max-ttl. This is necessary since most people use far too large TTL values.

ttl (integer, default: 5)
When creating a new Gnutella packet we use this as TTL. Please use a sane value. This ttl needs not to be as large as it is for IP packets. A value below 10 is more than enough. Have a look at the Gnutella page for a calculation of a 'sane value'.

download-path (string, default: /tmp)
This is where the spider saves needles in.

share-path (string, default: /tmp)
Here are all the files we share with others. The Gnutella spider will recurse into directories. So be careful with this option.

max-downloads (integer, default: 4)
Maximum number of concurrent downloads from the network.

max-uploads (integer, default: 4)
Maximum number of concurrent uploads to the network.

connection-speed (integer, default: 28)
This is what we send as our connection speed in KBit/s. We also use this value to throttle down the network transfer rate for file uploads.

min-speed (integer, default: 28)
Search for needles on hosts with a minimum speed. Set it to 0 if you do not care about that. This value is in KBit/s, too.

file-extensions (string array, default: empty list)
If we get replies on search queries we check if the file extension of this reply matches one of these extensions. Useful extensions are 'mp3' and 'mpg'.
connections (integer, default: 4)
This is the number of concurrent connections the Gnutella spider tries to keep up to the network. The IP addresses and the port information is taken from the host catcher hash.

force-ip (string, default: not set)
You can force the Gnutella spider to send outgoing replies with this IP as host information. Must be in dotted decimals notation. This is useful if you are behind a masquerading gateway. You need to install some kind of port forwarder on the gateway so other people can reach you from the outside. Serveez is a good port forwarder.

force-port (integer, default: not set)
Force the Gnutella spider to send outgoing replies with the force-port as port information. See above for more information.

disable (boolean, default: false)
With this configuration option you can disable the bindings for a Gnutella server instance. This means that no remote client can connect without being told so (e.g., by push requests).

3.4.7 Tunnel Server

3.4.7.1 General description
The Tunnel server is for mapping one port configuration to another. So we should rather speak of a port forwarder. Two port forwarders can form a tunnel. Generally this means that you can setup Serveez to accept network or pipe connections in order to pass all transfer data on this line to another port configuration. This can be useful to work around gateways and firewalls. When instantiating an ICMP source or destination you must ensure root privileges for the application. On Windows NT and Windows 2000 you need to be either logged in as Administrator or have set the registry key HKLM\System\CurrentControlSet\Services\Afd\Parameters\DisableRawSecurity to 1 (DWORD). One of the given examples in serveez.cfg shows how you can setup a tunnel server for forwarding a pipe connection. Please keep in mind when forwarding a TCP or pipe connection over ICMP or UDP you loose reliability since the latter two are packet oriented rather than connection oriented. We are not willing to implement our own TCP stack to work on ICMP/UDP directly.

Forwarding between the same types of connection is always possible. When forwarding to an ICMP tunnel we use a special protocol which we will outline in the following section.

3.4.7.2 Extended ICMP protocol specification
Since ICMP (Internet Control Message Protocol) does have a fixed packet format we had to extend it in order to use it for our own purposes. The protocol field of the IP header contains a binary ‘1’ which is the identifier for ICMP (e.g., ‘6’ identifies TCP). When creating an ICMP socket the IP header is always generated by the kernel. This is the main difference to raw sockets where the IP header must be generated at userspace level.

When receiving an ICMP packet it also contains the IP header. When sending an ICMP packet you must not prepend this IP header. The kernel will do this itself. The IP header
always follows the actual ICMP header followed by the ICMP packet data. Since this section does not cover raw sockets we leave the IP header structure out here.

The modified ICMP message format is as:

<table>
<thead>
<tr>
<th>Offset</th>
<th>Size</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>Message type.</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Message type sub code.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Checksum.</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Senders unique identifier.</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>Sequence number.</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>Port number.</td>
</tr>
<tr>
<td>10</td>
<td>0-65506</td>
<td>Packet load.</td>
</tr>
</tbody>
</table>

Each of these fields can be modified and processed by Serveez and do not get touched by the kernel at all. The ICMP socket implementation of Serveez differentiates two types of sockets: listening and connected ICMP sockets. This is non-standard because it actually makes no sense since there is no difference for the kernel. The introduction of these semantics allow Serveez to forward data between connection-oriented (TCP and named pipes) and packet-oriented (UDP and ICMP) protocols.

Message type

Valid message types are for instance ‘8’ for an echo message and ‘0’ for its echo reply. These two messages are used for the systems builtin ping services. Serveez uses its own message type identifier which is ‘42’ (ICMP_SERVEEZ) by default.

Message type sub code

Serveez also defines its own message type sub codes described in the following table.

<table>
<thead>
<tr>
<th>Sub code</th>
<th>Constant identifier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ICMP_SERVEEZ_DATA</td>
<td>packet contains data</td>
</tr>
<tr>
<td>1</td>
<td>ICMP_SERVEEZ_REQ</td>
<td>unused</td>
</tr>
<tr>
<td>2</td>
<td>ICMP_SERVEEZ_ACK</td>
<td>unused</td>
</tr>
<tr>
<td>3</td>
<td>ICMP_SERVEEZ_CLOSE</td>
<td>disconnection message</td>
</tr>
<tr>
<td>4</td>
<td>ICMP_SERVEEZ_CONNECT</td>
<td>connect message</td>
</tr>
</tbody>
</table>

Checksum

The checksum field of the ICMP header is used to check the ICMP headers and the payloads (packet data) validity. We are using the standard Internet Checksum algorithm described in RFC 1071. If the check failed we drop the packet.

Senders unique identifier

The senders identifier field is used to determine if a received packet has been sent by the sender itself and should therefore be dropped. This happens because each ICMP socket setup for receiving gets all sent ICMP packets system wide. Thus Serveez will even be notified if the kernel creates some echo reply or destination unreachable message due to a request completely outside the scope of Serveez.
Chapter 3: Server

Sequence number

Each connected ICMP socket increments its sequence number when sending a packet. Thus a connection message type packet of such a socket always has a zero sequence number. This field could (but is not yet) also be used to reorder ICMP packets or to detect missing packets.

Port number

The port field of the modified packet format helps Serveez to establish connected ICMP sockets. A simple packet filter detects if a received packet is kind of reply to a socket's sent packets by comparing this port number. The packet is dropped if the comparison fails and it is not a listening socket.

Except the data message type subcode all ICMP packets created and sent by Serveez have a zero payload. The connect message subcode identifies a new connection and the disconnection message subcode its shutdown without actually transmitting data. These two subcodes emulate a TCP connections connect, accept and shutdown system call.

3.4.7.3 Configuration

This might be the most easiest configuration to setup. You essentially need to define the source port configuration and the target port configuration. The serveez.cfg in the data/ directory shows two example configurations how to tunnel TCP connections over UDP and ICMP. The UDP tunnel accesses the standard HTTP port 80 and the ICMP tunnel accesses the standard Telnet port 23.

source (port configuration, no default)

The source port configuration. This is usually the same you bind the server to.

target (port configuration, no default)

The target port configuration.

3.4.8 Fake Ident Server

3.4.8.1 General description

Most systems run the 'ident protocol' on port 113. Internet hosts can connect to that port and find out what user is having a connection to the host. For example a webservers can query your username when you fetch a file (e.g., Serveez' internal ident-coserver can do that). Most IRC servers protect themselves by allowing only users that have a valid ident response. Therefore mIRC (for windoze) has a built in ident server. This fake ident server can be used to 'fake' a response. This is useful when you connect through a masquerading gateway and the gateway cannot handle ident requests correctly. (Or, of course, you are using windoze, need an ident response and do not have mIRC at hand.)

This server has two modes of operation. In one mode all requests get 'ERROR : NO-USER' as response. This is a valid but not very helpful response. The other mode makes the server send a valid and useful response. It contains a system type and a username. The system type is usually 'UNIX'. Others are valid but never used (at least i have never seen something else).

3.4.8.2 Configuration

This server is easy to configure.
systemtype (string, default: UNIX)
The system type to respond. The username field of the response has other meanings depending on this field, so do not make things up here. Read the RFC to learn more.

username (string, default: <NULL>)
If no username is set (which means this field does not appear in the configuration file) the server runs in the flag-all-requests-as-error mode. Use your favourite nickname here.

3.4.9 Passthrough Server

3.4.9.1 General description
The program passthrough server provides basic inetd functionality. Basically it can accept connections and pass this connection to the standard input (stdin) and standard output (stdout) handles of programs. Depending on the platform (operating system) the user is able to configure different methods how this can be achieved.

3.4.9.2 Configuration
This server has different types of configuration options specifying its behaviour. Some of them are mandatory and some are optional. The very least to configure is the program to be started when a new connection is made.

binary (string, no default)
This parameter specifies the program to execute when a new connection has been accepted. The parameter is mandatory and must be a fully qualified file name (including path).

directory (string, no default)
This will be the working directory of the executed program. If you omit this parameter the server uses the current directory (the directory is not changed).

user (string, no default)
If you omit this parameter no user or group will be set for the started program. Otherwise you need to specify this information in the format ‘user[.group]’. If the group is omitted the user’s primary group will be used.

argv (string array, no default)
This list of character strings is going to be the program’s argument list (command line). If the first list item (which is argv[0] and the program’s name) is left blank it defaults to the name specified in the binary parameter.

do-fork (boolean, default: true)
This flag specifies the method used to pass the connection to the program. If it is true the server uses the Unix’ish fork and exec method. Otherwise it will pass the data through a unnamed pair of sockets [ or two pairs of anonymous pipes ].

single-threaded (boolean, default: true)
This parameter applies to servers bound to UDP and ICMP port configurations only. For programs which process all incoming packets and eventually time out,
the program is said to be ‘single-threaded’ and should use a true value here. If a program gets a packet and can receive further packets, it is said to be a ‘multi-threaded’ program, and should use a false value.

thread-frequency (integer, default: 40)

The optional thread-frequency parameter specifies the maximum number of program instances that may be respawned from the server within an interval of 60 seconds.

3.4.10 Mandel Server

3.4.10.1 General description

The distributed Mandelbrot server is an Internet server completely written in Guile with the help of the API provided by the underlying Serveez application. The reader will not see any occurrence of the networking API of Guile.

It implements a protocol called ‘dnc’. ‘dnc’ - short for “Distributed Number Cruncher”. The Mandelbrot server manages the computation of a graphic visualization of the Mandelbrot set fractal. Each client can connect to the server and ask for something to calculate and is meant to send its result back to the server. Finally the server produces a bitmap in the XPM format and uses a specified viewer application to bring it onto your screen.

3.4.10.2 Configuration

The server can be setup to manage the calculation of the Mandelbrot set at various locations (rectangular region in the complex plane), in a specific pixel resolution and colour depth. Moreover you can define the name of the final output file and the viewer application the output file is displayed with.

start (string, default: -2.0-1.5i)

Specifies the upper left corner of the final bitmap in the complex plane.

dnc (string, default: +1.1+1.5i)

Specifies the lower right corner of the final bitmap in the complex plane.

x-res (integer, default: 320)

The real part pixel resolution.

y-res (integer, default: 240)

The imaginary part pixel resolution.

colors (integer, default: 256)

Number of maximum colours used in the bitmap. Also determines the maximum iteration depth.

outfile (string, default: mandel.xpm)

When the Mandel server has managed to calculate the whole bitmap it produces an output file in the XPM format. You can specify the name and location of this output file.

viewer (string, default: xv)

Here you can setup your favourite bitmap viewer application. It should be able to parse and display the XPM format.
4 Coserver

4.1 What are coservers

If it is necessary to complete blocking tasks in Serveez you have to use coservers. The actual implementation differs on platforms. On Unices they are implemented as processes communicating with Serveez over pipes. On Win32 Serveez uses threads and shared memory.

4.2 Writing coservers

4.2.1 Making and configuring preparations

First you have to change into the src/libserveez/coserver/ directory of the Serveez package. Then edit the Makefile.am and add your header and implementation file to the libcoserver_la_SOURCES variable.

4.2.2 Coserver header file

You have to declare the coserver handle routine here. This callback gets the input buffer argument and delivers the output buffer result. Both of these buffers are supposed to be lines separated by a ‘
’.

4.2.3 Coserver implementation file

Here you need to #include "libserveez/coserver/coserver.h" and implement the coserver handle routine declared in the coserver header file. This can be any blocking system call. On successful completion you can return the result or NULL on errors. The input and output buffers are plain strings and can have any format with one exception. Because the coservers communicate via a line protocol with Serveez these buffers must not contain ‘
’ (0x0d).

4.2.4 Make your coserver available in Serveez

For this you have to edit coserver.h and coserver.c files which are located in the src/libserveez/coserver/ directory. In the header file you have to define a further COSERVER_• id (macro) and set the MAX_COSERVER TYPES define to the appropriate value. Then you should define a further svz_coserver_• macro in the same file.

In coserver.c you have to implement the svz_coserver_• macro. This macro takes three arguments. The first is always specific to your coserver and is used to create the actual request string. Then follows the result callback routine, and an optional argument for this callback. The latter two are simply passed to the svz_coserver_send_request routine. This routine takes four arguments where the first is the previously defined COSERVER_• id and the second is the input buffer for the coserver handle routine without the trailing ‘
’.

Then you need to add your coserver to the svz_coserver types array specifying the COSERVER_• id, the coserver description, the coserver handle routine discussed above, the number of coserver instances to be created and an optional initialization routine.

4.3 Existing coservers
4.3.1 Identification (Ident) coserver

The Identification protocol is briefly documented in RFC1413. It provides a means to determine the identity of a user of a particular TCP connection. Given a TCP port number pair, it returns a character string which identifies the owner of that connection on the server’s (that is the client’s) system.

This is a connection based application on TCP. A server listens for TCP connections on TCP port 113 (decimal). Once a connection is established, the server reads a line of data which specifies the connection of interest. If it exists, the system dependent user identifier of the connection of interest is sent as the reply. The server may then either shut down the connection or it may continue to read/respond to more queries.

The Ident coserver is a client to this kind of service. For every established network connection you can use this service by calling the appropriate macro from coserver.h. But you could also use the Ident coserver as is without this macro. The messages from Serveez to this coserver are formatted this way:

Format:
RemoteAddressInDottedDecimals ":" RemotePort ":" LocalPort

Macro:
svz_coserver_ident (sock, MyIdentCallback, sock->id, sock->version);

In this context sock is of type svz_socket_t and MyIdentCallback is something like the following example. Both of the last two (optional) arguments identify a valid socket structure and user can be NULL if there is no ident daemon running on the foreign machine. The last two argument within the above macro will be the last two arguments in the callback below. Thus you will know what kind of data the invocation of the callback is related to.

Callback:
int
MyIdentCallback (char *user, int id, int version)
{
printf ("Identified user: %s\n", user);
return 0;
}

4.3.2 Domain Name Server (DNS) coserver

The DNS coserver is using gethostbyname to translate a given hostname to the associated IP address. The format of the coserver input line and the macro from coserver.h is shown below. The IRC server is currently using this coserver for resolving its ‘?-Lines’. See Section 3.4 [Existing servers], page 37, for more information. In the example below realhost is something like ‘www.lkcc.org’.

Format:
RemoteHostname

Macro:
svz_coserver_dns (realhost, irc_connect_server, ircserver, NULL);

Callback:
int
irc_connect_server (char *ip, irc_server_t *server)
{
    printf ("The ip address is: %s\n", ip);
    return 0;
}

4.3.3 Reverse Domain Name Server (reverse DNS) coserver
As easily guessed from the name this coserver is just doing the reverse as the DNS coserver. It translates a given IP address into a hostname using gethostbyaddr. In the macro the ip address is given as an unsigned long in host byte order. The Reverse DNS coserver itself takes something like ‘192.168.2.1’.

Format:
RemoteAddressInDottedDecimals

Macro:
svz_coserver_reverse (addr, MyReverseCallback, sock->id, sock->version);

Callback:
int
MyReverseCallback (char *host, int id, int version)
{
    printf ("Hostname is: %s\n", host);
    return 0;
}
5 Embedding

This chapter documents how to embed Serveez into C programs and describes all parts of the API it provides.

The Serveez core library provides all of the functionality necessary in order to write Internet protocol servers (currently TCP, UDP, ICMP and RAW sockets), pipe servers (connection-oriented via a pair of named pipes) and coservers in a portable way. All of the included servers are based upon this library, which encapsulates the native network and file system programming interface of different Unices and Windows systems.

The following sections will give the reader an overview about how to use its core library.

5.1 Embedding Serveez

This chapter deals with embedding the Serveez core library into standalone C/C++ applications and using it in order to write additional servers.

5.1.1 Compiling and linking

When you have installed a version of Serveez passing the `configure` script the `$prefix` argument, e.g., `./configure --prefix=/usr/local`, you will find the `libserveez` library in `/usr/local/lib` and the include headers in `/usr/local/include`. If you want to compile a C program using the Serveez API and link against the Serveez core library `libserveez`, which is `libserveez.so` for Unices and `libserveez.dll` for Windows systems, you need to tell the compiler and linker where to find the headers and libraries.

Most C compilers you can use will understand the following command line options for this purpose. The ‘-I’ argument specifies the directory of additional include headers, the ‘-L’ argument the directory to additional libraries and the ‘-l’ argument the library itself to link against.

$ cc test.c -I/usr/local/include -o test -L/usr/local/lib -lserveez

In order to obtain the correct compiler and linker flag you can also run the `serveez-config` script which gets installed with the Serveez package. The `serveez-config` script can be invoked with the following set of option.

- h, --help
  Displays the usage information.

- v, --version
  Displays installed Serveez version.

- l, --ldflags
  Prints the linker flags (libraries to link with including directory information).

- c, --cflags
  Prints the compiler flags to compile with.

5.1.2 A simple example

The following small example shows how to use the Serveez core library to print the list of known network interface. As you will notice there are three major steps to do: Include the library header with `#include <libserveez.h>`, initialize the library via `svz_boot` and
finalize it via svz_halt. In between these calls you can use all of the API functions, variables and macros described in Section 5.2 [Embedding API], page 56.

```c
#include <stdio.h>
#include <stdlib.h>
#include <libserveez.h>

static int
display_ifc (const svz_interface_t *ifc,
    void *closure)
{
    char *addr = svz_inet_ntoa (ifc->ipaddr);

    if (ifc->description)
        /* interface with description */
        printf ('%40s: %s
',
            ifc->description, addr);
    else
        /* interface with interface # only */
        printf ('%31s%09lu: %s
',
            "interface ", ifc->index, addr);
    return 0;
}

int
main (int argc, char **argv)
{
    /* Library initialization. */
    svz_boot ("example");

    /* Display a list of interfaces. */
    printf ("local interfaces:
");
    svz_foreach_interface (display_ifc, NULL);

    /* Library finalization. */
    svz_halt ();

    return EXIT_SUCCESS;
}
```

### 5.2 Embedding API

In this chapter the reader will find a short description of each function, global variable and macro provided by the Serveez core library. The API can either be used to implement a new server or coserver module for use with Serveez or for supporting network and server functionality within your own applications without caring about the details and system programming.
Most of the Serveez core library interface functionality should be prefixed with svz_. Small symbols will refer to functions and variables in most cases and big letter symbols refer to macros.

[FIXME: The subsections are named inconsistently because originally, the API reference was a separate document; on merge, weirdness like “Port config funcs” was necessary to avoid conflict with the other “Port configuration” node. —ttn]

5.2.1 Library features

The configure script used to build libserveez takes many options (see Section 1.1 [Build and install], page 2). Some of these are encapsulated by svz_library_features.

\[
\text{const char *} \ \text{const *} \quad \text{[Function]}
\]

\[
\text{svz_library_features} \ (\text{size_t *} \ \text{count})
\]

Return a list (length saved to \text{count}) of strings representing the features compiled into libserveez.

Here is a table describing the features in detail:

- **debug**: Present when `--enable-debug`.
- **heap-counters**: Present when `--enable-heap-count`.
- **interface-list**: Present when `--enable-iflist`.
- **poll**: Present when `--enable-poll` and you have poll(2).
- **sendfile**: Present when `--enable-sendfile` and you have sendfile(2) or some workalike (e.g., TransmitFile).
- **log-mutex**: Present when svz_log uses a mutex around its internal stdio operations, implying that you have some kind of thread capability (perhaps in a separate library). If your system has fwrite_unlocked, the configure script assumes that fwrite et al already operate in a locked fashion, and disables this.
- **flood-protection**: Present when `--enable-flood`.
- **core**: The networking core. This is always present.

5.2.2 Memory management

The core library of Serveez is able to keep track of the memory an application or part of a program consumes, and also controls itself in the same manner. When you are using this memory allocator interface you can determine and afterwards remove memory leaks. This is a very important feature as servers are by nature long-lived programs.

The three allocator function pointers for malloc, realloc and free make it possible to instruct Serveez to use different kinds of memory, which might be necessary if you want the library to work with shared memory arenas or any other underlying memory API.
void
svz_set_mm_funcs (svz_malloc_func_t cus_malloc, svz_realloc_func_t cus_realloc,
svz_free_func_t cus_free)
    Set the internal memory management functions to cus_malloc, cus_realloc and
cus_free, respectively. The default internal values are malloc, realloc and free.

void *
svz_malloc (size_t size)
    Allocate size bytes of memory and return a pointer to this block.

void *
svz_calloc (size_t size)
    Allocate size bytes of memory and return a pointer to this block. The memory is
cleared (filled with zeros).

void *
svz_realloc (void *ptr, size_t size)
    Change the size of a block of memory at ptr, previously returned by svz_malloc, to
size bytes. If ptr is NULL, allocate a new block.

void
svz_free (void *ptr)
    Free a block of memory at ptr, previously returned by svz_malloc or svz_realloc.
If ptr is NULL, do nothing.

char *
svz_strdup (const char *src)
    Duplicate the given string src if it is not NULL and has non-zero length. Return the
new string.

void
svz_get_curalloc (size_t *to)
    Write values to to[0] and to[1] representing the number of currently allocated bytes
and blocks, respectively. If Serveez was not configured with ‘--enable-debug’, the
values are always 0.

5.2.3 Data structures

Since most servers need to store information about its clients or want to keep track of data
during runtime, we include a pair of of useful data structures. The actual aim was to provide
higher level data structures which the C programming language does not support. Some of
the included servers which come with Serveez make extensive use of them.

5.2.3.1 Array

The array data structure is a simple array implementation. Each array has a size and
capacity. The array indices range from zero to the array’s size minus one. You can put
any kind of data into this array which fits into the size of a pointer. The array grows
automatically if necessary.
svz_array_t * [Function]
svz_array_create (size_t capacity, svz_free_func_t destroy)
    Create a new array with the initial capacity capacity and return a pointer to it. If capacity is zero it defaults to some value. If destroy is non-NULL, svz_array_destroy calls that function (typically used to free dynamically allocated memory). For example, if the array contains data allocated by svz_malloc, destroy should be specified as svz_free. If the array contains data which should not be released, destroy should be NULL.

void [Function]
svz_array_destroy (svz_array_t *array)
    Completely destroy the array array. The array handle is invalid afterwards. The routine runs the destroy callback for each element of the array.

void * [Function]
svz_array_get (svz_array_t *array, size_t index)
    Return the array element at the position index of the array array if the index is within the array range. Return NULL if not.

void * [Function]
svz_array_set (svz_array_t *array, size_t index, void *value)
    Replace the array element at the position index of the array array with the value value and return the previous value at this index. Return NULL and do nothing if array is NULL or the index is out of the array range.

void [Function]
svz_array_add (svz_array_t *array, void *value)
    Append the value value at the end of the array array. Do nothing if array is NULL.

void * [Function]
svz_array_del (svz_array_t *array, size_t index)
    Remove the array element at the position index of the array array. Return its previous value or NULL if the index is out of the array’s range.

size_t [Function]
svz_array_size (svz_array_t *array)
    Return the current size of array.

svz_array_foreach (array, value, i) [Macro]
    Expand into a for-statement header, for iterating over array. On each cycle, value is assigned to successive elements of array, and i the element’s position.

5.2.3.2 Hashtable
A hashtable associates keys of arbitrary size and content with values. This data structure is also called associative array sometimes because you use keys in order to access values instead of numbers. You cannot store two values associated with the same key. The values can have any simple C types like integers or pointers.
svz_hash_t *  
svz_hash_create (size_t size, svz_free_func_t destroy)  
Create a new hash table with an initial capacity size. Return a non-zero pointer to the newly created hash. The size is calculated down to a binary value. The destroy callback specifies an element destruction callback for use by svz_hash_clear and svz_hash_destroy for each value. If no such operation should be performed the argument must be NULL.

svz_hash_t *  
svz_hash_configure (svz_hash_t *hash, size_t (*keylen) (const char *),  
unsigned long (*code) (const char *), int (*equals) (const char *, const char *))  
Set the internal keylen, code and equals functions for hash table hash. Return hash.
keylen takes const char *data and returns size_t, the number of bytes in data representing the key.
code takes const char *data and returns unsigned long.
equals takes const char *data1, const char *data2 and returns int, which should be non-zero if equal.
As a special case, a NULL value means don’t set that function, leaving it to its default value.

void  
svz_hash_destroy (svz_hash_t *hash)  
Destroy the existing hash table hash, svz_freeing all keys within the hash, the hash table and the hash itself. If a non-NULL element destruction callback was specified to svz_hash_create, that function is called on each value.

void *  
svz_hash_delete (svz_hash_t *hash, const char *key)  
Delete an existing entry accessed via a key from the hash table hash. Return NULL if there is no such key, otherwise the previous value.

void *  
svz_hash_put (svz_hash_t *hash, const char *key, void *value)  
Add a new element consisting of key and value to hash. When key already exists, replace and return the old value. Note: This is sometimes the source of memory leaks.

void *  
svz_hash_get (const svz_hash_t *hash, const char *key)  
Return the value associated with key in the hash table hash, or NULL if there is no such key.

void  
svz_hash_foreach (svz_hash_do_t *func, svz_hash_t *hash, void *closure)  
Iterate func over each key/value pair in hash. func is called with three void * args: the key, the value and the opaque (to svz_hash_foreach) closure.
size_t

svz_hash_size (const svz_hash_t *hash)

Return the number of keys in the hash table hash. If hash is NULL, return zero.

char *

svz_hash_contains (const svz_hash_t *hash, void *value)

Return the key associated with value in the hash table hash, or NULL if there is no such value.

int

svz_hash_exists (const svz_hash_t *hash, char *key)

Return non-zero if key is stored within the hash table hash, otherwise zero. This function is useful when you cannot tell whether the return value of svz_hash_get (== NULL) indicates a real value in the hash or a non-existing hash key.

5.2.4 svz_address_t

A network address comprises a family, such as AF_INET (also known as IPv4), and its bits in network byte order, such as the bytes 127, 0, 0 and 1 (also known as the IPv4 loopback address). Many libserveez functions take svz_address_t *.

Please note: Although svz_address_t supports IPv6, the rest of libserveez it does not (yet). This means you can freely create and manipulate address objects with the functions described in this section, but any attempt to pass to the rest of libserveez an address with a family other than AF_INET will immediately abort the process. When full IPv6 support is in place, this blurb will be deleted and the list returned by svz_library_features will include an appropriate indicator (see Section 5.2.1 [Library features], page 57).

svz_address_t *

svz_address_make (int family, const void *bits)

Return an address object to hold an address in family, represented by bits. family must be one of:

AF_INET An IPv4 address; bits is in_addr_t *.

AF_INET6 (if supported by your system) An IPv6 address; bits is struct in6_addr *.

The bits are expected in network byte order. If there are problems, return NULL.

int

svz_address_family (const svz_address_t *addr)

Return the address family of addr.

int

svz_address_to (void *dest, const svz_address_t *addr)

Copy the address bits out of addr to dest. Return 0 on success, -1 if either addr or dest is NULL, or the addr family is AF_UNSPEC.

1 that is, if your system supports it
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\texttt{int svz\_address\_same (const svz\_address\_t *a, const svz\_address\_t *b)}

Return 1 if \textit{a} and \textit{b} represent the same address (identical family and bits), otherwise 0.

\texttt{const char * svz\_pp\_address (char *buf, size\_t size, const svz\_address\_t *addr)}

Format an external representation of \textit{addr} into \textit{buf}, of \textit{size} bytes. The format depends on the family of \textit{addr}. For IPv4, this is numbers-and-dots. For IPv6, it is “the most appropriate IPv6 network address format for \textit{addr}”, according to the manpage of \texttt{inet\_ntop}, the function that actually does the work.

If \textit{buf} or \textit{addr} is NULL, or \textit{size} is not big enough, return \texttt{NULL}. Otherwise, return \textit{buf}.

\texttt{const char * svz\_pp\_addr\_port (char *buf, size\_t size, const svz\_address\_t *addr, in\_port\_t port)}

Format an external representation of \textit{addr} and \textit{port} (in network byte order) into \textit{buf}, of \textit{size} bytes. The address \textit{xrep} (external representation) is done by \texttt{svz\_pp\_address}, q.v. The rest of the formatting depends on the \textit{addr} family.

\begin{tabular}{ll}
\textbf{Family} & \textbf{Formatting} \\
AF\_INET (IPv4) & \textit{xrep}:port \\
AF\_INET6 (IPv6) & [\textit{xrep}]:port \\
\end{tabular}

If \textit{buf} or \textit{addr} is NULL, or \textit{size} is not big enough, return \texttt{NULL}. Otherwise, return \textit{buf}.

\texttt{svz\_address\_t * svz\_address\_copy (const svz\_address\_t *addr)}

Return a copy of \textit{addr}.

\texttt{SVZ\_SET\_ADDR (place, family, bits)}

Expand to a series of commands. First, if \textit{place} is non-NULL, then \texttt{svz\_free} it. Next, assign to \textit{place} a new address object made by calling \texttt{svz\_address\_make} with \textit{family} and \textit{bits}.

\texttt{SVZ\_PP\_ADDR (buf, addr)}

Expand to a call to \texttt{svz\_pp\_address}, passing it \textit{buf} and \texttt{sizeof buf}, in addition to \textit{addr}.

\texttt{SVZ\_PP\_ADDR\_PORT (buf, addr, port)}

Expand to a call to \texttt{svz\_pp\_addr\_port}, passing it \textit{buf} and \texttt{sizeof buf}, in addition to \textit{addr} and \textit{port}.

\textbf{5.2.5 Utility functions}

Within this section you will find some miscellaneous functionality and left overs of the C API.

\texttt{void svz\_log (int level, const char *format, \ldots)}

Print a message to the log system. \textit{level} specifies the prefix.
void
svz_log_setfile (FILE *file)
    Set the file stream file to the log file all messages are printed to. Can also be stdout or stderr.

int
svz_hexdump (FILE *out, char *action, int from, char *buffer, int len, int max)
    Dump buffer with the length len to the file stream out. Display description action along with origin and size info first, followed by the hexadecimal text representation. Stop output at either max or len (if max is zero) bytes. from is a numerical identifier of the buffers creator.

cchar *
svz_itoa (unsigned int i)
    Convert an unsigned integer to its decimal string representation, returning a pointer to an internal buffer. (You should copy the result.)

unsigned int
svz_atoi (char *str)
    Convert string str in decimal format to an unsigned integer. Stop conversion on any invalid characters.

cchar *
svz_getcwd (void)
    Return the current working directory in a newly allocated string. (You should svz_free it when done.)

int
svz_openfiles (int maxsockets)
    Check for the current and maximum limit of open files of the current process and try to set the limit to maxsockets.

cchar *
svz_time (long t)
    Transform the given binary data t (UTC time) to an ASCII time text representation without any trailing characters.

cchar *
svz_tolower (char *str)
    Convert the given string str to lower case text representation.

cchar *
svz_sys_version (void)
    Return a statically-allocated string describing some operating system version details.

int
svz_socket_unavailable_error_p (void)
    Return 1 if there was a "socket unavailable" error recently, 0 otherwise. This checks svz_errno against WSAEWOULDBLOCK (woe32) or EAGAIN (Unix).
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const char * svz_sys_strerror (void)

Return a string describing the most recent system error.

The next two functions log (with SVZ_LOG_ERROR) the current system error or network error, forming the prefix of the message using fmt and args. This formatted prefix cannot exceed 255 bytes. The rest of the message comprises: colon, space, error description, newline.

void svz_log_sys_error (char const *fmt, ...)

Log the current system error.

void svz_log_net_error (char const *fmt, ...)

Log the current network error.

int svz_mingw_at_least_nt4_p (void)

Return 1 if running MinGW (Windows) NT4x or later, otherwise 0.

5.2.6 Networking and other low level functions

This chapter deals with the basic networking and file systems functions. It encapsulates systems calls in a portable manner. These functions should behave identically on Windows and Unices.

char * svz_inet_ntoa (in_addr_t ip)

Convert ip, an address in network byte order, to its dotted decimal representation, returning a pointer to a statically allocated buffer. (You should copy the result.)

int svz_inet_aton (char *str, struct sockaddr_in *addr)

Convert the Internet host address str from the standard numbers-and-dots notation into binary data and store it in the structure that addr points to. Return zero if the address is valid, nonzero otherwise. As a special case, if str is ‘*’ (asterisk), store INADDR_ANY in addr.

int svz_closesocket (svz_t_socket sockfd)

Close the socket sockfd. Return 0 if successful, -1 otherwise.

int svz_fd_cloexec (int fd)

Set the close-on-exec flag of the given file descriptor fd and return zero on success. Otherwise return non-zero.
int
svz_tcp_cork (svz_t_socket fd, int set)
    Enable or disable the TCP_CORK socket option of the socket fd. This is useful for
    performance reasons when using sendfile with any prepending or trailing data not
    inside the file to transmit. Return zero on success, otherwise non-zero.

int
svz_tcp_nodelay (svz_t_socket fd, int set, int *old)
    Enable or disable the TCP_NODELAY setting for the socket fd depending on the flag
    set, effectively enabling or disabling the Nagle algorithm. This means that packets
    are always sent as soon as possible and no unnecessary delays are introduced. If old
    is not NULL, save the old setting there. Return zero on success, otherwise non-zero.

int
svz_sendfile (int out_fd, int in_fd, off_t *offset, size_t count)
    Transmit data between one file descriptor and another where in_fd is the source and
    out_fd the destination. The offset argument is a pointer to a variable holding the
    input file pointer position from which reading starts. On return, the offset variable
    will be set to the offset of the byte following the last byte that was read. count is the
    number of bytes to copy. Return the number of bytes actually read/written or -1 on
    errors.

int
svz_open (const char *file, int flags, mode_t mode)
    Open the filename file and convert it into a file handle. The given flags specify the
    access mode and the mode argument the permissions if the O_CREAT flag is set.

int
svz_close (int fd)
    Close the given file handle fd. Return -1 on errors.

int
svz_fstat (int fd, struct stat *buf)
    Return information about the specified file associated with the file descriptor fd re-
    turned by svz_open. Store available information in the stat buffer buf.

FILE *
svz_fopen (const char *file, const char *mode)
    Open the file whose name is the string pointed to by file and associate a stream with
    it.

int
svz_fclose (FILE *f)
    Dissociate the named stream f from its underlying file.

5.2.7 Client connections
Serveez tries to handle all kinds of Internet protocols like TCP (connection oriented), UDP,
ICMP and RAW (packet oriented) and communication across named pipes (also connection
oriented) in the same way. Therefore it uses a structure called svz_socket_t which is the
abstraction of any kind of communication endpoint (can be client or server or both together).
5.2.7.1 TCP sockets

TCP sockets provide a reliable, stream oriented, full duplex connection between two sockets on top of the Internet Protocol (IP). TCP guarantees that the data arrives in order and retransmits lost packets. It generates and checks a per packet checksum to catch transmission errors. TCP does not preserve record boundaries.

```c
svz_socket_t * svz_tcp_connect (svz_address_t *host, in_port_t port)
    Create a TCP connection to host host and set the socket descriptor in structure sock to the resulting socket. Return NULL on errors.

int svz_tcp_read_socket (svz_socket_t *sock)
    Read all data from sock and call the check_request function for the socket, if set. Return -1 if the socket has died, zero otherwise. This is the default function for reading from sock.

int svz_tcp_send_oob (svz_socket_t *sock)
    If the underlying operating system supports urgent data (out-of-band) in TCP streams, try to send the byte in sock->oob through the socket structure sock as out-of-band data. Return zero on success and -1 otherwise (also if urgent data is not supported).
```

5.2.7.2 Pipe connections

The pipe implementation supports both named and anonymous pipes. Pipe servers are implemented as listeners on a file system FIFO on Unices or “Named Pipes” on Windows (can be shared over a Windows network).

A FIFO special file is similar to a pipe, except that it is created in a different way. Instead of being an anonymous communications channel, a FIFO special file is entered into the file system.

Once you have created a FIFO special file in this way, any process can open it for reading or writing, in the same way as an ordinary file. However, it has to be open at both ends simultaneously before you can proceed to do any input or output operations on it.

```c
svz_socket_t * svz_pipe_create (svz_t handle recv_fd, svz_t handle send_fd)
    Create a socket structure containing both the pipe descriptors recv_fd and send_fd. Return NULL on errors.

int svz_pipe_create_pair (svz_t handle pipe_desc[2])
    Create a (non blocking) pair of pipes. This differs in Win32 and Unices. Return a non-zero value on errors.

svz_socket_t * svz_pipe_connect (svz_pipe_t *recv, svz_pipe_t *send)
    Create a pipe connection socket structure to the pair of named pipes recv and send. Return NULL on errors.
```
int 

svz_invalid_handle_p (svz_t *handle) 

Return 1 if handle is invalid, otherwise 0.

void

svz_invalidate_handle (svz_t *href)

Invalidate the handle pointed at by href.

int

svz_closehandle (svz_t *handle)

Close handle. Return 0 if successful, -1 otherwise.

5.2.7.3 UDP sockets

The UDP sockets implement a connectionless, unreliable datagram packet service. Packets may be reordered or duplicated before they arrive. UDP generates and checks checksums to catch transmission errors.

svz_socket_t *

svz_udp_connect (svz_address_t *host, in_port_t port)

Create a UDP connection to host at port and set the socket descriptor in structure sock to the resulting socket. Return a NULL value on errors.

This function can be used for port bouncing. If you assign the handle_request callback to something server specific and the cfg field of the server’s configuration to the returned socket structure, this socket is able to handle a dedicated UDP connection to some other UDP server.

int

svz_udp_write (svz_socket_t *sock, char *buf, int length)

Write buf into the send queue of the UDP socket sock. If length argument supersedes the maximum length for UDP messages it is split into smaller packets.

5.2.7.4 ICMP sockets

The ICMP socket implementation is currently used in the tunnel server which comes with the Serveez package. It implements a user protocol receiving and sending ICMP packets by opening a raw socket with the protocol IPPROTO_ICMP.

The types of ICMP packets passed to the socket can be filtered using the ICMP_FILTER socket option (or by software as done here). ICMP packets are always processed by the kernel too, even when passed to a user socket.

svz_socket_t *

svz_icmp_connect (svz_address_t *host, in_port_t port, uint8_t type)

Create an ICMP socket for receiving and sending. Return NULL on errors, otherwise an enqueued socket structure.

int

svz_icmp_send_control (svz_socket_t *sock, uint8_t type)

“If you are calling this function we will send an empty ICMP packet signaling that this connection is going down soon.” [ttn sez: huh?]
int svz_icmp_write (svz_socket_t *sock, char *buf, int length)

Send buf with length length via this ICMP socket sock. If length supersedes the maximum ICMP message size the buffer is split into smaller packets.

5.2.7.5 Raw sockets

A raw socket receives or sends the raw datagram not including link-level headers. It is currently used by the ICMP socket implementation of the core library. The IPv4 layer generates an IP header when sending a packet unless the IP_HDRINCL socket option is enabled on the socket. When it is enabled, the packet must contain an IP header. For receiving the IP header is always included in the packet.

Only processes with an effective userid of zero (Administrator or root) or the CAP_NET_RAW capability are allowed to open raw sockets. All packets or errors matching the protocol number specified for the raw socket are passed to this socket. A protocol of IPPROTO_RAW implies enabled IP_HDRINCL and receives all IP protocols. Sending is not allowed.

[FIXME: All funcs internalized! Write something else here!]

5.2.7.6 Passthrough connections

The functions described in this section allow you to pass through client connections to the standard input (stdin) and standard output (stdout) of external programs. Some of the routines deal with the management of program environments. Basically, there are two methods for passing through a duplex connection: the Unix’ish fork and exec method and the shuffle method where the main process keeps control over the communication on the original duplex connection and passes this data through two pairs of pipes, or yet another socket connection, to the child process. All of the three method are implemented calling them SVZ_PROCESS_FORK, SVZ_PROCESS_SHUFFLE_PIPE and SVZ_PROCESS_SHUFFLE_SOCK.

int svz_sock_process (svz_socket_t *sock, char *bin, char *dir, char **argv,
                     svz_envblock_t *envp, int forkp, char *user)

Start a new program bin, a fully qualified executable filename, passing the socket or pipe descriptor(s) in the socket structure sock to its stdin and stdout. If dir is non-NULL, it specifies the working directory of the new process.

The program arguments and the environment of the new process are taken from argv and envp. Normally argv[0] should be set to the program’s name. If NULL, it defaults to bin.

The forkp argument is a flag that controls the passthrough method. If non-zero, pipe descriptors or the socket descriptor are passed to the child process directly through fork and exec. Otherwise, socket transactions are passed via a pair or pipes or sockets (depending on whether or not the system provides socketpair).

You can pass the user and group identifications in the format ‘user[.group]’ (group is optional), as SVZ_PROCESS_NONE or SVZ_PROCESS_OWNER in the user argument. This specifies the permissions of the new child process. If SVZ_PROCESS_OWNER is passed the permissions are set to the executable file bin owner; SVZ_PROCESS_NONE does not change user or group.

Return the new process id on success, -1 on failure.
Please note: On M$-Windows platforms it is not possible to pass a socket connection to stdin/stdout of a child process. That is why this function creates an inheritable version of the socket and puts the socket handle number into the environment variables SEND_HANDLE and RECV_HANDLE. A spawned child process can use these handles as if they were self-created. After calling WSAStartup the child process can send and recv as usual.

Relatedly, Windoze does not use SIGCHLD to inform the parent when a child dies, so for that platform, you should use the next function (which is not otherwise available):

```c
int svz_mingw_child_dead_p (char *prefix, svz_t_handle *pid)
```

Check child pointed at by pid by waiting a bit. If it is dead, close and invalidate its handle, and return 1. Otherwise, return 0. prefix is for error messages; it should be either the empty string, or a string ending in colon and space.

On non-Windoze, this is the function you want to use:

```c
int svz_most_recent_dead_child_p (svz_t_handle pid)
```

Return 1 if a child process pid died recently, updating other internal state by side effect. Otherwise, return 0.

```c
void svz_envblock_setup (void)
```

Set up internal tables for environment block wrangling.

This function must be called once after svz_boot so that subsequent functions (like svz_envblock_default) can work correctly.

```c
svz_envblock_t *
svz_envblock_create (void)
```

Create and return a fresh environment block, useful for passing to svz_envblock_default and svz_envblock_add. Its size is initially set to zero.

```c
int svz_envblock_default (svz_envblock_t *env)
```

Fill environment block env with the environment variables from the current process, replacing its current contents (if any).

```c
int svz_envblock_add (svz_envblock_t *env, char *format, . . .)
```

Insert a new environment variable into environment block env. The format argument is a printf-style format string describing how to format the optional arguments. You specify environment variables in the ‘VAR=VALUE’ format.

```c
void svz_envblock_destroy (svz_envblock_t *env)
```

Destroy environment block env completely. Afterwards, env is invalid and should therefore not be further referenced.
void *  
svz_envblock_get (svz_envblock_t *env)

Convert environment block env into something which can be passed to execve (Unix) or CreateProcess (Windows). Additionally, under Windows, sort the environment block.

(Unfortunately the layout of environment blocks in Unices and Windows differ. On Unices you have a NULL terminated array of character strings (i.e., char **) and on Windows systems you have a simple character string containing the environment variables in the format ‘VAR=VALUE’ each separated by a zero byte (i.e., char *). The end of the list is indicated by a further zero byte.)

5.2.8 Socket management

The functions described in this section deal with the operations on C structures called svz_socket_t. See the description of each function for details on which kind of socket it can handle and what they are for.

int  
svz_sock_nconnections (void)

Return the number of currently connected sockets.

int  
svz_sock_write (svz_socket_t *sock, char *buf, int len)

Write len bytes from the memory location pointed to by buf to the output buffer of the socket sock. Also try to flush the buffer to the socket of sock if possible. Return a non-zero value on error, which normally means a buffer overflow.

int  
svz_sock_printf (svz_socket_t *sock, const char *fmt, ...)  

Print a formatted string on the socket sock. fmt is the printf-style format string, which describes how to format the optional arguments.

int  
svz_sock_resize_buffers (svz_socket_t *sock, int send_buf_size, int recv_buf_size)

Resize the send and receive buffers for the socket sock. send_buf_size is the new size for the send buffer, recv_buf_size for the receive buffer. Note that data may be lost when the buffers shrink. For a new buffer size of 0 the buffer is freed and the pointer set to NULL.

int  
svz_sock_check_request (svz_socket_t *sock)

Check for the kind of packet delimiter within sock and and assign one of the default check_request routines (one or more byte delimiters or a fixed size). Afterwards this function will never ever be called again because the callback gets overwritten here.

void  
svz_sock_reduce_recv (svz_socket_t *sock, int len)

Shorten the receive buffer of sock by len bytes.
void svz_sock_reduce_send (svz_socket_t *sock, int len)

Reduce the send buffer of sock by len bytes.

Because libserveez manages the creation and destruction of svz_socket_t objects internally, the following API element is useful for synchronizing client-code references to those objects with those objects.

void svz_sock_prefree (int addsub, svz_sock_prefree_fn fn)

Register (if addsub is non-zero), or unregister (otherwise) the function fn to be called immediately prior to a svz_socket_t being freed. fn is called with one arg sock, and should not return anything. In other words:

typedef void (svz_sock_prefree_fn) (const svz_socket_t *);

Note the const!

5.2.9 Coserver functions

This section describes the internal coserver interface of Serveez. Coservers are helper processes meant to perform blocking tasks. This is necessary because Serveez itself is single threaded. Each coserver is connected via a pair of pipes to the main thread of Serveez communicating over a simple text line protocol. Each request/response is separated by a newline character.

int svz_foreach_coserver (svz_coserver_do_t *func, void *closure)

Call func for each coserver, passing additionally the second arg closure. If func returns a negative value, return immediately with that value (breaking out of the loop), otherwise, return 0.

void svz_coserver_check (void)

Under woe32 check if there was any response from an active coserver. Moreover keep the coserver threads/processes alive. If one of the coservers dies due to buffer overrun or might be overloaded, start a new one.

Call this function whenever there is time, e.g., within the timeout of the select system call.

void svz_coserver_destroy (int type)

Destroy specific coservers with the type type. All instances of this coserver type will be stopped.

svz_coserver_t *

svz_coserver_create (int type)

Create and return a single coserver with the given type type.

const char *

svz_coserver_type_name (const svz_coserver_t *coserver)

Return the type name of coserver.
void
svz_coserver_rdns_invoke (svz_address_t *addr, svz_coserver_handle_result_t cb,
void *closure)
Enqueue a request for the reverse DNS coserver to resolve address addr, arranging
for callback cb to be called with two args: the hostname (a string) and the opaque
data closure.

void
svz_coserver_dns_invoke (char *host, svz_coserver_handle_result_t cb,
void *closure)
Enqueue a request for the DNS coserver to resolve host, arranging for callback cb to
be called with two args: the ip address in dots-and-numbers notation and the opaque
data closure.

void
svz_coserver_ident_invoke (svz_socket_t *sock, svz_coserver_handle_result_t cb,
void *closure)
Enqueue a request for the ident coserver to resolve the client identity at sock, arrang-
ing for callback cb to be called with two args: the identity (string) and the opaque
data closure.

To make use of coservers, you need to start the coserver interface by calling svz_updn_all_cossers once before, and once after, entering the main server loop.

int
svz_updn_all_coservers (int direction)
If direction is non-zero, init coserver internals. Otherwise, finalize them. Return 0 if
successful.
If direction is positive, init also starts one instance each of the built in servers. If
negative, it doesn’t.

5.2.10 Codec functions
The codec interface of the Serveez core API supplies routines for setting up socket structures
to perform encoding or decoding of its receive or send buffers. It is a transparent layer of
buffer transition. The interface itself tries to unify different types of codecs. In order to
add a new codec the programmer needs to write some wrapper functions around the actual
implementation to fulfill certain entry and exit semantics of this interface.

int
svz_foreach_codec (svz_codec_do_t *func, void *closure)
Call func for each codec, passing additionally the second arg closure. If func returns
a negative value, return immediately with that value (breaking out of the loop),
otherwise, return 0.

svz_codec_t *
svz_codec_get (char *description, int type)
Find an appropriate codec for the given description and type (one of either SVZ_CODEC_ENCODER or SVZ_CODEC_DECODER). Return NULL if there is no such codec reg-
istered.
void svz_codec_ratio (svz_codec_t *codec, svz_codec_data_t *data)
    Print a text representation of a codec’s current ratio in percent if possible.

int svz_codec_register (svz_codec_t *codec)
    Register codec. Does not register invalid or duplicate codecs. Return zero on success, non-zero otherwise.

int svz_codec_unregister (svz_codec_t *codec)
    Remove codec from the list of known codecs. Return zero if the codec could be successfully removed, non-zero otherwise.

int svz_codec_sock_receive_setup (svz_socket_t *sock, svz_codec_t *codec)
    Arrange for sock to decode or encode its receive data via codec. Return zero on success, non-zero otherwise.
    (You need to have set the check_request method previously for this to work.)

int svz_codec_sock_receive (svz_socket_t *sock)
    “This routine is the new check_request callback for reading codecs. It is applied in svz_codec_sock_receive_setup. Usually it gets called whenever there is data in the receive buffer. It lets the current receive buffer be the input of the codec. The output buffer of the codec gets the new receive buffer of sock. The old check_request callback of sock gets called afterwards. When leaving this function, the receive buffer gets restored again with the bytes snipped consumed by the codec itself.” [ttn sez: huh?]

int svz_codec_sock_send_setup (svz_socket_t *sock, svz_codec_t *codec)
    Arrange for sock to encode or decode its send buffer via codec. Return zero on success, non-zero otherwise.
    (You need to have properly set the write_socket member of sock previously for this to work.)

int svz_codec_sock_send (svz_socket_t *sock)
    “This is the new write_socket callback for sock which is called whenever there is data within the send buffer available and sock is scheduled for writing. It uses the current send buffer as input buffer for the codec. The output buffer of the codec is used to invoke the write_socket callback saved within svz_codec_sock_send_setup. After this the send buffer is restored again without the bytes consumed by the codec.” [ttn sez: huh?]

int svz_codec_sock_disconnect (svz_socket_t *sock)
    Try to release the resources of both the receiving and sending codec of sock.
This callback is used as the disconnected_socket callback of the socket structure sock. It is called by default if the codec socket structure sock gets disconnected for some external reason.

```
svz_codec_t * svz_codec_sock_detect (svz_socket_t *sock)
```

Return a valid codec detected by scanning the receive buffer of sock, or NULL if no codec could be detected.

### 5.2.11 Server types

As already noted in the main Serveez manual a server type is the main specification of the abilities and configuration items of a server which can be instantiated. It is represented by svz_servertype_t in Serveez. It contains server specific members like its name, different callbacks, a single default configuration and a list of configuration items which determine what can be configured.

#### 5.2.11.1 Macros for setting up a new server type

When specifying a server type you also need to define configuration items for it. These items refer to addresses in the example configuration of the server type. These macros can be used to define such items.

```
SVZ_REGISTER_INT (name, item, defaultable) [Macro]
```

Register a simple integer. C-type: int. The given name specifies the symbolic name of the integer and item the integer itself (not its address). The defaultable argument can be either SVZ_ITEM_DEFAULTABLE or SVZ_ITEM_NOTDEFAULTABLE.

```
SVZ_REGISTER_BOOL (name, item, defaultable) [Macro]
```

Register a boolean value. C-type: int.

```
SVZ_REGISTER_INTARRAY (name, item, defaultable) [Macro]
```

Register an array of integers. C-type: svz_array_t *.

```
SVZ_REGISTER_STR (name, item, defaultable) [Macro]
```

Register a simple character string. C-type: char *.

```
SVZ_REGISTER_STRARRAY (name, item, defaultable) [Macro]
```

Register a string array. C-type: svz_array_t *.

```
SVZ_REGISTER_HASH (name, item, defaultable) [Macro]
```

Register a hash table associating strings with strings only. C-type: svz_hash_t *.

```
SVZ_REGISTER_PORTCFG (name, item, defaultable) [Macro]
```

Register a port configuration. C-type: svz_portcfg_t *.

```
SVZ_REGISTER_END () [Macro]
```

Indicate the end of the list of configuration items. It is the only mandatory item you need to specify in an example server type configuration.

```
SVZ_CONFIG_DEFINE (description, config, prototypes) [Macro]
```

Expand to a data structure that properly associates the example configuration config with the name description and its configuration items prototypes, for use within a server type definition.
5.2.11.2 General server type functionality

The following set of functions are used to manage the list of known server types in the Serveez core library. Serveez itself uses some of these functions to register its built-in server types.

int svz_foreach_servertype (svz_servertype_do_t *func, void *closure)

Call func for each server type, passing additionally the second arg closure. If func returns a negative value, return immediately with that value (breaking out of the loop), otherwise, return 0.

void svz_servertype_add (svz_servertype_t *server)

Add the server type server to the currently registered servers.

svz_servertype_t * svz_servertype_get (char *name, int dynamic)

Find a server type definition by its short name. If dynamic is set to non-zero, try to load a shared library that provides that server type. Return NULL if no server with the given variable prefix name has been found.

svz_servertype_t * svz_servertype_find (svz_server_t *server)

Find a given server instance server server type. Return NULL if there is no such server type (which should never occur since a server is a child of a server type).

5.2.11.3 Dynamic server loading

The core API of Serveez is able to register server types dynamically at runtime. It uses the dynamic linker capabilities of the underlying operating system to load shared libraries (or DLLs on Win32). This has been successfully tested on Windows and GNU/Linux. Other systems are supported but yet untested. Please tell us if you notice misbehaviour of any sort.

void svz_dynload_path_set (svz_array_t *paths)

Set the additional search paths for the serveez library. The given array of strings gets svz_freed.

svz_array_t * svz_dynload_path_get (void)

Create an array of strings containing each an additional search path. The loadpath is hold in the environment variable ‘SERVEEZ_LOAD_PATH’ which can be set from outside the library or modified using svz_dynload_path_set. The returned array needs to be destroyed after usage.

5.2.12 Server functions

A server in Serveez is an instantiated (configured) server type. It is merely a copy of a specific server type with a unique server name, and is represented by svz_server_t in the core library.
5.2.12.1 Server functionality

This section contains functions dealing with the list of known servers in the core library of Serveez, also with the basics like creation and destruction of such servers.

```c
void svz_foreach_server (svz_server_do_t *func, void *closure)
    Call func for each server, passing additionally the second arg closure.
```

```c
svz_server_t * svz_server_find (void *cfg)
    Find a server instance by the given configuration structure cfg. Return NULL if there
    is no such configuration in any server instance.
```

```c
svz_server_t * svz_server_clients (svz_server_t *server)
    Return a list of clients (socket structures) which are associated with the given server
    instance server. If there is no such socket, return NULL. Caller should svz_array_destruct the returned array.
```

```c
svz_server_t * svz_server_get (char *name)
    Get the server instance with the given instance name name. Return NULL if there is
    no such server yet.
```

```c
int svz_updn_all_servers (int direction)
    If direction is non-zero, run the initializers of all servers, returning -1 if some server
did not think it is a good idea to run. Otherwise, run the local finalizers for all server
instances.
```

5.2.12.2 Configuration

These functions provide an interface for configuring a server. They are used to create and
modify the default configuration of a server type in order to create a server configuration.

```c
int svz_config_type_instantiate (char *type, char *name, char *instance, void *options, svz_config_accessor_t *accessor, size_t ebufsz, char *ebuf)
    Instantiate a configurable type. The type argument specifies the configurable type
    name, name the name of the type (in the domain of the configurable type) and
    instance the instance name of the type. Return zero on success, otherwise -1.
```

```c
void svz_config_free (svz_config_prototype_t *prototype, void *cfg)
    Release the configuration cfg of the given configuration prototype prototype. If cfg
    is NULL, do nothing.
```

```c
void * svz_collect (int type, size_t count, void *data)
    Create a collection of type, given the count items of data. Valid values of type are
    one of: SVZ_INTARRAY, SVZ_STRARRAY, SVZ_STRHASH. For a string hash, data should
be alternating keys and values; the returned hash table will have \texttt{count} / 2 elements. The C type of \texttt{data} for an int array should be \texttt{int[]} , and for string array or hash it should be \texttt{char*[]} . On error (either bad \texttt{type} or odd \texttt{count} for string hash), return \texttt{NULL}.

Here are some convenience macros for \texttt{svz_collect}:

\begin{itemize}
\item \texttt{SVZ\_COLLECT\_INTARRAY (cvar)}
  \begin{itemize}
  \item [Macro]
  \begin{itemize}
  \item Return an integer array \texttt{svz\_array\_t} * created from \texttt{int cvar[]} .
  \end{itemize}
\end{itemize}

\item \texttt{SVZ\_COLLECT\_STRARRAY (cvar)}
  \begin{itemize}
  \item [Macro]
  \begin{itemize}
  \item Return a string array \texttt{svz\_array\_t} * created from \texttt{char* cvar[]} .
  \end{itemize}
\end{itemize}

\item \texttt{SVZ\_COLLECT\_STRHASH (cvar)}
  \begin{itemize}
  \item [Macro]
  \begin{itemize}
  \item Return a string hash \texttt{svz\_hash\_t} * created from \texttt{char* cvar[]} .
  \end{itemize}
\end{itemize}
\end{itemize}

### 5.2.12.3 Bindings

The following functionality represents the relationship between port configurations as described in Section 5.2.13 \[Port config funcs\], page 80 and server instances. When binding a server to a specific port configuration the core library creates listeners as needed by itself.

\begin{itemize}
\item \texttt{int}
  \begin{itemize}
  \item \texttt{svz\_server\_bind (svz\_server\_t} *\texttt{server, svz\_portcfg\_t} *\texttt{port)}
    \begin{itemize}
    \item [Function]
    \begin{itemize}
    \item Bind the server instance \texttt{server} to the port configuration \texttt{port} if possible. Return non-zero on errors, otherwise zero. It might occur that a single server is bound to more than one network port if, e.g., the TCP/IP address is specified by ‘*’ (asterisk) since this gets expanded to the known list of interfaces.
    \end{itemize}
  \end{itemize}
\end{itemize}

\item \texttt{svz\_array\_t} *
  \begin{itemize}
  \item \texttt{svz\_server\_portcfgs (svz\_server\_t} *\texttt{server)}
    \begin{itemize}
    \item [Function]
    \begin{itemize}
    \item Return an array of port configurations to which the server instance \texttt{server} is currently bound to, or \texttt{NULL} if there is no such binding. Caller should \texttt{svz\_array\_destroy} the returned array when done.
    \end{itemize}
  \end{itemize}
\end{itemize}

\item \texttt{svz\_array\_t} *
  \begin{itemize}
  \item \texttt{svz\_server\_listeners (svz\_server\_t} *\texttt{server)}
    \begin{itemize}
    \item [Function]
    \begin{itemize}
    \item Return an array of listening socket structures to which the server instance \texttt{server} is currently bound to, or \texttt{NULL} if there is no such binding. Caller should \texttt{svz\_array\_destroy} the returned array when done.
    \end{itemize}
  \end{itemize}
\end{itemize}

\item \texttt{svz\_array\_t} *
  \begin{itemize}
  \item \texttt{svz\_sock\_servers (svz\_socket\_t} *\texttt{sock)}
    \begin{itemize}
    \item [Function]
    \begin{itemize}
    \item Return the array of server instances bound to the listening \texttt{sock}, or \texttt{NULL} if there are no bindings. Caller should \texttt{svz\_array\_destroy} the returned array when done.
    \end{itemize}
  \end{itemize}
\end{itemize}

\item \texttt{int}
  \begin{itemize}
  \item \texttt{svz\_binding\_contains\_server (svz\_socket\_t} *\texttt{sock, svz\_server\_t} *\texttt{server)}
    \begin{itemize}
    \item [Function]
    \begin{itemize}
    \item Checks whether the server instance \texttt{server} is bound to the server socket structure \texttt{sock}. Return one if so, otherwise zero.
    \end{itemize}
  \end{itemize}
\end{itemize}
\end{itemize}
size_t

svz_pp_server_bindings (char *buf, size_t size, svz_server_t *server)

Format a space-separated list of current port configuration bindings for server into
buf, which has size bytes. The string is guaranteed to be nul-terminated. Return the
length (at most size - 1) of the formatted string.

5.2.12.4 Server core

svz_t_handle svz_child_died

Set to a non-zero value whenever the server receives a SIGCHLD signal.

int

svz_shutting_down_p (void)

Return non-zero if the core is in the process of shutting down (typically as a result of
a signal).

int

svz_foreach_socket (svz_socket_do_t *func, void *closure)

Call func for each socket, passing additionally the second arg closure. If func returns
a negative value, return immediately with that value (breaking out of the loop),
otherwise, return 0.

svz_socket_t *

svz_sock_find (int id, int version)

Return the socket structure for the socket id id and the version version, or NULL if no
such socket exists. If version is -1 it is not checked.

int

svz_sock_schedule_for_shutdown (svz_socket_t *sock)

Mark socket sock as killed. That means that no further operations except discon-
necting and freeing are allowed. All marked sockets will be deleted once the server
loop is through.

int

svz_sock_enqueue (svz_socket_t *sock)

Enqueue the socket sock into the list of sockets handled by the server loop.

void

svz_sock_setparent (svz_socket_t *child, svz_socket_t *parent)

Set the child socket’s parent to parent.

This should be called whenever a listener accepts a connection and creates a new
child socket.

svz_socket_t *

svz_sock_getparent (svz_socket_t *child)

Return the child socket’s parent socket structure, or NULL if this socket does not exist
anymore. This might happen if a listener dies for some reason.
void

svz_sock_setreferrer (svz_socket_t *sock, svz_socket_t *referrer)

Set the referring socket structure of sock to referrer. If referrer is NULL the reference will be invalidated.

This can be used to create some relationship between two socket structures.

svz_socket_t *

svz_sock_getreferrer (svz_socket_t *sock)

Get the referrer of the socket structure sock. Return NULL if there is no such socket.

svz_portcfg_t *

svz_sock_portcfg (svz_socket_t *sock)

Return the parent’s port configuration of sock, or NULL if the given socket has no parent, i.e. is a listener.

5.2.12.5 Server loop

This section describes the main server loop functionality. There two modes of operation. The default mode as used in Serveeez is to jump into the loop and wait until the core library drops out of it. In the other mode, the caller tells the Serveeez core library to scan (and process) its socket chain once and return immediately. Thus, caller is able to issue additional functionality in between each pass, useful if such functionality cannot be handled within the timers (notifliers) of servers and sockets.

void

svz_loop_pre (void)

Initialize top-of-cycle state.

Call this function once before using svz_loop_one.

void

svz_loop_post (void)

Clean up bottom-of-cycle state.

Call this function once after using svz_loop_one.

void

svz_loop (void)

Loop, serving. In other words, handle all signals, incoming and outgoing connections and listening server sockets.

void

svz_loop_one (void)

Handle all things once.

This function is called regularly by svz_loop.

5.2.12.6 Server sockets

This section deals with creating and handling listeners. These functions provide the default routines invoked when accepting a new connection on a listener. This is necessary for connection oriented protocols (TCP and named pipes) only.

[FIXME: All funcs internalized! Write something else here!]
5.2.13 Port configurations

A port configuration is a structure defining a network or file system configuration. Depending on the type of a server, it can be bound to one or more port configurations. There are two major types of port configurations: connection oriented (TCP and PIPE), and packet oriented (ICMP, UDP and RAW).

```c
struct sockaddr_in * svz_portcfg_addr (svz_portcfg_t *port)
    Return the pointer of the sockaddr_in structure of the given port configuration port
    if it is a network port configuration. Otherwise return NULL.

in_port_t svz_portcfg_port (svz_portcfg_t *port)
    Return the UDP or TCP port of the given port configuration or zero if it neither
    TCP nor UDP.

char * svz_portcfg_ipaddr (svz_portcfg_t *port)
    Return the pointer to the ip address ipaddr of the given port configuration port if it
    is a network port configuration. Otherwise return NULL.

char * svz_portcfg_device (svz_portcfg_t *port)
    Return the network device name stored in the given port configuration port if it is a
    network port configuration. Return NULL if there is no such device set or if the port
    configuration is not a network port configuration.
```

Serveez maintains an internal list of port configurations, with each identified by its name. When you bind a server to a port configuration, it does not get bound to a certain name but to its content. If there are two or more port configuration specifying the same network or file system configuration just a single one gets actually used.

```c
svz_portcfg_t * svz_portcfg_create (void)
    Create a new blank port configuration.

int svz_portcfg_equal (svz_portcfg_t *a, svz_portcfg_t *b)
    Check if two given port configurations structures are equal, i.e. specifying the same
    network port or pipe files. Return SVZ_PORTCFG_EQUAL if a and b are identical,
    SVZ_PORTCFG_MATCH if the network address of either port configuration contains the
    other (INADDR_ANY match), and otherwise SVZ_PORTCFG_NOMATCH or possibly SVZ_    
    PORTCFG_CONFLICT.

svz_portcfg_t * svz_portcfg_add (char *name, svz_portcfg_t *port)
    Add the given port configuration port associated with the name name to the list of
    known port configurations. Return NULL on errors. If the return port configuration
    equals the given port configuration the given one has been successfully added.
```
svz_portcfg_t * [Function]
svz_portcfg_get (char *name)
Return the port configuration associated with the given name name. Return NULL on errors.

void [Function]
svz_portcfg_destroy (svz_portcfg_t *port)
Make the given port configuration port completely unusable, removing it from the list of known port configurations. Do nothing if port is NULL.

int [Function]
svz_portcfg_mkaddr (svz_portcfg_t *this)
Construct the sockaddr_in fields from the ipaddr field. Return zero if it worked. If it does not work, the ipaddr field did not consist of an ip address in dotted decimal form.

svz_portcfg_t * [Function]
svz_portcfg_dup (svz_portcfg_t *port)
Make a copy of the given port configuration port.

5.2.14 Boot functions
The most important functions are svz_boot and svz_halt which must be the first and the last call to the core API.

void [Function]
svz_boot (char const *client)
Initialize the core library. client is typically a program’s argv[0]. If NULL, take it to be ‘anonymous’.

long [Function]
svz_uptime (void)
Return the number of seconds since svz_boot was called, or -1 if svz_boot has not yet been called.

void [Function]
svz_halt (void)
Finalization of the core library.

5.2.14.1 Runtime parameters
There are several runtime parameters indicating the abilities of the libserveez core API:

SVZ_RUNPARM_VERBOSITY
The log-level verbosity.

SVZ_RUNPARM_MAX_SOCKETS
Maximum number of clients allowed to connect.

These are manipulated by svz_runparm and two convenience macros, both of which accept nick, a C token without the prefix ‘SVZ_RUNPARM_’ (e.g., VERBOSITY).
int
svz_runparm (int a, int b)

Set or get a runtime parameter. If a is -1, return the value of runtime parameter b.
If a specifies a runtime parameter, set it to b and return 0. Otherwise, return -1.

SVZ_RUNPARM (nick)

Return the value of runtime parameter nick.

SVZ_RUNPARM_X (nick, val)

Set the runtime parameter nick to have value val, an integer.

5.2.15 Network interface functions

The network interface functions of the Serveez core API allow access to the network devices
on your system. The system administrator can set up these devices to be bound to different
Internet addresses and thereby split the network configuration into different domains. Thus,
the system is able to separate the traffic of different networks. If set up correctly, Serveez
can follow these rules.

int
svz_foreach_interface (svz_interface_do_t *func, void *closure)

Call func for each interface, passing additionally the second arg closure. If func
returns a negative value, return immediately with that value (breaking out of the
loop), otherwise, return 0.

int
svz_interface_add (size_t index, char *desc, int family, const void *bits,
int detected)

Add a network interface to the current list of known interfaces. Drop duplicate entries.
The given arguments index specifies the network interface index number, desc an
interface description, family an address-family (e.g., AF_INET), bits the address data
in network-byte order, and the detected flag if the given network interface has been
detected by Serveez itself or not.

5.2.16 Useful Windows functions

Serveez is meant to run on Windows systems as well (with some restrictions of course).
These functions are available with the Windows implementation of the Serveez core API
only. They allow access to the Windows registry database and some other useful things.

int
svz_windoze_daemon_control (char *prog)

If prog is non-NULL, start the daemon thread with it. Otherwise (if prog is NULL),
stop the daemon thread. Return 0 on success, -1 on failure.

WCHAR *
svz_windoze_asc2uni (CHAR *asc)

Convert an ASCII string into a UNICODE string.

CHAR *
svz_windoze_uni2asc (WCHAR *unicode)

Convert a UNICODE string into an ASCII string.
6 Porting issues

Serveez was always designed with an eye on maximum portability. Autoconf and Automake have done a great job at this. A lot of \#define's help to work around some of the different Unix' oddities. Have a look at config.h for a complete list of all these conditionals.

Most doubtful might be the Win32 port. There are two different ways of compiling Serveez on Win32: Cygwin and MinGW. The Cygwin version of Serveez depends on the Unix emulation layer DLL cygwin1.dll. Both versions work but it is preferable to use MinGW for performance reasons. The Cygwin version is slow and limited to a very low number (some 64) of open files/network connections.¹

There are major differences between the Win32 and Unix implementations due to the completely different API those systems provide.

Processes and Threads
Because process communication is usually done by a pair of unidirectional pipes we chose that method in order to implement the coservers in Unix. The Win32 implementation are threads which are still part of the main process.

Sockets and Handles
On Win32 systems there is a difference in network sockets and file descriptors. Thus we had to implement quite a complex main socket loop.

Named Pipes
Both systems Unix and Win32 do provide this functionality (Windows NT 4.0 and above). The main differences here are the completely different APIs. On a common Unix you create a named pipe within the filesystem via mkfifo. On Win32 you have to CreateNamedPipe which will create some special network device. A further difference is what you can do with these pipes. On Win32 systems this 'network device' is valid on remote machines. Named pipes on Unix are unidirectional, on Win32 they are bidirectional and instantiatable.

Winsock Versions
There are some difference between the original Winsock 1.1 API and the new version 2.2.x. In a nutshell, WinSock 2 is WinSock 1.1 on steroids, it's a superset of 1.1's APIs and architecture. In addition to its new features, it also clarifies existing ambiguities in the 1.1 WinSock specification and adds new extensions that take advantage of operating system features and enhance application performance and efficiency. Finally, WinSock 2 includes a number of new protocol-specific extensions. These extensions—such as multicast socket options— are relegated to a separate annex, since the main WinSock 2 protocol specification is protocol-independent.

The Winsock DLL and import library for version 1.1 are wsock32.dll and wsock32.lib and for version 2.2 it is ws2_32.dll and ws2_32.lib. Serveez is currently using version 2.2.

The Winsock API is still a bit buggy. Connected datagram behaviors are not pertinent to any WinSock 2 features, but to generic WinSock. On Win95

¹ This was written circa 2003—maybe the situation is now improved.
it is possible to use `recvfrom/WSARecvFrom` on a “connected” UDP socket, but on NT4 `recvfrom/WSARecvFrom` fail with 10056 (WSAEISCONN). NOTE: `sendto/WSASendTo` fail with WSAEISCONN on both (which I do not see any reason for, but anyway ...).

Raw sockets on Windows systems
Raw sockets require Winsock 2. To use them under Windows NT/2000, you must be logged in as an Administrator. On any other Microsoft’s we were trying to use the ICMP.DLL (an idiotic and almost useless API) without success. Microsoft says they will replace it as soon as something better comes along. (Microsoft’s been saying this since the Windows 95 days, however, yet this functionality still exists in Windows 2000.) It seems like you cannot send ICMP or even raw packets from the userspace of Windows (except via the ICMP.DLL which is limited to echo requests). We also noticed that you cannot receive any packets previously sent. The only thing which works on all Windows systems (9x/ME/NT/2000/XP) is receiving packets the “kernel” itself generated (like echo replies). One good thing we noticed about Windows 2000 is that the checksums of fragmented ICMP packets get correctly recalculated. That is not the case in the current Linux kernels.

Miscellaneous
To use the Win32 Winsock in the Cygwin port, you just need to `#define Win32_Winsock` and `#include "windows.h"` at the top of your source file(s). You will also want to add `-lwsock32` to the compiler’s command line so you link against `libwsock32.a`

What preprocessor macros do I need to know about? We use `_WIN32` to signify access to the Win32 API and `__CYGWIN__` for access to the Cygwin environment provided by the dll. We chose `_WIN32` because this is what Microsoft defines in VC++ and we thought it would be a good idea for compatibility with VC++ code to follow their example. We use `_MFC_VER` to indicate code that should be compiled with VC++.

Why we do not use pipes for coservers? Windows differentiates between sockets and file descriptors, that is why you can not `select` file descriptors. Please close the pipe’s descriptors via `CloseHandle` and not `closesocket`, because this will fail.

The C run-time libraries have a preset limit for the number of files that can be open at any one time. The limit for applications that link with the single-thread static library (LIBC.LIB) is 64 file handles or 20 file streams. Applications that link with either the static or dynamic multithread library (LIBCMT.LIB or MSVCR10.LIB and MSVCR10.DLL), have a limit of 256 file handles or 40 file streams. Attempting to open more than the maximum number of file handles or file streams causes program failure.

As far as I know, one of the big limitations of Winsock is that the SOCKET type is *not* equivalent to file descriptor. It is however with BSD and POSIX sockets. That is one of the major reasons for using a separate data type, SOCKET, not an int, a typical type for a file descriptor. This implies that
you cannot mix SOCKETs and stdio, sorry. This is the case when you use
\texttt{-mno-cygwin}.
Actually they are regular file handles, just like any other. There is a bug in
all 9x/kernel32 libc/msv/crtdll interface implementations \texttt{GetFileType} returns
\texttt{TYPE_UNKNOWN} for socket handles. Since this is AFAIK the only unknown type
there is, you know you have a socket handle. There is a fix in the more re-
cent perl distributions that you can use as a general solution. \texttt{-loldnames}
\texttt{-lperlcrt -lmsvcrt} will get you \texttt{TYPE_CHAR} for socket handles.

Now follows the list on which operating systems and architectures Serveez has been build
and tested successfully.
\begin{itemize}
  \item FreeBSD 3.3, 4.0, 4.3, 4.4, 4.5, 4.6, 4.7 on Intel
  \item FreeBSD 4.0, 4.4, 4.6 on Alpha
  \item NetBSD 1.5, 1.6 on Alpha
  \item OpenBSD 3.0, 3.1 on Alpha
  \item OpenBSD 3.1 on Intel
  \item GNU/Linux 2.x.x on Intel
  \item GNU/Linux 2.x.x on Alpha
  \item GNU/Linux 2.2.x on Sparc64 (UltraSparcII + MachV)
  \item GNU/Linux 2.x.x on PowerPC (RS/6000)
  \item GNU/Linux 2.4.x on ia64 (Itanium)
  \item GNU/Linux 2.4.x on StrongARM (iPAQ)
  \item GNU/Linux 2.4.x on Motorola 680x0
  \item GNU/Linux 2.4.x on IBM S/390
  \item GNU/Linux 2.4.x on HP PA-RISC
  \item GNU/Linux 2.4.x on MIPS
  \item Solaris 2.6, 2.7 on Sparc32, Sparc64
  \item SunOS 5.8 on Sparc32
  \item SunOS 5.6 on Intel
  \item AIX 4.3 on RS/6000
  \item MacOS X10.1/Darwin 1.4, 5.4, 5.5 on PowerPC (Macintosh)
  \item Windows 95 on Intel
  \item Windows 98 on Intel
  \item Windows Millennium Edition on Intel
  \item Windows NT 4.0 on Intel
  \item Windows 2000 on Intel
  \item Windows XP on Intel
  \item IRIX 6.x on MIPS
  \item Tru64/OSF1 UNIX V4.0 (former Digital UNIX) on Alpha
  \item Tru64/OSF1 UNIX V5.x (former Digital UNIX) on Alpha
  \item HP-UX B.11.11 on HP PA-RISC (PA-8700/PA-8600)
  \item HP-UX B.11.22 on ia64 (Itanium)
\end{itemize}
Chapter 7: Bibliography

This section contain some of the documents and resources we read and used to implement various parts of this package. They appear in no specific order.

1. RFC 760
   The Internet Protocol
2. RFC 1071
   Computing the Internet Checksum
3. RFC 1413
   Identification Protocol
4. RFC 1459
   Internet Relay Chat Protocol
5. RFC 1945
   Hypertext Transfer Protocol – HTTP/1.0
6. RFC 2068
   Hypertext Transfer Protocol – HTTP/1.1
7. RFC 2616
   Hypertext Transfer Protocol – HTTP/1.1
8. RFC 768
   User Datagram Protocol
9. RFC 791
   Internet Protocol
10. RFC 777
    Internet Control Message Protocol
11. http://www.mingw.org/
    Home of the MinGW (Minimal GNU for Windows) project
    The Gnutella Protocol
    The official EFNet site (includes Hybrid IRC server)
    Winsock Development Information
15. http://tangentsoft.net/wskfaq/
    Winsock Programmer’s FAQ
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