powerd++

0.4.4

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1 Main Page

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     / /                                   /_/
     \/ multi-core CPU clock daemon for FreeBSD®
```

The powerd++ daemon is a drop-in replacement for FreeBSD's native powerd. Its purpose is to reduce the energy consumption of CPUs for the following benefits:

- Avoid unnecessary fan noise from portable devices
- Improve the battery runtime of portable devices
- Improve hardware lifetime by reducing thermal stress
- Energy conservation

Contents

1.1 Using powerd++

Powerd++ offers the following features:

- Load target based clock frequency control
- Tunable sampling with moving average filter
- Load recording and replay tooling for benchmarking, tuning and reporting issues
- Command line compatibility with `powerd(8)`
- Temperature based throttling
- Expressive command line arguments with units, ranges and argument chaining
- Helpful error messages
- Comprehensive manual pages

1.1.1 Packages

The FreeBSD port is `sysutils/powerdxx`, the package name `powerdxx`.

1.1.2 Running powerd++

It is not intended to run powerd++ simultaneously with powerd. To prevent this powerd++ uses the same default pidfile as powerd:

```
# service powerdxx onestart
Starting powerdxx.
powerd++: (ECONFLICT) a power daemon is already running under PID: 59866
/usr/local/etc/rc.d/powerdxx: WARNING: failed to start powerdxx
```

So if powerd is already setup, it first needs to be disabled:

```
# service powerd stop
Stopping powerd.
Waiting for PIDS: 50127.
# service powerd disable
powerd disabled in /etc/rc.conf
```

Afterwards powerd++ can be enabled:

```
# service powerdxx enable
powerdxx enabled in /etc/rc.conf
# service powerdxx start
Starting powerdxx.
```

1.1.3 Manuals

Comprehensive manual pages exist for powerd++ and its accompanying tools loadrec and loadplay:

```
> man powerd++ loadrec loadplay
```

The current version of the manual pages may be read directly from the repository:

```
> man man/*
```

The manual pages as of the last release can also be `read online`.

1.1.4 Tuning

Three parameters affect the responsiveness of powerd++:

- The load target (refer to `-a`, `-b` and `-n`)
- The polling interval (refer to `-p`)
- The sample count (refer to `-s`)

The key to tuning powerd++ is the `-f` flag, which keeps powerd++ in foreground and causes it to report its activity. This allows directly observing the effects of a parameter set.

Observing the defaults in action may be a good start:

```
# powerd++ -f
power:  online, load:  693 MHz,  42 C, cpu.0.freq: 2401 MHz, wanted: 1848 MHz
power:  online, load:  475 MHz,  43 C, cpu.0.freq: 1800 MHz, wanted: 1266 MHz
power:  online, load:  271 MHz,  43 C, cpu.0.freq: 1300 MHz, wanted:  722 MHz
power:  online, load:   64 MHz,  43 C, cpu.0.freq:  768 MHz, wanted:  170 MHz
power:  online, load:   55 MHz,  42 C, cpu.0.freq:  768 MHz, wanted:  146 MHz
power:  online, load:   57 MHz,  42 C, cpu.0.freq:  768 MHz, wanted:  152 MHz
power:  online, load:   60 MHz,  44 C, cpu.0.freq:  768 MHz, wanted:  160 MHz
power:  online, load:   67 MHz,  42 C, cpu.0.freq:  768 MHz, wanted:  178 MHz
...
```

Note, the immediate high load is due to the load buffer being filled under the assumption that the past load fits the current clock frequency when powerd++ starts.

1.1.5 Reporting Issues / Requesting Features

Please report issues and feature requests on GitHub or to kamikaze@bsdforen.de.

Build Issues In case of a build issue, please report the build output as well as the output of `make info`:

```
> make info
VERSION="0.4.3+c8"
GITVERSION="0.4.3+c8"
GITHASH="8431d86abe7479a4c0a040c19551ff3fa2454ea1"
PKGVERSION=""
TARGETS="powerd++ loadrec loadplay libloadplay.so"
CXX="ccache c++"
CXXFLAGS="-O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic"
CXXVERSION="FreeBSD clang version 8.0.1 (tags/RELEASE_801/final 366581) (based on LLVM 8.0.1) Target
: x86_64-unknown-freebsd12.1 Thread model: posix InstalledDir: /usr/bin"
UNAME_A="FreeBSD AprilRyan.norad 12.1-STABLE FreeBSD 12.1-STABLE #1 ea071b9cb32(stable/12)-dirty: Mo
n Oct 28 23:37:31 CET 2019     root@AprilRyan.norad:/usr/obj/S403/amd64/usr/src/amd64.amd64/sys/S403
  amd64"
```

Performance Issues If powerd++ behaves in some unexpected or undesired manner, please mention all the command line flags (e.g. from `/etc/rc.conf` `powerdxx_flags`) and provide a load recording:

```
> loadrec -o myissue.load
```

The default recording duration is 30 s. Do not omit the `-o` parameter, printing the output on the terminal may create significant load and impact the recorded load significantly.

Before submitting the report, try to reproduce the behaviour using the recorded load:

```
> loadplay -i myissue.load -o /dev/null powerd++ -f
power:  online, load:  224 MHz, cpu.0.freq:  768 MHz, wanted:  597 MHz
power:  online, load:  155 MHz, cpu.0.freq:  768 MHz, wanted:  413 MHz
power:  online, load:   85 MHz, cpu.0.freq:  768 MHz, wanted:  226 MHz
power:  online, load:   29 MHz, cpu.0.freq:  768 MHz, wanted:   77 MHz
power:  online, load:   23 MHz, cpu.0.freq:  768 MHz, wanted:   61 MHz
...
```

1.2 Building/Installing

The `Makefile` offers a set of targets, it is written for FreeBSD's `make(1)`:

Target	Description
all	Build everything
info	Print the build configuration
debug	Build with `CXXFLAGS=-O0 -g -DEBUG`
paranoid	Turn on undefined behaviour canaries
install	Install tools and manuals
deinstall	Deinstall tools and manuals
clean	Clear build directory `obj/`
releasetest	Attempt a build and install from a gitless repo clone
testbuild	Test build with a set of compilers
tb	Alias for testbuild
doc	Build HTML documentation
gh-pages	Build and publish HTML and PDF documentation

1.2.1 Building

The `all` target is the default target that is called implicitly if make is run without arguments:

```
> make
c++  -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic  -c src/powerd++.cpp -o powerd++.o
c++  -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic  -c src/clas.cpp -o clas.o
c++  -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic  -c src/utility.cpp -o utility.o
c++ -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic -lutil powerd++.o clas.o utility.o -o powerd++
c++  -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic  -c src/loadrec.cpp -o loadrec.o
c++ -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic  loadrec.o clas.o utility.o -o loadrec
c++  -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic  -c src/loadplay.cpp -o loadplay.o
c++ -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic  loadplay.o clas.o utility.o -o loadplay
c++  -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic -fPIC -c src/libloadplay.cpp -o libloadplay.o
c++ -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic -lpthread -shared libloadplay.o -o libloadplay.so
>
```

The `debug` and `paranoid` flags perform the same build as the `all` target, but with different/additional `CXXF`↩ `LAGS`. The `debug` and `paranoid` targets can be combined.

`make testbuild` / `make tb` The `testbuild` target builds all supported test builds, the list of builds can be queried from the `TESTBUILDS` make variable:

```
> make -VTESTBUILDS
clang++90 clang++80 clang++70 g++9
```

A specific test build may be selected by appending it to the `testbuild` target:

```
> make tb/g++9
[testbuild/g++9]: make
g++9  -O2 -pipe -march=haswell  -std=c++17 -Wall -Werror -pedantic -c ../src/powerd++.cpp -o powerd++.o
...
```

Instead of creating the default target any non-documentation target may be appended to the `testbuild` target:

```
> make tb/g++9/clean
[testbuild/g++9]: make clean
rm -f *.o powerd++ loadrec loadplay libloadplay.so
```

In order to run a specific target on all test builds, the build can be omitted from the target:

```
> make tb/clean
[testbuild/clang++90]: make clean
rm -f *.o powerd++ loadrec loadplay libloadplay.so
[testbuild/clang++80]: make clean
rm -f *.o powerd++ loadrec loadplay libloadplay.so
[testbuild/clang++70]: make clean
rm -f *.o powerd++ loadrec loadplay libloadplay.so
[testbuild/g++9]: make clean
rm -f *.o powerd++ loadrec loadplay libloadplay.so
```

1.2.2 Installing

The installer installs the tools and manual pages according to a recipe in `pkg/files`. The following variables can be passed to `make install` or `make deinstall` to affect the install destination:

Variable	Default
DESTDIR	
PREFIX	/usr/local
DOCSDIR	${PREFIX}/share/doc/powerdxx

`DESTDIR` can be used to install powerd++ into a chroot or jail, e.g. to put it into the staging area when building a package using the FreeBSD ports. Unlike `PREFIX` and `DOCSDIR` it does not affect the installed files themselves.

1.2.3 Documentation

Building the documentation requires `doxygen` 1.8.15 or later, building the PDF version of the documentation requires `xelatex` as provided by the tex-xetex package.

The doc target populates `doc/html` and `doc/latex`, to create the PDF documentation `doc/latex/refman.`↩
`pdf` must be built.

The gh-pages target builds the HTML and PDF documentation and drops it into the `gh-pages` submodule for publishing on `github.io`.

1.3 Development

The following table provides an overview of repository contents:

File/Folder	Contents
`doc/`	Output directory for doxygen documentation
`doxy/`	Doxygen configuration and filter scripts
`gh-pages/`	Submodule for publishing the documentation
`man/`	Manual pages written using mdoc(7) markup
`obj/`	Build output
`pkg/`	Installer scripts and instructions
`loads/`	Load recordings useful for testing
`src/`	C++ source files
`src/sys/`	C++ wrappers for common C interfaces
`powerd++.rc`	Init script / service description
`LICENSE.md`	ISC license
`Makefile`	Build instructions
`README.md`	Project overview

1.3.1 Design

The life cycle of the powerd++ process goes through three stages:

1. Command line argument parsing
2. Initialisation and optionally printing the detected/configured parameters
3. Clock frequency control

The first stage is designed to maximise usability by providing both, the compact short option syntax (e.↩
g. `-vfbhadp`) as well as the more self-descriptive long option syntax (e.g. `--verbose --foreground --batt`
`hiadaptive`).

The second stage is designed to trigger all known error conditions in order to fail before calling daemon(3) at the start of the third stage. Both the first and second stage are meant to provide specific, helpful error messages.

The third stage tracks the CPU load and performs clock frequency control. It is designed to provide its functionality with as little runtime as possible. This is achieved by:

- Using integer arithmetic only
- Minimising branching

The latter is achieved by using function templates to roll out possible runtime state combinations as multiple functions. A single, central switch/case selects the correct function each cycle. This basically rolls out multiple code paths through a single function into multiple functions with a single code path.

The trade-off made is for runtime over code size. With every bit of state rolled out like this the number of functions that need to be generated doubles, thus this approach is limited to the few bits of state that control the most expensive functionality, e.g. the foreground mode.

1.3.2 License

This project is published under the ISC license.

2 LICENSE

3 Manual loadplay(1)

```
loadplay(1)             FreeBSD General Commands Manual            loadplay(1)


NAME
     loadplay - CPU load player


SYNOPSIS
     loadplay -h
     loadplay [-i file] [-o file] command [...]


DESCRIPTION
     The loadplay command replays a load recording created with loadrec(1).
     The command can either be powerd(8) or powerd++(8), compatibility with
     other tools has not been tested.


   OPTIONS
     The following options are supported:


     -h, --help
             Show usage and exit.


     -i, --input file
             Read load recording from file instead of stdin.


     -o, --output file
             Output statistics to file instead of stdout.


USAGE NOTES
     The loadplay command injects the library "libloadplay.so" into command.
     This library simulates the load from the input and outputs load
     statistics.
```

```
  OUTPUT
    The first line of output contains column headings, columns are separated
    by a single space.

    The Following columns are present, columns containing %d occur for each
    core simulated:

    time[s]
            The simulation progress in 0.001 second resolution.

    cpu.%d.rec.freq[MHz]
            The recorded clock frequency, sampled at the end of the frame.

    cpu.%d.rec.load[MHz]
            The recorded load in 0.1 MHz resolution.

    cpu.%d.run.freq[MHz]
            The simulated clock frequency set by the host process, sampled at
            the end of the frame.

    cpu.%d.run.load[MHz]
            The simulated load in 0.1 MHz resolution.

  SAMPLING
    There is one sample for each recorded line. The duration of each frame
    depends on the recording, which defaults to 25~ms.  At this sample rate
    loads are dominated by noise, so a gliding average should be applied to
    any load columns for further use, such as plotting.

IMPLEMENTATION NOTES
    The injected libloadplay.so works by intercepting system function calls
    and substituting the host environment with the recording. To achieve this
    the following function calls are intercepted:

    •   sysctl(3), sysctlnametomib(3), sysctlbyname(3)

    •   daemon(3)

    •   geteuid(2)

    •   pidfile_open(3), pidfile_write(3), pidfile_close(3),
        pidfile_remove(3), pidfile_fileno(3)

  INITIALISATION
    The sysctl family of functions is backed by a table that is initialised
    from the header of the load recording. If the heading is incomplete the
    setup routines print a message on stderr.  All the following intercepted
    function calls will return failure, ensuring that the host process is
    unable to operate and terminates.
```

Like powerd++(8) and loadrec(1) loadplay is core agnostic. Meaning that any core may have a .freq and .freq_levels sysctl handle. Due to this flexibility load recordings may in part or wholly be fabricated to test artificial loads or systems and features that do not yet exist. E.g. it is possible to offer a .freq handle for each core or fabricate new .freq_levels.

SIMULATION

If setup succeeds a simulation thread is started that reads the remaining input lines, simulates the load and updates the **kern.cp_times** entry in the thread safe sysctl table. For each frame a line of output with load statistics is produced.

Interaction with the host process happens solely through the sysctl table. The simulation reads the recorded loads and the current core frequencies to update **kern.cp_times**. The host process reads this data and adjusts the clock frequencies, which in turn affects the next frame.

FINALISATION

After reading the last line of input the simulation thread sends a SIGINT to the process to cause it to terminate.

ENVIRONMENT

LOADPLAY_IN

If set the file named is used for input instead of stdin. This only affects the input of **loadplay**, the host process is not affected.

LOADPLAY_OUT

If set the file named is used for output instead of stdout. This only affects the output of **loadplay**, the host process is not affected.

LD_PRELOAD

Used to inject the library "libloadplay.so" into the host process.

LD_LIBRARY_PATH

Is set to the same path **loadplay** was called through. Remains untouched if the path does not contain a '/' character.

I.e. calling "obj/loadplay" will set "LD_LIBRARY_PATH=obj", calling "loadplay" will not.

This behaviour facilitates running test builds of **loadplay** and the library "libloadplay.so" without performing an install.

FILES

/usr/local/lib/libloadplay.so

A library injected into command via the LD_PRELOAD environment variable.

EXAMPLES

Play a load recording with loadplay:

```
    > loadplay -i loads/freq_tracking.load powerd++
time[s] cpu.0.rec.freq[MHz] cpu.0.rec.load[MHz] cpu.0.run.freq[MHz] cpu.0.run.load[MHz] cpu.1.rec.freq[MHz]
 0.025 1700 1700.0 1700 1700.0 1700 0.0 1700 0.0 1700 1700.0 1700 1700.0 1700 850.0 1700 850.0
  0.050 1700 1700.0 1700 1700.0 1700 1700.0 1700 1700.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
 0.075 1700 566.7 1700 566.6 1700 1700.0 1700 1700.0 1700 0.0 1700 0.0 1700 566.7 1700 566.6
    0.100 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
    0.125 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
    0.150 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
    0.175 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
    0.200 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
    0.225 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
    0.250 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
    0.275 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0 1700 0.0
```

Capture load and **loadplay** output simultaneously into two different files:

```
    > loadplay -i loads/freq_tracking.load -o load.csv powerd++ -f > load.out
```

Capture and display **loadplay** output:

```
    > loadplay -i loads/freq_tracking.load -o load.csv powerd++ -f $|$ tee load.out
    power:  online, load:  527 MHz, cpu0.freq: 1700 MHz, wanted: 1405 MHz
    power:  online, load:  459 MHz, cpu0.freq: 1400 MHz, wanted: 1224 MHz
    power:  online, load:  502 MHz, cpu0.freq: 1200 MHz, wanted: 1338 MHz
    power:  online, load:  548 MHz, cpu0.freq: 1300 MHz, wanted: 1461 MHz
    power:  online, load:  704 MHz, cpu0.freq: 1500 MHz, wanted: 1877 MHz
    power:  online, load:  750 MHz, cpu0.freq: 1900 MHz, wanted: 2000 MHz
    power:  online, load:  805 MHz, cpu0.freq: 2000 MHz, wanted: 2146 MHz
    power:  online, load:  772 MHz, cpu0.freq: 2200 MHz, wanted: 2058 MHz
    power:  online, load:  574 MHz, cpu0.freq: 2000 MHz, wanted: 1530 MHz
    power:  online, load:  515 MHz, cpu0.freq: 1500 MHz, wanted: 1373 MHz
```

SEE ALSO
loadrec(1), powerd(8), powerd++(8), rtld(1), signal(3), tee(1)

AUTHORS
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FreeBSD 12.1-STABLE   March 5, 2020   FreeBSD 12.1-STABLE

4 Manual loadrec(1)

loadrec(1)   FreeBSD General Commands Manual   loadrec(1)

NAME
loadrec - CPU load recorder

SYNOPSIS
loadrec -h
loadrec [**-v**] [**-d** _ival_] [**-p** _ival_] [**-o** _file_]

DESCRIPTION

The loadrec command performs a recording of the current load. The purpose is to reproduce this load to test different powerd(8) and powerd++(8) configurations under identical load conditions using loadplay(1).

ARGUMENTS

The following argument types can be given:

ival A time interval can be given in seconds or milliseconds.

s, ms

An interval without a unit is treated as milliseconds.

file A file name.

OPTIONS

The following options are supported:

-h, --help

Show usage and exit.

-v, --verbose

Be verbose and produce initial diagnostics on *stderr*.

-d, --duration *ival*

The duration of the recording session, defaults to 30 seconds.

-p, --poll *ival*

The polling interval to take load samples at, defaults to 25 milliseconds.

-o, --output *file*

The output file to write the load to.

USAGE NOTES

To create reproducible results set a fixed CPU frequency below the threshold at which the turbo mode is activated. E.g. an Intel(R) Core(TM) i7-4500U CPU supports the following frequency settings:

```
> sysctl dev.cpu.0.freq_levels
dev.cpu.0.freq_levels: 2401/15000 2400/15000 2300/14088 2200/13340 2000/11888 1900/11184 1800/10495 1700/968
```

Supposedly the first mode, which is off by 1 MHz, invokes the turbo mode. However all modes down to 1800 MHz actually invoke the turbo mode for this model. The only way to determine this is by benchmarking the steppings to find out that there is a huge performance step between 1700 and 1800 MHz and that all the modes above 1700 MHz show the exact same performance (given similar thermal conditions).

So in order to produce a usable measurement for this CPU the clock needs to be set to 1700 MHz or lower (higher is better to be able to record a wider range of loads):

```
    # service powerd++ stop
    Stopping powerdxx.
    Waiting for PIDS: 63574.
    # powerd++ -M1700
```

Run loadrec for a brief time to test it:

```
    > loadrec -d.25s
    usr.app.powerdxx.loadrec.features=1
    hw.machine=amd64
    hw.model=Intel(R) Core(TM) i7-4500U CPU @ 1.80GHz
    hw.ncpu=4
    hw.acpi.acline=1
    dev.cpu.0.freq=768
 dev.cpu.0.freq_levels=2401/15000 2400/15000 2300/14088 2200/13340 2000/11888 1900/11184 1800/10495 1700/9680
 0 768 768 768 768 728001 0 278439 54957 10215972 753315 0 245117 7838 10270972 767662 0 241991 37110 10230545 77
    25 768 768 768 768 0 0 0 0 3 2 0 0 0 1 0 0 0 0 3 0 0 0 0 4
    25 768 768 768 768 0 0 0 0 3 1 0 0 0 2 0 0 0 0 3 1 0 0 0 2
    25 768 768 768 768 0 0 1 0 2 1 0 2 0 0 0 0 0 0 3 0 0 1 0 2
    25 768 768 768 768 3 0 0 0 1 1 0 2 0 1 1 0 3 0 0 2 0 2 0 0
    25 768 768 768 768 0 0 0 0 3 0 0 1 0 2 0 0 0 0 3 3 0 0 0 0
    25 768 768 768 768 0 0 0 0 3 0 0 0 0 3 0 0 0 0 3 2 0 1 0 0
    25 768 768 768 768 0 0 0 0 3 0 0 0 0 3 0 0 0 0 3 2 0 1 0 0
    25 768 768 768 768 2 0 0 0 1 1 0 1 0 1 0 0 2 0 1 2 0 1 0 0
    25 768 768 768 768 0 0 0 0 4 1 0 2 0 1 0 0 0 0 4 0 0 1 0 2
    25 768 768 768 768 0 0 0 0 3 2 0 1 0 0 0 0 0 0 3 0 0 0 0 4
```

Printing the load creates significant load itself, so for the actual measurement the output should be written to a file. Create your workload and start your measurement:

```
    > loadrec -o video-session.load
```

On the example setup **loadrec** produces a load of 0.001 (i.e. 0.1%), so its effect on the measurement is negligible.

SEE ALSO
     cpufreq(4), loadplay(1), powerd(8), powerd++(8), sysctl(8)

AUTHORS
     Implementation and manual by Dominic Fandrey <kami@freebsd.org>

FreeBSD 12.1-STABLE   4 February, 2019   FreeBSD 12.1-STABLE

5 Manual powerd++(8)

powerd++(8)   FreeBSD System Manager's Manual   powerd++(8)

NAME
     powerd++ - CPU clock speed daemon

```
SYNOPSIS
     powerd++ -h
     powerd++ [-vfN] [-a mode] [-b mode] [-n mode] [-m freq] [-M freq]
              [-F freq:freq] [-A freq:freq] [-B freq:freq] [-H temp:temp]
              [-t sysctl] [-p ival] [-s cnt] [-P file]


DESCRIPTION
     The powerd++ daemon monitors the system load and adjusts the CPU clock
     speed accordingly.  It is a drop-in replacement for powerd(8) and
     supports two modes of operation, a load feedback control loop or fixed
     frequency operation.


   ARGUMENTS
     The following argument types can be given:


     mode    The mode is either a load target or a fixed freq.  The powerd(8)
             modes are interpreted as follows:
             maximum, max
                     Use the highest clock frequency.
             minimum, min
                     Use the lowest clock frequency.
             adaptive, adp
                     A target load of 0.5 (50%).
             hiadaptive, hadp
                     A target load of 0.375 (37.5%).


             If a scalar number is given, it is interpreted as a load.


     load    A load is either a fraction in the range [0.0, 1.0] or a
             percentage in the range [0%, 100%].


     freq    A clock frequency consists of a number and a frequency unit.
                   Hz, KHz, MHz, GHz, THz
             The unit is not case sensitive, if omitted MHz are assumed for
             compatibility with powerd(8).


     temp    A temperature consisting of a number and a temperature unit.
             Supported units are:
                   C, K, F, R
             These units stand for deg. Celsius, Kelvin, deg. Fahrenheit and
             deg. Rankine. A value without a unit is treated as deg. Celsius.


     sysctl  The name of a sysctl(3), may consists of the characters
             [0-9A-Za-z%._-].  Characters preceded by ‘%’ are considered
             formatting fields. Allowed formatting fields are specific to a
             particular sysctl. Unexpected formatting fields are rejected.  In
             order to produce a literal ‘%’, ‘%%’ should be used.


     ival    A time interval can be given in seconds or milliseconds.
                   s, ms
             An interval without a unit is treated as milliseconds.


     cnt     A positive integer.
```

```
  file    A file name.


OPTIONS
  The following options are supported:


  -h, --help
          Show usage and exit


  -v, --verbose
          Be verbose and produce initial diagnostics on stderr.


  -f, --foreground
          Stay in foreground, produce an event log on stdout.


  -N, --idle-nice
          Treat nice time as idle.


          This option exists for powerd(8) compatibility, but note that
          most heavy workloads such as compiling software mostly consist of
          nice time. Users considering this flag may be better served with
          running at a fixed low frequency:
                powerd++ -b min


  -a, --ac mode
          Mode to use while the AC power line is connected (default hadp).


  -b, --batt mode
          Mode to use while battery powered (default adp).


  -n, --unknown mode
          Mode to use while the power line state is unknown (default hadp).


  -m, --min freq
          The lowest CPU clock frequency to use (default 0Hz).


  -M, --max freq
          The highest CPU clock frequency to use (default 1THz).


  --min-ac freq
          The lowest CPU clock frequency to use on AC power.


  --max-ac freq
          The highest CPU clock frequency to use on AC power.


  --min-batt freq
          The lowest CPU clock frequency to use on battery power.


  --max-batt freq
          The highest CPU clock frequency to use on battery power.
```

```
    -F, --freq-range freq:freq
            A pair of frequency values representing the minimum and maximum
            CPU clock frequency.

    -A, --freq-range-ac freq:freq
            A pair of frequency values representing the minimum and maximum
            CPU clock frequency on AC power.

    -B, --freq-range-batt freq:freq
            A pair of frequency values representing the minimum and maximum
            CPU clock frequency on battery power.

    -H, --hitemp-range temp:temp
            Set the high to critical temperature range, enables temperature
            based throttling.

    -t, --temperature sysctl
            Set the temperature source sysctl name. May contain a single '%d'
            to insert the core ID.

    -p, --poll ival
            The polling interval that is used to take load samples and update
            the CPU clock (default 0.5s).

    -s, --samples cnt
            The number of load samples to use to calculate the current load.
            The default is 4.

    -P, --pid file
            Use an alternative pidfile, the default is /var/run/powerd.pid.
            The default ensures that powerd(8) and powerd++ are not run
            simultaneously.

    -i, -r load
            Legacy arguments from powerd(8) not applicable to powerd++ and
            thus ignored.

SERVICE
    The powerd++ daemon can be run as an rc(8) service. Add the following
    line to rc.conf(5):
          powerdxx_enable="YES"
    Command line arguments can be set via powerdxx_flags.

TOOLS
    The loadrec(1) and loadplay(1) tools offer the possibility to record
    system loads and replay them.

IMPLEMENTATION NOTES
    This section describes the operation of powerd++.

    Both powerd(8) and powerd++ have in common, that they work by polling
    kern.cp_times via sysctl(3), which is an array of the accumulated loads
    of every core. By subtracting the last cp_times sample the loads over the
    polling interval can be determined. This information is used to set a new
    CPU clock frequency by updating dev.cpu.0.freq.
```

Initialisation

After parsing command line arguments **powerd++** assigns a clock frequency controller to every core. I.e. cores are grouped by a common dev.cpu.%d.freq handle that controls the clock for all of them. Due to limitations of cpufreq(4) dev.cpu.0.freq is the controlling handle for all cores, even across multiple CPUs. However **powerd++** is not built with that assumption and per CPU, core or thread controls will work as soon as the hardware and kernel support them.

In the next initialisation stage the available frequencies for every core group are determined to set appropriate lower and upper boundaries. This is a purely cosmetic measure and used to avoid unnecessary frequency updates. The controlling algorithm does not require this information, so failure to do so will only be reported (non-fatally) in verbose mode.

Unless the -H option is given, the initialisation checks for a critical temperature source. If one is found temperature throttling is implicitly turned on, causing throttling to start 10 deg. Celsius below the critical temperature.

So far the sysctl(3) dev.cpu.%d.coretemp.tjmax is the only supported critical temperature source.

Detaching From the Terminal

After the initialisation phase **powerd++** prepares to detach from the terminal. The first step is to acquire a lock on the pidfile. Afterwards all the frequencies are read and written as a last opportunity to fail. After detaching from the terminal the pidfile is written and the daemon goes into frequency controlling operation until killed by a signal.

Load Control Loop

The original powerd(8) uses a hysteresis to control the CPU frequency. I.e. it determines the load over all cores since taking the last sample (the summary load during the last polling interval) and uses a lower and an upper load boundary to decide whether it should update the frequency or not.

powerd++ has some core differences. It can take more than two samples (four by default), this makes it more robust against small spikes in load, while retaining much of its ability to quickly react to sudden surges in load. Changing the number of samples does not change the runtime cost of running **powerd++**.

Instead of taking the sum of all loads, the highest load within the core group is used to decide the next frequency target. Like with powerd(8) this means, that high load on a single core will cause an increase in the clock frequency. Unlike powerd(8) it also means that moderate load over all cores allows a decrease of the clock frequency.

The **powerd++** daemon steers the clock frequency to match a load target, e.g. if there was a 25% load at 2 GHz and the load target was 50%, the frequency would be set to 1 GHz.

```
   Temperature Based Throttling
     If temperature based throttling is active and the temperature is above
     the high temperature boundary (the critical temperature minus 10 deg.
     Celsius by default), the core clock is limited to a value below the
     permitted maximum. The limit depends on the remaining distance to the
     critical temperature.

     Thermal throttling ignores user-defined frequency limits, i.e. when using
     -F, -B, -A or -m to prevent the clock from going unreasonably low,
     sufficient thermal load may cause powerd++ to select a clock frequency
     below the user provided minimum.

   Termination and Signals
     The signals HUP and TERM cause an orderly shutdown of powerd++.  An
     orderly shutdown means the pidfile is removed and the clock frequencies
     are restored to their original values.

FILES
     /var/run/powerd.pid
             Common pidfile with powerd(8).

     /usr/local/etc/rc.d/powerdxx
             Service file, enable in rc.conf(5).

EXAMPLES
     Run in foreground, minimum clock frequency 800 MHz:
           powerd++ -fm800

     Report configuration before detaching into the background:
           powerd++ -v

     Target 75% load on battery power and run at 2.4 GHz on AC power:
           powerd++ -b .75 -a 2.4ghz

     Target 25% load on AC power:
           powerd++ -a 25%

     Use the same load sampling powerd(8) does:
           powerd++ -s1 -p.25s

     Limit CPU clock frequencies to a range from 800 MHz to 1.8 GHz:
           powerd++ -F800:1.8ghz

DIAGNOSTICS
     The powerd++ daemon exits 0 on receiving an INT or TERM signal, and >0 if
     an error occurs.

COMPATIBILITY
     So far powerd++ requires ACPI to detect the current power line state.

SEE ALSO
     cpufreq(4), powerd(8), loadrec(1), loadplay(1)

AUTHORS
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CAVEATS
     Unlike powerd(8), powerd++ refuses to run if the frequency control driver
     is known not to allow user control of the CPU frequency (e.g.
     hwpstate_intel(4) ).

FreeBSD 12.1-STABLE             March 3, 2020             FreeBSD 12.1-STABLE
```

6 TOOLS

6.1 playdiff

Computes metrics of the deviations between two `loadplay(1)` generated outputs.

```
usage: tools/playdiff file1 file2 ...
```

The output of `loadplay(1)` is not reproducible. Due to differences in timing between each run there are slight variations in the load that a powerd samples. This makes it difficult to tell whether a second run with a different parameter set or a different powerd version exhibits different behaviour, which is important for regression testing.

The most intuitive way of dealing with this is plotting a graph. The `playdiff` tool instead provides metrics to make the same judgement.

Metrics

The `playdiff` tool integrates the deviations and absolute deviations between two `loadplay` outputs over time. These values are used to present four metrics per column of `loadplay` output:

- Integral over Deviations (ID)
- Mean Deviation (MD)
- Integral over Absolute Deviations (IAD)
- Mean Absolute Deviation (MAD)

Interpreting the Data

The integrals and means provide the same information, but the magnitude of the means is independent of the duration of the load replay, thus the means make it easier to interpret the data.

The following excerpt of a real dataset, shows the IAD looks high, the MAD is a much better presentation. An average CPU frequency deviation of 34 MHz is noteworthy, but not indicative of a fundamental difference.

A look at the MAD column of the `run.load` row shows that `loadplay` presented different load data to the powerd between runs. The `rec.load` row confirms that both runs are based on the same recording. However the ID column shows that the accumulated deviation over the entire run is less than 0.05 MHz. This is indicative of an aliasing effect that implies there was a small time offset between both runs, apart from that performance of the powerd was the same.

```
--- a/load.play
+++ b/load.play
                              ID            MD           IAD           MAD
time[s]                      0.0           0.0           0.0           0.0
cpu.0.rec.freq[MHz]          0.0           0.0           0.0           0.0
cpu.0.rec.load[MHz]          0.0           0.0           0.0           0.0
cpu.0.run.freq[MHz]        -94.0          -3.1        1016.0          33.9
cpu.0.run.load[MHz]          0.0           0.0         160.0           5.3
```

6.2 playfilter

Post-process loadplay(1) output.

```
usage: tools/playfilter [ filters... ] [--] [ files... ]
```

Takes an optional list of filters and an optional list of files. The first argument not matching the syntax for a filter is treated as a file. Alternatively the `--` argument can be provided to mark the end of the list of filters. This allows providing file names that look like filters.

The syntax for a filter is `FILTER=ARG[,...]`. Individual filters are described in the `Filters` subsection.

Files

If no file names are given, `stdin` is used as the input. Otherwise the given files are concatenated. Each line of input is expected to contain a fixed number of fields separated by white space. The first line of each file is referred to as the header and expected to contain the column names.

Subsequent headers are discarded if they match the first file's header. A mismatch is treated as an error.

Filters

The following filters are supported.

Filter	Arguments	Describe
cut	glob	Remove unmatched columns
movingavg	glob pre [post]	Apply a moving average (mean)
subsample	n	Only output every nth sample
patch	glob	Patch concatenated x column
clone	glob n	Clone matched columns n times
hmax	glob	Add column with the max of matched columns
hmin	glob	Add column with the min of matched columns
hsum	glob	Add column with the sum of matched columns
havg	glob	Add column with the mean of matched columns
precision	glob digits	Set a fixed amount of fraction digits
style	format	Format output (must be the last filter)

Selecting Columns The `glob` argument of a filter is used to select the columns to apply a filter to. The pattern should match the names of the columns without the unit, an optional square bracket enclosure at the end of a column name.

Note the that the horizontal filters `hmax`, `hmin`, `hsum` and `havg` require that all matched columns have the same unit.

Pretty Printing The following filters can be used to customise output:

- `cut=GLOB`
- `precision=GLOB,DIGITS`
- `style=FORMAT`

The `cut` filter selects a subset of columns to output:

```
# obj/loadplay -i loads/freq_tracking.load -o replay.csv obj/powerd++
# tools/playfilter cut='time|cpu.3.*' -- replay.csv
time[s] cpu.3.rec.freq[MHz] cpu.3.rec.load[MHz] cpu.3.run.freq[MHz] cpu.3.run.load[MHz]
0.025 1700 850.0 1700 850.0
0.050 1700 0.0 1700 0.0
0.075 1700 566.7 1700 566.7
0.100 1700 0.0 1700 0.0
...
```

The `precision` filter sets a fixed number of fraction digits for the matched columns:

```
# tools/playfilter cut='time|cpu.3.*' precision='*.load',3 -- replay.csv
```

```
time[s] cpu.3.rec.freq[MHz] cpu.3.rec.load[MHz] cpu.3.run.freq[MHz] cpu.3.run.load[MHz]
0.025 1700 850.000 1700 850.000
0.050 1700 0.000 1700 0.000
0.075 1700 566.700 1700 566.700
0.100 1700 0.000 1700 0.000
...
```

The `style` filter is only allowed as the last filter in the pipeline, because it produces output that is not valid filter input. It formats the output for different applications, the supported styles are:

- `CSV`: Fields are separated by a `,` and column names are quoted using `"`
- `MD`: The output is formatted as a markdown table

```
# tools/playfilter cut='time|cpu.3.*' precision='*.load',3 style=md -- replay.csv
| time[s] | cpu.3.rec.freq[MHz] | cpu.3.rec.load[MHz] | cpu.3.run.freq[MHz] | cpu.3.run.load[MHz] |
|--------:|--------------------:|--------------------:|--------------------:|--------------------:|
|   0.025 |                1700 |             850.000 |                1700 |             850.000 |
|   0.050 |                1700 |               0.000 |                1700 |               0.000 |
|   0.075 |                1700 |             566.700 |                1700 |             566.700 |
|   0.100 |                1700 |               0.000 |                1700 |               0.000 |
...
```

Subsampling The following filters can be used for subsampling:

- `subsample=N`
- `movingavg=GLOB,PRE[,POST]`

If only a subset of the available lines is required, the `subsample` filter can be used:

```
# tools/playfilter cut='time|cpu.3.*' subsample=4 precision='*.load',3 style=md -- replay.csv
| time[s] | cpu.3.rec.freq[MHz] | cpu.3.rec.load[MHz] | cpu.3.run.freq[MHz] | cpu.3.run.load[MHz] |
|--------:|--------------------:|--------------------:|--------------------:|--------------------:|
|   0.100 |                1700 |               0.000 |                1700 |               0.000 |
|   0.200 |                1700 |               0.000 |                1700 |               0.000 |
|   0.300 |                1700 |               0.000 |                1700 |               0.000 |
|   0.400 |                1700 |               0.000 |                1700 |               0.000 |
...
```

The above example uses every fourth sample, however that means the information of the other 3 samples is not used. This can be avoided by applying a low-pass filter:

```
# tools/playfilter cut='time|cpu.3.*' movingavg='cpu*',4 subsample=4 precision='*.load',3 style=md -- replay.csv
| time[s] | cpu.3.rec.freq[MHz] | cpu.3.rec.load[MHz] | cpu.3.run.freq[MHz] | cpu.3.run.load[MHz] |
|--------:|--------------------:|--------------------:|--------------------:|--------------------:|
|   0.100 |                1700 |             354.175 |                1700 |             354.175 |
|   0.200 |                1700 |               0.000 |                1700 |               0.000 |
|   0.300 |                1700 |               0.000 |                1700 |               0.000 |
|   0.400 |                1700 |               0.000 |                1700 |               0.000 |
...
```

The above example uses a four sample pre-filter, i.e. every sample contains the mean value of the last four samples. Synchronised to the subsampling interval this results in the reported sample containing the mean of the original samples without overlap. For this example the `0.100 s` sample contains the mean of the original `0.025 s`, `0.050 s`, `0.075 s` and `0.100 s` samples.

Imitating `powerd(8)` Sampling The default sample time of `powerd(8)` is `0.250 s`:

```
# tools/playfilter cut='time|cpu.0.*.load' movingavg='cpu.*',10 subsample=10 precision='*.load',3 style=md -- replay.csv
| time[s] | cpu.0.rec.load[MHz] | cpu.0.run.load[MHz] |
|--------:|--------------------:|--------------------:|
|   0.250 |             396.670 |             396.670 |
|   0.500 |             170.000 |             170.000 |
|   0.750 |               0.000 |               0.000 |
|   1.000 |             405.000 |             405.000 |
...
```

However `powerd(8)` uses the sum of the load of all cores. This can be achieved using one of the horizontal family of filters:

- `hmax=GLOB` (horizontal maximum)
- `hmin=GLOB` (horizontal minimum)
- `hsum=GLOB` (horizontal sum)
- `havg=GLOB` (horizontal mean)

This set of filters creates a new column by aggregating data from the matched columns:

```
# tools/playfilter movingavg='cpu.*',10 subsample=10 hsum='*.run.load' hsum='*.rec.load' cut='time|sum*'
       precision='sum*',3 style=md -- replay.csv
| time[s] | sum(cpu.{0,1,2,3}.run.load)[MHz] | sum(cpu.{0,1,2,3}.rec.load)[MHz] |
|--------:|---------------------------------:|---------------------------------:|
|   0.250 |                         1048.340 |                         1048.340 |
|   0.500 |                          212.500 |                          212.500 |
|   0.750 |                            0.000 |                            0.000 |
|   1.000 |                         2115.000 |                         2115.000 |
...
```

Note there are separate filter steps for the `run.load` and `rec.load` columns to create two separate sums.

Imitating `powerd++(8)` Sampling and Filtering The default sample rate of `powerd++(8)` is `0.5 s` and instead of the sum it uses the maximum. On top of it, it uses the mean of the last 4 sampled maxima:

```
# tools/playfilter movingavg='cpu.*',20 subsample=20 hmax='*.run.load' hmax='*.rec.load' movingavg='max*',4
       cut='time|max*' precision='max*',3 style=md -- replay.csv
| time[s] | max(cpu.{0,1,2,3}.run.load)[MHz] | max(cpu.{0,1,2,3}.rec.load)[MHz] |
|--------:|---------------------------------:|---------------------------------:|
|   0.500 |                          283.335 |                          283.335 |
|   1.000 |                          294.168 |                          294.168 |
|   1.500 |                          446.112 |                          449.445 |
|   2.000 |                          525.521 |                          526.771 |
...
```

Side by Side Filter Comparisons Columns can be reproduced, so different filters can be applied to the same data:

- `clone=GLOB,N`

This can be used to compare the effects of different filters:

```
# tools/playfilter cut='time|cpu.0.rec.load' clone='*.load',2 movingavg='*.load.0',80 movingavg='*.load.1',40,40
       precision='cpu.*',3 style=md -- replay.csv
| time[s] | cpu.0.rec.load[MHz] | cpu.0.rec.load.0[MHz] | cpu.0.rec.load.1[MHz] |
|--------:|--------------------:|----------------------:|----------------------:|
|   0.025 |            1700.000 |              1700.000 |               236.993 |
|   0.050 |            1700.000 |              1700.000 |               259.921 |
|   0.075 |             566.700 |              1322.230 |               281.784 |
|   0.100 |               0.000 |               991.675 |               302.652 |
...
```

The column `cpu.0.rec.load` contains the original data, `cpu.0.rec.load.0` applies a `2 s` moving average. The `cpu.0.rec.load.1` column contains a symmetric `2 s` moving average (i.e. `1 s` pre and `1 s` post), which is the best in hindsight representation of a filtered value.

Plotting these illustrates that this produces the same curve with a `1 s` offset. This illustrates how a `2 s` moving average causes `1 s` of latency reacting to load events like spikes and drops.

Serialising Multiple Replays It is possible to concatenate multiple replays, but it usually requires patching the `time` column:

- `patch=GLOB`

Without patching, the time column jumps back down when transitioning from one file to the next:

```
# tools/playfilter movingavg='*.run.load',20 subsample=20 hmax='*.run.load' cut='time|max*|cpu.0.run.freq'
       movingavg='max*',4 precision=time,3 precision='max*',1 style=md -- replay.csv replay.csv
| time[s] | cpu.0.run.freq[MHz] | max(cpu.{0,1,2,3}.run.load)[MHz] |
|--------:|--------------------:|--------------------------------:|
|   0.500 |                1700 |                           283.3 |
|   1.000 |                1400 |                           294.2 |
|   1.500 |                1200 |                           446.1 |
|   2.000 |                1300 |                           525.5 |
...
|  28.500 |                1800 |                           732.8 |
|  29.000 |                2000 |                           665.3 |
|  29.500 |                1900 |                           690.1 |
|  30.000 |                1900 |                           810.0 |
|   0.500 |                1700 |                           593.3 |
|   1.000 |                1400 |                           650.8 |
|   1.500 |                1200 |                           525.8 |
|   2.000 |                1300 |                           525.5 |
...
|  28.500 |                1800 |                           732.8 |
|  29.000 |                2000 |                           665.3 |
|  29.500 |                1900 |                           690.1 |
|  30.000 |                1900 |                           810.0 |
```

The `patch` filter uses the previous value as an offset for following values if the new value is less than or equal to the previous one:

```
# tools/playfilter patch=time movingavg='*.run.load',20 subsample=20 hmax='*.run.load' cut='time|max*|cpu.0.run.freq'
       movingavg='max*',4 precision=time,3 precision='max*',1 style=md -- replay.csv replay.csv
| time[s] | cpu.0.run.freq[MHz] | max(cpu.{0,1,2,3}.run.load)[MHz] |
|--------:|--------------------:|--------------------------------:|
|   0.500 |                1700 |                           283.3 |
|   1.000 |                1400 |                           294.2 |
|   1.500 |                1200 |                           446.1 |
|   2.000 |                1300 |                           525.5 |
...
|  28.500 |                1800 |                           732.8 |
|  29.000 |                2000 |                           665.3 |
|  29.500 |                1900 |                           690.1 |
|  30.000 |                1900 |                           810.0 |
|  30.500 |                1700 |                           593.3 |
|  31.000 |                1400 |                           650.8 |
|  31.500 |                1200 |                           525.8 |
|  32.000 |                1300 |                           525.5 |
...
|  58.500 |                1800 |                           732.8 |
|  59.000 |                2000 |                           665.3 |
|  59.500 |                1900 |                           690.1 |
|  60.000 |                1900 |                           810.0 |
```

7 Module Index

7.1 Modules

Here is a list of all modules:

8 Namespace Index

8.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

9 Hierarchical Index

9.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

10 Class Index

10.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

11 File Index

11.1 File List

Here is a list of all documented files with brief descriptions:

12 Module Documentation

12.1 Standard I/O File Access

A set of file instances providing access to stderr, stdout and stdin.

Variables

- file< link, write > sys::io::ferr {stderr}

  File access instances for stderr.
- file< link, write > sys::io::fout {stdout}

  File access instances for stdout.
- file< link, read > sys::io::fin {stdin}

  File access instances for stdin.

12.1.1 Detailed Description

A set of file instances providing access to stderr, stdout and stdin.

In theory these should be functions returning a reference to a local static file object, to avoid global object initialisation order issues.

This would be annoying to access, though. In practice it works the way it is and it would be hard to notice if it did not.

13 Namespace Documentation

13.1 anonymous_namespace{clas.cpp} Namespace Reference

File local scope.

Classes

- struct Value

  Determine the unit of a string encoded value.

Enumerations

- enum Unit : size_t {
  Unit::SCALAR, Unit::PERCENT, Unit::SECOND, Unit::MILLISECOND,
  Unit::HZ, Unit::KHZ, Unit::MHZ, Unit::GHZ,
  Unit::THZ, Unit::CELSIUS, Unit::KELVIN, Unit::FAHRENHEIT,
  Unit::RANKINE, Unit::UNKNOWN }

  Command line argument units.

Variables

- const char ∗const UnitStr [ ]

  The unit strings on the command line, for the respective Unit instances.

13.1.1 Detailed Description

File local scope.

13.1.2 Enumeration Type Documentation

13.1.2.1 Unit `enum anonymous_namespace{clas.cpp}::Unit : size_t [strong]`

Command line argument units.

These units are supported for command line arguments, for SCALAR arguments the behaviour of powerd is to be imitated.

Enumerator

SCALAR	Values without a unit.
PERCENT	%
SECOND	s
MILLISECOND	ms
HZ	hz
KHZ	khz
MHZ	mhz
GHZ	ghz
THZ	thz
CELSIUS	C.
KELVIN	K.
FAHRENHEIT	F.
RANKINE	R.
UNKNOWN	Unknown unit.

13.1.3 Variable Documentation

13.1.3.1 UnitStr `const char* const anonymous_namespace{clas.cpp}::UnitStr[]`

Initial value:
```
{
    "", "%", "s", "ms", "hz", "khz", "mhz", "ghz", "thz", "C", "K", "F", "R"
}
```

The unit strings on the command line, for the respective Unit instances.

13.2 anonymous_namespace{libloadplay.cpp} Namespace Reference

File local scope.

Classes

- class Callback

  Implements a recursion safe std::function wrapper.
- struct CoreFrameReport

  The report frame information for a single CPU pipeline. More...
- struct CoreReport

  The reported state of a single CPU pipeline. More...
- class Emulator

  Instances of this class represent an emulator session.
- class Hold

  Sets a referenced variable to a given value and restores it when going out of context.
- class Main

  Singleton class representing the main execution environment.
- struct mib_t

  Represents MIB, but wraps it to provide the necessary operators to use it as an std::map key.
- class Report

  Provides a mechanism to provide frame wise per core load information.
- class Sysctls

  Singleton class representing the sysctl table for this library.
- class SysctlValue

  Instances of this class represents a specific sysctl value.

Typedefs

- using cycles_t = uint64_t

  Clock cycle counting type.
- template<auto Ownership>
  using ofile = io::file< Ownership, io::write >

  Output file type alias.
- template<auto Ownership>
  using ifile = io::file< Ownership, io::read >

  Input file type alias.

Functions

- template<size_t Size>
  int strcmp (char const ∗const s1, char const (&s2)[Size])

  Safe wrapper around strncmp, which automatically determines the buffer size of s2.
- std::regex operator""_r (char const ∗const str, size_t const len)

  User defined literal for regular expressions.
- template<typename ... ArgTs>
  constexpr void dprintf (ArgTs &&... args)

  Calls io::ferr.printf(...) if built with -DEBUG.
- template<> std::string SysctlValue::get< std::string > () const

  Returns a copy of the value string.
- template<typename... MsgTs>
  ofile< io::link > debug (MsgTs &&... msg)

  Print a debugging message if built with -DEBUG.
- template<typename... MsgTs>
  ofile< io::link > warn (MsgTs &&... msg)

Print a warning.

- int sys_result (int const result)

  Combine sys_results with a computed result.
- template<typename... MsgTs>
  ofile< io::link > fail (MsgTs &&... msg)

  This prints an error message and sets sys_results to make the hijacked process fail.
- ofile< io::link > operator<< (ofile< io::link > fout, CoreFrameReport const &frame)

  Print recorded and running clock frequency and load for a frame.

Variables

- constexpr const flag_t FEATURES

  The set of supported features.
- int sys_results = 0

  The success return value of intercepted functions.
- class anonymous_namespace{libloadplay.cpp}::Sysctls sysctls

  Sole instance of Sysctls.
- bool sysctl_startup = true

  Set to activate fallback to the original sysctl functions.
- class anonymous_namespace{libloadplay.cpp}::Main main

  Sole instance of Main.

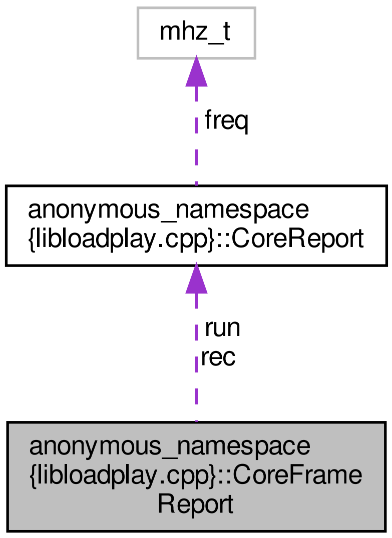
13.2.1 Detailed Description

File local scope.

13.2.2 Class Documentation

13.2.2.1 struct anonymous_namespace{libloadplay.cpp}::CoreFrameReport The report frame information for a single CPU pipeline.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::CoreFrameReport:


mhz_t
freq
anonymous_namespace {libloadplay.cpp}::CoreReport
run
rec
anonymous_namespace {libloadplay.cpp}::CoreFrame Report

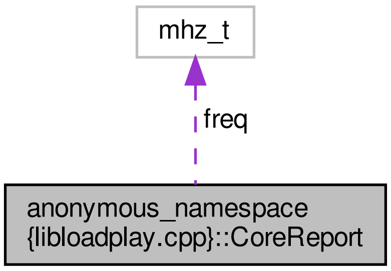
Class Members

CoreReport	rec	The recorded core state.
CoreReport	run	The running core state.

13.2.2.2 struct anonymous_namespace{libloadplay.cpp}::CoreReport

The reported state of a single CPU pipeline.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::CoreReport:



Class Members

mhz_t	freq	The core clock frequency in [MHz].
double	load	The core load as a fraction.

13.2.3 Typedef Documentation

13.2.3.1 ifile `template<auto Ownership>`

`using anonymous_namespace{libloadplay.cpp}::ifile = typedef io::file<Ownership, io::read>`

Input file type alias.

Template Parameters

Ownership	The io::ownership type of the file

13.2.3.2 ofile `template<auto Ownership>`

```
using anonymous_namespace{libloadplay.cpp}::ofile = typedef io::file<Ownership, io::write>
```

Output file type alias.

Template Parameters

Ownership	The io::ownership type of the file

13.2.4 Function Documentation

13.2.4.1 debug() `template<typename... MsgTs>`

```
ofile<io::link> anonymous_namespace{libloadplay.cpp}::debug (
              MsgTs &&... msg )  [inline]
```

Print a debugging message if built with -DEBUG.

Template Parameters

Msg←↩ Ts	The message argument types

Parameters

msg	The debugging message

Returns

An output file handle for extending the message

13.2.4.2 dprintf() `template<typename ... ArgTs>`

```
constexpr void anonymous_namespace{libloadplay.cpp}::dprintf (
              ArgTs &&... args )  [constexpr]
```

Calls io::ferr.printf(...) if built with -DEBUG.

Template Parameters

Arg←↩ Ts	The argument types to forward

Parameters

args	Arguments are forwarded to fprintf()

13.2.4.3 fail()

```
template<typename... MsgTs>
ofile<io::link> anonymous_namespace{libloadplay.cpp}::fail (
            MsgTs &&... msg )  [inline]
```

This prints an error message and sets sys_results to make the hijacked process fail.

Template Parameters

Msg↩ Ts	The message argument types

Parameters

msg	The error message

Returns

An output file handle for extending the message

13.2.4.4 operator""""_r()

```
std::regex anonymous_namespace{libloadplay.cpp}::operator""_r (
            char const *const str,
            size_t const len )  [inline]
```

User defined literal for regular expressions.

Parameters

str,len	The literal string and its length

Returns

A regular expression

13.2.4.5 operator<<()

```
ofile<io::link> anonymous_namespace{libloadplay.cpp}::operator<< (
            ofile< io::link > fout,
            CoreFrameReport const & frame )
```

Print recorded and running clock frequency and load for a frame.

The clock frequency is printed at 1 MHz resolution, the load at 0.1 MHz.

Parameters

fout	The stream to print to
frame	The frame information to print

Returns

A reference to the out stream

13.2.4.6 strcmp() `template<size_t Size>`

```
int anonymous_namespace{libloadplay.cpp}::strcmp (
              char const *const s1,
              char const (&) s2[Size] )  [inline]
```

Safe wrapper around strncmp, which automatically determines the buffer size of s2.

Template Parameters

Size	The size of the buffer s2

Parameters

s1,s2	The strings to compare

Return values

0	Strings are equal
!0	Strings are not equal

13.2.4.7 sys_result()

```
int anonymous_namespace{libloadplay.cpp}::sys_result (
              int const result )  [inline]
```

Combine sys_results with a computed result.

Parameters

result	A computed result

Return values

sys_results	If sys_results is a non-zero value
result	If sys_results is set to 0

13.2.4.8 SysctlValue::get< std::string >() `template<>`

`std::string anonymous_namespace{libloadplay.cpp}::SysctlValue::get< std::string > ( ) const`

Returns a copy of the value string.

Returns

The value

13.2.4.9 warn() `template<typename... MsgTs>`

```
ofile<io::link> anonymous_namespace{libloadplay.cpp}::warn (
            MsgTs &&... msg )  [inline]
```

Print a warning.

Template Parameters

Msg↩ Ts	The message argument types

Parameters

msg	The warning message

Returns

An output file handle for extending the message

13.2.5 Variable Documentation

13.2.5.1 FEATURES `constexpr const flag_t anonymous_namespace{libloadplay.cpp}::FEATURES [constexpr]`

Initial value:
```
{
    1_FREQ_TRACKING
}
```

The set of supported features.

This value is used to ensure correct input data interpretation.

13.2.5.2 sysctl_startup `bool anonymous_namespace{libloadplay.cpp}::sysctl_startup = true`

Set to activate fallback to the original sysctl functions.

This is reset when Main initialisation completes.

13.3 anonymous_namespace{loadplay.cpp} Namespace Reference

File local scope.

Enumerations

- enum OE {
  OE::USAGE, OE::FILE_IN, OE::FILE_OUT, OE::CMD,
  OE::OPT_NOOPT = CMD, OE::OPT_UNKNOWN, OE::OPT_DASH, OE::OPT_LDASH,
  OE::OPT_DONE }

  An enum for command line parsing.

Functions

- const char ∗ filename (char const ∗const path)

  Performs very rudimentary file name argument checks.
- void execute (char const ∗const file, char ∗const argv[ ])

  Executes the given command, substituting this process.
- void set_library_path (int const argc, char ∗const argv[ ])

  If running from an explicit path add the path to the library search path.

Variables

- const char ∗const USAGE = "[-h] [-i file] [-o file] command [...]"

  The short usage string.
- const Parameter< OE > PARAMETERS [ ]

  Definitions of command line parameters.

13.3.1 Detailed Description

File local scope.

13.3.2 Enumeration Type Documentation

13.3.2.1 OE `enum anonymous_namespace{loadplay.cpp}::OE [strong]`

An enum for command line parsing.

Enumerator

USAGE	Print help.
FILE_IN	Set input file instead of stdin.
FILE_OUT	Set output file instead of stdout.
CMD	The command to execute.
OPT_NOOPT	Obligatory.
OPT_UNKNOWN	Obligatory.
OPT_DASH	Obligatory.
OPT_LDASH	Obligatory.
OPT_DONE	Obligatory.

13.3.3 Function Documentation

13.3.3.1 execute()

```
void anonymous_namespace{loadplay.cpp}::execute (
        char const *const file,
        char *const argv[] )
```

Executes the given command, substituting this process.

This function is a wrapper around execvp(3) and does not return.

Parameters

file	The command to execute, looked up in PATH if no path is provided
argv	The command line arguments of the command

Exceptions

errors::Exception{Exit::EEXEC}	

13.3.3.2 filename()

```
const char* anonymous_namespace{loadplay.cpp}::filename (
        char const *const path )
```

Performs very rudimentary file name argument checks.

- Fail on empty path
- Return nullptr on '-'

Parameters

path	The file path to check

Returns

The given path or nullptr if the given path is '-'

13.3.3.3 set_library_path()

```
void anonymous_namespace{loadplay.cpp}::set_library_path (
        int const argc,
        char *const argv[] )
```

If running from an explicit path add the path to the library search path.

This function facilitates calling `loadplay` directly from the build directory for testing and allows it to pick up `libloadplay.so` from the same directory.

Parameters

argc,argv	The command line arguments provided to loadplay

Precondition

argc >= 2

Warning

This function changes the contents of argv[0]

13.3.4 Variable Documentation

13.3.4.1 PARAMETERS `const Parameter<OE> anonymous_namespace{loadplay.cpp}::PARAMETERS[]`

Initial value:

```
{
    {OE::USAGE,     'h', "help",    "",              "Show usage and exit"},
    {OE::FILE_IN,   'i', "input",   "file",          "Input file (load recording)"},
    {OE::FILE_OUT,  'o', "output",  "file",          "Output file (replay stats)"},
    {OE::CMD,        0 , "",        "command,[...]", "The command to execute"},
}
```

Definitions of command line parameters.

13.4 anonymous_namespace{loadrec.cpp} Namespace Reference

File local scope.

Typedefs

- template<auto Ownership>
  using ofile = io::file< Ownership, io::write >

  Output file type alias.

Enumerations

- enum OE {
  OE::USAGE, OE::IVAL_DURATION, OE::IVAL_POLL, OE::FILE_OUTPUT,
  OE::FILE_PID, OE::FLAG_VERBOSE, OE::OPT_UNKNOWN, OE::OPT_NOOPT,
  OE::OPT_DASH, OE::OPT_LDASH, OE::OPT_DONE }

  An enum for command line parsing.

Functions

- template<typename... MsgTs>
  void verbose (MsgTs &&... msg)

  Outputs the given printf style message on stderr if g.verbose is set.
- void init ()

  Set up output to the given file.
- void read_args (int const argc, char const ∗const argv[ ])

  Parse command line arguments.
- void print_sysctls ()

  Print the sysctls.
- void run ()

  Report the load frames.

Variables

- constexpr const flag_t FEATURES

  The set of supported features.
-

  struct {
  bool **verbose** {false}
  Verbosity flag.
  ms **duration** {30000}
  Recording duration in ms.
  ms **interval** {25}
  Recording sample interval in ms.
  ofile< io::link > **fout** = io::fout
  The output stream either io::fout (stdout) or a file.
  const char ∗ **outfilename** {nullptr}
  The user provided output file name.
  const SysctlOnce< coreid_t, 2 > **ncpu** {1U, {CTL_HW, HW_NCPU}}
  The number of CPU cores/threads.
  } g

  The global state.
- const char ∗const USAGE = "[-hv] [-d ival] [-p ival] [-o file]"

  The short usage string.
- const Parameter< OE > PARAMETERS [ ]

  Definitions of command line parameters.

13.4.1 Detailed Description

File local scope.

13.4.2 Typedef Documentation

13.4.2.1 ofile `template<auto Ownership>`

`using anonymous_namespace{loadrec.cpp}::ofile = typedef io::file<Ownership, io::write>`

Output file type alias.

Template Parameters

Ownership	The io::ownership type of the file

13.4.3 Enumeration Type Documentation

13.4.3.1 OE `enum anonymous_namespace{loadrec.cpp}::OE [strong]`

An enum for command line parsing.

Enumerator

USAGE	Print help.
IVAL_DURATION	Set the duration of the recording.
IVAL_POLL	Set polling interval.
FILE_OUTPUT	Set output file.
FILE_PID	Set PID file.
FLAG_VERBOSE	Verbose output on stderr.
OPT_UNKNOWN	Obligatory.
OPT_NOOPT	Obligatory.
OPT_DASH	Obligatory.
OPT_LDASH	Obligatory.
OPT_DONE	Obligatory.

13.4.4 Function Documentation

13.4.4.1 print_sysctls() `void anonymous_namespace{loadrec.cpp}::print_sysctls ( )`

Print the sysctls.

13.4.4.2 read_args()

```
void anonymous_namespace{loadrec.cpp}::read_args (
        int const argc,
        char const *const argv[] )
```

Parse command line arguments.

Parameters

argc,argv	The command line arguments

13.4.4.3 run() `void anonymous_namespace{loadrec.cpp}::run ( )`

Report the load frames.

This prints the time in ms since the last frame and the cp_times growth as a space separated list.

13.4.4.4 verbose() `template<typename... MsgTs>`

```
void anonymous_namespace{loadrec.cpp}::verbose (
                MsgTs &&... msg )  [inline]
```

Outputs the given printf style message on stderr if g.verbose is set.

Template Parameters

Msg↩ Ts	The message argument types

Parameters

msg	The message to output

13.4.5 Variable Documentation

13.4.5.1 FEATURES `constexpr const flag_t anonymous_namespace{loadrec.cpp}::FEATURES [constexpr]`

Initial value:
```
{
    1_FREQ_TRACKING
}
```

The set of supported features.

This value is stored in load recordings to allow loadplay to correctly interpret the data.

13.4.5.2 PARAMETERS `const Parameter<OE> anonymous_namespace{loadrec.cpp}::PARAMETERS[]`

Initial value:
```
{
    {OE::USAGE,         'h', "help",     "",     "Show usage and exit"},
    {OE::FLAG_VERBOSE,  'v', "verbose",  "",     "Be verbose"},
    {OE::IVAL_DURATION, 'd', "duration", "ival", "The duration of the recording"},
    {OE::IVAL_POLL,     'p', "poll",     "ival", "The polling interval"},
    {OE::FILE_OUTPUT,   'o', "output",   "file", "Output to file"},
    {OE::FILE_PID,      'P', "pid",      "file", "Ignored"},
}
```

Definitions of command line parameters.

13.5 anonymous_namespace{powerd++.cpp} Namespace Reference

File local scope.

Classes

- struct Core

  Contains the management information for a single CPU core. More...
- struct CoreGroup

  Contains the management information for a group of cores with a common clock frequency. More...
- class FreqGuard

  A core frequency guard.
- struct Global

  A collection of all the gloabl, mutable states.

Enumerations

- enum AcLineState : unsigned int { AcLineState::BATTERY, AcLineState::ONLINE, AcLineState::UNKNOWN, AcLineState::LENGTH }

  The available AC line states.
- enum OE {
  OE::USAGE, OE::MODE_AC, OE::MODE_BATT, OE::FREQ_MIN,
  OE::FREQ_MAX, OE::FREQ_MIN_AC, OE::FREQ_MAX_AC, OE::FREQ_MIN_BATT,
  OE::FREQ_MAX_BATT, OE::FREQ_RANGE, OE::FREQ_RANGE_AC, OE::FREQ_RANGE_BATT,
  OE::HITEMP_RANGE, OE::MODE_UNKNOWN, OE::TEMP_CTL, OE::IVAL_POLL,
  OE::FILE_PID, OE::FLAG_VERBOSE, OE::FLAG_FOREGROUND, OE::FLAG_NICE,
  OE::CNT_SAMPLES, OE::IGNORE, OE::OPT_UNKNOWN, OE::OPT_NOOPT,
  OE::OPT_DASH, OE::OPT_LDASH, OE::OPT_DONE }

  An enum for command line parsing.

Functions

- template<typename... MsgTs>
  void verbose (MsgTs &&... msg)

  Outputs the given printf style message on stderr if g.verbose is set.
- void sysctl_fail (sys::sc_error< sys::ctl::error > const err)

  Treat sysctl errors.
- void init ()

  Perform initial tasks.
- template<bool Load = 1, bool Temperature = 0>
  void update_loads ()

  Updates the cp_times ring buffer and computes the load average for each core.
- template<> void update_loads< 0, 0 > ()

  Do nada if neither load nor temperature are to be updated.
- template<bool Foreground, bool Temperature, bool Fixed>
  void update_freq (Global::ACSet const &acstate)

  Update the CPU clocks depending on the AC line state and targets.
- void update_freq ()

  Dispatch update_freq<>().
- void init_loads ()

Fill the loads buffers with n samples.

- void set_mode (AcLineState const line, char const ∗const str)

  Sets a load target or fixed frequency for the given AC line state.
- void read_args (int const argc, char const ∗const argv[ ])

  Parse command line arguments.
- void show_settings ()

  Prints the configuration on stderr in verbose mode.
- void signal_recv (int signal)

  Sets g.signal, terminating the main loop.
- void run_daemon ()

  Daemonise and run the main loop.

Variables

- struct anonymous_namespace{powerd++.cpp}::Global g

  The gobal state.
- const char ∗const USAGE = "[-hvfN] [-abn mode] [-mM freq] [-FAB freq:freq] [-H temp:temp] [-t sysctl] [-p ival] [-s cnt] [-P file]"

  The short usage string.
- const Parameter< OE > PARAMETERS [ ]

  Definitions of command line parameters.

13.5.1 Detailed Description

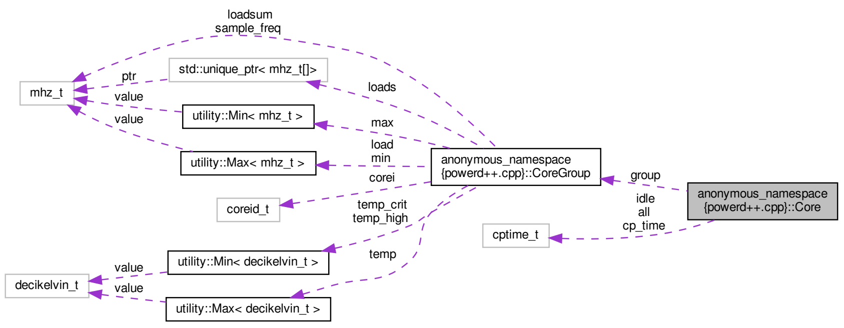
File local scope.

13.5.2 Class Documentation

13.5.2.1 struct anonymous_namespace{powerd++.cpp}::Core

Contains the management information for a single CPU core.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::Core:



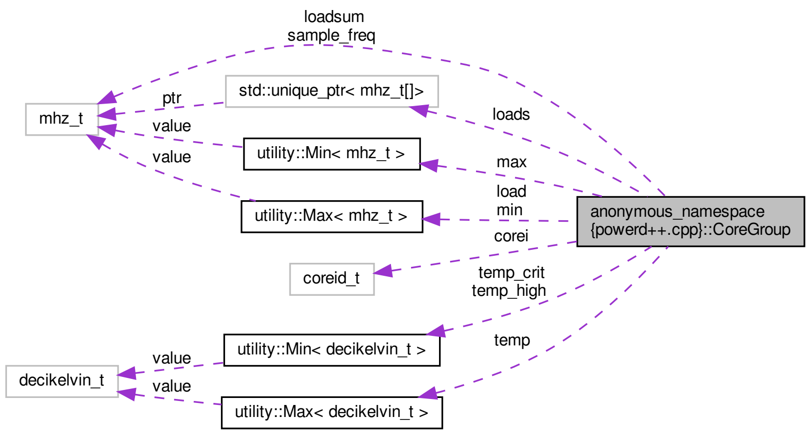
Class Members

cptime_t	all	Count of all ticks.
const cptime_t ∗	cp_time	A pointer to the kern.cp_times section for this core.
CoreGroup ∗	group	The core that controls the frequency for this core.
cptime_t	idle	The idle ticks count.
SysctlSync< decikelvin_t >	temp	The dev.cpu. d.temperature sysctl, if present.

13.5.2.2 struct anonymous_namespace{powerd++.cpp}::CoreGroup

Contains the management information for a group of cores with a common clock frequency.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::CoreGroup:



Class Members

coreid_t	corei	The number of the core owning dev.cpu. d.freq.
SysctlSync< mhz_t >	freq	The sysctl dev.cpu. d.freq.
Max< mhz_t >	load	The maximum load reported by all cores in the group. This is updated by update_loads().
unique_ptr< mhz_t[ ]>	loads	A ring buffer of maximum load samples for this core group. Each maximum load sample is weighted with the core frequency at which it was taken. This is updated by update_loads().
mhz_t	loadsum	The maximum load sum of all controlled cores. This is updated by update_loads().
Min< mhz_t >	max	The maximum group clock rate. The least of all core maxima in the group.
Max< mhz_t >	min	The minimum group clock rate. The greatest of all core minima in the group.
mhz_t	sample_freq	The dev.cpu. d.freq value for the current load sample. This is updated by update_loads().
Max< decikelvin_t >	temp	The maximum temperature measurement taken in the group.
Min< decikelvin_t >	temp_crit	Critical core temperature in dK.
Min< decikelvin_t >	temp_high	High core temperature in dK.

13.5.3 Enumeration Type Documentation

13.5.3.1 AcLineState `enum anonymous_namespace{powerd++.cpp}::AcLineState : unsigned int [strong]`

The available AC line states.

Enumerator

BATTERY	Battery is power source.
ONLINE	External power source.
UNKNOWN	Unknown power source.
LENGTH	Enum length.

13.5.3.2 OE `enum anonymous_namespace{powerd++.cpp}::OE [strong]`

An enum for command line parsing.

Enumerator

USAGE	Print help.
MODE_AC	Set AC power mode.
MODE_BATT	Set battery power mode.
FREQ_MIN	Set minimum clock frequency.
FREQ_MAX	Set maximum clock frequency.
FREQ_MIN_AC	Set minimum clock frequency on AC power.
FREQ_MAX_AC	Set maximum clock frequency on AC power.
FREQ_MIN_BATT	Set minimum clock frequency on battery power.
FREQ_MAX_BATT	Set maximum clock frequency on battery power.
FREQ_RANGE	Set clock frequency range.
FREQ_RANGE_AC	Set clock frequency range on AC power.
FREQ_RANGE_BATT	Set clock frequency range on battery power.
HITEMP_RANGE	Set a high temperature range.
MODE_UNKNOWN	Set unknown power source mode.
TEMP_CTL	Override temperature sysctl.
IVAL_POLL	Set polling interval.
FILE_PID	Set pidfile.
FLAG_VERBOSE	Activate verbose output on stderr.
FLAG_FOREGROUND	Stay in foreground, log events to stdout.
FLAG_NICE	Treat nice time as idle.
CNT_SAMPLES	Set number of load samples.
IGNORE	Legacy settings.
OPT_UNKNOWN	Obligatory.

Enumerator

OPT_NOOPT	Obligatory.
OPT_DASH	Obligatory.
OPT_LDASH	Obligatory.
OPT_DONE	Obligatory.

13.5.4 Function Documentation

13.5.4.1 init() `void anonymous_namespace{powerd++.cpp}::init ( )`

Perform initial tasks.

- Get number of CPU cores/threads
- Determine the clock controlling core for each core
- Set the MIBs of hw.acpi.acline and kern.cp_times

13.5.4.2 init_loads() `void anonymous_namespace{powerd++.cpp}::init_loads ( )`

Fill the loads buffers with n samples.

The samples are filled with the target load, this creates a bias to stay at the initial frequency until sufficient real measurements come in to flush these initial samples out.

13.5.4.3 read_args()

```
void anonymous_namespace{powerd++.cpp}::read_args (
        int const argc,
        char const *const argv[] )
```

Parse command line arguments.

Parameters

argc,argv	The command line arguments

13.5.4.4 set_mode()

```
void anonymous_namespace{powerd++.cpp}::set_mode (
        AcLineState const line,
        char const *const str )
```

Sets a load target or fixed frequency for the given AC line state.

The string must be in the following format:

```
mode_predefined = "minimum" | "min" | "maximum" | "max" |
                  "adaptive" | "adp" | "hiadptive" | "hadp";
mode =            mode_predefined | load | freq;
```

Scalar values are treated as loads.

The predefined values have the following meaning:

Symbol	Meaning
minimum	The minimum clock rate (default 0 MHz)
min	
maximum	The maximum clock rate (default 1000000 MHz)
max	
adaptive	A target load of 50%
adp	
hiadptive	A target load of 37.5%
hadp	

Parameters

line	The power line state to set the mode for
str	A mode string

13.5.4.5 signal_recv() `void anonymous_namespace{powerd++.cpp}::signal_recv ( int signal )`

Sets g.signal, terminating the main loop.

Parameters

signal	The signal number received

13.5.4.6 sysctl_fail() `void anonymous_namespace{powerd++.cpp}::sysctl_fail ( sys::sc_error< sys::ctl::error > const err ) [inline]`

Treat sysctl errors.

Fails appropriately for the given error.

Parameters

err	The errno value after calling sysctl

13.5.4.7 update_freq() `template<bool Foreground, bool Temperature, bool Fixed>`

```
void anonymous_namespace{powerd++.cpp}::update_freq (
              Global::ACSet const & acstate )
```

Update the CPU clocks depending on the AC line state and targets.

Template Parameters

Foreground	Set for foreground operation (reporting on std::cout)
Temperature	Set for temperature based throttling
Fixed	Set for fixed frequency mode

Parameters

acstate	The set of acline dependent variables

13.5.4.8 update_loads() `template<bool Load = 1, bool Temperature = 0>`

```
void anonymous_namespace{powerd++.cpp}::update_loads ( )
```

Updates the cp_times ring buffer and computes the load average for each core.

Template Parameters

Load	Determines whether CoreGroup::loadsum is updated
Temperature	Determines whether CoreGroup::temp is updated

13.5.4.9 verbose() `template<typename... MsgTs>`

```
void anonymous_namespace{powerd++.cpp}::verbose (
              MsgTs &&... msg ) [inline]
```

Outputs the given printf style message on stderr if g.verbose is set.

Template Parameters

Msg↩ Ts	The message argument types

Parameters

msg	The message to output

13.5.5 Variable Documentation

13.5.5.1 PARAMETERS `const Parameter<OE> anonymous_namespace{powerd++.cpp}::PARAMETERS[]`

Initial value:
```
{
    {OE::USAGE,          'h', "help",            "",          "Show usage and exit"},
    {OE::FLAG_VERBOSE,   'v', "verbose",         "",          "Be verbose"},
    {OE::FLAG_FOREGROUND, 'f', "foreground",     "",          "Stay in foreground"},
    {OE::FLAG_NICE,      'N', "idle-nice",       "",          "Treat nice time as idle"},
    {OE::MODE_AC,        'a', "ac",              "mode",      "Mode while on AC power"},
    {OE::MODE_BATT,      'b', "batt",            "mode",      "Mode while on battery power"},
    {OE::MODE_UNKNOWN,   'n', "unknown",         "mode",      "Mode while power source is unknown"},
    {OE::FREQ_MIN,       'm', "min",             "freq",      "Minimum CPU frequency"},
    {OE::FREQ_MAX,       'M', "max",             "freq",      "Maximum CPU frequency"},
    {OE::FREQ_MIN_AC,     0 , "min-ac",          "freq",      "Minimum CPU frequency on AC power"},
    {OE::FREQ_MAX_AC,     0 , "max-ac",          "freq",      "Maximum CPU frequency on AC power"},
    {OE::FREQ_MIN_BATT,   0 , "min-batt",        "freq",      "Minimum CPU frequency on battery power"},
    {OE::FREQ_MAX_BATT,   0 , "max-batt",        "freq",      "Maximum CPU frequency on battery power"},
    {OE::FREQ_RANGE,     'F', "freq-range",      "freq:freq", "CPU frequency range (min:max)"},
    {OE::FREQ_RANGE_AC,  'A', "freq-range-ac",   "freq:freq", "CPU frequency range on AC power"},
    {OE::FREQ_RANGE_BATT, 'B', "freq-range-batt", "freq:freq", "CPU frequency range on battery power"},
    {OE::HITEMP_RANGE,   'H', "hitemp-range",    "temp:temp", "High temperature range (high:critical)"},
    {OE::TEMP_CTL,       't', "temperature",     "sysctl",    "Override temperature source sysctl"},
    {OE::IVAL_POLL,      'p', "poll",            "ival",      "The polling interval"},
    {OE::CNT_SAMPLES,    's', "samples",         "cnt",       "The number of samples to use"},
    {OE::FILE_PID,       'P', "pid",             "file",      "Alternative PID file"},
    {OE::IGNORE,         'i', "",                "load",      "Ignored"},
    {OE::IGNORE,         'r', "",                "load",      "Ignored"}
}
```

Definitions of command line parameters.

13.6 clas Namespace Reference

A collection of functions to process command line arguments.

Functions

- types::cptime_t load (char const ∗const str)
  Convert string to load in the range [0, 1024].
- types::mhz_t freq (char const ∗const str)
  Convert string to frequency in MHz.
- types::ms ival (char const ∗const str)
  Convert string to time interval in milliseconds.
- size_t samples (char const ∗const str)
  A string encoded number of samples.
- types::decikelvin_t temperature (char const ∗const str)
  Convert string to temperature in dK.
- int celsius (types::decikelvin_t const val)
  Converts dK into ℃ for display purposes.
- template<typename T >
  std::pair< T, T > range (T(&func)(char const ∗const), char const ∗const str)
  Takes a string encoded range of values and returns them.
- const char ∗ sysctlname (char const ∗const str)
  Verify that the given string only contains characters allowed in sysctl names.
- template<typename ... CharTs>
  const char ∗ formatfields (char const ∗const fmt, CharTs const ... fields)
  Sanitise user-provided formatting strings.

13.6.1 Detailed Description

A collection of functions to process command line arguments.

13.6.2 Function Documentation

13.6.2.1 celsius()

```
int clas::celsius (
        types::decikelvin_t const val )  [inline]
```

Converts dK into ℃ for display purposes.

Parameters

val	A temperature in dK

Returns

The temperature in ℃

13.6.2.2 formatfields()

```
template<typename ... CharTs>
const char* clas::formatfields (
        char const *const fmt,
        CharTs const ... fields )
```

Sanitise user-provided formatting strings.

Ensure that the given string contains no more than the given formatting fields in the given order.

This only passes plain data format fields, no flags, field width or precision are allowed.

Exceptions

errors::Exit::EFORMATFIELD	For unexpected formatting fields

Parameters

fmt	The formatting string to sanitise
fields	A set of characters representing a printf-style formatting

Returns

The given string

13.6.2.3 freq() `types::mhz_t clas::freq ( char const *const str )`

Convert string to frequency in MHz.

The given string must have the following format:

```
freq = <float>, [ "hz" | "khz" | "mhz" | "ghz" | "thz" ];
```

For compatibility with powerd MHz are assumed, if no unit string is given.

The resulting frequency must be in the range [0Hz, 1THz].

Parameters

str	A string encoded frequency

Returns

The frequency given by str

13.6.2.4 ival() `types::ms clas::ival ( char const *const str )`

Convert string to time interval in milliseconds.

The given string must have the following format:

```
ival = <float>, [ "s" | "ms" ];
```

For compatibility with powerd scalar values are assumed to represent milliseconds.

Parameters

str	A string encoded time interval

Returns

The interval in milliseconds

13.6.2.5 load() `types::cptime_t clas::load ( char const *const str )`

Convert string to load in the range [0, 1024].

The given string must have the following format:

```
load = <float>, [ "%" ];
```

The input value must be in the range [0.0, 1.0] or [0%, 100%].

Parameters

str	A string encoded load

Return values

[0,1024]	The load given by str
>	1024 The given string is not a load

13.6.2.6 range() `template<typename T >`

```
std::pair<T, T> clas::range (
              T(&)(char const *const) func,
              char const *const str )
```

Takes a string encoded range of values and returns them.

A range has the format `from:to`.

Template Parameters

T	The return type of the conversion function

Parameters

func	The function that converts the values from the string
str	The string containing the range

Returns

A pair with the `from` and `to` values

13.6.2.7 samples() `size_t clas::samples (`

```
              char const *const str )
```

A string encoded number of samples.

The string is expected to contain a scalar integer.

Parameters

str	The string containing the number of samples

Returns

The number of samples

13.6.2.8 sysctlname() `const char * clas::sysctlname ( char const *const str )`

Verify that the given string only contains characters allowed in sysctl names.

The currently permitted characters are: `[0-9A-Za-z%._-]`

Exceptions

errors::Exit::ESYSCTLNAME	For empty or invalid strings

Returns

The given string

13.6.2.9 temperature() `types::decikelvin_t clas::temperature ( char const *const str )`

Convert string to temperature in dK.

The given string must have the following format:

```
temperature = <float>, [ "C" | "K" | "F" | "R" ];
```

In absence of a unit ℃ is assumed.

Parameters

str	A string encoded temperature

Returns

The temperature given by str

13.7 constants Namespace Reference

A collection of constants.

Variables

- const char ∗const CP_TIMES = "kern.cp_times"

  The MIB name for per-CPU time statistics.
- const char ∗const ACLINE = "hw.acpi.acline"

  The MIB name for the AC line state.
- const char ∗const FREQ = "dev.cpu.%d.freq"

  The MIB name for CPU frequencies.
- const char ∗const FREQ_LEVELS = "dev.cpu.%d.freq_levels"

  The MIB name for CPU frequency levels.
- const char ∗const TEMPERATURE = "dev.cpu.%d.temperature"

  The MIB name for CPU temperatures.
- const char ∗const TJMAX_SOURCES [ ]

  An array of maximum temperature sources.
- const char ∗const FREQ_DRIVER = "dev.cpufreq.%d.freq_driver"

  The MIB name for the CPU frequency drivers.
- const char ∗const FREQ_DRIVER_BLACKLIST [ ]

  A list of driver prefixes, that are known not to allow manual frequency control.
- const types::mhz_t FREQ_DEFAULT_MAX {1000000}

  Default maximum clock frequency value.
- const types::mhz_t FREQ_DEFAULT_MIN {0}

  Default minimum clock frequency value.
- const types::mhz_t FREQ_UNSET {1000001}

  Clock frequency representing an uninitialised value.
- const char ∗const POWERD_PIDFILE = "/var/run/powerd.pid"

  The default pidfile name of powerd.
- const types::cptime_t ADP {512}

  The load target for adaptive mode, equals 50% load.
- const types::cptime_t HADP {384}

  The load target for hiadaptive mode, equals 37.5% load.
- const types::decikelvin_t HITEMP_OFFSET {100}

  The default temperautre offset between high and critical temperature.

13.7.1 Detailed Description

A collection of constants.

13.7.2 Variable Documentation

13.7.2.1 FREQ_DRIVER_BLACKLIST `const char* const constants::FREQ_DRIVER_BLACKLIST[]`

Initial value:
```
{
    "hwpstate_"
}
```

A list of driver prefixes, that are known not to allow manual frequency control.

13.7.2.2 TJMAX_SOURCES `const char* const constants::TJMAX_SOURCES[]`

Initial value:
```
{
    "dev.cpu.%d.coretemp.tjmax"
}
```

An array of maximum temperature sources.

13.8 errors Namespace Reference

Common error handling types and functions.

Classes

- struct Exception

  Exceptions bundle an exit code, errno value and message. More...

Enumerations

- enum Exit : int {
  Exit::OK, Exit::ECLARG, Exit::EOUTOFRANGE, Exit::ELOAD,
  Exit::EFREQ, Exit::EMODE, Exit::EIVAL, Exit::ESAMPLES,
  Exit::ESYSCTL, Exit::ENOFREQ, Exit::ECONFLICT, Exit::EPID,
  Exit::EFORBIDDEN, Exit::EDAEMON, Exit::EWOPEN, Exit::ESIGNAL,
  Exit::ERANGEFMT, Exit::ETEMPERATURE, Exit::EEXCEPT, Exit::EFILE,
  Exit::EEXEC, Exit::EDRIVER, Exit::ESYSCTLNAME, Exit::EFORMATFIELD,
  Exit::LENGTH }

  Exit codes.

Functions

- void fail (Exit const exitcode, int const err, std::string const &msg)

  Throws an Exception instance with the given message.

Variables

- const char *const ExitStr [ ]

  Printable strings for exit codes.

13.8.1 Detailed Description

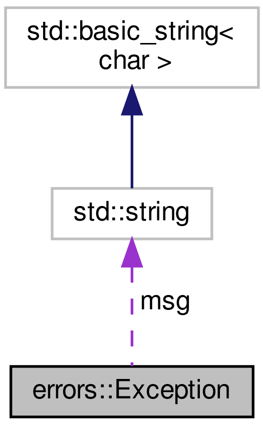
Common error handling types and functions.

13.8.2 Class Documentation

13.8.2.1 struct errors::Exception

Exceptions bundle an exit code, errno value and message.

Collaboration diagram for errors::Exception:



Class Members

int	err	The errno value at the time of creation.
Exit	exitcode	The code to exit with.
string	msg	An error message.

13.8.3 Enumeration Type Documentation

13.8.3.1 Exit `enum errors::Exit : int [strong]`

Exit codes.

Enumerator

OK	Regular termination.
ECLARG	Unexpected command line argument.

Enumerator

EOUTOFRANGE	A user provided value is out of range.
ELOAD	The provided value is not a valid load.
EFREQ	The provided value is not a valid frequency.
EMODE	The provided value is not a valid mode.
EIVAL	The provided value is not a valid interval.
ESAMPLES	The provided value is not a valid sample count.
ESYSCTL	A sysctl operation failed.
ENOFREQ	System does not support changing core frequencies.
ECONFLICT	Another frequency daemon instance is running.
EPID	A pidfile could not be created.
EFORBIDDEN	Insufficient privileges to change sysctl.
EDAEMON	Unable to detach from terminal.
EWOPEN	Could not open file for writing.
ESIGNAL	Failed to install signal handler.
ERANGEFMT	A user provided range is missing the separator.
ETEMPERATURE	The provided value is not a valid temperature.
EEXCEPT	Untreated exception.
EFILE	Not a valid file name.
EEXEC	Command execution failed.
EDRIVER	Frequency driver does not allow manual control.
ESYSCTLNAME	User provided sysctl contains invalid characters.
EFORMATFIELD	Formatting string contains unexpected field.
LENGTH	Enum length.

13.8.4 Function Documentation

13.8.4.1 fail()

```
void errors::fail (
        Exit const exitcode,
        int const err,
        std::string const & msg )   [inline]
```

Throws an Exception instance with the given message.

Parameters

exitcode	The exit code to return on termination
err	The errno value at the time the exception was created
msg	The message to show

13.8.5 Variable Documentation

13.8.5.1 ExitStr `const char* const errors::ExitStr[]`

Initial value:
```
{
    "OK", "ECLARG", "EOUTOFRANGE", "ELOAD", "EFREQ", "EMODE", "EIVAL",
    "ESAMPLES", "ESYSCTL", "ENOFREQ", "ECONFLICT", "EPID", "EFORBIDDEN",
    "EDAEMON", "EWOPEN", "ESIGNAL", "ERANGEFMT", "ETEMPERATURE",
    "EEXCEPT", "EFILE", "EEXEC", "EDRIVER", "ESYSCTLNAME", "EFORMATFIELD"
}
```

Printable strings for exit codes.

13.9 nih Namespace Reference

Not invented here namespace, for code that substitutes already commonly available functionality.

Classes

- struct enum_has_members

  Tests whether the given enum provides all the required definitions.
- class Options

  An instance of this class offers operators to retrieve command line options and arguments.
- struct Parameter

  Container for an option definition. *More...*

Functions

- template<class OptionT >
  size_t argCount (Parameter< OptionT > const &def)

  Retrieves the count of arguments in an option definition.

13.9.1 Detailed Description

Not invented here namespace, for code that substitutes already commonly available functionality.

13.9.2 Class Documentation

13.9.2.1 struct nih::Parameter

template<class OptionT>
struct nih::Parameter< OptionT >

Container for an option definition.

Aliases can be defined by creating definitions with the same option member.

The lparam, args and usage members have to be 0 terminated, using string literals is safe.

Template Parameters

OptionT	An enum or enum class representing the available options

Class Members

const char ∗	args	A comma separated list of arguments. Set to nullptr or "" if no argument is available.
const char ∗	lparam	The long version of this parameter. Set to nullptr or "" if no long parameter is available.
OptionT	option	The enum value to return for this option.
char	sparam	The short version of this parameter. Set to 0 if no short parameter is available.
const char ∗	usage	A usage string.

13.9.3 Function Documentation

13.9.3.1 argCount() `template<class OptionT >`

```
size_t nih::argCount (
            Parameter< OptionT > const & def )
```

Retrieves the count of arguments in an option definition.

Template Parameters

OptionT	An enum or enum class representing the available options

Parameters

def	The parameter definition

Returns

The number of arguments specified in the given definition

13.10 sys Namespace Reference

Wrappers around native system interfaces.

Namespaces

- ctl

  This namespace contains safer c++ wrappers for the sysctl() interface.
- env

Provides wrappers around the getenv() family of functions.
- io

  This namespace contains c++ wrappers for <cstdio> functionality.
- pid

  This namespace contains safer c++ wrappers for the pidfile_∗() interface.
- sig

  This namespace provides c++ wrappers for signal(3).

Classes

- struct sc_error

  Can be thrown by syscall function wrappers if the function returned with an error.

13.10.1 Detailed Description

Wrappers around native system interfaces.

13.11 sys::ctl Namespace Reference

This namespace contains safer c++ wrappers for the sysctl() interface.

Classes

- struct error

  The domain error type. More...
- class Once

  A read once representation of a Sysctl.
- class Sync

  This is a wrapper around Sysctl that allows semantically transparent use of a sysctl.
- class Sysctl

  Represents a sysctl MIB address.
- class Sysctl< 0 >

  This is a specialisation of Sysctl for sysctls using symbolic names.

Typedefs

- typedef int mib_t

  Management Information Base identifier type (see sysctl(3)).
- template<typename T , size_t MibDepth = 0>
  using SysctlSync = Sync< T, Sysctl< MibDepth > >

  A convenience alias around Sync.
- template<typename T , size_t MibDepth = 0>
  using SysctlOnce = Once< T, Sysctl< MibDepth > >

  A convenience alias around Once.

Functions

- void sysctl_raw (mib_t const ∗name, u_int const namelen, void ∗const oldp, size_t ∗const oldlenp, void const ∗const newp, size_t const newlen)

    A wrapper around the sysctl() function.
- template<size_t MibDepth>
  void sysctl_get (mib_t const (&mib)[MibDepth], void ∗const oldp, size_t &oldlen)

    Returns a sysctl() value to a buffer.
- template<size_t MibDepth>
  void sysctl_set (mib_t const (&mib)[MibDepth], void const ∗const newp, size_t const newlen)

    Sets a sysctl() value.
- template<typename ... ArgTs>
  Sysctl (mib_t const, ArgTs const ...) -> Sysctl<(1+sizeof...(ArgTs))>

    Create a Sysctl from a set of predefined MIBs.
- Sysctl (char const ∗const) -> Sysctl< 0 >

    Create a Sysctl<0> by name.
- Sysctl () -> Sysctl< 0 >

    Default construct a Sysctl<0>.

13.11.1 Detailed Description

This namespace contains safer c++ wrappers for the sysctl() interface.

The template class Sysctl represents a sysctl address and offers handles to retrieve or set the stored value.

The template class Sync represents a sysctl value that is read and written synchronously.

The template class Once represents a read once value.

13.11.2 Class Documentation

13.11.2.1 struct sys::ctl::error The domain error type.

13.11.3 Typedef Documentation

13.11.3.1 SysctlOnce `template<typename T , size_t MibDepth = 0>`

`using sys::ctl::SysctlOnce = typedef Once<T, Sysctl<MibDepth> >`

A convenience alias around Once.

```
// Once<coreid_t, Sysctl<2>> ncpu{0, {CTL_HW, HW_NCPU}};
SysctlOnce<coreid_t, 2> ncpu{1, {CTL_HW, HW_NCPU}};
```

Template Parameters

T	The type to represent the sysctl as
MibDepth	The maximum allowed MIB depth

13.11.3.2 SysctlSync `template<typename T , size_t MibDepth = 0>`

```
using sys::ctl::SysctlSync = typedef Sync<T, Sysctl<MibDepth> >
```

A convenience alias around Sync.

```
// Sync<int, Sysctl<0>> sndUnit{{"hw.snd.default_unit"}};
SysctlSync<int> sndUnit{{"hw.snd.default_unit"}};
if (sndUnit != 3) {    // read from sysctl
    sndUnit = 3;      // assign to sysctl
}
```

Template Parameters

T	The type to represent the sysctl as
MibDepth	The MIB depth, provide only for compile time initialisation

13.11.4 Function Documentation

13.11.4.1 Sysctl() `template<typename ... ArgTs>`

```
sys::ctl::Sysctl (
                mib_t const ,
                ArgTs const ... ) -> Sysctl<(1+sizeof...(ArgTs))>
```

Create a Sysctl from a set of predefined MIBs.

Template Parameters

Args	List of argument types, should all be mib_t

13.11.4.2 sysctl_get() `template<size_t MibDepth>`

```
void sys::ctl::sysctl_get (
                mib_t const (&) mib[MibDepth],
                void *const oldp,
                size_t & oldlen )
```

Returns a sysctl() value to a buffer.

Template Parameters

MibDepth	The length of the MIB buffer

Parameters

mib	The MIB buffer

Parameters

oldp,oldlen	A pointers to the return buffer and a reference to its length

Exceptions

sys::sc_error<error>	Throws if sysctl() fails for any reason

13.11.4.3 sysctl_raw()

```
void sys::ctl::sysctl_raw (
              mib_t const * name,
              u_int const namelen,
              void *const oldp,
              size_t *const oldlenp,
              void const *const newp,
              size_t const newlen )  [inline]
```

A wrapper around the sysctl() function.

All it does is throw an exception if sysctl() fails.

Parameters

name,namelen	The MIB buffer and its length
oldp,oldlenp	Pointers to the return buffer and its length
newp,newlen	A pointer to the buffer with the new value and the buffer length

Exceptions

sys::sc_error<error>	Throws if sysctl() fails for any reason

13.11.4.4 sysctl_set()

```
template<size_t MibDepth>
void sys::ctl::sysctl_set (
              mib_t const (&) mib[MibDepth],
              void const *const newp,
              size_t const newlen )
```

Sets a sysctl() value.

Template Parameters

MibDepth	The length of the MIB buffer

Parameters

mib	The MIB buffer
newp,newlen	A pointer to the buffer with the new value and the buffer length

Exceptions

sys::sc_error<error>	Throws if sysctl() fails for any reason

13.12 sys::env Namespace Reference

Provides wrappers around the getenv() family of functions.

Classes

- struct error

    The domain error type. More...
- class Var

    A reference type refering to an environment variable.
- struct Vars

    A singleton class providing access to environment variables.

Variables

- struct sys::env::Vars vars

    Singleton providing access to environment variables.

13.12.1 Detailed Description

Provides wrappers around the getenv() family of functions.

13.12.2 Class Documentation

13.12.2.1 struct sys::env::error The domain error type.

13.13 sys::io Namespace Reference

This namespace contains c++ wrappers for <cstdio> functionality.

Classes

- struct contains

  Check whether a set type contains a value. More...
- struct contains< set< Set ... >, Value >

  Specialise io::contains to unpack io::set.
- struct enable_if

  Similar to std::enable_if, but it also has the value of the expression.
- struct enable_if< false, T >

  Specialise enable_if for a false expression.
- class file

  Produces file access types around the C file handling facilities. More...
- class file< link, Features ... >

  Specialise for FILE object linking file instances.
- class file< own, Features ... >

  Specialise for FILE object owning file instances.
- class file_feature

  Implements the base functionality of all file access types.
- class file_feature< FileT, read, Tail ... >

  Implement read support for file types.
- class file_feature< FileT, seek, Tail ... >

  Implement seek support for file types.
- class file_feature< FileT, write, Tail ... >

  Implement write support for file types.
- struct is_superset_of

  Check whether the left hand set is a superest of the right hand set. More...
- struct is_superset_of< LSetT, set< RSet ... > >

  Specialise is_superset_of to unpack the right hand io::set.
- struct query

  Ask questions about the contents of a string. More...
- struct set

  Pack a set of integral values in a type. More...

Typedefs

- template<class SetT , auto Value>
  using contains_t = typename contains< SetT, Value >::type

  Check whether a set type contains a value.
- template<class LSetT , class RSetT >
  using is_superset_of_t = typename is_superset_of< LSetT, RSetT >::type

  Check whether the left hand set is a superest of the right hand set.

Enumerations

- enum feature { feature::read, feature::write, feature::seek }

  Feature flags for file type composition.
- enum ownership { ownership::own, ownership::link }

  Ownership relation to the underlying FILE object.

Variables

- template<class SetT , auto Value>
  constexpr const auto contains_v = contains<SetT, Value>::value

  Check whether a set type contains a value.
- template<class LSetT , class RSetT >
  constexpr const auto is_superset_of_v = is_superset_of<LSetT, RSetT>::value

  Check whether the left hand set is a superest of the right hand set.
- file< link, write > ferr {stderr}

  File access instances for stderr.
- file< link, write > fout {stdout}

  File access instances for stdout.
- file< link, read > fin {stdin}

  File access instances for stdin.

13.13.1 Detailed Description

This namespace contains c++ wrappers for <cstdio> functionality.

13.13.2 Class Documentation

13.13.2.1 struct sys::io::contains

template<class SetT, auto Value>
struct sys::io::contains< SetT, Value >

Check whether a set type contains a value.

Template Parameters

SetT	A set of integral values packed in io::set
Value	The value to look up

13.13.2.2 class sys::io::file

template<ownership Ownership, feature ... Features>
class sys::io::file< Ownership, Features >

Produces file access types around the C file handling facilities.

Template Parameters

Ownership	Determine the ownership relationship to the underlying FILE object
Features	A list of features the file type supports

See also

- ownership
- feature
- file<own, Features ...>
- file<link, Features ...>
- file_feature

13.13.2.3 struct sys::io::is_superset_of

template<class LSetT, class RSetT>
struct sys::io::is_superset_of< LSetT, RSetT >

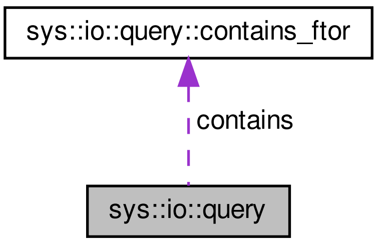
Check whether the left hand set is a superest of the right hand set.

Template Parameters

LSetT,RSetT	Two io::set instances

13.13.2.4 struct sys::io::query Ask questions about the contents of a string.

Collaboration diagram for sys::io::query:



Class Members

struct contains_ftor	contains	Query the string for characters.

13.13.2.5 struct sys::io::set

template<auto ... Set>
struct sys::io::set< Set >

Pack a set of integral values in a type.

Template Parameters

Set	A set of integral values

13.13.3 Typedef Documentation

13.13.3.1 contains_t `template<class SetT , auto Value>`

`using sys::io::contains_t = typedef typename contains<SetT, Value>::type`

Check whether a set type contains a value.

Template Parameters

SetT	A set of integral values packed in io::set
Value	The value to look up

13.13.3.2 is_superset_of_t `template<class LSetT , class RSetT >`

`using sys::io::is_superset_of_t = typedef typename is_superset_of<LSetT, RSetT>::type`

Check whether the left hand set is a superest of the right hand set.

Template Parameters

LSetT,RSetT	Two io::set instances

13.13.4 Enumeration Type Documentation

13.13.4.1 feature `enum sys::io::feature [strong]`

Feature flags for file type composition.

See also

file_feature

Enumerator

read	The file type supports read operations. See also file_feature<FileT, read, Tail ...>
write	The file type supports write operations. See also file_feature<FileT, write, Tail ...>
seek	The file type supports seek operations. See also file_feature<FileT, seek, Tail ...>

13.13.4.2 ownership `enum sys::io::ownership [strong]`

Ownership relation to the underlying FILE object.

Enumerator

own	The file instance owns the FILE object. See also file<own, Features ...>
link	The file instance refers to a FILE object managed somewhere else. See also file<link, Features ...>

13.13.5 Variable Documentation

13.13.5.1 contains_v `template<class SetT , auto Value>`

`constexpr const auto sys::io::contains_v = contains<SetT, Value>::value [constexpr]`

Check whether a set type contains a value.

Template Parameters

SetT	A set of integral values packed in io::set
Value	The value to look up

13.13.5.2 is_superset_of_v `template<class LSetT , class RSetT >`

`constexpr const auto sys::io::is_superset_of_v = is_superset_of<LSetT, RSetT>::value [constexpr]`

Check whether the left hand set is a superest of the right hand set.

Template Parameters

LSetT,RSetT	Two io::set instances

13.14 sys::pid Namespace Reference

This namespace contains safer c++ wrappers for the pidfile_∗() interface.

Classes

- struct error

  The domain error type. More...
- class Pidfile

  A wrapper around the pidfile_∗ family of commands implementing the RAII pattern.

13.14.1 Detailed Description

This namespace contains safer c++ wrappers for the pidfile_∗() interface.

The class Pidfile implements the RAII pattern for holding a pidfile.

13.14.2 Class Documentation

13.14.2.1 struct sys::pid::error The domain error type.

13.15 sys::sig Namespace Reference

This namespace provides c++ wrappers for signal(3).

Classes

- struct error

  The domain error type. More...
- class Signal

  Sets up a given signal handler and restores the old handler when going out of scope.

Typedefs

- using sig_t = void(∗)(int)

    Convenience type for signal handlers.

13.15.1 Detailed Description

This namespace provides c++ wrappers for signal(3).

13.15.2 Class Documentation

13.15.2.1 struct sys::sig::error The domain error type.

13.16 timing Namespace Reference

Namespace for time management related functionality.

Classes

- class Cycle

    Implements an interruptible cyclic sleeping functor.

13.16.1 Detailed Description

Namespace for time management related functionality.

13.17 types Namespace Reference

A collection of type aliases.

Typedefs

- typedef std::chrono::milliseconds ms

    Millisecond type for polling intervals.
- typedef int coreid_t

    Type for CPU core indexing.
- typedef unsigned long cptime_t

    Type for load counting.
- typedef unsigned int mhz_t

    Type for CPU frequencies in MHz.
- typedef int decikelvin_t

    Type for temperatures in dK.

13.17.1 Detailed Description

A collection of type aliases.

13.17.2 Typedef Documentation

13.17.2.1 cptime_t `typedef unsigned long types::cptime_t`

Type for load counting.

According to src/sys/kern/kern_clock.c the type is `long` (an array of loads `long[CPUSTATES]` is defined). But in order to have defined wrapping characteristics `unsigned long` will be used here.

13.18 utility Namespace Reference

A collection of generally useful functions.

Namespaces

- literals

  Contains literal operators.

Classes

- class Formatter

  A formatting wrapper around string literals.
- struct FromChars

  A functor for reading numerical values from a string or character array.
- class Max

  A simple value container that provides the maximum of assigned values.
- class Min

  A simple value container that provides the minimum of assigned values.
- class Sum

  A simple value container only allowing += and copy assignment.
- struct Underlined

  A line of text and an underlining line.

Functions

- template<typename T , size_t Count>
  constexpr size_t countof (T(&)[Count])

  Like sizeof(), but it returns the number of elements an array consists of instead of the number of bytes.
- template<typename... Args>
  void sprintf (Args...)

  This is a safeguard against accidentally using sprintf().
- template<size_t Size, typename... Args>
  int sprintf_safe (char(&dst)[Size], char const ∗const format, Args const ... args)

  A wrapper around snprintf() that automatically pulls in the destination buffer size.
- template<class ET , typename VT = typename std::underlying_type<ET>::type>
  constexpr VT to_value (ET const op)

  Casts an enum to its underlying value.
- Underlined highlight (std::string const &str, ptrdiff_t const offs, ptrdiff_t const len=1)

  Underline the given number of characters.

13.18.1 Detailed Description

A collection of generally useful functions.

13.18.2 Function Documentation

13.18.2.1 countof() `template<typename T , size_t Count>`

```
constexpr size_t utility::countof (
            T(&) [Count] )  [constexpr]
```

Like sizeof(), but it returns the number of elements an array consists of instead of the number of bytes.

Template Parameters

T,Count	The type and number of array elements

Returns

The number of array entries

13.18.2.2 highlight() `utility::Underlined utility::highlight (`

```
            std::string const & str,
            ptrdiff_t const offs,
            ptrdiff_t const len = 1 )
```

Underline the given number of characters.

The given length and offset use byte-addressing, the resulting text is sanitised for printing, which may affect the actual number of underlining characters:

- Control characters, multi-byte character fragments and invalid code points are substituted by printf-style escapes
- Multi-byte characters are underlined with a single character

Double width characters are not supported (i.e. the resulting underline is too short).

The underlining string is only as long as it needs to be, i.e. it is not right-padded with white space.

Parameters

str	The string to sanitise and underline
offs,len	The byte-offset and length of the underline

Returns

The sanitised text and the underline

13.18.2.3 sprintf() `template<typename... Args>`

```
void utility::sprintf (
              Args...   )  [inline]
```

This is a safeguard against accidentally using sprintf().

Using it triggers a static_assert(), preventing compilation.

Template Parameters

Args	Catch all arguments

13.18.2.4 sprintf_safe() `template<size_t Size, typename... Args>`

```
int utility::sprintf_safe (
              char(&) dst[Size],
              char const *const format,
              Args const ... args )  [inline]
```

A wrapper around snprintf() that automatically pulls in the destination buffer size.

Template Parameters

Size	The destination buffer size
Args	The types of the arguments

Parameters

dst	A reference to the destination buffer
format	A printf style formatting string
args	The printf arguments

Returns

The number of characters in the resulting string, regardless of the available space

13.18.2.5 to_value()

```
template<class ET , typename VT = typename std::underlying_type<ET>::type>
constexpr VT utility::to_value (
              ET const op )  [constexpr]
```

Casts an enum to its underlying value.

Template Parameters

ET,VT	The enum and value type

Parameters

op	The operand to convert

Returns

The integer representation of the operand

13.19 utility::literals Namespace Reference

Contains literal operators.

Functions

- constexpr Formatter< 16384 > operator""_fmt (char const *const fmt, size_t const)
  Literal to convert a string literal to a Formatter instance.

13.19.1 Detailed Description

Contains literal operators.

13.19.2 Function Documentation

13.19.2.1 operator""""_fmt() `constexpr Formatter<16384> utility::literals::operator""_fmt (`

```
char const *const fmt,
size_t const  )  [constexpr]
```

Literal to convert a string literal to a Formatter instance.

Parameters

fmt	A printf style format string

Returns

A Formatter instance

13.20 version Namespace Reference

Version information constants and types.

Namespaces

- literals
  Literals to set flag bits.

Typedefs

- typedef uint64_t flag_t
  The data type to use for feature flags.

Enumerations

- enum LoadrecBits { LoadrecBits::FREQ_TRACKING }
  Feature flags for load recordings.

Variables

- const char *const LOADREC_FEATURES = "usr.app.powerdxx.loadrec.features"
  The pseudo MIB name for the load recording feature flags.

13.20.1 Detailed Description

Version information constants and types.

13.20.2 Enumeration Type Documentation

13.20.2.1 LoadrecBits `enum version::LoadrecBits [strong]`

Feature flags for load recordings.

Enumerator

FREQ_TRACKING	Record clock frequencies per frame.

13.21 version::literals Namespace Reference

Literals to set flag bits.

Functions

- constexpr flag_t operator""_FREQ_TRACKING (unsigned long long int value)

    Set the FREQ_TRACKING bit.

13.21.1 Detailed Description

Literals to set flag bits.

13.21.2 Function Documentation

13.21.2.1 operator""""_FREQ_TRACKING()

```
constexpr flag_t version::literals::operator""_FREQ_TRACK←
ING (
            unsigned long long int value )  [constexpr]
```

Set the FREQ_TRACKING bit.

Parameters

value	The bit value

Returns

The flag at the correct bit position

14 Class Documentation

14.1 anonymous_namespace{libloadplay.cpp}::Callback< FunctionArgs > Class Template Reference

Implements a recursion safe std::function wrapper.

Public Types

- typedef std::function< void(FunctionArgs...)> function_t

  The callback function type.

Public Member Functions

- Callback ()

  Default constructor, creates a non-callable handle.
- Callback (function_t const &callback)

  Construct from function.
- Callback (function_t &&callback)

  Construct from temporary function.
- void operator() (FunctionArgs... args)

  Forward call to callback functions.

Private Attributes

- function_t callback

  Storage for the callback function.
- bool called {false}

  Set if this handle is currently in use.

14.1.1 Detailed Description

template<typename... FunctionArgs>
class anonymous_namespace{libloadplay.cpp}::Callback< FunctionArgs >

Implements a recursion safe std::function wrapper.

The purpose is to prevent recursive calls of a callback function handle, in cases when a callback function performs actions that cause a successive call of the callback function.

To avoid having to return a value when a successive function call occurs only functions returning void are valid callback functions.

This is not thread safe.

Template Parameters

Function↩ Args	The argument types of the callback function

14.1.2 Constructor & Destructor Documentation

14.1.2.1 Callback() [1/2] template<typename... FunctionArgs>

```
anonymous_namespace{libloadplay.cpp}::Callback< FunctionArgs >::Callback (
              function_t const & callback )   [inline]
```

Construct from function.

Parameters

callback	The callback function

14.1.2.2 Callback() [2/2] template<typename... FunctionArgs>

```
anonymous_namespace{libloadplay.cpp}::Callback< FunctionArgs >::Callback (
              function_t && callback )   [inline]
```

Construct from temporary function.

Parameters

callback	The callback function

14.1.3 Member Function Documentation

14.1.3.1 operator()() template<typename... FunctionArgs>

```
void anonymous_namespace{libloadplay.cpp}::Callback< FunctionArgs >::operator() (
              FunctionArgs... args )   [inline]
```

Forward call to callback functions.

Parameters

args	The arguments to the callback function

Exceptions

std::bad_function_call	In case this handler was default constructed or constructed from a nullptr

The documentation for this class was generated from the following file:

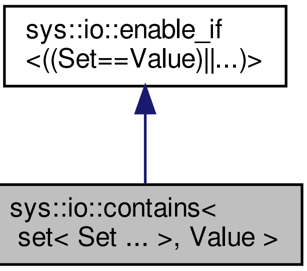
- src/libloadplay.cpp

14.2 sys::io::contains< set< Set ... >, Value > Struct Template Reference

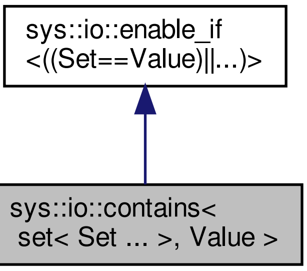
Specialise io::contains to unpack io::set.

`#include <io.hpp>`

Inheritance diagram for sys::io::contains< set< Set ... >, Value >:



Collaboration diagram for sys::io::contains< set< Set ... >, Value >:



Additional Inherited Members

14.2.1 Detailed Description

template<auto ... Set, auto Value>
struct sys::io::contains< set< Set ... >, Value >

Specialise io::contains to unpack io::set.

Template Parameters

Set	The set of integral values to search
Value	The value to find in Set

The documentation for this struct was generated from the following file:

- src/sys/io.hpp

14.3 sys::io::query::contains_ftor Struct Reference

Test a string whether it contains a set of characters.

```
#include <io.hpp>
```

Public Member Functions

- constexpr bool operator() (char const ch) const
  Check for a single character.
- template<typename ... CharTs>
  constexpr bool any (CharTs const ... chars) const
  Check for a set of characters if at least one is part of the string.
- template<typename ... CharTs>
  constexpr bool all (CharTs const ... chars) const
  Check for a set of characters if all of them are part of the string.

Public Attributes

- const char ∗const str
  The string to ask about.

14.3.1 Detailed Description

Test a string whether it contains a set of characters.

14.3.2 Member Function Documentation

14.3.2.1 all() template<typename ... CharTs>

```
constexpr bool sys::io::query::contains_ftor::all (
            CharTs const ... chars ) const  [inline], [constexpr]
```

Check for a set of characters if all of them are part of the string.

Template Parameters

Char↩ Ts	The character types

Parameters

chars	The set of characters

Returns

Whether all of the given characters are in the string

14.3.2.2 any() `template<typename ... CharTs>`

```
constexpr bool sys::io::query::contains_ftor::any (
            CharTs const ... chars ) const  [inline], [constexpr]
```

Check for a set of characters if at least one is part of the string.

Template Parameters

Char↵ Ts	The character types

Parameters

chars	The set of characters

Returns

Whether at least one of the given characters is in the string

14.3.2.3 operator()() `constexpr bool sys::io::query::contains_ftor::operator() (`

```
            char const ch ) const  [inline], [constexpr]
```

Check for a single character.

Parameters

ch	The character to check for

Returns

Whether the given character is part of the string

The documentation for this struct was generated from the following file:

- src/sys/io.hpp

14.4 timing::Cycle Class Reference

Implements an interruptible cyclic sleeping functor.

`#include <Cycle.hpp>`

Public Member Functions

- bool operator() () const

  Completes an interrupted sleep cycle.
- template<class... DurTraits>
  bool operator() (std::chrono::duration< DurTraits... > const &cycleTime)

  Sleep for the time required to complete the given cycle time.

Private Types

- using clock = std::chrono::steady_clock

  Use steady_clock, avoid time jumps.
- using us = std::chrono::microseconds

  Shorthand for microseconds.

Private Attributes

- std::chrono::time_point< clock > clk = clock::now()

  The current time clock.

14.4.1 Detailed Description

Implements an interruptible cyclic sleeping functor.

Cyclic sleeping means that instead of having a fixed sleeping time, each sleep is timed to meet a fixed wakeup time. I.e. the waking rhythm does not drift with changing system loads.

The canonical way to do this in C++ is like this:
```
#include <chrono>
#include <thread>
int main() {
    std::chrono::milliseconds const ival{500};
    auto time = std::chrono::steady_clock::now();
    while (…something…) {
        std::this_thread::sleep_until(time += ival);
        …do stuff…
    }
    return 0;
}
```

The issue is that you might want to install a signal handler to guarantee stack unwinding and sleep_until() will resume its wait after the signal handler completes.

The Cycle class offers you an interruptible sleep:
```
#include "Cycle.hpp"
#include <csignal>
…signal handlers…
int main() {
    std::chrono::milliseconds const ival{500};
    …setup some signal handlers…
    timing::Cycle sleep;
    while (…something… && sleep(ival)) {
        …do stuff…
    }
    return 0;
}
```

In the example the while loop is terminated if the `sleep()` is interrupted by a signal. Optionally the sleep cycle can be resumed:

```
timing::Cycle sleep;
while (…something…) {
    if (!sleep(ival)) {
        …interrupted…
        while (!sleep());
    }
    …do stuff…
}
```

Note there was a design decision between providing a cycle time to the constructor or providing it every cycle. The latter was chosen so the cycle time can be adjusted.

14.4.2 Member Function Documentation

14.4.2.1 operator()() [1/2] `bool timing::Cycle::operator() ( ) const [inline]`

Completes an interrupted sleep cycle.

I.e. if the last sleep cycle was 500 ms and the sleep was interrupted 300 ms into the cycle, this would sleep for the remaining 200 ms unless interrupted.

Return values

true	Sleep completed uninterrupted
false	Sleep was interrupted

14.4.2.2 operator()() [2/2] `template<class... DurTraits>`

```
bool timing::Cycle::operator() (
                std::chrono::duration< DurTraits... > const & cycleTime ) [inline]
```

Sleep for the time required to complete the given cycle time.

I.e. if the time since the last sleep cycle was 12 ms and the given cycleTime was 500 ms, the actual sleeping time would be 488 ms.

Template Parameters

Dur↩ Traits	The traits of the duration type

Parameters

cycle↩ Time	The duration of the cycle to complete

Return values

true	Command completed uninterrupted
false	Command was interrupted

14.4.3 Member Data Documentation

14.4.3.1 clk `std::chrono::time_point<clock> timing::Cycle::clk = clock::now()  [private]`

The current time clock.

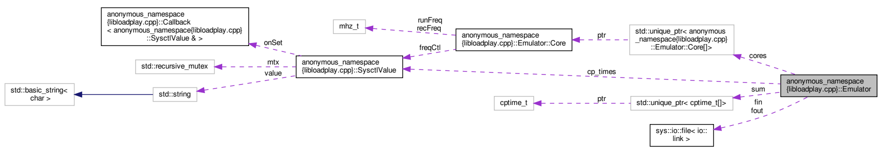
The documentation for this class was generated from the following file:

- src/Cycle.hpp

14.5 anonymous_namespace{libloadplay.cpp}::Emulator Class Reference

Instances of this class represent an emulator session.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::Emulator:


anonymous_namespace {libloadplay.cpp}::Callback < anonymous_namespace{libloadplay.cpp} ::SysctlValue & >
onSet
std::recursive_mutex
mtx
value
std::basic_string< char >
std::string
anonymous_namespace {libloadplay.cpp}::SysctlValue
mhz_t
runFreq
recFreq
freqCtl
anonymous_namespace {libloadplay.cpp}::Emulator::Core
ptr
std::unique_ptr< anonymous _namespace{libloadplay.cpp} ::Emulator::Core[]>
cores
cp_times
anonymous_namespace {libloadplay.cpp}::Emulator
sum
cptime_t
ptr
std::unique_ptr< cptime_t[]>
fin
fout
sys::io::file< io:: link >

Classes

- struct Core

  Per core information. More...

Public Member Functions

- Emulator (ifile< io::link > fin, ofile< io::link > fout, bool const &die)

  The constructor initialises all the members necessary for emulation.
- void operator() ()

  Performs load emulation and prints statistics on io::fout.

Private Attributes

- ifile< io::link > fin

    The input data source.
- ofile< io::link > fout

    The output data sink.
- const bool & die

    A reference to a bool that tells the emulator to die.
- const size_t size = sysctls[CP_TIMES].size()

    The size of the kern.cp_times buffer.
- const int ncpu = this->size / sizeof(cptime_t[CPUSTATES])

    The number of CPUs in kern.cp_times, may be greater than the hw.ncpu value (e.g.
- std::unique_ptr< Core[ ]> cores {new Core[this->ncpu]{}}

    Simulation state information for each core.
- SysctlValue & cp_times = sysctls[CP_TIMES]

    The kern.cp_times sysctl handler.
- std::unique_ptr< cptime_t[ ]> sum {new cptime_t[CPUSTATES * ncpu]{}}

    The current kern.cp_times values.

14.5.1 Detailed Description

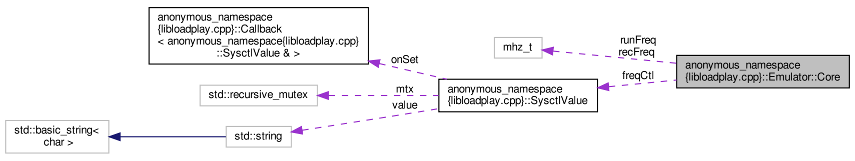
Instances of this class represent an emulator session.

This should be run in its own thread and expects the sysctl table to be complete.

14.5.2 Class Documentation

14.5.2.1 struct anonymous_namespace{libloadplay.cpp}::Emulator::Core Per core information.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::Emulator::Core:


anonymous_namespace {libloadplay.cpp}::Callback < anonymous_namespace{libloadplay.cpp} ::SysctlValue & >
mhz_t
runFreq
recFreq
onSet
anonymous_namespace {libloadplay.cpp}::Emulator::Core
freqCtl
std::recursive_mutex
mtx
anonymous_namespace {libloadplay.cpp}::SysctlValue
value
std::basic_string< char >
std::string

Class Members

cycles_t	carryCycles[CPUSTATES]	The cycles carried over to the next frame in [cycles]. This is determined at the beginning of frame and used to calculated the simulation load at the beginning of the next frame.
SysctlValue *	freqCtl	The sysctl handler. The constructor ensures this points to a valid handler.
mhz_t	recFreq	The recorded clock frequency. If FREQ_TRACKING is enabled this is updated at during the preliminary stage and used at the beginning of frame stage.
mhz_t	runFreq	The clock frequency the simulation is running at. Updated at the end of frame and used in the next frame.
cycles_t	runLoadCycles	The load cycles simulated for this frame in [cycles]. This is determined at the beginning of frame and used to calculate the reported load at the end of frame.

14.5.3 Constructor & Destructor Documentation

14.5.3.1 Emulator()

```
anonymous_namespace{libloadplay.cpp}::Emulator::Emulator (
        ifile< io::link > fin,
        ofile< io::link > fout,
        bool const & die )  [inline]
```

The constructor initialises all the members necessary for emulation.

It also prints the column headers on stdout.

Exceptions

std::out_of_range	In case one of the required sysctls is missing

Parameters

fin,fout	The character input and output streams
die	If the referenced bool is true, emulation is terminated prematurely

14.5.4 Member Function Documentation

14.5.4.1 operator()()

```
void anonymous_namespace{libloadplay.cpp}::Emulator::operator() ( )  [inline]
```

Performs load emulation and prints statistics on io::fout.

Reads fin to pull in load changes and updates the kern.cp_times sysctl to represent the current state.

When it runs out of load changes it terminates emulation and sends a SIGINT to the process.

14.5.5 Member Data Documentation

14.5.5.1 ncpu

```
const int anonymous_namespace{libloadplay.cpp}::Emulator::ncpu = this->size / sizeof(cptime↩
_t[CPUSTATES])  [private]
```

The number of CPUs in kern.cp_times, may be greater than the hw.ncpu value (e.g.

if hyperthreading was turned off).

The documentation for this class was generated from the following file:

- src/libloadplay.cpp

14.6 sys::io::enable_if< bool, T > Struct Template Reference

Similar to std::enable_if, but it also has the value of the expression.

```
#include <io.hpp>
```

Public Types

- using type = T

  Provide the requested type.

Static Public Attributes

- static constexpr const bool value {true}

  The given expression is true.

14.6.1 Detailed Description

template<bool, class T = void>
struct sys::io::enable_if< bool, T >

Similar to std::enable_if, but it also has the value of the expression.

Template Parameters

T	The return type if the expression is true

The documentation for this struct was generated from the following file:

- src/sys/io.hpp

14.7 sys::io::enable_if< false, T > Struct Template Reference

Specialise enable_if for a false expression.

```
#include <io.hpp>
```

Static Public Attributes

- static constexpr const bool value {false}

  The given expression is false.

14.7.1 Detailed Description

template<class T>
struct sys::io::enable_if< false, T >

Specialise enable_if for a false expression.

Template Parameters

T	The return type if the expression was true

The documentation for this struct was generated from the following file:

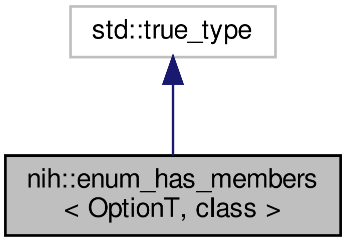
- src/sys/io.hpp

14.8 nih::enum_has_members< OptionT, class > Struct Template Reference

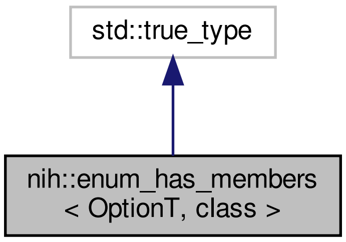
Tests whether the given enum provides all the required definitions.

`#include <Options.hpp>`

Inheritance diagram for nih::enum_has_members< OptionT, class >:



Collaboration diagram for nih::enum_has_members< OptionT, class >:



14.8.1 Detailed Description

template<class OptionT, class = void>
struct nih::enum_has_members< OptionT, class >

Tests whether the given enum provides all the required definitions.

The Options<> template expects the provided enum to provide the following members:

Member	Description
OPT_UNKNOWN	An undefined option (long or short) was encountered
OPT_NOOPT	The encountered command line argument is not an option
OPT_DASH	A single dash "-" was encountered
OPT_LDASH	Double dashes "--" were encountered
OPT_DONE	All command line arguments have been processed

Template Parameters

OptionT	An enum or enum class representing the available options

The documentation for this struct was generated from the following file:

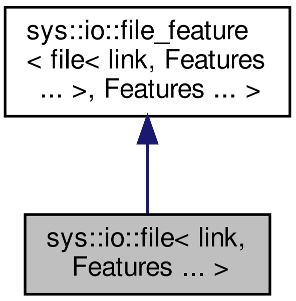
- src/Options.hpp

14.9 sys::io::file< link, Features ... > Class Template Reference

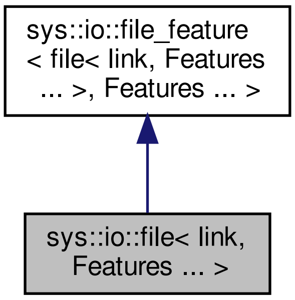
Specialise for FILE object linking file instances.

```
#include <io.hpp>
```

Inheritance diagram for sys::io::file< link, Features ... >:


sys::io::file_feature < file< link, Features ... >, Features ... >
sys::io::file< link, Features ... >

Collaboration diagram for sys::io::file< link, Features ... >:


sys::io::file_feature < file< link, Features ... >, Features ... >
sys::io::file< link, Features ... >

Public Member Functions

- file (FILE ∗const handle)

  Use the given FILE object.
- file ()

  Default construct.
- template<ownership Ownership, feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
  file (file< Ownership, Superset ... > const &copy)

  Copy construct from another file type instance.
- template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
  file (file< own, Superset ... > &&)=delete

  Must not move construct from files with ownership of their handle.
- template<ownership Ownership, feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
  file & operator= (file< Ownership, Superset ... > const &copy)

  Copy assign from another file type instance.
- template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
  file & operator= (file< own, Superset ... > &&)=delete

  Must not move assign from files with ownership of their handle.
- FILE ∗ get () const

  Provide the internal FILE object pointer.

Additional Inherited Members

14.9.1 Detailed Description

template<feature ... Features>
class sys::io::file< link, Features ... >

Specialise for FILE object linking file instances.

Lack of ownership implies some semantics:

- Cannot be used to open files
- Can be copy constructed/assigned from other owning and non-owning file instances
- Cannot be move constructed/assigned from owning file instances
- Cannot close()

Template Parameters

Features	The set of file access features to support

14.9.2 Constructor & Destructor Documentation

14.9.2.1 file() [1/3] template<feature ... Features>

```
sys::io::file< link, Features ... >::file (
            FILE *const handle )  [inline], [explicit]
```

Use the given FILE object.

This can be used to refer to FILE objects managed by legacy C code.

Parameters

handle	A pointer to a FILE object

14.9.2.2 file() [2/3] template<feature ... Features>

```
template<ownership Ownership, feature ...  Superset, class = is_superset_of_t<set<Superset ...>, set<↩
Features ...>>>
sys::io::file< link, Features ... >::file (
            file< Ownership, Superset ...  > const & copy )  [inline]
```

Copy construct from another file type instance.

The origin file type instance must support all features supported by this file type.

Template Parameters

Ownership	The ownership status of the other file type
Superset	The feature set of another file type
Cond	Whether Superset is an actual superset of Features

Parameters

copy	The lvalue file to acquire the FILE object from

14.9.2.3 file() [3/3] template<feature ... Features>

```
template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
```

```
sys::io::file< link, Features ... >::file (
            file< own, Superset ... > && )  [delete]
```

Must not move construct from files with ownership of their handle.

Template Parameters

Superset	The feature set of another FILE object owning file type

14.9.3 Member Function Documentation

14.9.3.1 get() `template<feature ... Features>`

```
FILE* sys::io::file< link, Features ... >::get ( ) const  [inline]
```

Provide the internal FILE object pointer.

Can be used to pass the file to legacy C interfaces.

Returns

A pointer to the managed FILE object

14.9.3.2 operator=() [1/2] `template<feature ... Features>`

```
template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
file& sys::io::file< link, Features ... >::operator= (
            file< own, Superset ... > && )  [delete]
```

Must not move assign from files with ownership of their handle.

Template Parameters

Superset	The feature set of another FILE object owning file type

Returns

A self reference

14.9.3.3 operator=() [2/2] `template<feature ... Features>`

```
template<ownership Ownership, feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<↩
Features ...>>>
file& sys::io::file< link, Features ... >::operator= (
            file< Ownership, Superset ... > const & copy )  [inline]
```

Copy assign from another file type instance.

The origin file type instance must support all features supported by this file type.

Template Parameters

Ownership	The ownership status of the other file type
Superset	The feature set of another file type
Cond	Whether Superset is an actual superset of Features

Parameters

copy	The lvalue file to acquire the FILE object from

Returns

A self reference

The documentation for this class was generated from the following file:

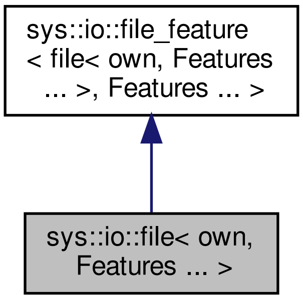
- src/sys/io.hpp

14.10 sys::io::file< own, Features ... > Class Template Reference

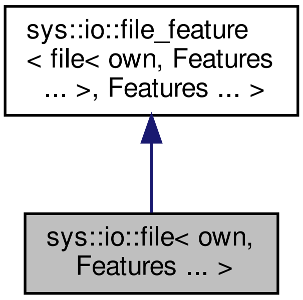
Specialise for FILE object owning file instances.

`#include <io.hpp>`

Inheritance diagram for sys::io::file< own, Features ... >:


sys::io::file_feature < file< own, Features ... >, Features ... >
sys::io::file< own, Features ... >

Collaboration diagram for sys::io::file< own, Features ... >:


sys::io::file_feature < file< own, Features ... >, Features ... >
sys::io::file< own, Features ... >

Public Member Functions

- file (file const &)=delete

  Must not copy construct for risk of multiple close() on the same file.
- file (file &&move)

  Move construct from a temporary.
- file (FILE ∗const handle)

  Take ownership of the given FILE object.
- file ()

  Default construct.
- template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
  file (file< own, Superset ... > &&move)

  Move construct from another owning file type instance.
- file (char const ∗const filename, char const ∗const mode)

  Open a file by name.
- ~file ()

  Free all resources.
- file & operator= (file &&move)

  Move assign from a temporary.
- template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
  file & operator= (file< own, Superset ... > &&move)

  Move assign from another owning file type instance.
- FILE ∗ get () const

  Provide the internal FILE object pointer.
- FILE ∗ release ()

  Surrender ownership of the internal FILE object pointer.
- file & close ()

  Close the file.

Friends

- template<ownership , feature ... >
  class file

  Friend all file classes for move assignment.

Additional Inherited Members

14.10.1 Detailed Description

template<feature ... Features>
class sys::io::file< own, Features ... >

Specialise for FILE object owning file instances.

Ownership implies some semantics:

- Offers a constructor that opens a file
- Cannot be copy constructed/assigned
- Can be move constructed/assigned from other owning file instances
- Can close()
- Implicit close() when going out of scope

Template Parameters

Features	The set of file access features to support

14.10.2 Constructor & Destructor Documentation

14.10.2.1 file() [1/4]

```
template<feature ... Features>
sys::io::file< own, Features ... >::file (
            file< own, Features ... > && move )  [inline]
```

Move construct from a temporary.

Parameters

move	The rvalue file to acquire the FILE object from

14.10.2.2 file() [2/4]

```
template<feature ... Features>
sys::io::file< own, Features ... >::file (
            FILE *const handle )  [inline], [explicit]
```

Take ownership of the given FILE object.

This can be used to take ownership of FILE objects provided by a legacy C interface.

Parameters

handle	A pointer to a FILE object

14.10.2.3 file() [3/4]

```
template<feature ... Features>
template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
sys::io::file< own, Features ... >::file (
            file< own, Superset ... > && move )  [inline]
```

Move construct from another owning file type instance.

The origin file type instance must support all features supported by this file type.

Template Parameters

Superset	The feature set of the original FILE object owner

Parameters

move	The rvalue file to acquire the FILE object from

14.10.2.4 file() [4/4]

```
template<feature ... Features>
sys::io::file< own, Features ... >::file (
            char const *const filename,
            char const *const mode )  [inline]
```

Open a file by name.

Failure to open a file occurs silently, but can be detected by boolean checking the file instance.

The arguments of this constructor are forwarded to fopen(), provided the mode argument does not contradict the feature set of this file type.

It is recommended to always add the 'b' (binary) character to the mode string, because text mode behaves quirkily.

The feature::seek feature is not supported with 'a' (append), it is available with 'a+', but it behaves quirkily. Which means two different files of the same type may have different seek behaviour, depending on how the file was opened. Refer to the fopen() spec for the unsettling details.

See also

fopen()

Parameters

filename	The name of the file
mode	The file access mode, must not contradict the feature set of this file type

14.10.3 Member Function Documentation

14.10.3.1 close() `template<feature ... Features>`

```
file& sys::io::file< own, Features ... >::close ( )  [inline]
```

Close the file.

Returns

A self reference

14.10.3.2 get() `template<feature ... Features>`

```
FILE* sys::io::file< own, Features ... >::get ( ) const  [inline]
```

Provide the internal FILE object pointer.

Can be used to pass the file to legacy C interfaces.

Returns

A pointer to the managed FILE object

14.10.3.3 operator=() [1/2] `template<feature ... Features>`

```
file& sys::io::file< own, Features ... >::operator= (
            file< own, Features ... > && move )  [inline]
```

Move assign from a temporary.

Parameters

move	The rvalue file to acquire the FILE object from

Returns

A self reference

14.10.3.4 operator=() [2/2] `template<feature ... Features>`

```
template<feature ... Superset, class = is_superset_of_t<set<Superset ...>, set<Features ...>>>
file& sys::io::file< own, Features ... >::operator= (
            file< own, Superset ... > && move )  [inline]
```

Move assign from another owning file type instance.

The origin file type instance must support all features supported by this file type.

Template Parameters

Superset	The feature set of the original FILE object owner

Parameters

move	The rvalue file to acquire the FILE object from

Returns

A self reference

14.10.3.5 release() `template<feature ... Features>`

```
FILE* sys::io::file< own, Features ... >::release ( )  [inline]
```

Surrender ownership of the internal FILE object pointer.

Can be used to pass the file to legacy C interfaces.

Returns

A pointer to the managed FILE object

The documentation for this class was generated from the following file:

- src/sys/io.hpp

14.11 sys::io::file_feature< FileT,... > Class Template Reference

Implements the base functionality of all file access types.

`#include <io.hpp>`

Public Member Functions

- operator bool () const

  Cast to boolean.
- bool eof () const

  Return whether the file instance is in EOF state.
- bool error () const

  Return whether the file instance is in an error state.

Protected Member Functions

- operator FileT & ()

  Implicit cast up to inheriting file access type.
- file_feature (FILE ∗const handle)

  Construct from a FILE object pointer.

Protected Attributes

- FILE ∗ handle

  A pointer to the underlying FILE object.

14.11.1 Detailed Description

template<class FileT, feature ...>
class sys::io::file_feature< FileT,... >

Implements the base functionality of all file access types.

Template Parameters

FileT	The file access type inheriting the feature

See also

file_feature<FileT, read, Tail ...>

file_feature<FileT, write, Tail ...>

file_feature<FileT, seek, Tail ...>

14.11.2 Constructor & Destructor Documentation

14.11.2.1 file_feature()

```
template<class FileT , feature ... >
sys::io::file_feature< FileT,... >::file_feature (
            FILE *const handle )  [inline], [protected]
```

Construct from a FILE object pointer.

Parameters

handle	A pointer to the object keeping file descriptor state

14.11.3 Member Function Documentation

14.11.3.1 eof() `template<class FileT , feature ... >`

`bool sys::io::file_feature< FileT,... >::eof ( ) const [inline]`

Return whether the file instance is in EOF state.

See also

feof()

Returns

Whether the file instance points to a FILE object and is in EOF state

14.11.3.2 error() `template<class FileT , feature ... >`

`bool sys::io::file_feature< FileT,... >::error ( ) const [inline]`

Return whether the file instance is in an error state.

See also

ferror()

Returns

Whether the file instance points to a FILE object and is in an error state

14.11.3.3 operator bool() `template<class FileT , feature ... >`

`sys::io::file_feature< FileT,... >::operator bool ( ) const [inline], [explicit]`

Cast to boolean.

See also

feof()

ferror()

Return values

true	The file instance point to a FILE object, which is not in EOF or error state
false	The file instance does not point to a FILE object, or the FILE object is in EOF or error state

The documentation for this class was generated from the following file:

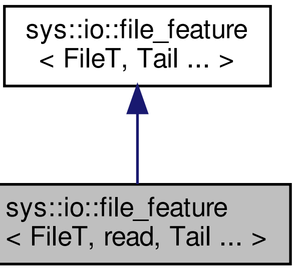
- src/sys/io.hpp

14.12 sys::io::file_feature< FileT, read, Tail ... > Class Template Reference

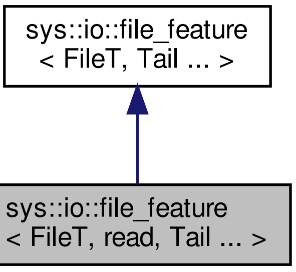
Implement read support for file types.

`#include <io.hpp>`

Inheritance diagram for sys::io::file_feature< FileT, read, Tail ... >:



Collaboration diagram for sys::io::file_feature< FileT, read, Tail ... >:



Public Member Functions

- int getc ()

  Read a single character from the file.
- template<typename T >
  std::size_t read (T &dst)

  Read the given object from the file.
- template<typename T , std::size_t Count>
  std::size_t read (T(&dst)[Count], std::size_t const count)

  Read the requested number of objects from the file.

- template<auto CountFmt, typename ... RefTs>
  int scanf (char const (&fmt)[CountFmt], RefTs &... refs)

  Read formatted input.
- template<auto Count>
  bool gets (char(&dst)[Count])

  Read a line from the file.

Additional Inherited Members

14.12.1 Detailed Description

template<class FileT, feature ... Tail>
class sys::io::file_feature< FileT, read, Tail ... >

Implement read support for file types.

Template Parameters

FileT	The file access type inheriting the feature
Tail	The remaining features

14.12.2 Member Function Documentation

14.12.2.1 getc() `template<class FileT , feature ... Tail>`

```
int sys::io::file_feature< FileT, read, Tail ... >::getc ( )  [inline]
```

Read a single character from the file.

See also

fgetc()

Returns

The character or EOF

14.12.2.2 gets() `template<class FileT , feature ... Tail>`

```
template<auto Count>
bool sys::io::file_feature< FileT, read, Tail ... >::gets (
              char(&) dst[Count] )  [inline]
```

Read a line from the file.

Reads the file up to and including the first newline or terminating zero, as long as it fits into the destination buffer. Always zero terminated.

See also

fgets()

Template Parameters

Count	The maximum number of characters to read

Parameters

dst	A reference to the destination buffer

Return values

true	Characters have been read
false	Characters could not be read

14.12.2.3 read() [1/2] template<class FileT , feature ... Tail>

```
template<typename T >
std::size_t sys::io::file_feature< FileT, read, Tail ... >::read (
              T & dst )  [inline]
```

Read the given object from the file.

See also

fread()

Template Parameters

T	The object type, should be a POD type

Parameters

dst	A reference to the object to overwrite

Returns

The number of characters read

14.12.2.4 read() [2/2] template<class FileT , feature ... Tail>

```
template<typename T , std::size_t Count>
std::size_t sys::io::file_feature< FileT, read, Tail ... >::read (
              T(&) dst[Count],
              std::size_t const count )  [inline]
```

Read the requested number of objects from the file.

See also

fread()

Template Parameters

T	The object type, should be a POD type
Count	The number of objects in the destination buffer

Parameters

dst	A reference to an array of objects
count	The number of objects to read

Returns

The number of characters read

14.12.2.5 scanf() `template<class FileT , feature ... Tail>`

```
template<auto CountFmt, typename ... RefTs>
int sys::io::file_feature< FileT, read, Tail ... >::scanf (
              char const (&) fmt[CountFmt],
              RefTs &... refs )  [inline]
```

Read formatted input.

See also

fscanf()

Template Parameters

CountFmt	The number of characters in the format string
RefTs	The argument types to read

Parameters

fmt	The input format
refs	A set of references to write to

Returns

The number of inputs successfully parsed

Return values

E↩ OF	No inputs could be parsed due to end of file

The documentation for this class was generated from the following file:

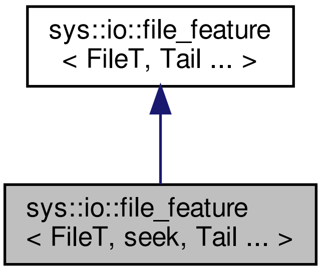
- src/sys/io.hpp

14.13 sys::io::file_feature< FileT, seek, Tail ... > Class Template Reference

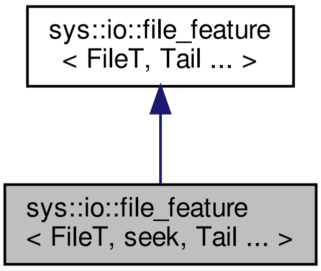
Implement seek support for file types.

```
#include <io.hpp>
```

Inheritance diagram for sys::io::file_feature< FileT, seek, Tail ... >:


sys::io::file_feature < FileT, Tail ... >
sys::io::file_feature < FileT, seek, Tail ... >

Collaboration diagram for sys::io::file_feature< FileT, seek, Tail ... >:


sys::io::file_feature < FileT, Tail ... >
sys::io::file_feature < FileT, seek, Tail ... >

Public Member Functions

- FileT & seek (long int const offset, int const origin)

    Seek file position.
- FileT & rewind ()

    Reset file position to the beginning of the file.
- long int tell ()

    Retrieve the current file position.

Additional Inherited Members

14.13.1 Detailed Description

template<class FileT, feature ... Tail>
class sys::io::file_feature< FileT, seek, Tail ... >

Implement seek support for file types.

Template Parameters

FileT	The file access type inheriting the feature
Tail	The remaining features

14.13.2 Member Function Documentation

14.13.2.1 rewind() `template<class FileT , feature ... Tail>`

```
FileT& sys::io::file_feature< FileT, seek, Tail ... >::rewind ( )  [inline]
```

Reset file position to the beginning of the file.

See also

frewind()

Returns

A self reference

14.13.2.2 seek() `template<class FileT , feature ... Tail>`

```
FileT& sys::io::file_feature< FileT, seek, Tail ... >::seek (
              long int const offset,
              int const origin )  [inline]
```

Seek file position.

See also

fseek()

Parameters

offset	The origin relative file position for binary files or an absolute position returned by tell() for text files
origin	One of SEEK_SET, SEEK_CUR, SEEK_END

Returns

A self reference

14.13.2.3 tell() `template<class FileT , feature ... Tail>`

`long int sys::io::file_feature< FileT, seek, Tail ... >::tell ( ) [inline]`

Retrieve the current file position.

See also

ftell()

Returns

The current file offset

The documentation for this class was generated from the following file:

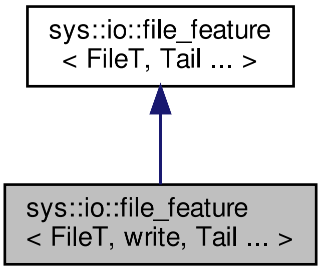
- src/sys/io.hpp

14.14 sys::io::file_feature< FileT, write, Tail ... > Class Template Reference

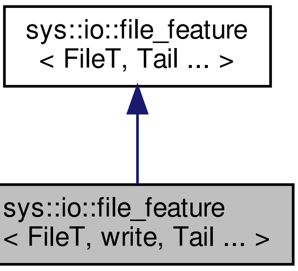
Implement write support for file types.

`#include <io.hpp>`

Inheritance diagram for sys::io::file_feature< FileT, write, Tail ... >:



Collaboration diagram for sys::io::file_feature< FileT, write, Tail ... >:



Public Member Functions

- template<auto CountFmt, typename ... ArgTs>
  FileT & printf (char const (&fmt)[CountFmt], ArgTs const &... args)

  Output with printf style formatting.
- template<auto CountFmt>
  FileT & printf (char const (&fmt)[CountFmt])

  Output a printf style formatted string.
- template<std::size_t Count>
  FileT & print (char const (&msg)[Count])

  Print an unformatted string, excluding the last character.
- FileT & putc (int const character)

  Write a single character to the string.
- template<typename T >
  FileT & write (T const &src)

  Write an object to file.
- template<typename T , std::size_t Count>
  FileT & write (T const (&src)[Count], std::size_t const count)

  Write an objects to file.
- FileT & flush ()

  Flush file buffers.

Additional Inherited Members

14.14.1 Detailed Description

template<class FileT, feature ... Tail>
class sys::io::file_feature< FileT, write, Tail ... >

Implement write support for file types.

Template Parameters

FileT	The file access type inheriting the feature
Tail	The remaining features

14.14.2 Member Function Documentation

14.14.2.1 flush() `template<class FileT , feature ... Tail>`

```
FileT& sys::io::file_feature< FileT, write, Tail ... >::flush ( )  [inline]
```

Flush file buffers.

See also

fflush()

Returns

A self reference

14.14.2.2 print() `template<class FileT , feature ... Tail>`

```
template<std::size_t Count>
FileT& sys::io::file_feature< FileT, write, Tail ... >::print (
                char const (&) msg[Count] )  [inline]
```

Print an unformatted string, excluding the last character.

This method is built around the assumption that the argument is a string literal and the last character is a terminating zero.

See also

fwrite()

Template Parameters

Count	The number of characters in the string

Parameters

msg	The string to print

Returns

A self reference

14.14.2.3 printf() [1/2]

```
template<class FileT , feature ... Tail>
template<auto CountFmt>
FileT& sys::io::file_feature< FileT, write, Tail ... >::printf (
            char const (&) fmt[CountFmt] )  [inline]
```

Output a printf style formatted string.

This overload exists as a workaround for a bug in clang++-8's -Wformat-security that does not recognise the format as a literal string if no arguments follow.

See also

fprintf()

Template Parameters

CountFmt	The number of characters in the formatting string

Parameters

fmt	The format string

Returns

A self reference

14.14.2.4 printf() [2/2]

```
template<class FileT , feature ... Tail>
template<auto CountFmt, typename ... ArgTs>
FileT& sys::io::file_feature< FileT, write, Tail ... >::printf (
            char const (&) fmt[CountFmt],
            ArgTs const &... args )  [inline]
```

Output with printf style formatting.

See also

fprintf()

Template Parameters

CountFmt	The number of characters in the formatting string
ArgTs	The argument types of the data to print

Parameters

fmt	The format string
args	The set of data to print

Returns

A self reference

14.14.2.5 putc() `template<class FileT , feature ... Tail>`

```
FileT& sys::io::file_feature< FileT, write, Tail ... >::putc (
            int const character )  [inline]
```

Write a single character to the string.

See also

fputc()

Parameters

character	The character to write

Returns

A self reference

14.14.2.6 write() [1/2] `template<class FileT , feature ... Tail>`

```
template<typename T >
FileT& sys::io::file_feature< FileT, write, Tail ... >::write (
            T const & src )  [inline]
```

Write an object to file.

See also

fwrite()

Template Parameters

T	The object type, should be a POD type

Parameters

src	The object to write out to the file

Returns

A self reference

14.14.2.7 write() [2/2]

```
template<class FileT , feature ... Tail>
template<typename T , std::size_t Count>
FileT& sys::io::file_feature< FileT, write, Tail ... >::write (
              T const (&) src[Count],
              std::size_t const count )  [inline]
```

Write an objects to file.

See also

fwrite()

Template Parameters

T	The object type, should be a POD type
Count	The number of objects in the source buffer

Parameters

src	The object to write out to the file
count	The number of objects to write

Returns

A self reference

The documentation for this class was generated from the following file:

- src/sys/io.hpp

14.15 utility::Formatter< BufSize > Class Template Reference

A formatting wrapper around string literals.

```
#include <utility.hpp>
```

Public Member Functions

- constexpr Formatter (char const ∗const fmt)

  Construct from string literal.
- template<typename... ArgTs>
  std::string operator() (ArgTs const &... args) const

  Returns a formatted string.

Private Attributes

- const char ∗const fmt

  Pointer to the string literal.

14.15.1 Detailed Description

template<size_t BufSize>
class utility::Formatter< BufSize >

A formatting wrapper around string literals.

Overloads operator (), which treats the string as a printf formatting string, the arguments represent the data to format.

In combination with the literal _fmt, it can be used like this:

```
std::cout << "%-15.15s %#018p\n"_fmt("Address:", this);
```

Template Parameters

Buf←Size	The buffer size for formatting, resulting strings cannot grow beyond `BufSize - 1`

14.15.2 Member Function Documentation

14.15.2.1 operator()() `template<size_t BufSize>`

```
template<typename... ArgTs>
std::string utility::Formatter< BufSize >::operator() (
              ArgTs const &... args ) const  [inline]
```

Returns a formatted string.

Template Parameters

Arg←Ts	Variadic argument types

Parameters

args	Variadic arguments

Returns

An std::string formatted according to fmt

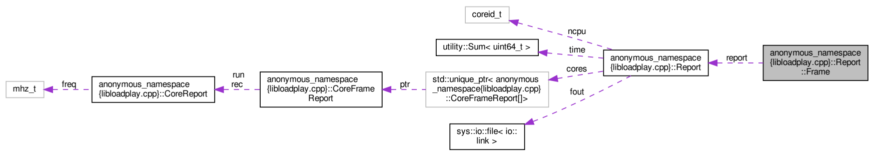
The documentation for this class was generated from the following file:

- src/utility.hpp

14.16 anonymous_namespace{libloadplay.cpp}::Report::Frame Class Reference

Represents a frame of the report.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::Report::Frame:


coreid_t
ncpu
utility::Sum< uint64_t >
time
anonymous_namespace {libloadplay.cpp}::Report
report
anonymous_namespace {libloadplay.cpp}::Report ::Frame
cores
std::unique_ptr< anonymous _namespace{libloadplay.cpp} ::CoreFrameReport[]>
fout
sys::io::file< io:: link >
ptr
anonymous_namespace {libloadplay.cpp}::CoreFrame Report
run
rec
anonymous_namespace {libloadplay.cpp}::CoreReport
freq
mhz_t

Public Member Functions

- Frame (Report &report, uint64_t const duration)

  Construct a report frame.
- CoreFrameReport & operator[ ] (coreid_t const i)

  Subscript operator for per core frame report data.
- const CoreFrameReport & operator[ ] (coreid_t const i) const

  Subscript operator for per core frame report data.
- ∼Frame ()

  Finalises the frame by outputting it.

Private Attributes

- Report & report

  The report this frame belongs to.

14.16.1 Detailed Description

Represents a frame of the report.

It provides access to each CoreFrameReport via the subscript operator [].

The frame data is output when the frame goes out of scope.

14.16.2 Constructor & Destructor Documentation

14.16.2.1 Frame() `anonymous_namespace{libloadplay.cpp}::Report::Frame::Frame (`

```
Report & report,
uint64_t const duration )   [inline]
```

Construct a report frame.

Parameters

report	The report this frame belongs to
duration	The frame duration

14.16.3 Member Function Documentation

14.16.3.1 operator[]() [1/2] `CoreFrameReport& anonymous_namespace{libloadplay.cpp}::Report::Frame↵ ::operator[] (`

```
coreid_t const i )   [inline]
```

Subscript operator for per core frame report data.

Parameters

i	The core index

Returns

A reference to the core frame data

14.16.3.2 operator[]() [2/2] `const CoreFrameReport& anonymous_namespace{libloadplay.cpp}::Report::Frame↵ ::operator[] (`

```
coreid_t const i ) const   [inline]
```

Subscript operator for per core frame report data.

Parameters

i	The core index

Returns

A const reference to the core frame data

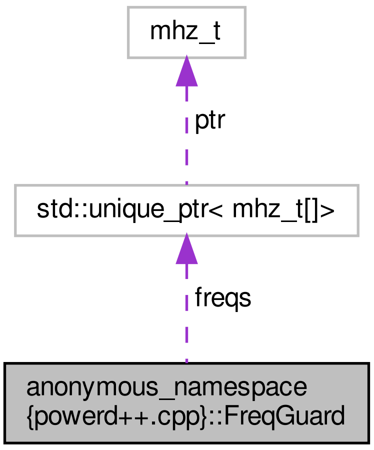
The documentation for this class was generated from the following file:

- src/libloadplay.cpp

14.17 anonymous_namespace{powerd++.cpp}::FreqGuard Class Reference

A core frequency guard.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::FreqGuard:



Public Member Functions

- FreqGuard ()

  Read and write all core frequencies, may throw.
- ∼FreqGuard ()

  Restore all core frequencies.

Private Attributes

- std::unique_ptr< mhz_t[ ]> freqs

  The list of initial frequencies.

14.17.1 Detailed Description

A core frequency guard.

This uses the RAII pattern to achieve two things:

- Upon creation it reads and writes all controlling cores
- Upon destruction it sets all cores to the maximum frequencies

The documentation for this class was generated from the following file:

- src/powerd++.cpp

14.18 utility::FromChars Struct Reference

A functor for reading numerical values from a string or character array.

`#include <utility.hpp>`

Public Member Functions

- template<typename T >
  bool operator() (T &dst)

  Retrieve an integral or floating point value from the array.
- operator bool () const

  Check if unread characters remain.
- FromChars (char const ∗const start, char const ∗const end)

  Range based constructor.
- template<size_t CountV>
  FromChars (char const (&str)[CountV], bool const terminator=true)

  Construct from a character array.
- FromChars (std::string const &str)

  Construct functor from a string.

Public Attributes

- const char ∗ it

  The next character to read.
- const char ∗const end

  The first character of the same array that may not be read, this should usually point to a terminating zero or behind a buffer.

14.18.1 Detailed Description

A functor for reading numerical values from a string or character array.

14.18.2 Constructor & Destructor Documentation

14.18.2.1 FromChars() [1/3] utility::FromChars::FromChars (

```
        char const *const start,
        char const *const end )   [inline]
```

Range based constructor.

Parameters

start,end	The character array range

14.18.2.2 FromChars() [2/3] `template<size_t CountV>`

```
utility::FromChars::FromChars (
            char const (&) str[CountV],
            bool const terminator = true )  [inline]
```

Construct from a character array.

Template Parameters

CountV	The number of characters

Parameters

str	The character array to parse from
terminator	Indicates whether the character array has a terminating null character.

14.18.2.3 FromChars() [3/3] `utility::FromChars::FromChars (`

```
            std::string const & str )  [inline]
```

Construct functor from a string.

Note that changing the string during the lifetime of the functor may silently invalidate the functor's state and thus invoke undefined behaviour.

Parameters

str	The string to parse from

14.18.3 Member Function Documentation

14.18.3.1 operator bool() `utility::FromChars::operator bool ( ) const  [inline]`

Check if unread characters remain.

Return values

false	All characters have been read
true	Characters remain to be read

14.18.3.2 operator()() `template<typename T >`

```
bool utility::FromChars::operator() (
              T & dst )  [inline]
```

Retrieve an integral or floating point value from the array.

The operation may fail for multiple reasons:

- No more characters left to read, in that case the functor will equal false
- The given characters do not represent a valid value, in that case the functor will equal true

Template Parameters

T	The value type to retrieve

Parameters

dst	The lvalue to assign to

Return values

true	The numerical value was successfully read from the array
false	The numerical value could not be read from the array

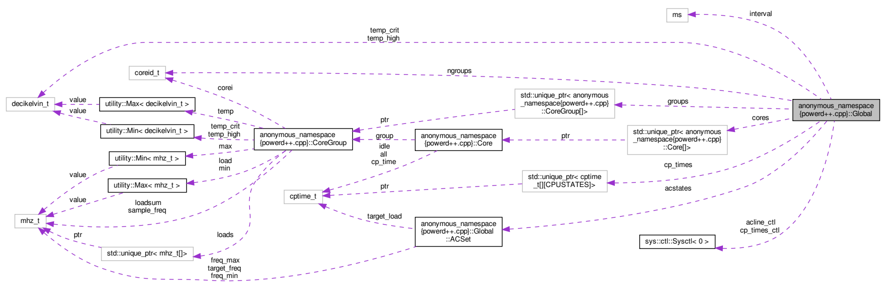
The documentation for this struct was generated from the following file:

- src/utility.hpp

14.19 anonymous_namespace{powerd++.cpp}::Global Struct Reference

A collection of all the gloabl, mutable states.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::Global:


ms
interval
temp_crit
temp_high
coreid_t
ngroups
corei
decikelvin_t
value
value
utility::Max< decikelvin_t >
temp
utility::Min< decikelvin_t >
temp_crit
temp_high
std::unique_ptr< anonymous _namespace{powerd++.cpp} ::CoreGroup[]>
groups
anonymous_namespace {powerd++.cpp}::Global
cores
ptr
anonymous_namespace {powerd++.cpp}::CoreGroup
group
anonymous_namespace {powerd++.cpp}::Core
ptr
std::unique_ptr< anonymous _namespace{powerd++.cpp} ::Core[]>
max
utility::Min< mhz_t >
load
min
idle
all
cp_time
cp_times
value
utility::Max< mhz_t >
cptime_t
ptr
std::unique_ptr< cptime _t[][CPUSTATES]>
acstates
value
loadsum
sample_freq
target_load
mhz_t
anonymous_namespace {powerd++.cpp}::Global ::ACSet
acline_ctl
cp_times_ctl
ptr
loads
sys::ctl::Sysctl< 0 >
std::unique_ptr< mhz_t[]>
freq_max
target_freq
freq_min

Classes

- struct ACSet

  Per AC line state settings. More...

Public Member Functions

- Global ()

  Perform initialisations that cannot fail/throw.

Public Attributes

- volatile sig_atomic_t signal {0}

  The last signal received, used for terminating.
- size_t samples {4}

  The number of load samples to take.
- ms interval {500}

  The polling interval.
- size_t sample {0}

  The current sample.
- const SysctlOnce< coreid_t, 2 > ncpu {1, {CTL_HW, HW_NCPU}}

  The number of CPU cores or threads.
- ACSet acstates [3]

  The power states.
- Sysctl< 0 > acline_ctl

  The hw.acpi.acline ctl.
- bool verbose {false}

  Verbose mode.
- bool foreground {false}

  Foreground mode.
- bool idleStates [CPUSTATES] {}

  The list of states considered idle.
- bool temp_throttling {false}

  Temperature throttling mode.
- decikelvin_t temp_crit {0}

  User set critical core temperature in dK.
- decikelvin_t temp_high {0}

  User set high core temperature in dK.
- const char ∗ pidfilename {POWERD_PIDFILE}

  Name of an alternative pidfile.
- Sysctl< 0 > cp_times_ctl

  The kern.cp_times sysctl.
- const char ∗ tempctl_name {TEMPERATURE}

  The sysctl name pattern for the temperature sysctl.
- std::unique_ptr< cptime_t[ ][CPUSTATES]> cp_times

  The kern.cp_times buffer for all cores.
- std::unique_ptr< Core[ ]> cores {new Core[this->ncpu]}

  This buffer is to be allocated with ncpu instances of the Core struct to store the management information of every core.
- coreid_t ngroups {0}

  The number of frequency controlling core groups.
- std::unique_ptr< CoreGroup[ ]> groups {nullptr}

  This buffer is to be allocated with the number of core groups.

14.19.1 Detailed Description

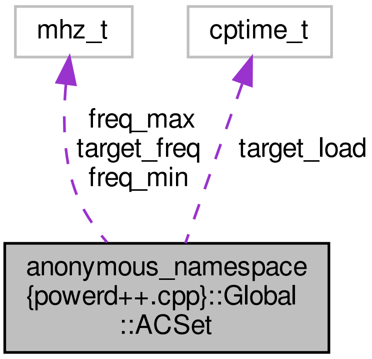
A collection of all the gloabl, mutable states.

This is mostly for semantic clarity.

14.19.2 Class Documentation

14.19.2.1 struct anonymous_namespace{powerd++.cpp}::Global::ACSet Per AC line state settings.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::Global::ACSet:



Class Members

mhz_t	freq_max	Highest frequency to set in MHz.
mhz_t	freq_min	Lowest frequency to set in MHz.
const char ∗const	name	The string representation of this state.
mhz_t	target_freq	Fixed clock frequencies to use if the target load is set to 0.
cptime_t	target_load	Target load times [0, 1024]. The value 0 indicates the corresponding fixed frequency setting from target_freqs should be used.

14.19.3 Member Data Documentation

14.19.3.1 acstates `ACSet anonymous_namespace{powerd++.cpp}::Global::acstates[3]`

Initial value:
```
{
        {FREQ_UNSET,       FREQ_UNSET,       ADP,  0, "battery"},
        {FREQ_UNSET,       FREQ_UNSET,       HADP, 0, "online"},
        {FREQ_DEFAULT_MIN, FREQ_DEFAULT_MAX, HADP, 0, "unknown"}
    }
```

The power states.

14.19.3.2 groups `std::unique_ptr<CoreGroup[]> anonymous_namespace{powerd++.cpp}::Global::groups {nullptr}`

This buffer is to be allocated with the number of core groups.

A core group is created by init() for each core that has a dev.cpu.d.freq handle.

14.19.3.3 pidfilename `const char* anonymous_namespace{powerd++.cpp}::Global::pidfilename {POWERD_PIDF←↩ ILE}`

Name of an alternative pidfile.

If not given pidfile_open() uses a default name.

14.19.3.4 tempctl_name `const char* anonymous_namespace{powerd++.cpp}::Global::tempctl_name {TEMPERA←↩ TURE}`

The sysctl name pattern for the temperature sysctl.

May contain a single d.

The documentation for this struct was generated from the following file:

- src/powerd++.cpp

14.20 anonymous_namespace{libloadplay.cpp}::Hold< T > Class Template Reference

Sets a referenced variable to a given value and restores it when going out of context.

Public Member Functions

- Hold (T &ref, T const value)
    The constructor sets the referenced variable to the given value.
- ∼Hold ()
    Restores the original value.

Private Attributes

- const T restore
    The original value.
- T & ref
    Reference to the variable.

14.20.1 Detailed Description

template<typename T>
class anonymous_namespace{libloadplay.cpp}::Hold< T >

Sets a referenced variable to a given value and restores it when going out of context.

Template Parameters

T	The type of the value to hold

14.20.2 Constructor & Destructor Documentation

14.20.2.1 Hold()

```
template<typename T >
anonymous_namespace{libloadplay.cpp}::Hold< T >::Hold (
              T & ref,
              T const value )  [inline]
```

The constructor sets the referenced variable to the given value.

Parameters

ref	The variable to hold and restore
value	The value to set the variable to

The documentation for this class was generated from the following file:

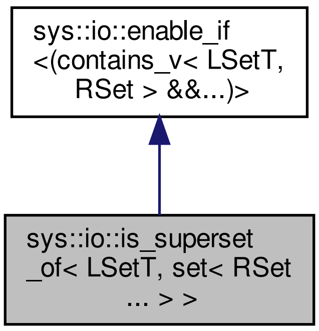
- src/libloadplay.cpp

14.21 sys::io::is_superset_of< LSetT, set< RSet ... > > Struct Template Reference

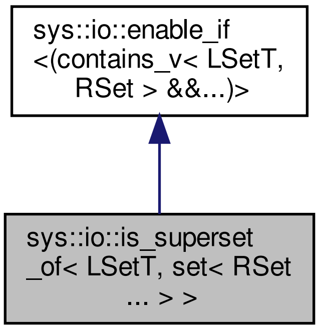
Specialise is_superset_of to unpack the right hand io::set.

`#include <io.hpp>`

Inheritance diagram for sys::io::is_superset_of< LSetT, set< RSet ... > >:



Collaboration diagram for sys::io::is_superset_of< LSetT, set< RSet ... > >:



Additional Inherited Members

14.21.1 Detailed Description

template<class LSetT, auto ... RSet>
struct sys::io::is_superset_of< LSetT, set< RSet ... > >

Specialise is_superset_of to unpack the right hand io::set.

Template Parameters

LSetT	The left hand io::set
RSet	The right hand io::set values

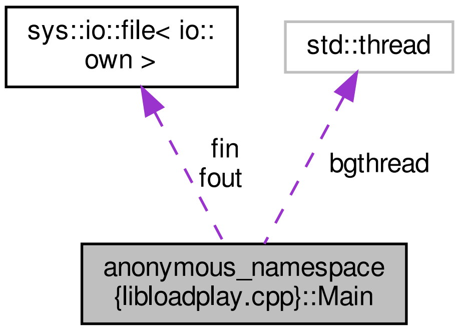
The documentation for this struct was generated from the following file:

- src/sys/io.hpp

14.22 anonymous_namespace{libloadplay.cpp}::Main Class Reference

Singleton class representing the main execution environment.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::Main:



Public Member Functions

- Main ()

  The constructor starts up the emulation.
- ∼Main ()

  Clean up the background emulation thread.

Private Attributes

- std::thread bgthread

  The background emulation thread.
- ifile< io::own > fin

  The optional input file.
- ofile< io::own > fout

  The optional output file.
- bool die {false}

  Used to request premature death from the emulation thread.

14.22.1 Detailed Description

Singleton class representing the main execution environment.

14.22.2 Constructor & Destructor Documentation

14.22.2.1 Main() `anonymous_namespace{libloadplay.cpp}::Main::Main ( ) [inline]`

The constructor starts up the emulation.

- Read the headers from input and populate sysctls
- Ensure the existence of all required sysctls
- Spawn an Emulator instance in its own thread

The documentation for this class was generated from the following file:

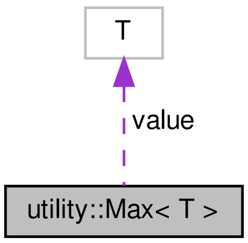
- src/libloadplay.cpp

14.23 utility::Max< T > Class Template Reference

A simple value container that provides the maximum of assigned values.

`#include <utility.hpp>`

Collaboration diagram for utility::Max< T >:



Public Member Functions

- constexpr Max (T const &value)

  Construct from an initial value.
- constexpr operator T const & () const

  Returns the current maximum.
- constexpr Max & operator= (T const &value)

  Assign a new value, if it is greater than the current value.

Private Attributes

- T value

  The maximum of the assigned values.

14.23.1 Detailed Description

template<typename T>
class utility::Max< T >

A simple value container that provides the maximum of assigned values.

Template Parameters

T	The value type

14.23.2 Constructor & Destructor Documentation

14.23.2.1 Max() `template<typename T >`

```
constexpr utility::Max< T >::Max (
              T const & value )  [inline], [explicit], [constexpr]
```

Construct from an initial value.

Parameters

value	The initial value

14.23.3 Member Function Documentation

14.23.3.1 operator T const &() `template<typename T >`

```
constexpr utility::Max< T >::operator T const & ( ) const  [inline], [constexpr]
```

Returns the current maximum.

Returns

The maximum by const reference

14.23.3.2 operator=() `template<typename T >`

```
constexpr Max& utility::Max< T >::operator= (
              T const & value )  [inline], [constexpr]
```

Assign a new value, if it is greater than the current value.

Parameters

value	The value to assign

Returns

A self reference

The documentation for this class was generated from the following file:

- src/utility.hpp

14.24 anonymous_namespace{libloadplay.cpp}::mib_t Struct Reference

Represents MIB, but wraps it to provide the necessary operators to use it as an std::map key.

Public Member Functions

- template<typename... Ints>
  constexpr mib_t (Ints const ... ints)

  Construct a mib with the given number of arguments.
- mib_t (int const ∗const mibs, u_int const len)

  Initialise from a pointer to an int array.
- bool operator== (mib_t const &op) const

  Equality operator required by std::map.
- bool operator< (mib_t const &op) const

  Less than operator required by std::map.
- operator int ∗ ()

  Cast to `int ∗` for value access.
- operator int const ∗ () const

  Cast to `int const ∗` for value access.

Public Attributes

- int mibs [CTL_MAXNAME]

  The mib values.

14.24.1 Detailed Description

Represents MIB, but wraps it to provide the necessary operators to use it as an std::map key.

14.24.2 Constructor & Destructor Documentation

14.24.2.1 mib_t() [1/2] template<typename... Ints>

```
constexpr anonymous_namespace{libloadplay.cpp}::mib_t::mib_t (
                Ints const ... ints )  [inline], [constexpr]
```

Construct a mib with the given number of arguments.

Template Parameters

Ints	A list of integer types

Parameters

ints	A list of integers to create a mib from

14.24.2.2 mib_t() [2/2] `anonymous_namespace{libloadplay.cpp}::mib_t::mib_t ( int const *const mibs, u_int const len ) [inline]`

Initialise from a pointer to an int array.

Parameters

mibs,len	The array and its length

14.24.3 Member Function Documentation

14.24.3.1 operator int *() `anonymous_namespace{libloadplay.cpp}::mib_t::operator int * ( ) [inline]`

Cast to `int *` for value access.

Returns

A pointer to mibs

14.24.3.2 operator int const *() `anonymous_namespace{libloadplay.cpp}::mib_t::operator int const * ( ) const [inline]`

Cast to `int const *` for value access.

Returns

A pointer to mibs

14.24.3.3 operator<() `bool anonymous_namespace{libloadplay.cpp}::mib_t::operator< ( mib_t const & op ) const [inline]`

Less than operator required by std::map.

Parameters

op	Another mib_t instance

Returns

Whether this mib is less than the given one

14.24.3.4 operator==() `bool anonymous_namespace{libloadplay.cpp}::mib_t::operator== ( mib_t const & op ) const [inline]`

Equality operator required by std::map.

Parameters

op	Another mib_t instance

Returns

Whether all values in this and the given mib are equal

The documentation for this struct was generated from the following file:

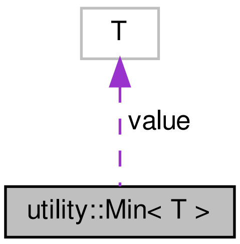
- src/libloadplay.cpp

14.25 utility::Min< T > Class Template Reference

A simple value container that provides the minimum of assigned values.

`#include <utility.hpp>`

Collaboration diagram for utility::Min< T >:



Public Member Functions

- constexpr Min (T const &value)

  Construct from an initial value.
- constexpr operator T const & () const

  Returns the current minimum.
- constexpr Min & operator= (T const &value)

  Assign a new value, if it is less than the current value.

Private Attributes

- T value

  The minimum of the assigned values.

14.25.1 Detailed Description

template<typename T>
class utility::Min< T >

A simple value container that provides the minimum of assigned values.

Template Parameters

T	The value type

14.25.2 Constructor & Destructor Documentation

14.25.2.1 Min() template<typename T >

```
constexpr utility::Min< T >::Min (
              T const & value )  [inline], [explicit], [constexpr]
```

Construct from an initial value.

Parameters

value	The initial value

14.25.3 Member Function Documentation

14.25.3.1 operator T const &() template<typename T >

```
constexpr utility::Min< T >::operator T const & ( ) const  [inline], [constexpr]
```

Returns the current minimum.

Returns

The minimum by const reference

14.25.3.2 operator=() `template<typename T >`

```
constexpr Min& utility::Min< T >::operator= (
              T const & value )  [inline], [constexpr]
```

Assign a new value, if it is less than the current value.

Parameters

value	The value to assign

Returns

A self reference

The documentation for this class was generated from the following file:

- src/utility.hpp

14.26 sys::ctl::Once< T, SysctlT > Class Template Reference

A read once representation of a Sysctl.

```
#include <sysctl.hpp>
```

Public Member Functions

- Once (T const &value, SysctlT const &sysctl) noexcept

  The constructor tries to read and store the requested sysctl.
- operator T const & () const

  Return a const reference to the value.

Private Attributes

- T value

  The sysctl value read upon construction.

14.26.1 Detailed Description

template<typename T, class SysctlT>
class sys::ctl::Once< T, SysctlT >

A read once representation of a Sysctl.

This reads a sysctl once upon construction and always returns that value. It does not support assignment.

This class is intended for sysctls that are not expected to change, such as hw.ncpu. A special property of this class is that the constructor does not throw and takes a default value in case reading the sysctl fails.

```
// Read number of CPU cores, assume 1 on failure:
Once<coreid_t, Sysctl<2>> ncpu{1, {CTL_HW, HW_NCPU}};
// Equivalent:
int hw_ncpu;
try {
    Sysctl<2>{CTL_HW, HW_NCPU}.get(hw_ncpu);
} catch (sys::sc_error<error>) {
    hw_ncpu = 1;
}
```

Template Parameters

T	The type to represent the sysctl as
SysctlT	The Sysctl type

14.26.2 Constructor & Destructor Documentation

14.26.2.1 Once() `template<typename T , class SysctlT >`

```
sys::ctl::Once< T, SysctlT >::Once (
                T const & value,
                SysctlT const & sysctl )  [inline], [noexcept]
```

The constructor tries to read and store the requested sysctl.

If reading the requested sysctl fails for any reason, the given value is stored instead.

Parameters

value	The fallback value
sysctl	The sysctl to represent

14.26.3 Member Function Documentation

14.26.3.1 operator T const &() `template<typename T , class SysctlT >`

```
sys::ctl::Once< T, SysctlT >::operator T const & ( ) const  [inline]
```

Return a const reference to the value.

Returns

A const reference to the value

The documentation for this class was generated from the following file:

- src/sys/sysctl.hpp

14.27 nih::Options< OptionT, DefCount > Class Template Reference

An instance of this class offers operators to retrieve command line options and arguments.

```
#include <Options.hpp>
```

Public Member Functions

- Options (int const argc, char const ∗const ∗const argv, char const ∗const usage, Parameter< OptionT > const (&defs)[DefCount])
  Construct an options functor.
- Options & operator() ()
  Updates the internal state by parsing the next option.
- operator OptionT () const
  Implicitly cast to the current option.
- const char ∗ operator[ ] (int const i) const
  Retrieve arguments to the current option.
- std::string usage () const
  Returns a string for usage output, created from the option definitions.
- utility::Underlined show (int const i, int const n=1) const
  Provide a string containing the entire command line, with the indexed argument highlighted.
- std::string show () const
  Highlight the last recently accessed argument.
- int offset () const
  Returns the argument offset of the current parameter/argument.

Private Member Functions

- const Parameter< OptionT > & get (char const ch)
  Finds the short option matching the given character.
- const Parameter< OptionT > & get (char const ∗const str)
  Finds the long option matching the given string.

Static Private Member Functions

- static const char ∗ removePath (char const ∗const file)
  Returns a pointer to the file name portion of the given string.
- static bool match (char const ∗const lstr, char const ∗const rstr)
  Returns true if the given strings match.
- static bool bmatch (char const ∗const str, char const ∗const prefix)
  Returns true if the given string starts with the given prefix.

Private Attributes

- const int argc

  The number of command line arguments.
- const char ∗const ∗const argv

  The command line arguments.
- const char ∗const usageStr

  A string literal for the usage() output.
- const Parameter< OptionT >(& defs)[DefCount]

  A reference to the option definitions.
- const Parameter< OptionT > opt_unknown

  The option definition to use for unknown options.
- const Parameter< OptionT > opt_noopt

  The option definition to use for non-options.
- const Parameter< OptionT > opt_dash

  The option definition to use for a single dash.
- const Parameter< OptionT > opt_ldash

  The option definition to use for a single double-dash.
- int argi

  The index of the command line argument containing the current option.
- const char ∗ argp

  Points to the current short option character.
- const Parameter< OptionT > ∗ current

  Points to the current option definition.
- int showi

  The argument index to show if no argument is supplied to show().

14.27.1 Detailed Description

template<class OptionT, size_t DefCount>
class nih::Options< OptionT, DefCount >

An instance of this class offers operators to retrieve command line options and arguments.

Check the `operator ()` and `operator []` for use.

Template Parameters

OptionT	An enum or enum class matching the requirements set by enum_has_members
DefCount	The number of option definitions

14.27.2 Constructor & Destructor Documentation

14.27.2.1 Options() `template<class OptionT , size_t DefCount>`

`nih::Options< OptionT, DefCount >::Options (`

```
            int const argc,
            char const *const *const argv,
            char const *const usage,
            Parameter< OptionT > const (&) defs[DefCount] )   [inline]
```

Construct an options functor.

Parameters

argc,argv	The command line arguments
usage	A usage string following "usage: progname "
defs	An array of parameter definitions

14.27.3 Member Function Documentation

14.27.3.1 bmatch() template<class OptionT , size_t DefCount>

```
static bool nih::Options< OptionT, DefCount >::bmatch (
            char const *const str,
            char const *const prefix )   [inline], [static], [private]
```

Returns true if the given string starts with the given prefix.

Parameters

str,prefix	Two 0 terminated strings

Return values

true	The string starts with the prefix
false	The string does not start with the prefix

14.27.3.2 get() [1/2] template<class OptionT , size_t DefCount>

```
const Parameter<OptionT>& nih::Options< OptionT, DefCount >::get (
            char const *const str )   [inline], [private]
```

Finds the long option matching the given string.

Parameters

str	The long option to find

Returns

An option definition by reference

14.27.3.3 get() [2/2]

```
template<class OptionT , size_t DefCount>
const Parameter<OptionT>& nih::Options< OptionT, DefCount >::get (
            char const ch )  [inline], [private]
```

Finds the short option matching the given character.

Parameters

ch	The short option to find

Returns

An option definition by reference

14.27.3.4 match()

```
template<class OptionT , size_t DefCount>
static bool nih::Options< OptionT, DefCount >::match (
            char const *const lstr,
            char const *const rstr )  [inline], [static], [private]
```

Returns true if the given strings match.

Parameters

lstr,rstr	Two 0 terminated strings

Return values

true	The given strings match
false	The strings do not match

14.27.3.5 offset()

```
template<class OptionT , size_t DefCount>
int nih::Options< OptionT, DefCount >::offset ( ) const  [inline]
```

Returns the argument offset of the current parameter/argument.

Warning

This may return a value >= argc if the current state is OptionT::OPT_DONE

Returns

The current argument index

14.27.3.6 operator OptionT() `template<class OptionT , size_t DefCount>`

`nih::Options< OptionT, DefCount >::operator OptionT ( ) const [inline]`

Implicitly cast to the current option.

Returns

An OptionT member representing the current option

Return values

OPT_UNKNOWN	An option that was not in the list of option definitions was encountered
OPT_NOOPT	An argument that is not an option was encountered
OPT_DASH	A lone dash "-" was encountered
OPT_LDASH	A lone long dash "--" was encountered
OPT_DONE	All arguments have been processed, or argument processing has not yet started

14.27.3.7 operator()() `template<class OptionT , size_t DefCount>`

`Options& nih::Options< OptionT, DefCount >::operator() ( ) [inline]`

Updates the internal state by parsing the next option.

When reaching the end of the argument list, the internal state is reset, so a successive call will restart the argument parsing.

Returns

A self-reference

14.27.3.8 operator[]() `template<class OptionT , size_t DefCount>`

```
const char* nih::Options< OptionT, DefCount >::operator[] (
                int const i ) const [inline]
```

Retrieve arguments to the current option.

The string containing the current option is returned with i = 0, the arguments following the option with greater values of i.

When no more arguments are left the empty string is returned.

Parameters

i	The index of the argument to retrieve

Returns

The option or one of its arguments

14.27.3.9 removePath() `template<class OptionT , size_t DefCount>`

```
static const char* nih::Options< OptionT, DefCount >::removePath (
            char const *const file )  [inline], [static], [private]
```

Returns a pointer to the file name portion of the given string.

Parameters

file	The string containing the path to the file

Returns

A pointer to the file name portion of the path

14.27.3.10 show() [1/2] `template<class OptionT , size_t DefCount>`

```
std::string nih::Options< OptionT, DefCount >::show ( ) const  [inline]
```

Highlight the last recently accessed argument.

Returns

- A string with the last recently accessed argument underlined

See also

show(int const, int const = 1)

14.27.3.11 show() [2/2] `template<class OptionT , size_t DefCount>`

```
utility::Underlined nih::Options< OptionT, DefCount >::show (
            int const i,
            int const n = 1 ) const  [inline]
```

Provide a string containing the entire command line, with the indexed argument highlighted.

The current implementation highlights arguments by underlining them with ^~~~.

Parameters

i	The argument index, like operator []
n	The number of arguments to highlight, highlights all remaining arguments if n <= 0

Returns

A string formatted to highlight the given argument

14.27.3.12 usage() `template<class OptionT , size_t DefCount>`

`std::string nih::Options< OptionT, DefCount >::usage ( ) const [inline]`

Returns a string for usage output, created from the option definitions.

Returns

A usage string for printing on the CLI

14.27.4 Member Data Documentation

14.27.4.1 opt_dash `template<class OptionT , size_t DefCount>`

`const Parameter<OptionT> nih::Options< OptionT, DefCount >::opt_dash [private]`

Initial value:

```
{
        OptionT::OPT_DASH, 0, nullptr, nullptr, nullptr
    }
```

The option definition to use for a single dash.

14.27.4.2 opt_ldash `template<class OptionT , size_t DefCount>`

`const Parameter<OptionT> nih::Options< OptionT, DefCount >::opt_ldash [private]`

Initial value:

```
{
        OptionT::OPT_LDASH, 0, nullptr, nullptr, nullptr
    }
```

The option definition to use for a single double-dash.

14.27.4.3 opt_noopt `template<class OptionT , size_t DefCount>`

`const Parameter<OptionT> nih::Options< OptionT, DefCount >::opt_noopt [private]`

Initial value:
```
{
        OptionT::OPT_NOOPT, 0, nullptr, nullptr, nullptr
    }
```

The option definition to use for non-options.

14.27.4.4 opt_unknown `template<class OptionT , size_t DefCount>`

`const Parameter<OptionT> nih::Options< OptionT, DefCount >::opt_unknown [private]`

Initial value:
```
{
        OptionT::OPT_UNKNOWN, 0, nullptr, nullptr, nullptr
    }
```

The option definition to use for unknown options.

14.27.4.5 showi `template<class OptionT , size_t DefCount>`

`int nih::Options< OptionT, DefCount >::showi [mutable], [private]`

The argument index to show if no argument is supplied to show().

This is initially 0 for each new argument and updated by use of the subscript operator.

This is for error handling convenience and not considered part of the state.

The documentation for this class was generated from the following file:

- src/Options.hpp

14.28 sys::pid::Pidfile Class Reference

A wrapper around the pidfile_∗ family of commands implementing the RAII pattern.

`#include <pidfile.hpp>`

Public Member Functions

- Pidfile (char const ∗const pfname, mode_t const mode)
  Attempts to open the pidfile.
- ∼Pidfile ()
  Removes the pidfile.
- pid_t other ()
  Returns the PID of the other process holding the lock.
- void write ()
  Write PID to the file, should be called after daemon().

Private Attributes

- pid_t otherpid

    In case of failure to acquire the lock, the PID of the other process holding it is stored here.
- pidfh ∗ pfh

    Pointer to the pidfile state data structure.

14.28.1 Detailed Description

A wrapper around the pidfile_∗ family of commands implementing the RAII pattern.

14.28.2 Constructor & Destructor Documentation

14.28.2.1 Pidfile()

```
sys::pid::Pidfile::Pidfile (
    char const *const pfname,
    mode_t const mode )  [inline]
```

Attempts to open the pidfile.

Parameters

pfname,mode	Arguments to pidfile_open()

Exceptions

pid_t	Throws the PID of the other process already holding the requested pidfile
sys::sc_error<error>	Throws with the errno of pidfile_open()

14.28.3 Member Function Documentation

14.28.3.1 write()

```
void sys::pid::Pidfile::write ( )  [inline]
```

Write PID to the file, should be called after daemon().

Exceptions

sys::sc_error<error>	Throws with the errno of pidfile_write()

14.28.4 Member Data Documentation

14.28.4.1 pfh `pidfh* sys::pid::Pidfile::pfh [private]`

Pointer to the pidfile state data structure.

Thus is allocated by pidfile_open() and assumedly freed by pidfile_remove().

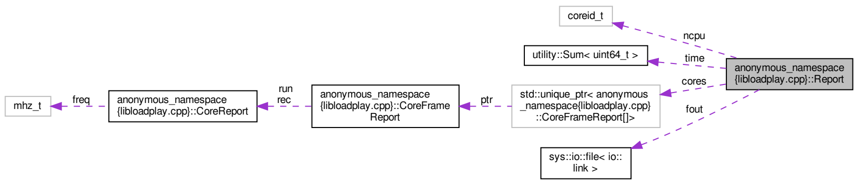
The documentation for this class was generated from the following file:

- src/sys/pidfile.hpp

14.29 anonymous_namespace{libloadplay.cpp}::Report Class Reference

Provides a mechanism to provide frame wise per core load information.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::Report:


coreid_t
utility::Sum< uint64_t >
anonymous_namespace {libloadplay.cpp}::Report
ncpu
time
cores
fout
mhz_t
freq
anonymous_namespace {libloadplay.cpp}::CoreReport
run rec
anonymous_namespace {libloadplay.cpp}::CoreFrame Report
ptr
std::unique_ptr< anonymous _namespace{libloadplay.cpp} ::CoreFrameReport[]>
sys::io::file< io:: link >

Classes

- class Frame

  Represents a frame of the report.

Public Member Functions

- Report (ofile< io::link > fout, coreid_t const ncpu)

  Construct a report.
- template<typename ... ArgTs>
  Frame frame (ArgTs &&... args)

  Constructs a frame for this report.

Private Attributes

- ofile< io::link > fout

  The output stream to report to.
- const coreid_t ncpu

  The number of cpu cores to provide reports for.
- Sum< uint64_t > time

  The time passed in [ms].
- std::unique_ptr< CoreFrameReport[ ]> cores

  Per frame per core data.

14.29.1 Detailed Description

Provides a mechanism to provide frame wise per core load information.

14.29.2 Constructor & Destructor Documentation

14.29.2.1 Report()

```
anonymous_namespace{libloadplay.cpp}::Report::Report (
        ofile< io::link > fout,
        coreid_t const ncpu )  [inline]
```

Construct a report.

Parameters

fout	The stream to output to
ncpu	The number of CPU cores to report

14.29.3 Member Function Documentation

14.29.3.1 frame()

```
template<typename ... ArgTs>
Frame anonymous_namespace{libloadplay.cpp}::Report::frame (
        ArgTs &&... args )  [inline]
```

Constructs a frame for this report.

Template Parameters

Arg↩ Ts	The constructor argument types

Parameters

args	The constructor arguments

The documentation for this class was generated from the following file:

- src/libloadplay.cpp

14.30 sys::sc_error< Domain > Struct Template Reference

Can be thrown by syscall function wrappers if the function returned with an error.

```
#include <error.hpp>
```

Public Member Functions

- operator int () const
  Cast to integer.
- const char ∗ c_str () const
  Return c style string.

Public Attributes

- int error
  The errno set by the native C function.

14.30.1 Detailed Description

template<class Domain>
struct sys::sc_error< Domain >

Can be thrown by syscall function wrappers if the function returned with an error.

This is its own type for easy catching, but implicitly casts to int for easy comparison.

Template Parameters

Domain	A type marking the domain the error comes from, e.g. sys::ctl::error

14.30.2 Member Function Documentation

14.30.2.1 c_str() `template<class Domain >`

`const char* sys::sc_error< Domain >::c_str ( ) const [inline]`

Return c style string.

Returns

A string representation of the error

14.30.2.2 operator int() `template<class Domain >`

`sys::sc_error< Domain >::operator int ( ) const [inline]`

Cast to integer.

Returns

The errno code

The documentation for this struct was generated from the following file:

- src/sys/error.hpp

14.31 sys::sig::Signal Class Reference

Sets up a given signal handler and restores the old handler when going out of scope.

`#include <signal.hpp>`

Public Member Functions

- Signal (int const sig, sig_t const handler)

  Sets up the given handler.
- ~Signal ()

  Restore previous signal handler.

Private Attributes

- const int sig

  The signal this handler is handling.
- const sig_t handler

  The previous signal handler.

14.31.1 Detailed Description

Sets up a given signal handler and restores the old handler when going out of scope.

14.31.2 Constructor & Destructor Documentation

14.31.2.1 Signal()

```
sys::sig::Signal::Signal (
        int const sig,
        sig_t const handler )  [inline]
```

Sets up the given handler.

Parameters

sig	The signal to set a handler for
handler	The signal handling function

Exceptions

sys::sc_error<error>	Throws with the errno of signal()

The documentation for this class was generated from the following file:

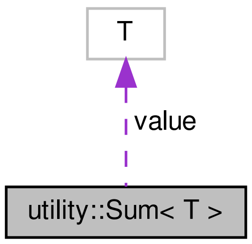
- src/sys/signal.hpp

14.32 utility::Sum< T > Class Template Reference

A simple value container only allowing += and copy assignment.

`#include <utility.hpp>`

Collaboration diagram for utility::Sum< T >:



Public Member Functions

- constexpr Sum (T const &value)

  Construct from an initial value.
- constexpr Sum ()

  Default construct.
- constexpr operator T const & () const

  Returns the current sum of values.
- constexpr Sum & operator+= (T const &value)

  Add a value to the sum.

Private Attributes

- T value

  The sum of values accumulated.

14.32.1 Detailed Description

template<typename T>
class utility::Sum< T >

A simple value container only allowing += and copy assignment.

Template Parameters

T	The value type

14.32.2 Constructor & Destructor Documentation

14.32.2.1 Sum()

```
template<typename T >
constexpr utility::Sum< T >::Sum (
              T const & value )  [inline], [explicit], [constexpr]
```

Construct from an initial value.

Parameters

value	The initial value

14.32.3 Member Function Documentation

14.32.3.1 operator T const &()

```
template<typename T >
constexpr utility::Sum< T >::operator T const & ( ) const  [inline], [constexpr]
```

Returns the current sum of values.

Returns

The sum of values by const reference

14.32.3.2 operator+=()

```
template<typename T >
constexpr Sum& utility::Sum< T >::operator+= (
              T const & value )  [inline], [constexpr]
```

Add a value to the sum.

Parameters

value	The value to add to the current sum

Returns

A self reference

The documentation for this class was generated from the following file:

- src/utility.hpp

14.33 sys::ctl::Sync< T, SysctlT > Class Template Reference

This is a wrapper around Sysctl that allows semantically transparent use of a sysctl.

`#include <sysctl.hpp>`

Public Member Functions

- constexpr Sync ()

    The default constructor.
- constexpr Sync (SysctlT const &sysctl) noexcept

    The constructor copies the given Sysctl instance.
- Sync & operator= (T const &value)

    Transparently assiges values of type T to the represented Sysctl instance.
- operator T () const

    Implicitly cast to the represented type.

Private Attributes

- SysctlT sysctl

    A sysctl to represent.

14.33.1 Detailed Description

template<typename T, class SysctlT>
class sys::ctl::Sync< T, SysctlT >

This is a wrapper around Sysctl that allows semantically transparent use of a sysctl.

```
Sync<int, Sysctl<0>> sndUnit{{"hw.snd.default_unit"}};
if (sndUnit != 3) {    // read from sysctl
    sndUnit = 3;      // assign to sysctl
}
```

Note that both assignment and read access (implemented through type casting to T) may throw an exception.

Template Parameters

T	The type to represent the sysctl as
SysctlT	The Sysctl type

14.33.2 Constructor & Destructor Documentation

14.33.2.1 Sync() [1/2] template<typename T , class SysctlT >

`constexpr sys::ctl::Sync< T, SysctlT >::Sync ( )  [inline], [constexpr]`

The default constructor.

This is available to defer initialisation to a later moment. This might be useful when initialising global or static instances by a character string repesented name.

14.33.2.2 Sync() [2/2]

```
template<typename T , class SysctlT >
constexpr sys::ctl::Sync< T, SysctlT >::Sync (
            SysctlT const & sysctl ) [inline], [constexpr], [noexcept]
```

The constructor copies the given Sysctl instance.

Parameters

sysctl	The Sysctl instance to represent

14.33.3 Member Function Documentation

14.33.3.1 operator T()

```
template<typename T , class SysctlT >
sys::ctl::Sync< T, SysctlT >::operator T ( ) const [inline]
```

Implicitly cast to the represented type.

Returns

Returns the value from the sysctl

14.33.3.2 operator=()

```
template<typename T , class SysctlT >
Sync& sys::ctl::Sync< T, SysctlT >::operator= (
            T const & value ) [inline]
```

Transparently assiges values of type T to the represented Sysctl instance.

Parameters

value	The value to assign

Returns

A self reference

The documentation for this class was generated from the following file:

- src/sys/sysctl.hpp

14.34 sys::ctl::Sysctl< MibDepth > Class Template Reference

Represents a sysctl MIB address.

```
#include <sysctl.hpp>
```

Public Member Functions

- template<typename... Tail>
  constexpr Sysctl (mib_t const head, Tail const ... tail) noexcept

  Initialise the MIB address directly.
- size_t size () const

  The size of the sysctl.
- void get (void ∗const buf, size_t const bufsize) const

  Update the given buffer with a value retrieved from the sysctl.
- template<typename T >
  void get (T &value) const

  Update the given value with a value retreived from the sysctl.
- template<typename T >
  std::unique_ptr< T[ ]> get () const

  Retrieve an array from the sysctl address.
- void set (void const ∗const buf, size_t const bufsize)

  Update the the sysctl value with the given buffer.
- template<typename T >
  void set (T const &value)

  Update the the sysctl value with the given value.

Private Attributes

- mib_t mib [MibDepth]

  Stores the MIB address.

14.34.1 Detailed Description

template<size_t MibDepth>
class sys::ctl::Sysctl< MibDepth >

Represents a sysctl MIB address.

It offers set() and get() methods to access these sysctls.

There are two ways of initialising a Sysctl instance, by symbolic name or by directly using the MIB address. The latter one only makes sense for sysctls with a fixed address, known at compile time, e.g. `Sysctl<2>{CTL_HW, HW_NCPU}` for "hw.ncpu". Check `/usr/include/sys/sysctl.h` for predefined MIBs.

For all other sysctls, symbolic names must be used. E.g. `Sysctl<0>{"dev.cpu.0.freq"}`. Creating a Sysctl from a symbolic name may throw.

Suitable deduction guides usually allow omitting the template arguments, i.e. Sysctl{CTL_HW, HW_NCPU} and Sysctl{"dev.cpu.0.freq"} implicitly use the correct template argument.

Template Parameters

MibDepth	The MIB level, e.g. "hw.ncpu" is two levels deep

14.34.2 Constructor & Destructor Documentation

14.34.2.1 Sysctl() `template<size_t MibDepth>`

```
template<typename... Tail>
constexpr sys::ctl::Sysctl< MibDepth >::Sysctl (
              mib_t const head,
              Tail const ... tail )  [inline], [constexpr], [noexcept]
```

Initialise the MIB address directly.

Some important sysctl values have a fixed address that can be initialised at compile time with a noexcept guarantee.

Spliting the MIB address into head and tail makes sure that `Sysctl(char *)` does not match the template and is instead implicitly cast to invoke `Sysctl(char const *)`.

Template Parameters

Tail	The types of the trailing MIB address values (must be mib_t)

Parameters

head,tail	The mib

14.34.3 Member Function Documentation

14.34.3.1 get() [1/3] `template<size_t MibDepth>`

```
template<typename T >
std::unique_ptr<T[]> sys::ctl::Sysctl< MibDepth >::get ( ) const  [inline]
```

Retrieve an array from the sysctl address.

This is useful to retrieve variable length sysctls, like characer strings.

Template Parameters

T	The type stored in the array

Returns

And array of T with the right length to store the whole sysctl value

Exceptions

sys::sc_error<error>	May throw if the size of the sysctl increases after the length was queried

14.34.3.2 get() [2/3] `template<size_t MibDepth>`

```
template<typename T >
void sys::ctl::Sysctl< MibDepth >::get (
            T & value ) const  [inline]
```

Update the given value with a value retreived from the sysctl.

Template Parameters

T	The type store the sysctl value in

Parameters

value	A reference to the target value

Exceptions

sys::sc_error<error>	Throws if value retrieval fails or is incomplete, e.g. because the value does not fit into the target type

14.34.3.3 get() [3/3] `template<size_t MibDepth>`

```
void sys::ctl::Sysctl< MibDepth >::get (
            void *const buf,
            size_t const bufsize ) const  [inline]
```

Update the given buffer with a value retrieved from the sysctl.

Parameters

buf,bufsize	The target buffer and its size

Exceptions

sys::sc_error<error>	Throws if value retrieval fails or is incomplete, e.g. because the value does not fit into the target buffer

14.34.3.4 set() [1/2] `template<size_t MibDepth>`

```
template<typename T >
void sys::ctl::Sysctl< MibDepth >::set (
              T const & value )  [inline]
```

Update the the sysctl value with the given value.

Template Parameters

T	The value type

Parameters

value	The value to set the sysctl to

14.34.3.5 set() [2/2] template<size_t MibDepth>

```
void sys::ctl::Sysctl< MibDepth >::set (
              void const *const buf,
              size_t const bufsize )  [inline]
```

Update the the sysctl value with the given buffer.

Parameters

buf,bufsize	The source buffer

Exceptions

sys::sc_error<error>	If the source buffer cannot be stored in the sysctl

14.34.3.6 size() template<size_t MibDepth>

```
size_t sys::ctl::Sysctl< MibDepth >::size ( ) const  [inline]
```

The size of the sysctl.

Returns

The size in characters

The documentation for this class was generated from the following file:

- src/sys/sysctl.hpp

14.35 sys::ctl::Sysctl< 0 > Class Reference

This is a specialisation of Sysctl for sysctls using symbolic names.

`#include <sysctl.hpp>`

Public Member Functions

- constexpr Sysctl ()

  The default constructor.
- Sysctl (char const ∗const name)

  Initialise the MIB address from a character string.
- size_t size () const

  The size of the sysctl.
- void get (void ∗const buf, size_t const bufsize) const

  Update the given buffer with a value retrieved from the sysctl.
- template<typename T >
  void get (T &value) const

  Update the given value with a value retreived from the sysctl.
- template<typename T >
  std::unique_ptr< T[ ]> get () const

  Retrieve an array from the sysctl address.
- void set (void const ∗const buf, size_t const bufsize)

  Update the the sysctl value with the given buffer.
- template<typename T >
  void set (T const &value)

  Update the the sysctl value with the given value.

Private Attributes

- mib_t mib [CTL_MAXNAME]

  Stores the MIB address.
- size_t depth

  The MIB depth.

14.35.1 Detailed Description

This is a specialisation of Sysctl for sysctls using symbolic names.

A Sysctl instance created with the default constructor is unitialised, initialisation can be deferred to a later moment by using copy assignment. This can be used to create globals but construct them inline where exceptions can be handled.

14.35.2 Constructor & Destructor Documentation

14.35.2.1 Sysctl() [1/2] `constexpr sys::ctl::Sysctl< 0 >::Sysctl ( ) [inline], [constexpr]`

The default constructor.

This is available to defer initialisation to a later moment.

14.35.2.2 Sysctl() [2/2] `sys::ctl::Sysctl< 0 >::Sysctl ( char const ∗const name ) [inline]`

Initialise the MIB address from a character string.

Parameters

name	The symbolic name of the sysctl

Exceptions

sys::sc_error<error>	May throw an exception if the addressed sysct does not exist or if the address is too long to store

14.35.3 Member Function Documentation

14.35.3.1 get() [1/3] template<typename T >

```
std::unique_ptr<T[]> sys::ctl::Sysctl< 0 >::get ( ) const  [inline]
```

Retrieve an array from the sysctl address.

This is useful to retrieve variable length sysctls, like characer strings.

Template Parameters

T	The type stored in the array

Returns

And array of T with the right length to store the whole sysctl value

Exceptions

sys::sc_error<error>	May throw if the size of the sysctl increases after the length was queried

14.35.3.2 get() [2/3] template<typename T >

```
void sys::ctl::Sysctl< 0 >::get (
            T & value ) const  [inline]
```

Update the given value with a value retreived from the sysctl.

Template Parameters

T	The type store the sysctl value in

Parameters

value	A reference to the target value

Exceptions

sys::sc_error<error>	Throws if value retrieval fails or is incomplete, e.g. because the value does not fit into the target type

14.35.3.3 get() [3/3]

```
void sys::ctl::Sysctl< 0 >::get (
              void *const buf,
              size_t const bufsize ) const  [inline]
```

Update the given buffer with a value retrieved from the sysctl.

Parameters

buf,bufsize	The target buffer and its size

Exceptions

sys::sc_error<error>	Throws if value retrieval fails or is incomplete, e.g. because the value does not fit into the target buffer

14.35.3.4 set() [1/2]

```
template<typename T >
void sys::ctl::Sysctl< 0 >::set (
              T const & value )  [inline]
```

Update the the sysctl value with the given value.

Template Parameters

T	The value type

Parameters

value	The value to set the sysctl to

14.35.3.5 set() [2/2]

```
void sys::ctl::Sysctl< 0 >::set (
              void const *const buf,
              size_t const bufsize )  [inline]
```

Update the the sysctl value with the given buffer.

Parameters

buf,bufsize	The source buffer

Exceptions

sys::sc_error<error>	If the source buffer cannot be stored in the sysctl

14.35.3.6 size() `size_t sys::ctl::Sysctl< 0 >::size ( ) const [inline]`

The size of the sysctl.

Returns

The size in characters

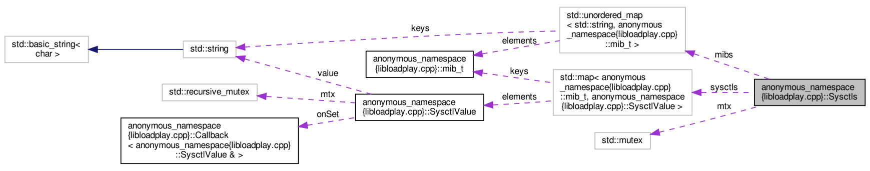
The documentation for this class was generated from the following file:

- src/sys/sysctl.hpp

14.36 anonymous_namespace{libloadplay.cpp}::Sysctls Class Reference

Singleton class representing the sysctl table for this library.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::Sysctls:


std::basic_string< char >
std::string
keys
std::unordered_map < std::string, anonymous _namespace{libloadplay.cpp} ::mib_t >
elements
anonymous_namespace {libloadplay.cpp}::mib_t
mibs
value
keys
std::recursive_mutex
mtx
std::map< anonymous _namespace{libloadplay.cpp} ::mib_t, anonymous_namespace {libloadplay.cpp}::SysctlValue >
sysctls
anonymous_namespace {libloadplay.cpp}::Sysctls
onSet
anonymous_namespace {libloadplay.cpp}::SysctlValue
elements
mtx
anonymous_namespace {libloadplay.cpp}::Callback < anonymous_namespace{libloadplay.cpp} ::SysctlValue & >
std::mutex

Public Member Functions

- void addValue (mib_t const &mib, std::string const &value)

  Add a value to the sysctls map.
- void addValue (std::string const &name, std::string const &value)

  Add a value to the sysctls map.
- const mib_t & getMib (char const ∗const name) const

  Returns a mib for a given symbolic name.
- const mib_t & getBaseMib (char const ∗const name) const

  Retrieves the base mib for a given mib name.
- SysctlValue & operator[ ] (char const ∗const name)

  Returns a reference to a sysctl value container.
- SysctlValue & operator[ ] (mib_t const &mib)

  Returns a reference to a sysctl value container.

Private Types

- typedef std::lock_guard< decltype(mtx)> lock_guard

  The appropriate lock guard type for mtx.

Private Attributes

- std::mutex mtx

  A simple mutex.
- std::unordered_map< std::string, mib_t > mibs

  Maps name → mib.
- std::map< mib_t, SysctlValue > sysctls

  Maps mib → (type, value).

14.36.1 Detailed Description

Singleton class representing the sysctl table for this library.

14.36.2 Member Function Documentation

14.36.2.1 addValue() [1/2]

```
void anonymous_namespace{libloadplay.cpp}::Sysctls::addValue (
        mib_t const & mib,
        std::string const & value ) [inline]
```

Add a value to the sysctls map.

Parameters

mib	The mib to add the value for
value	The value to store

14.36.2.2 addValue() [2/2]

```
void anonymous_namespace{libloadplay.cpp}::Sysctls::addValue (
        std::string const & name,
        std::string const & value ) [inline]
```

Add a value to the sysctls map.

Parameters

name	The symbolic name of the mib to add the value for
value	The value to store

14.36.2.3 getBaseMib()

`const mib_t& anonymous_namespace{libloadplay.cpp}::Sysctls::getBaseMib ( char const *const name ) const [inline]`

Retrieves the base mib for a given mib name.

E.g. the base mib for "dev.cpu.0.freq" is the mib for "dev.cpu.%d.freq".

Parameters

name	The MIB name

Returns

The MIB of the base name

14.36.2.4 getMib()

`const mib_t& anonymous_namespace{libloadplay.cpp}::Sysctls::getMib ( char const *const name ) const [inline]`

Returns a mib for a given symbolic name.

Parameters

name	The MIB name

Returns

The MIB

14.36.2.5 operator[]() [1/2]

`SysctlValue& anonymous_namespace{libloadplay.cpp}::Sysctls::operator[] ( char const *const name ) [inline]`

Returns a reference to a sysctl value container.

Parameters

name	The MIB name to return the reference for

Returns

A SysctlValue reference

14.36.2.6 operator[]() [2/2] SysctlValue& anonymous_namespace{libloadplay.cpp}::Sysctls::operator[] (mib_t const & *mib*) [inline]

Returns a reference to a sysctl value container.

Parameters

mib	The MIB to return the reference for

Returns

A SysctlValue reference

14.36.3 Member Data Documentation

14.36.3.1 mibs `std::unordered_map<std::string, mib_t> anonymous_namespace{libloadplay.cpp}::Sysctls::mibs [private]`

Initial value:

```
{
        {"hw.machine",     {CTL_HW, HW_MACHINE}},
        {"hw.model",       {CTL_HW, HW_MODEL}},
        {"hw.ncpu",        {CTL_HW, HW_NCPU}},
        {ACLINE,           {1000}},
        {FREQ,             {1001, -1}},
        {FREQ_LEVELS,      {1002, -1}},
        {CP_TIMES,         {1003}},
        {LOADREC_FEATURES, {1004}},
        {FREQ_DRIVER,      {1005, -1}},
        {TEMPERATURE,      {1006, -1}},
        {TJMAX_SOURCES[0], {1007, -1}}
    }
```

Maps name → mib.

14.36.3.2 sysctls `std::map<mib_t, SysctlValue> anonymous_namespace{libloadplay.cpp}::Sysctls::sysctls [private]`

Initial value:

```
{
        {{CTL_HW, HW_MACHINE}, {CTLTYPE_STRING, "hw.machine"}},
        {{CTL_HW, HW_MODEL},   {CTLTYPE_STRING, "hw.model"}},
        {{CTL_HW, HW_NCPU},    {CTLTYPE_INT,    "0"}},
        {{1000},               {CTLTYPE_INT,    "2"}},
        {{1001, -1},           {CTLTYPE_INT,    "0"}},
        {{1002, -1},           {CTLTYPE_STRING, ""}},
        {{1003},               {CTLTYPE_LONG,   ""}},
        {{1004},               {CTLTYPE_U64,    "0"}},
        {{1005, -1},           {CTLTYPE_STRING, ""}},
        {{1006, -1},           {CTLTYPE_INT,    "-1"}},
        {{1007, -1},           {CTLTYPE_INT,    "-1"}},
    }
```

Maps mib → (type, value).

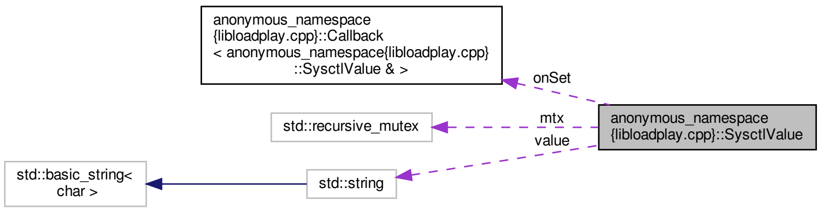
The documentation for this class was generated from the following file:

- src/libloadplay.cpp

14.37 anonymous_namespace{libloadplay.cpp}::SysctlValue Class Reference

Instances of this class represents a specific sysctl value.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::SysctlValue:


anonymous_namespace {libloadplay.cpp}::Callback < anonymous_namespace{libloadplay.cpp} ::SysctlValue & >
onSet
std::recursive_mutex
mtx
value
anonymous_namespace {libloadplay.cpp}::SysctlValue
std::basic_string< char >
std::string

Public Member Functions

- SysctlValue ()

  Default constructor.
- SysctlValue (SysctlValue const &copy)

  Copy constructor.
- SysctlValue (SysctlValue &&move)

  Move constructor.
- SysctlValue (unsigned int type, std::string const &value, callback_function const callback=nullptr)

  Construct from a type, value and optionally callback tuple.
- SysctlValue & operator= (SysctlValue const &copy)

  Copy assignment operator.
- SysctlValue & operator= (SysctlValue &&move)

  Move assignment operator.
- size_t size () const

  Returns the required storage size according to the CTLTYPE.
- template<typename T >
  int get (T ∗dst, size_t &size) const

  Copy a list of values into the given buffer.
- int get (char ∗dst, size_t &size) const

  Copy a C string into the given buffer.
- template<typename T >
  T get () const

  Returns a single value.
- int get (void ∗dst, size_t &size) const

  Copy a list of values into the given buffer.
- template<typename T >
  void set (T const ∗const newp, size_t newlen)

  Set this value to the values in the given buffer.
- int set (void const ∗const newp, size_t newlen)

  Set this value to the values in the given buffer.
- void set (std::string &&value)

  Move a string to the value.
- void set (std::string const &value)

Copy a string to the value.

- template<typename T >
  void set (T const &value)

  Set the value.
- void registerOnSet (callback_function &&callback)

  Register a callback function.
- void registerOnSet (callback_function const &callback)

  Register a callback function.

Private Types

- typedef std::lock_guard< decltype(mtx)> lock_guard

  Lock guard type, fitting the mutex.

Private Member Functions

- template<typename T >
  size_t size () const

  Provide the size of this value represented as a string of Ts.

Private Attributes

- decltype(onSet) typedef ::function_t callback_function

  Callback function type.
- std::recursive_mutex mtx

  A stackable mutex.
- unsigned int type

  The sysctl type.
- std::string value

  The value of the sysctl.
- Callback< SysctlValue & > onSet

  Callback function handle.

14.37.1 Detailed Description

Instances of this class represents a specific sysctl value.

There should only be one instance of this class per MIB.

Instances are thread safe.

14.37.2 Constructor & Destructor Documentation

14.37.2.1 SysctlValue() [1/3] `anonymous_namespace{libloadplay.cpp}::SysctlValue::SysctlValue ( SysctlValue const & copy ) [inline]`

Copy constructor.

Parameters

copy	The instance to copy

14.37.2.2 SysctlValue() [2/3] `anonymous_namespace{libloadplay.cpp}::SysctlValue::SysctlValue ( SysctlValue && move ) [inline]`

Move constructor.

Parameters

move	The instance to move

14.37.2.3 SysctlValue() [3/3] `anonymous_namespace{libloadplay.cpp}::SysctlValue::SysctlValue (`

```
unsigned int type,
std::string const & value,
callback_function const callback = nullptr )  [inline]
```

Construct from a type, value and optionally callback tuple.

Parameters

type	The CTLTYPE
value	A string representation of the value
callback	A callback function that is called for each set() call

14.37.3 Member Function Documentation

14.37.3.1 get() [1/4] `template<typename T >`

```
T anonymous_namespace{libloadplay.cpp}::SysctlValue::get ( ) const  [inline]
```

Returns a single value.

Template Parameters

T	The type of the value

Returns

The value

14.37.3.2 get() [2/4] `int anonymous_namespace{libloadplay.cpp}::SysctlValue::get (`

```
char * dst,
size_t & size ) const  [inline]
```

Copy a C string into the given buffer.

Parameters

dst,size	The destination buffer and size

Return values

0	On success
-1	On failure to fit all values into the taget buffer, also sets errno=ENOMEM

14.37.3.3 get() [3/4] `template<typename T >`

```
int anonymous_namespace{libloadplay.cpp}::SysctlValue::get (
T * dst,
size_t & size ) const  [inline]
```

Copy a list of values into the given buffer.

Template Parameters

T	The type of the values to extract

Parameters

dst,size	The destination buffer and size

Return values

0	On success
-1	On failure to fit all values into the target buffer, also sets errno=ENOMEM

14.37.3.4 get() [4/4] `int anonymous_namespace{libloadplay.cpp}::SysctlValue::get (`

```
void * dst,
size_t & size ) const  [inline]
```

Copy a list of values into the given buffer.

Parameters

dst,size	The destination buffer and size

Return values

0	On success
-1	On failure to fit all values into the taget buffer, also sets errno=ENOMEM

14.37.3.5 **operator=()** `[1/2]` `SysctlValue& anonymous_namespace{libloadplay.cpp}::SysctlValue::operator= ( SysctlValue && move ) [inline]`

Move assignment operator.

Parameters

move	The instance to move

Returns

A self reference

14.37.3.6 **operator=()** `[2/2]` `SysctlValue& anonymous_namespace{libloadplay.cpp}::SysctlValue::operator= ( SysctlValue const & copy ) [inline]`

Copy assignment operator.

Parameters

copy	The instance to copy

Returns

A self reference

14.37.3.7 **registerOnSet()** `[1/2]` `void anonymous_namespace{libloadplay.cpp}::SysctlValue::registerOnSet ( callback_function && callback ) [inline]`

Register a callback function.

Parameters

callback	The function to move to the callback handler

14.37.3.8 registerOnSet() [2/2] `void anonymous_namespace{libloadplay.cpp}::SysctlValue::registerOnSet ( callback_function const & callback ) [inline]`

Register a callback function.

Parameters

callback	The function to copy to the callback handler

14.37.3.9 set() [1/5] `void anonymous_namespace{libloadplay.cpp}::SysctlValue::set ( std::string && value ) [inline]`

Move a string to the value.

Parameters

value	The new value

14.37.3.10 set() [2/5] `void anonymous_namespace{libloadplay.cpp}::SysctlValue::set ( std::string const & value ) [inline]`

Copy a string to the value.

Parameters

value	The new value

14.37.3.11 set() [3/5] `template<typename T > void anonymous_namespace{libloadplay.cpp}::SysctlValue::set ( T const & value ) [inline]`

Set the value.

Template Parameters

T	The value type

Parameters

value	The value to set

14.37.3.12 set() [4/5]

```
template<typename T >
void anonymous_namespace{libloadplay.cpp}::SysctlValue::set (
              T const *const newp,
              size_t newlen )  [inline]
```

Set this value to the values in the given buffer.

Template Parameters

T	The type of the values

Parameters

newp,newlen	The source buffer and size

14.37.3.13 set() [5/5]

```
int anonymous_namespace{libloadplay.cpp}::SysctlValue::set (
              void const *const newp,
              size_t newlen )  [inline]
```

Set this value to the values in the given buffer.

The buffer will be treated as an array of CTLTYPE values.

Parameters

newp,newlen	The source buffer and size

14.37.3.14 size() [1/2]

```
template<typename T >
size_t anonymous_namespace{libloadplay.cpp}::SysctlValue::size ( ) const  [inline], [private]
```

Provide the size of this value represented as a string of Ts.

Template Parameters

T	The type this value is supposed to be a array of

Returns

The size of the whole string of Ts

14.37.3.15 size() [2/2] `size_t anonymous_namespace{libloadplay.cpp}::SysctlValue::size ( ) const [inline]`

Returns the required storage size according to the CTLTYPE.

Returns

The required buffer size to hold the values.

Exceptions

int	Throws -1 if the current CTLTYPE is not implemented.

14.37.4 Member Data Documentation

14.37.4.1 mtx `std::recursive_mutex anonymous_namespace{libloadplay.cpp}::SysctlValue::mtx [mutable], [private]`

A stackable mutex.

nice for exposing methods publicly and still let them allow accessing each other.

14.37.4.2 value `std::string anonymous_namespace{libloadplay.cpp}::SysctlValue::value [private]`

The value of the sysctl.

This is stored as a string and converted to the appropriate type by the set() and get() methods.

The documentation for this class was generated from the following file:

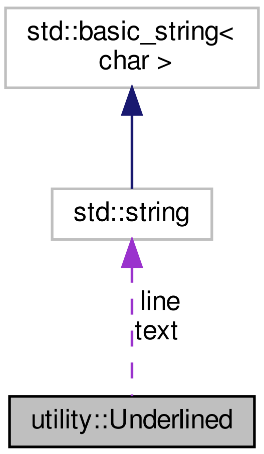
- src/libloadplay.cpp

14.38 utility::Underlined Struct Reference

A line of text and an underlining line.

`#include <utility.hpp>`

Collaboration diagram for utility::Underlined:



Public Member Functions

- operator std::string () const

  Implicit conversion to std::string.

Public Attributes

- std::string text

  The text with printf-style escapes.
- std::string line

  Aligned underlining characters ^∼∼∼.

14.38.1 Detailed Description

A line of text and an underlining line.

The text and the line are kept in a separate string to ease indenting them.

14.38.2 Member Function Documentation

14.38.2.1 operator std::string() `utility::Underlined::operator std::string ( ) const [inline]`

Implicit conversion to std::string.

Convenient if indentation is not required.

The documentation for this struct was generated from the following file:

- src/utility.hpp

14.39 anonymous_namespace{clas.cpp}::Value Struct Reference

Determine the unit of a string encoded value.

Public Member Functions

- operator double () const
  Implicitly cast to the magnitude.
- operator Unit () const
  Implicitly cast to the unit.
- Value & operator+= (double const off)
  Add offset to the magnitude.
- Value & operator-= (double const off)
  Subtract offset from the magnitude.
- Value & operator*= (double const fact)
  Scale magnitude by the given factor.
- Value & operator/= (double const div)
  Divide the magnitude by the given divisor.
- Value (char const *const valp, char *unitp=nullptr)
  Construct value from a null terminated character array.

Public Attributes

- double value
  The magnitude of the value.
- Unit unit
  The unit of the value.

14.39.1 Detailed Description

Determine the unit of a string encoded value.

14.39.2 Constructor & Destructor Documentation

14.39.2.1 Value()

```
anonymous_namespace{clas.cpp}::Value::Value (
        char const *const valp,
        char * unitp = nullptr ) [inline]
```

Construct value from a null terminated character array.

Parameters

valp	A pointer to the value portion of the array
unitp	Set by the constructor to point behind the magnitude

14.39.3 Member Function Documentation

14.39.3.1 operator double() `anonymous_namespace{clas.cpp}::Value::operator double ( ) const [inline]`

Implicitly cast to the magnitude.

Returns

The magnitude of the value

14.39.3.2 operator Unit() `anonymous_namespace{clas.cpp}::Value::operator Unit ( ) const [inline]`

Implicitly cast to the unit.

Returns

The unit of the value

14.39.3.3 operator*=() `Value& anonymous_namespace{clas.cpp}::Value::operator*= ( double const fact ) [inline]`

Scale magnitude by the given factor.

Parameters

fact	The factor to scale the magnitude by

Returns

A self reference

14.39.3.4 operator+=()

```
Value& anonymous_namespace{clas.cpp}::Value::operator+= (
    double const off ) [inline]
```

Add offset to the magnitude.

Parameters

off	The offset value

Returns

A self reference

14.39.3.5 operator-=()

```
Value& anonymous_namespace{clas.cpp}::Value::operator-= (
        double const off ) [inline]
```

Subtract offset from the magnitude.

Parameters

off	The offset value

Returns

A self reference

14.39.3.6 operator/=()

```
Value& anonymous_namespace{clas.cpp}::Value::operator/= (
        double const div ) [inline]
```

Divide the magnitude by the given divisor.

Parameters

div	The divisor to divide the magnitude by

Returns

A self reference

The documentation for this struct was generated from the following file:

- src/clas.cpp

14.40 sys::env::Var Class Reference

A reference type refering to an environment variable.

`#include <env.hpp>`

Public Member Functions

- template<size_t Size>
  Var (char const (&name)[Size])

  Construct an environment variable reference.
- Var (Var const &)=delete

  Do not permit copy construction.
- Var & operator= (Var const &)=delete

  Do not permit copy assignment.
- operator char const ∗ () const

  Retrieve the value of the environment variable.
- Var & operator= (char const ∗const assign)

  Assign a new value to the environment variable.
- Var & erase ()

  Explicitly deletes the environment variable.
- const char ∗ c_str () const

  Explicitly retrieve the value as a character array.

Private Attributes

- const char ∗const name

  A pointer to the variable name.

14.40.1 Detailed Description

A reference type refering to an environment variable.

To avoid issues with the lifetime of the name string this is not copy constructible or assignable.

14.40.2 Constructor & Destructor Documentation

14.40.2.1 Var() template<size_t Size>

```
sys::env::Var::Var (
                char const (&) name[Size] )   [inline]
```

Construct an environment variable reference.

Template Parameters

Size	The size of the name buffer

Parameters

name	The name of the environment variable

14.40.3 Member Function Documentation

14.40.3.1 c_str() `const char* sys::env::Var::c_str ( ) const [inline]`

Explicitly retrieve the value as a character array.

Returns

A pointer to the character array with the variable value

Return values

nullptr	The variable does not exist

14.40.3.2 erase() `Var& sys::env::Var::erase ( ) [inline]`

Explicitly deletes the environment variable.

Returns

A self-reference

Exceptions

sc_error<error>{EINVAL}	Invalid variable name
sc_error<error>{ENOMEM}	Failed to allocate memory when updating the environment

14.40.3.3 operator char const *() `sys::env::Var::operator char const * ( ) const [inline]`

Retrieve the value of the environment variable.

Returns

A pointer to the character array with the variable value

Return values

nullptr	The variable does not exist

14.40.3.4 operator=() `Var& sys::env::Var::operator= ( char const *const assign ) [inline]`

Assign a new value to the environment variable.

Deletes the variable if nullptr is assigned.

Parameters

assign	The new value

Returns

A self-reference

Exceptions

sc_error<error>{EINVAL}	Invalid variable name
sc_error<error>{ENOMEM}	Failed to allocate memory when updating the environment

The documentation for this class was generated from the following file:

- src/sys/env.hpp

14.41 sys::env::Vars Struct Reference

A singleton class providing access to environment variables.

`#include <env.hpp>`

Public Member Functions

- template<typename T >
  const Var operator[ ] (T const &name) const

  Access environment variable by name.
- template<typename T >
  Var operator[ ] (T const &name)

  Access environment variable by name.

14.41.1 Detailed Description

A singleton class providing access to environment variables.

14.41.2 Member Function Documentation

14.41.2.1 operator[]() [1/2] `template<typename T > Var sys::env::Vars::operator[] ( T const & name ) [inline]`

Access environment variable by name.

Template Parameters

T	The name argument type

Parameters

name	The name of the variable by reference

14.41.2.2 operator[]() [2/2] template<typename T >

```
const Var sys::env::Vars::operator[] (
                T const & name ) const   [inline]
```

Access environment variable by name.

Template Parameters

T	The name argument type

Parameters

name	The name of the variable by reference

The documentation for this struct was generated from the following file:

- src/sys/env.hpp

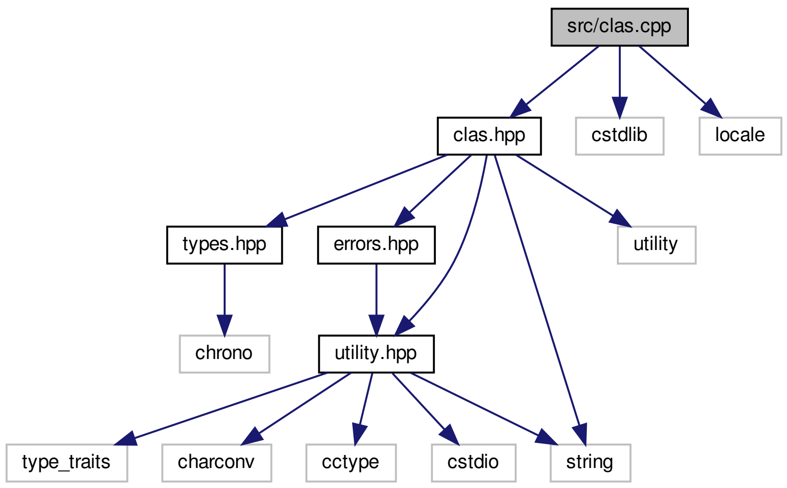
15 File Documentation

15.1 src/clas.cpp File Reference

Implements functions to process command line arguments.

```
#include "clas.hpp"
#include <cstdlib>
#include <locale>
```

Include dependency graph for clas.cpp:



Classes

- struct anonymous_namespace{clas.cpp}::Value

  Determine the unit of a string encoded value.

Namespaces

- anonymous_namespace{clas.cpp}

  File local scope.

Enumerations

- enum anonymous_namespace{clas.cpp}::Unit : size_t {
  anonymous_namespace{clas.cpp}::Unit::SCALAR, anonymous_namespace{clas.cpp}::Unit::PERCENT,
  anonymous_namespace{clas.cpp}::Unit::SECOND, anonymous_namespace{clas.cpp}::Unit::MILLISECOND,
  anonymous_namespace{clas.cpp}::Unit::HZ, anonymous_namespace{clas.cpp}::Unit::KHZ, anonymous_namespace{clas.cpp
  anonymous_namespace{clas.cpp}::Unit::GHZ,
  anonymous_namespace{clas.cpp}::Unit::THZ, anonymous_namespace{clas.cpp}::Unit::CELSIUS, anonymous_namespace{cla
  anonymous_namespace{clas.cpp}::Unit::FAHRENHEIT,
  anonymous_namespace{clas.cpp}::Unit::RANKINE, anonymous_namespace{clas.cpp}::Unit::UNKNOWN }

  Command line argument units.

Variables

- const char ∗const anonymous_namespace{clas.cpp}::UnitStr [ ]

  The unit strings on the command line, for the respective Unit instances.

15.1.1 Detailed Description

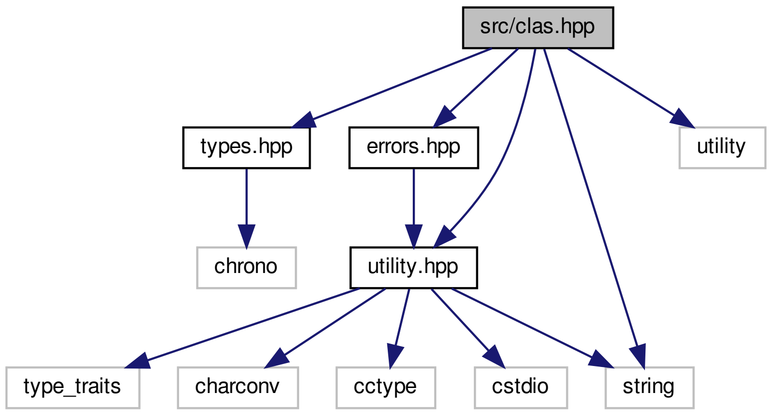
Implements functions to process command line arguments.

15.2 src/clas.hpp File Reference

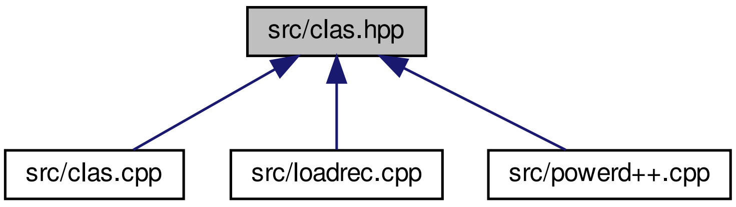
Provides functions to process command line arguments.

```
#include "types.hpp"
#include "errors.hpp"
#include "utility.hpp"
#include <string>
#include <utility>
```

Include dependency graph for clas.hpp:



This graph shows which files directly or indirectly include this file:



Namespaces

- clas

  A collection of functions to process command line arguments.

Functions

- types::cptime_t clas::load (char const ∗const str)

  Convert string to load in the range [0, 1024].
- types::mhz_t clas::freq (char const ∗const str)

  Convert string to frequency in MHz.
- types::ms clas::ival (char const ∗const str)

  Convert string to time interval in milliseconds.
- size_t clas::samples (char const ∗const str)

  A string encoded number of samples.
- types::decikelvin_t clas::temperature (char const ∗const str)

  Convert string to temperature in dK.
- int clas::celsius (types::decikelvin_t const val)

  Converts dK into ℃ for display purposes.
- template<typename T >
  std::pair< T, T > clas::range (T(&func)(char const ∗const), char const ∗const str)

  Takes a string encoded range of values and returns them.
- const char ∗ clas::sysctlname (char const ∗const str)

  Verify that the given string only contains characters allowed in sysctl names.
- template<typename ... CharTs>
  const char ∗ clas::formatfields (char const ∗const fmt, CharTs const ... fields)

  Sanitise user-provided formatting strings.

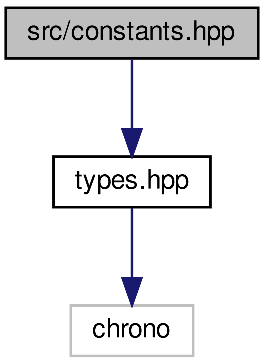
15.2.1 Detailed Description

Provides functions to process command line arguments.

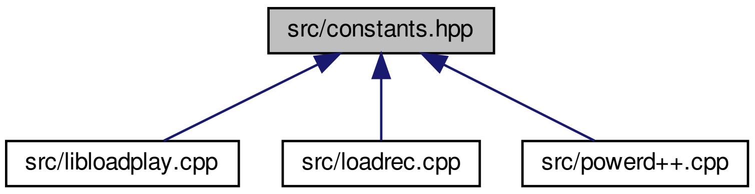
15.3 src/constants.hpp File Reference

Defines a collection of constants.

```
#include "types.hpp"
```
Include dependency graph for constants.hpp:



This graph shows which files directly or indirectly include this file:



Namespaces

- constants

  A collection of constants.

Variables

- const char ∗const constants::CP_TIMES = "kern.cp_times"

  The MIB name for per-CPU time statistics.
- const char ∗const constants::ACLINE = "hw.acpi.acline"

  The MIB name for the AC line state.
- const char ∗const constants::FREQ = "dev.cpu.%d.freq"

  The MIB name for CPU frequencies.
- const char ∗const constants::FREQ_LEVELS = "dev.cpu.%d.freq_levels"

  The MIB name for CPU frequency levels.
- const char ∗const constants::TEMPERATURE = "dev.cpu.%d.temperature"

  The MIB name for CPU temperatures.
- const char ∗const constants::TJMAX_SOURCES [ ]

  An array of maximum temperature sources.
- const char ∗const constants::FREQ_DRIVER = "dev.cpufreq.%d.freq_driver"

  The MIB name for the CPU frequency drivers.
- const char ∗const constants::FREQ_DRIVER_BLACKLIST [ ]

  A list of driver prefixes, that are known not to allow manual frequency control.
- const types::mhz_t constants::FREQ_DEFAULT_MAX {1000000}

  Default maximum clock frequency value.
- const types::mhz_t constants::FREQ_DEFAULT_MIN {0}

  Default minimum clock frequency value.
- const types::mhz_t constants::FREQ_UNSET {1000001}

  Clock frequency representing an uninitialised value.
- const char ∗const constants::POWERD_PIDFILE = "/var/run/powerd.pid"

  The default pidfile name of powerd.
- const types::cptime_t constants::ADP {512}

  The load target for adaptive mode, equals 50% load.
- const types::cptime_t constants::HADP {384}

  The load target for hiadaptive mode, equals 37.5% load.
- const types::decikelvin_t constants::HITEMP_OFFSET {100}

  The default temperautre offset between high and critical temperature.

15.3.1 Detailed Description

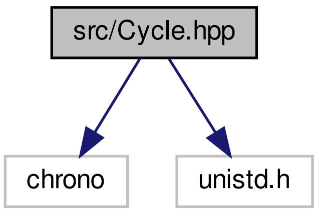
Defines a collection of constants.

15.4 src/Cycle.hpp File Reference

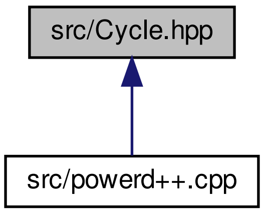
Implements timing::Cycle, a cyclic sleep functor.

```
#include <chrono>
#include <unistd.h>
```

Include dependency graph for Cycle.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- class timing::Cycle

    Implements an interruptible cyclic sleeping functor.

Namespaces

- timing

    Namespace for time management related functionality.

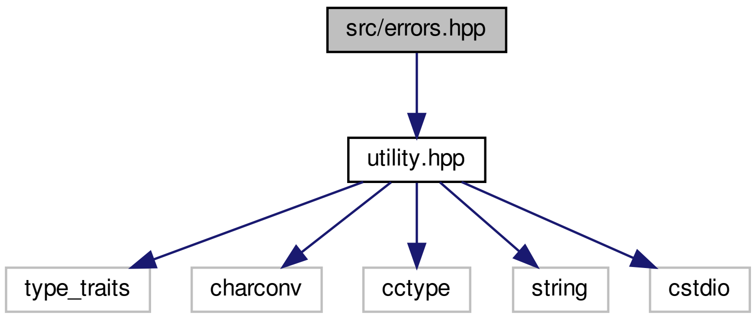
15.4.1 Detailed Description

Implements timing::Cycle, a cyclic sleep functor.

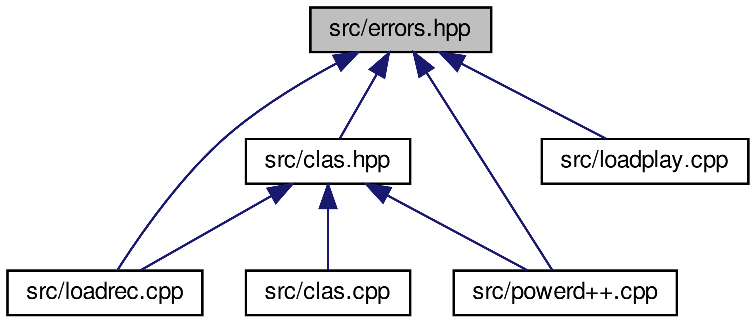
15.5 src/errors.hpp File Reference

Common error handling code.

`#include "utility.hpp"`
Include dependency graph for errors.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct errors::Exception

  Exceptions bundle an exit code, errno value and message. More...

Namespaces

- errors

  Common error handling types and functions.

Enumerations

- enum errors::Exit : int {
errors::Exit::OK, errors::Exit::ECLARG, errors::Exit::EOUTOFRANGE, errors::Exit::ELOAD,
errors::Exit::EFREQ, errors::Exit::EMODE, errors::Exit::EIVAL, errors::Exit::ESAMPLES,
errors::Exit::ESYSCTL, errors::Exit::ENOFREQ, errors::Exit::ECONFLICT, errors::Exit::EPID,
errors::Exit::EFORBIDDEN, errors::Exit::EDAEMON, errors::Exit::EWOPEN, errors::Exit::ESIGNAL,
errors::Exit::ERANGEFMT, errors::Exit::ETEMPERATURE, errors::Exit::EEXCEPT, errors::Exit::EFILE,
errors::Exit::EEXEC, errors::Exit::EDRIVER, errors::Exit::ESYSCTLNAME, errors::Exit::EFORMATFIELD,
errors::Exit::LENGTH }

  Exit codes.

Functions

- void errors::fail (Exit const exitcode, int const err, std::string const &msg)

  Throws an Exception instance with the given message.

Variables

- const char ∗const errors::ExitStr [ ]

  Printable strings for exit codes.

15.5.1 Detailed Description

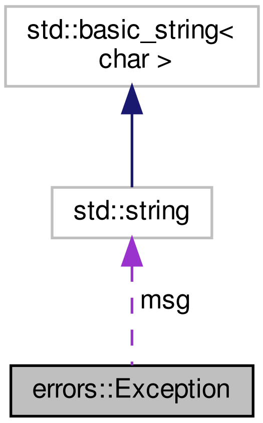
Common error handling code.

15.5.2 Class Documentation

15.5.2.1 struct errors::Exception

Exceptions bundle an exit code, errno value and message.

Collaboration diagram for errors::Exception:



Class Members

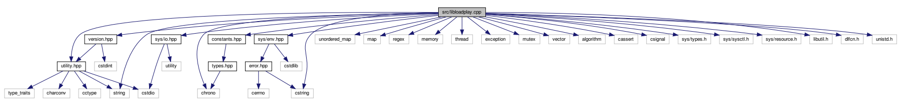
int	err	The errno value at the time of creation.
Exit	exitcode	The code to exit with.
string	msg	An error message.

15.6 src/libloadplay.cpp File Reference

Implements a library intended to be injected into a clock frequency deamon via LD_PRELOAD.

```
#include "utility.hpp"
#include "constants.hpp"
#include "version.hpp"
#include "sys/env.hpp"
#include "sys/io.hpp"
#include <unordered_map>
#include <map>
#include <string>
#include <regex>
#include <memory>
#include <thread>
#include <exception>
#include <mutex>
#include <chrono>
#include <vector>
#include <algorithm>
#include <cstring>
#include <cassert>
#include <csignal>
#include <sys/types.h>
#include <sys/sysctl.h>
#include <sys/resource.h>
#include <libutil.h>
#include <dlfcn.h>
#include <unistd.h>
```

Include dependency graph for libloadplay.cpp:



Classes

- struct anonymous_namespace{libloadplay.cpp}::mib_t

  Represents MIB, but wraps it to provide the necessary operators to use it as an std::map key.
- class anonymous_namespace{libloadplay.cpp}::Callback< FunctionArgs >

  Implements a recursion safe std::function wrapper.
- class anonymous_namespace{libloadplay.cpp}::SysctlValue

  Instances of this class represents a specific sysctl value.
- class anonymous_namespace{libloadplay.cpp}::Sysctls

Singleton class representing the sysctl table for this library.
- struct anonymous_namespace{libloadplay.cpp}::CoreReport

  The reported state of a single CPU pipeline. More...
- struct anonymous_namespace{libloadplay.cpp}::CoreFrameReport

  The report frame information for a single CPU pipeline. More...
- class anonymous_namespace{libloadplay.cpp}::Report

  Provides a mechanism to provide frame wise per core load information.
- class anonymous_namespace{libloadplay.cpp}::Report::Frame

  Represents a frame of the report.
- class anonymous_namespace{libloadplay.cpp}::Emulator

  Instances of this class represent an emulator session.
- struct anonymous_namespace{libloadplay.cpp}::Emulator::Core

  Per core information. More...
- class anonymous_namespace{libloadplay.cpp}::Main

  Singleton class representing the main execution environment.
- class anonymous_namespace{libloadplay.cpp}::Hold< T >

  Sets a referenced variable to a given value and restores it when going out of context.

Namespaces

- anonymous_namespace{libloadplay.cpp}

  File local scope.

Typedefs

- using anonymous_namespace{libloadplay.cpp}::cycles_t = uint64_t

  Clock cycle counting type.
- template<auto Ownership>
  using anonymous_namespace{libloadplay.cpp}::ofile = io::file< Ownership, io::write >

  Output file type alias.
- template<auto Ownership>
  using anonymous_namespace{libloadplay.cpp}::ifile = io::file< Ownership, io::read >

  Input file type alias.

Functions

- template<size_t Size>
  int anonymous_namespace{libloadplay.cpp}::strcmp (char const ∗const s1, char const (&s2)[Size])

  Safe wrapper around strncmp, which automatically determines the buffer size of s2.
- std::regex anonymous_namespace{libloadplay.cpp}::operator""_r (char const ∗const str, size_t const len)

  User defined literal for regular expressions.
- template<typename ... ArgTs>
  constexpr void anonymous_namespace{libloadplay.cpp}::dprintf (ArgTs &&... args)

  Calls io::ferr.printf(...) if built with -DEBUG.
- template<> std::string anonymous_namespace{libloadplay.cpp}::SysctlValue::get< std::string > () const

  Returns a copy of the value string.
- template<typename... MsgTs>
  ofile< io::link > anonymous_namespace{libloadplay.cpp}::debug (MsgTs &&... msg)

  Print a debugging message if built with -DEBUG.

- template<typename... MsgTs>
  ofile< io::link > anonymous_namespace{libloadplay.cpp}::warn (MsgTs &&... msg)

  Print a warning.
- int anonymous_namespace{libloadplay.cpp}::sys_result (int const result)

  Combine sys_results with a computed result.
- template<typename... MsgTs>
  ofile< io::link > anonymous_namespace{libloadplay.cpp}::fail (MsgTs &&... msg)

  This prints an error message and sets sys_results to make the hijacked process fail.
- ofile< io::link > anonymous_namespace{libloadplay.cpp}::operator<< (ofile< io::link > fout, Core↩
  FrameReport const &frame)

  Print recorded and running clock frequency and load for a frame.
- int sysctl (const int ∗name, u_int namelen, void ∗oldp, size_t ∗oldlenp, const void ∗newp, size_t newlen)

  Functions to intercept.
- int sysctlnametomib (const char ∗name, int ∗mibp, size_t ∗sizep)

  Intercept calls to sysctlnametomib().
- int daemon (int, int)

  Intercept calls to daemon().
- uid_t geteuid (void)

  Intercept calls to geteuid().
- pidfh ∗ pidfile_open (const char ∗, mode_t, pid_t ∗)

  Intercept calls to pidfile_open().
- int pidfile_write (pidfh ∗)

  Intercept calls to pidfile_write().
- int pidfile_close (pidfh ∗)

  Intercept calls to pidfile_close().
- int pidfile_remove (pidfh ∗)

  Intercept calls to pidfile_remove().
- int pidfile_fileno (pidfh const ∗)

  Intercept calls to pidfile_fileno().

Variables

- constexpr const flag_t anonymous_namespace{libloadplay.cpp}::FEATURES

  The set of supported features.
- int anonymous_namespace{libloadplay.cpp}::sys_results = 0

  The success return value of intercepted functions.
- class anonymous_namespace{libloadplay.cpp}::Sysctls anonymous_namespace{libloadplay.cpp}::sysctls

  Sole instance of Sysctls.
- bool anonymous_namespace{libloadplay.cpp}::sysctl_startup = true

  Set to activate fallback to the original sysctl functions.
- class anonymous_namespace{libloadplay.cpp}::Main anonymous_namespace{libloadplay.cpp}::main

  Sole instance of Main.

15.6.1 Detailed Description

Implements a library intended to be injected into a clock frequency deamon via LD_PRELOAD.

This library reads instructions from io::fin (stdin) and outputs statistics about the hijacked process on io::fout (stdout).

The following environment variables affect the operation of loadplay:

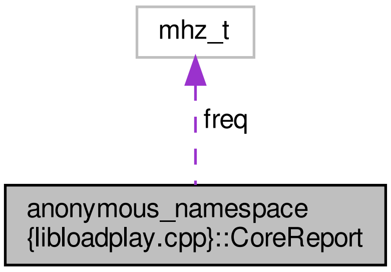
Variable	Description
LOADPLAY_IN	Alternative input file
LOADPLAY_O↩ UT	Alternative output file

15.6.2 Class Documentation

15.6.2.1 struct anonymous_namespace{libloadplay.cpp}::CoreReport

The reported state of a single CPU pipeline.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::CoreReport:



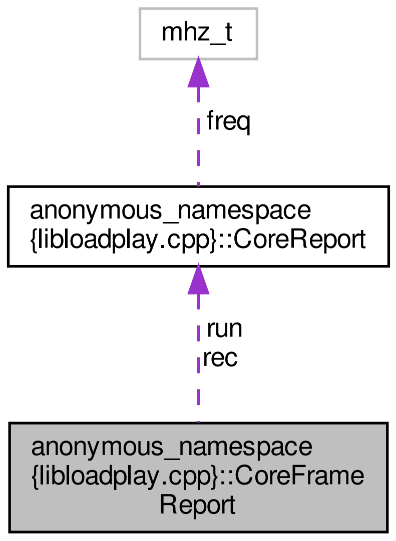
Class Members

mhz_t	freq	The core clock frequency in [MHz].
double	load	The core load as a fraction.

15.6.2.2 struct anonymous_namespace{libloadplay.cpp}::CoreFrameReport

The report frame information for a single CPU pipeline.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::CoreFrameReport:


mhz_t
freq
anonymous_namespace {libloadplay.cpp}::CoreReport
run
rec
anonymous_namespace {libloadplay.cpp}::CoreFrame Report

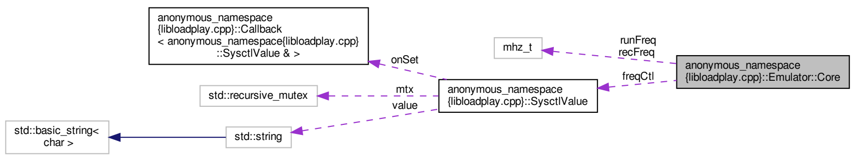
Class Members

CoreReport	rec	The recorded core state.
CoreReport	run	The running core state.

15.6.2.3 struct anonymous_namespace{libloadplay.cpp}::Emulator::Core

Per core information.

Collaboration diagram for anonymous_namespace{libloadplay.cpp}::Emulator::Core:


anonymous_namespace {libloadplay.cpp}::Callback < anonymous_namespace{libloadplay.cpp} ::SysctlValue & >
mhz_t
runFreq
recFreq
anonymous_namespace {libloadplay.cpp}::Emulator::Core
onSet
freqCtl
std::recursive_mutex
mtx
anonymous_namespace {libloadplay.cpp}::SysctlValue
value
std::basic_string< char >
std::string

Class Members

cycles_t	carryCycles[CPUSTATES]	The cycles carried over to the next frame in [cycles]. This is determined at the beginning of frame and used to calculated the simulation load at the beginning of the next frame.
SysctlValue ∗	freqCtl	The sysctl handler. The constructor ensures this points to a valid handler.

Class Members

mhz_t	recFreq	The recorded clock frequency. If FREQ_TRACKING is enabled this is updated at during the preliminary stage and used at the beginning of frame stage.
mhz_t	runFreq	The clock frequency the simulation is running at. Updated at the end of frame and used in the next frame.
cycles_t	runLoadCycles	The load cycles simulated for this frame in [cycles]. This is determined at the beginning of frame and used to calculate the reported load at the end of frame.

15.6.3 Function Documentation

15.6.3.1 daemon()

```
int daemon (
        int ,
        int  )
```

Intercept calls to daemon().

Prevents process from separating from the controlling terminal.

Returns

The value of sys_results

15.6.3.2 geteuid()

```
uid_t geteuid (
        void  )
```

Intercept calls to geteuid().

Tells the asking process that it is running as root.

Returns

Always returns 0

15.6.3.3 pidfile_close()

```
int pidfile_close (
        pidfh *  )
```

Intercept calls to pidfile_close().

Returns

The value of sys_results

15.6.3.4 pidfile_fileno()

```
int pidfile_fileno (
        pidfh const * )
```

Intercept calls to pidfile_fileno().

Returns

The value of sys_results

15.6.3.5 pidfile_open()

```
pidfh* pidfile_open (
        const char * ,
        mode_t ,
        pid_t * )
```

Intercept calls to pidfile_open().

Prevents pidfile locking and creation by the hijacked process.

Returns

A dummy pointer

15.6.3.6 pidfile_remove()

```
int pidfile_remove (
        pidfh * )
```

Intercept calls to pidfile_remove().

Returns

The value of sys_results

15.6.3.7 pidfile_write()

```
int pidfile_write (
        pidfh * )
```

Intercept calls to pidfile_write().

Returns

The value of sys_results

15.6.3.8 sysctl()

```
int sysctl (
    const int * name,
    u_int namelen,
    void * oldp,
    size_t * oldlenp,
    const void * newp,
    size_t newlen )
```

Functions to intercept.

Intercept calls to sysctl().

Uses the local anonymous_namespace{libloadplay::cpp}::sysctls store.

Falls back to the original under the following conditions:

- sysctl_startup is set
- The mib is not known to the simulation

The call may fail for 3 reasons:

1. The fail() function was called and sys_results was assigned -1
2. A target buffer was too small (errno == ENOMEM)
3. The given sysctl is not in the sysctls store (errno == ENOENT)

Parameters

name,namelen,oldp,oldlenp,newp,newlen	Please refer to sysctl(3)

Return values

0	The call succeeded
-1	The call failed

15.6.3.9 sysctlnametomib()

```
int sysctlnametomib (
    const char * name,
    int * mibp,
    size_t * sizep )
```

Intercept calls to sysctlnametomib().

Parameters

name,mibp,sizep	Please refer to sysctl(3)

Return values

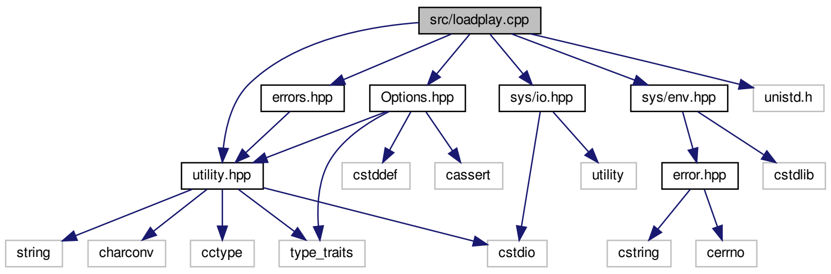
0	The call succeeded
-1	The call failed

15.7 src/loadplay.cpp File Reference

Implements loadplay, a bootstrapping tool for libloadplay.

```
#include "Options.hpp"
#include "errors.hpp"
#include "utility.hpp"
#include "sys/env.hpp"
#include "sys/io.hpp"
#include <unistd.h>
```

Include dependency graph for loadplay.cpp:



Namespaces

- anonymous_namespace{loadplay.cpp}

  File local scope.

Enumerations

- enum anonymous_namespace{loadplay.cpp}::OE {
  anonymous_namespace{loadplay.cpp}::OE::USAGE, anonymous_namespace{loadplay.cpp}::OE::FILE_IN,
  anonymous_namespace{loadplay.cpp}::OE::FILE_OUT, anonymous_namespace{loadplay.cpp}::OE::CMD,
  anonymous_namespace{loadplay.cpp}::OE::OPT_NOOPT = CMD, anonymous_namespace{loadplay.cpp}::OE::OPT_UNKNO
  anonymous_namespace{loadplay.cpp}::OE::OPT_DASH, anonymous_namespace{loadplay.cpp}::OE::OPT_LDASH,
  anonymous_namespace{loadplay.cpp}::OE::OPT_DONE }

  An enum for command line parsing.

Functions

- const char ∗ anonymous_namespace{loadplay.cpp}::filename (char const ∗const path)

  Performs very rudimentary file name argument checks.
- void anonymous_namespace{loadplay.cpp}::execute (char const ∗const file, char ∗const argv[ ])

  Executes the given command, substituting this process.
- void anonymous_namespace{loadplay.cpp}::set_library_path (int const argc, char ∗const argv[ ])

  If running from an explicit path add the path to the library search path.
- int main (int argc, char ∗argv[ ])

  Parse command line arguments and execute the given command.

Variables

- const char ∗const anonymous_namespace{loadplay.cpp}::USAGE = "[-h] [-i file] [-o file] command [...]"

  The short usage string.
- const Parameter< OE > anonymous_namespace{loadplay.cpp}::PARAMETERS [ ]

  Definitions of command line parameters.

15.7.1 Detailed Description

Implements loadplay, a bootstrapping tool for libloadplay.

15.7.2 Function Documentation

15.7.2.1 main()

```
int main (
    int argc,
    char ∗ argv[] )
```

Parse command line arguments and execute the given command.

Parameters

argc,argv	The command line arguments

Returns

An exit code

See also

Exit

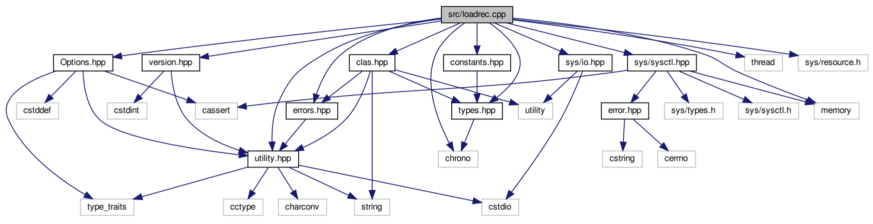
15.8 src/loadrec.cpp File Reference

Implements a load recorder, useful for simulating loads to test CPU clock daemons and settings.

```
#include "Options.hpp"
#include "types.hpp"
#include "constants.hpp"
#include "errors.hpp"
#include "utility.hpp"
#include "clas.hpp"
#include "version.hpp"
#include "sys/io.hpp"
#include "sys/sysctl.hpp"
#include <chrono>
#include <thread>
```

```
#include <memory>
#include <sys/resource.h>
```

Include dependency graph for loadrec.cpp:



Namespaces

- anonymous_namespace{loadrec.cpp}

    File local scope.

Typedefs

- template<auto Ownership>
  using anonymous_namespace{loadrec.cpp}::ofile = io::file< Ownership, io::write >

    Output file type alias.

Enumerations

- enum anonymous_namespace{loadrec.cpp}::OE {
  anonymous_namespace{loadrec.cpp}::OE::USAGE, anonymous_namespace{loadrec.cpp}::OE::IVAL_DURATION,
  anonymous_namespace{loadrec.cpp}::OE::IVAL_POLL, anonymous_namespace{loadrec.cpp}::OE::FILE_OUTPUT,
  anonymous_namespace{loadrec.cpp}::OE::FILE_PID, anonymous_namespace{loadrec.cpp}::OE::FLAG_VERBOSE,
  anonymous_namespace{loadrec.cpp}::OE::OPT_UNKNOWN, anonymous_namespace{loadrec.cpp}::OE::OPT_NOOPT,
  anonymous_namespace{loadrec.cpp}::OE::OPT_DASH, anonymous_namespace{loadrec.cpp}::OE::OPT_LDASH,
  anonymous_namespace{loadrec.cpp}::OE::OPT_DONE }

    An enum for command line parsing.

Functions

- template<typename... MsgTs>
  void anonymous_namespace{loadrec.cpp}::verbose (MsgTs &&... msg)

    Outputs the given printf style message on stderr if g.verbose is set.
- void anonymous_namespace{loadrec.cpp}::init ()

    Set up output to the given file.
- void anonymous_namespace{loadrec.cpp}::read_args (int const argc, char const ∗const argv[ ])

    Parse command line arguments.
- void anonymous_namespace{loadrec.cpp}::print_sysctls ()

    Print the sysctls.
- void anonymous_namespace{loadrec.cpp}::run ()

    Report the load frames.
- int main (int argc, char ∗argv[ ])

    Main routine, setup and execute daemon, print errors.

Variables

- constexpr const flag_t anonymous_namespace{loadrec.cpp}::FEATURES

  The set of supported features.
- struct {
  bool **verbose** {false}
  Verbosity flag.
  ms **duration** {30000}
  Recording duration in ms.
  ms **interval** {25}
  Recording sample interval in ms.
  ofile< io::link > **fout** = io::fout
  The output stream either io::fout (stdout) or a file.
  const char ∗ **outfilename** {nullptr}
  The user provided output file name.
  const SysctlOnce< coreid_t, 2 > **ncpu** {1U, {CTL_HW, HW_NCPU}}
  The number of CPU cores/threads.
  } anonymous_namespace{loadrec.cpp}::g

  The global state.
- const char ∗const anonymous_namespace{loadrec.cpp}::USAGE = "[-hv] [-d ival] [-p ival] [-o file]"

  The short usage string.
- const Parameter< OE > anonymous_namespace{loadrec.cpp}::PARAMETERS [ ]

  Definitions of command line parameters.

15.8.1 Detailed Description

Implements a load recorder, useful for simulating loads to test CPU clock daemons and settings.

15.8.2 Function Documentation

15.8.2.1 main()

```
int main (
    int argc,
    char ∗ argv[] )
```

Main routine, setup and execute daemon, print errors.

Parameters

argc,argv	The command line arguments

Returns

An exit code

See also

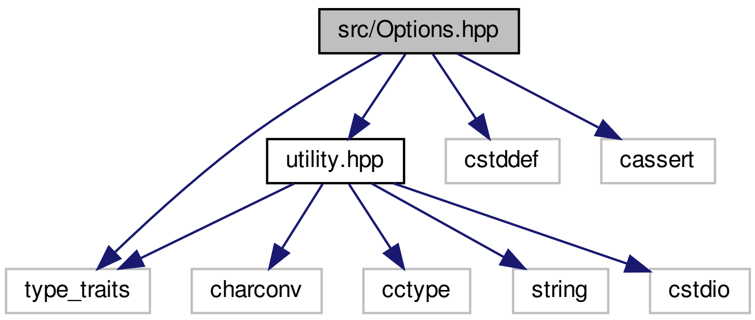
Exit

15.9 src/Options.hpp File Reference

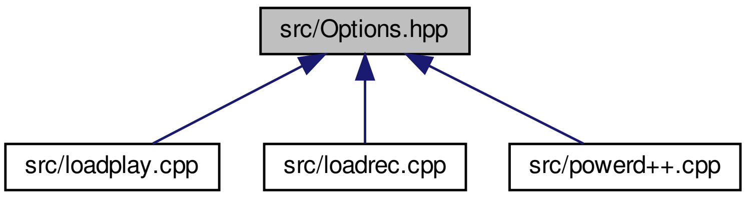
Provides the nih::Options functor template, a substitute for `getopt(3)`.

```
#include "utility.hpp"
#include <cstddef>
#include <type_traits>
#include <cassert>
```

Include dependency graph for Options.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct nih::enum_has_members< OptionT, class >

  Tests whether the given enum provides all the required definitions.
- struct nih::Parameter< OptionT >

  Container for an option definition. More...
- class nih::Options< OptionT, DefCount >

  An instance of this class offers operators to retrieve command line options and arguments.

Namespaces

- nih

  Not invented here namespace, for code that substitutes already commonly available functionality.

Functions

- template<class OptionT >
  size_t nih::argCount (Parameter< OptionT > const &def)

  Retrieves the count of arguments in an option definition.

15.9.1 Detailed Description

Provides the nih::Options functor template, a substitute for `getopt(3)`.

The `getopt(3)` interface takes the command line arguments as `char * const` instead of `char const *`. I.e. it reserves the right to mutate the provided arguments, which it actually does.

The nih::Options functor is not a drop in substitute, but tries to be easily adoptable and does not change the data entrusted to it.

To use the options an enum or enum class is required, e.g.:

```
enum class MyOptions {
    USAGE, FILE_IN, FILE_OUT, FLAG_VERBOSE,
    OPT_UNKNOWN, OPT_NOOPT, OPT_DASH, OPT_LDASH, OPT_DONE
};
```

The options prefixed with `OPT_` are obligatory. Their meaning is documented in nih::enum_has_members<>. Their presence is validated at compile time.

The enum values are returned when matching the next argument to a parameter. In order to do that a usage string and a list of parameter definitions are required:

```
static char const * const USAGE = "[-hv] [-i file] [-o file] [command ...]";
static nih::Parameter<MyOptions> const PARAMETERS[]{
    {MyOptions::USAGE,        'h', "help",    "",     "Show this help"},
    {MyOptions::USAGE,         0,  "usage",   "",     ""},
    {MyOptions::FILE_IN,      'i', "in",      "file", "Input file"},
    {MyOptions::FILE_OUT,     'o', "out",     "file", "Output file"},
    {MyOptions::FLAG_VERBOSE, 'v', "verbose", "",     "Verbose output"}
};
```

Each entry in the array defines a parameter consisting of the following:

Field	Meaning
`option`	The option symbol (enum value)
`sparam`	An optional parameter character (short parameter)
`lparam`	An optional long parameter string
`args`	A comma separated list of parameter arguments
`usage`	A descriptive string

Multiple parameters may be mapped to a single option (e.g. `--help` and `--usage`). Parameters without arguments are called flags. It is possible to map parameters with different numbers of arguments to a single option, but this is arguably semantically confusing and should not be done.

Multiple flags' parameter characters can be concatenated in an argument. A parameter with arguments' character can appear at the end of a character chain. The first argument to the parameter may be concatenated as well. E.g. `-v -i file`, `-vi file` and `-vifile` are all equivalent. Parameters' string representations always stand alone, they can neither be combined with each other nor with parameter characters. E.g. `--verbose --in file` is the equivalent parameter string representation.

The usage string and the parameter usage strings are used to assemble the string provided by the nih::Options<>::usage() method.

The parameter definitions must be passed to nih::Options constructor to create the functor:

```
#include <iostream>
...
int main(int argc, char * argv[]) {
    char const * infile = "-";
    char const * outfile = "-";
    bool verbose = false;
    auto getopt = nih::Options{argc, argv, USAGE, PARAMETERS};
    while (true) switch (getopt()) { // get new option/argument
    case MyOptions::USAGE:
        std::cerr << getopt.usage(); // show usage
        return 0;
    case MyOptions::FILE_IN:
        infile = getopt[1]; // get first argument
        break;
    case MyOptions::FILE_OUT:
        outfile = getopt[1]; // get first argument
        break;
    case MyOptions::FLAG_VERBOSE:
        verbose = true;
        break;
    case MyOptions::OPT_UNKNOWN:
    case MyOptions::OPT_NOOPT:
    case MyOptions::OPT_DASH:
    case MyOptions::OPT_LDASH:
        std::cerr << "Unexpected command line argument: "
                  << getopt[0] << '\n'; // output option/argument
        return 1;
    case MyOptions::OPT_DONE:
        return do_something(infile, outfile, verbose);
    }
    return 0;
}
```

Every call of the functor moves on to the next parameter or argument. For non-option arguments it returns `OPT_NOOPT`.

The `getopt[1]` calls return the first argument following the option. It is possible to retrieve more arguments than were defined in the options definition. The `[]` opterator always returns a valid, terminated string (provided the command line arguments are valid, terminated strings). So it is always safe to dereference the pointer, even when reading beyond the end of command line arguments.

The `getopt[0]` calls return the command line argument that contains the selected option. So in the `FILE_IN` case it could be any of `-i`, `--in`, `-vi`, `-ifile` or `-vifile`. This is useful for the `OPT_UNKNOWN` and `OPT_NOOPT` cases. The `getopt[1]` call on the other hand would return `file` regardless of argument chaining.

15.9.2 Class Documentation

15.9.2.1 struct nih::Parameter

template<class OptionT>
struct nih::Parameter< OptionT >

Container for an option definition.

Aliases can be defined by creating definitions with the same option member.

The lparam, args and usage members have to be 0 terminated, using string literals is safe.

Template Parameters

OptionT	An enum or enum class representing the available options

Class Members

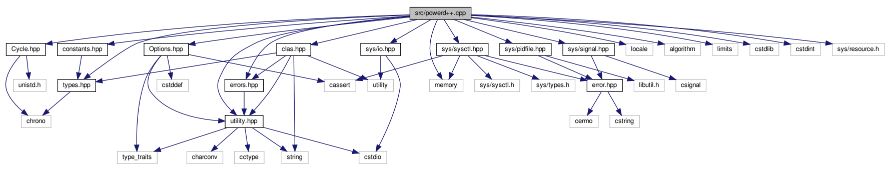
const char ∗	args	A comma separated list of arguments. Set to nullptr or "" if no argument is available.
const char ∗	lparam	The long version of this parameter. Set to nullptr or "" if no long parameter is available.
OptionT	option	The enum value to return for this option.
char	sparam	The short version of this parameter. Set to 0 if no short parameter is available.
const char ∗	usage	A usage string.

15.10 src/powerd++.cpp File Reference

Implements powerd++ a drop in replacement for FreeBSD's powerd.

```
#include "Options.hpp"
#include "Cycle.hpp"
#include "types.hpp"
#include "constants.hpp"
#include "errors.hpp"
#include "clas.hpp"
#include "utility.hpp"
#include "sys/sysctl.hpp"
#include "sys/pidfile.hpp"
#include "sys/signal.hpp"
#include "sys/io.hpp"
#include <locale>
#include <memory>
#include <algorithm>
#include <limits>
#include <cstdlib>
#include <cstdint>
#include <sys/resource.h>
```

Include dependency graph for powerd++.cpp:



Classes

- struct anonymous_namespace{powerd++.cpp}::CoreGroup

  Contains the management information for a group of cores with a common clock frequency. More...
- struct anonymous_namespace{powerd++.cpp}::Core

  Contains the management information for a single CPU core. More...
- struct anonymous_namespace{powerd++.cpp}::Global

  A collection of all the gloabl, mutable states.
- struct anonymous_namespace{powerd++.cpp}::Global::ACSet

  Per AC line state settings. More...
- class anonymous_namespace{powerd++.cpp}::FreqGuard

  A core frequency guard.

Namespaces

- anonymous_namespace{powerd++.cpp}

    File local scope.

Enumerations

- enum anonymous_namespace{powerd++.cpp}::AcLineState : unsigned int { anonymous_namespace{powerd++.cpp}::AcLineS
anonymous_namespace{powerd++.cpp}::AcLineState::ONLINE, anonymous_namespace{powerd++.cpp}::AcLineState::UNK
anonymous_namespace{powerd++.cpp}::AcLineState::LENGTH }

    The available AC line states.
- enum anonymous_namespace{powerd++.cpp}::OE {
anonymous_namespace{powerd++.cpp}::OE::USAGE, anonymous_namespace{powerd++.cpp}::OE::MODE_AC,
anonymous_namespace{powerd++.cpp}::OE::MODE_BATT, anonymous_namespace{powerd++.cpp}::OE::FREQ_MIN,
anonymous_namespace{powerd++.cpp}::OE::FREQ_MAX, anonymous_namespace{powerd++.cpp}::OE::FREQ_MIN_AC,
anonymous_namespace{powerd++.cpp}::OE::FREQ_MAX_AC, anonymous_namespace{powerd++.cpp}::OE::FREQ_MIN_BA
anonymous_namespace{powerd++.cpp}::OE::FREQ_MAX_BATT, anonymous_namespace{powerd++.cpp}::OE::FREQ_RANG
anonymous_namespace{powerd++.cpp}::OE::FREQ_RANGE_AC, anonymous_namespace{powerd++.cpp}::OE::FREQ_RANG
anonymous_namespace{powerd++.cpp}::OE::HITEMP_RANGE, anonymous_namespace{powerd++.cpp}::OE::MODE_UNKN
anonymous_namespace{powerd++.cpp}::OE::TEMP_CTL, anonymous_namespace{powerd++.cpp}::OE::IVAL_POLL,
anonymous_namespace{powerd++.cpp}::OE::FILE_PID, anonymous_namespace{powerd++.cpp}::OE::FLAG_VERBOSE,
anonymous_namespace{powerd++.cpp}::OE::FLAG_FOREGROUND, anonymous_namespace{powerd++.cpp}::OE::FLAG_N
anonymous_namespace{powerd++.cpp}::OE::CNT_SAMPLES, anonymous_namespace{powerd++.cpp}::OE::IGNORE,
anonymous_namespace{powerd++.cpp}::OE::OPT_UNKNOWN, anonymous_namespace{powerd++.cpp}::OE::OPT_NOOPT
anonymous_namespace{powerd++.cpp}::OE::OPT_DASH, anonymous_namespace{powerd++.cpp}::OE::OPT_LDASH,
anonymous_namespace{powerd++.cpp}::OE::OPT_DONE }

    An enum for command line parsing.

Functions

- template<typename... MsgTs>
void anonymous_namespace{powerd++.cpp}::verbose (MsgTs &&... msg)

    Outputs the given printf style message on stderr if g.verbose is set.
- void anonymous_namespace{powerd++.cpp}::sysctl_fail (sys::sc_error< sys::ctl::error > const err)

    Treat sysctl errors.
- void anonymous_namespace{powerd++.cpp}::init ()

    Perform initial tasks.
- template<bool Load = 1, bool Temperature = 0>
void anonymous_namespace{powerd++.cpp}::update_loads ()

    Updates the cp_times ring buffer and computes the load average for each core.
- template<> void anonymous_namespace{powerd++.cpp}::update_loads< 0, 0 > ()

    Do nada if neither load nor temperature are to be updated.
- template<bool Foreground, bool Temperature, bool Fixed>
void anonymous_namespace{powerd++.cpp}::update_freq (Global::ACSet const &acstate)

    Update the CPU clocks depending on the AC line state and targets.
- void anonymous_namespace{powerd++.cpp}::update_freq ()

    Dispatch update_freq<>().
- void anonymous_namespace{powerd++.cpp}::init_loads ()

    Fill the loads buffers with n samples.
- void anonymous_namespace{powerd++.cpp}::set_mode (AcLineState const line, char const ∗const str)

    Sets a load target or fixed frequency for the given AC line state.
- void anonymous_namespace{powerd++.cpp}::read_args (int const argc, char const ∗const argv[ ])

Parse command line arguments.
- void anonymous_namespace{powerd++.cpp}::show_settings ()

  Prints the configuration on stderr in verbose mode.
- void anonymous_namespace{powerd++.cpp}::signal_recv (int signal)

  Sets g.signal, terminating the main loop.
- void anonymous_namespace{powerd++.cpp}::run_daemon ()

  Daemonise and run the main loop.
- int main (int argc, char ∗argv[ ])

  Main routine, setup and execute daemon, print errors.

Variables

- struct anonymous_namespace{powerd++.cpp}::Global anonymous_namespace{powerd++.cpp}::g

  The gobal state.
- const char ∗const anonymous_namespace{powerd++.cpp}::USAGE = "[-hvfN] [-abn mode] [-mM freq] [-FAB freq:freq] [-H temp:temp] [-t sysctl] [-p ival] [-s cnt] [-P file]"

  The short usage string.
- const Parameter< OE > anonymous_namespace{powerd++.cpp}::PARAMETERS [ ]

  Definitions of command line parameters.

15.10.1 Detailed Description

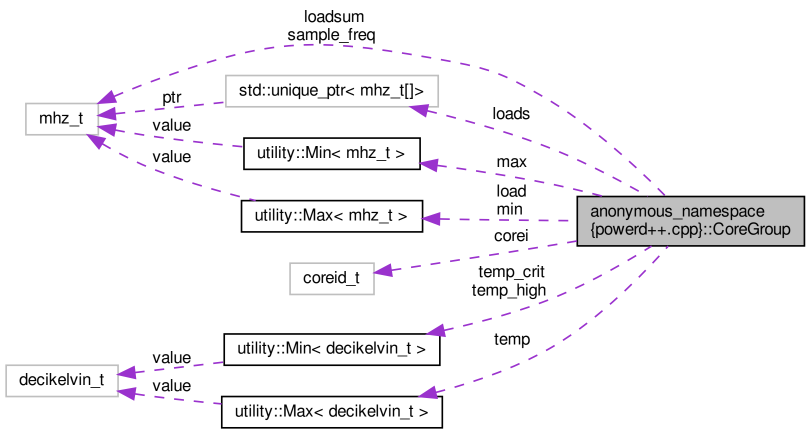
Implements powerd++ a drop in replacement for FreeBSD's powerd.

15.10.2 Class Documentation

15.10.2.1 struct anonymous_namespace{powerd++.cpp}::CoreGroup

Contains the management information for a group of cores with a common clock frequency.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::CoreGroup:



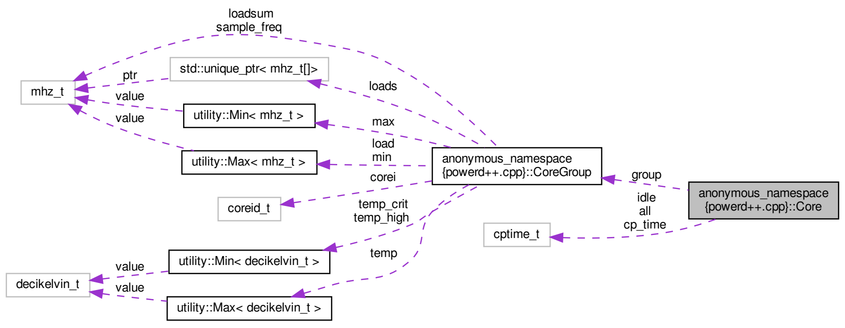
Class Members

coreid_t	corei	The number of the core owning dev.cpu. d.freq.
SysctlSync< mhz_t >	freq	The sysctl dev.cpu. d.freq.
Max< mhz_t >	load	The maximum load reported by all cores in the group. This is updated by update_loads().
unique_ptr< mhz_t[ ]>	loads	A ring buffer of maximum load samples for this core group. Each maximum load sample is weighted with the core frequency at which it was taken. This is updated by update_loads().
mhz_t	loadsum	The maximum load sum of all controlled cores. This is updated by update_loads().
Min< mhz_t >	max	The maximum group clock rate. The least of all core maxima in the group.
Max< mhz_t >	min	The minimum group clock rate. The greatest of all core minima in the group.
mhz_t	sample_freq	The dev.cpu. d.freq value for the current load sample. This is updated by update_loads().
Max< decikelvin_t >	temp	The maximum temperature measurement taken in the group.
Min< decikelvin_t >	temp_crit	Critical core temperature in dK.
Min< decikelvin_t >	temp_high	High core temperature in dK.

15.10.2.2 struct anonymous_namespace{powerd++.cpp}::Core

Contains the management information for a single CPU core.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::Core:



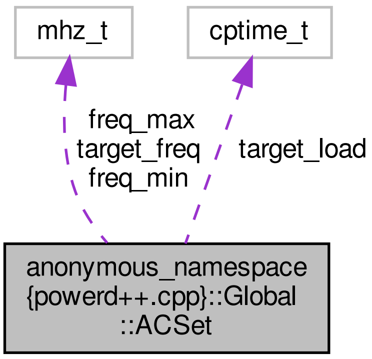
Class Members

cptime_t	all	Count of all ticks.
const cptime_t *	cp_time	A pointer to the kern.cp_times section for this core.
CoreGroup *	group	The core that controls the frequency for this core.
cptime_t	idle	The idle ticks count.
SysctlSync< decikelvin_t >	temp	The dev.cpu. d.temperature sysctl, if present.

15.10.2.3 struct anonymous_namespace{powerd++.cpp}::Global::ACSet

Per AC line state settings.

Collaboration diagram for anonymous_namespace{powerd++.cpp}::Global::ACSet:



Class Members

mhz_t	freq_max	Highest frequency to set in MHz.
mhz_t	freq_min	Lowest frequency to set in MHz.
const char ∗const	name	The string representation of this state.
mhz_t	target_freq	Fixed clock frequencies to use if the target load is set to 0.
cptime_t	target_load	Target load times [0, 1024]. The value 0 indicates the corresponding fixed frequency setting from target_freqs should be used.

15.10.3 Function Documentation

15.10.3.1 main()

```
int main (
    int argc,
    char * argv[] )
```

Main routine, setup and execute daemon, print errors.

Parameters

argc,argv	The command line arguments

Returns

An exit code

See also

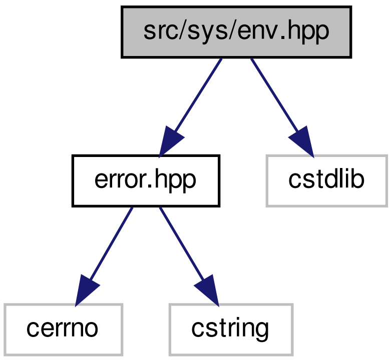
Exit

15.11 src/sys/env.hpp File Reference

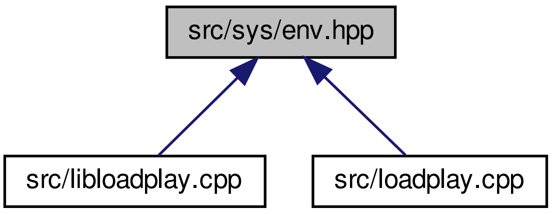
Implements zero-cost abstractions for the getenv(3) facilities.

```
#include "error.hpp"
#include <cstdlib>
```

Include dependency graph for env.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct sys::env::error

  The domain error type. More...
- class sys::env::Var

  A reference type refering to an environment variable.
- struct sys::env::Vars

  A singleton class providing access to environment variables.

Namespaces

- sys

  Wrappers around native system interfaces.
- sys::env

  Provides wrappers around the getenv() family of functions.

Variables

- struct sys::env::Vars sys::env::vars

  Singleton providing access to environment variables.

15.11.1 Detailed Description

Implements zero-cost abstractions for the getenv(3) facilities.

15.11.2 Class Documentation

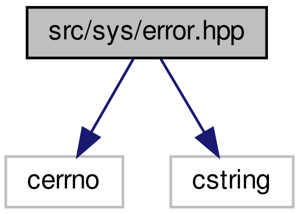
15.11.2.1 struct sys::env::error

The domain error type.

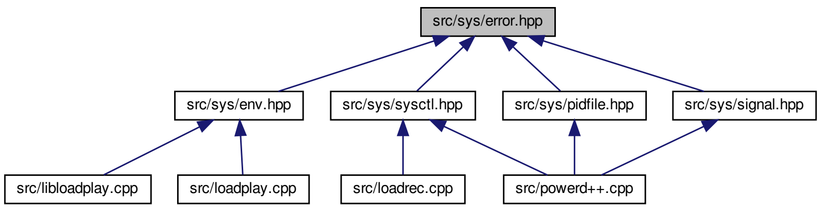
15.12 src/sys/error.hpp File Reference

Provides system call error handling.

```
#include <cerrno>
#include <cstring>
```
Include dependency graph for error.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct sys::sc_error< Domain >

  Can be thrown by syscall function wrappers if the function returned with an error.

Namespaces

- sys

  Wrappers around native system interfaces.

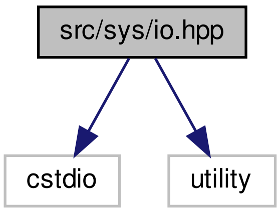
15.12.1 Detailed Description

Provides system call error handling.

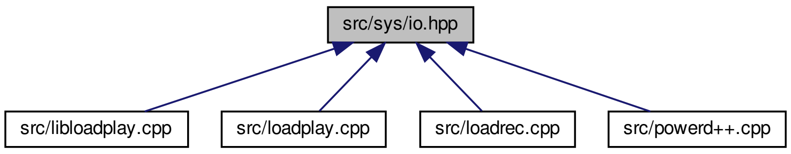
15.13 src/sys/io.hpp File Reference

Implements c++ wrappers for <cstdio> I/O functionality.

```
#include <cstdio>
#include <utility>
```
Include dependency graph for io.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- class sys::io::file< Ownership, Features >

  Produces file access types around the C file handling facilities. More...
- struct sys::io::enable_if< bool, T >

  Similar to std::enable_if, but it also has the value of the expression.
- struct sys::io::enable_if< false, T >

  Specialise enable_if for a false expression.
- struct sys::io::set< Set >

  Pack a set of integral values in a type. More...
- struct sys::io::contains< SetT, Value >

  Check whether a set type contains a value. More...
- struct sys::io::contains< set< Set ... >, Value >

  Specialise io::contains to unpack io::set.
- struct sys::io::is_superset_of< LSetT, RSetT >

  Check whether the left hand set is a superest of the right hand set. More...
- struct sys::io::is_superset_of< LSetT, set< RSet ... > >

  Specialise is_superset_of to unpack the right hand io::set.
- struct sys::io::query

  Ask questions about the contents of a string. More...
- struct sys::io::query::contains_ftor

  Test a string whether it contains a set of characters.
- class sys::io::file_feature< FileT,... >

  Implements the base functionality of all file access types.
- class sys::io::file_feature< FileT, read, Tail ... >

  Implement read support for file types.
- class sys::io::file_feature< FileT, write, Tail ... >

  Implement write support for file types.
- class sys::io::file_feature< FileT, seek, Tail ... >

  Implement seek support for file types.
- class sys::io::file< own, Features ... >

  Specialise for FILE object owning file instances.
- class sys::io::file< link, Features ... >

  Specialise for FILE object linking file instances.

Namespaces

- sys

  Wrappers around native system interfaces.
- sys::io

  This namespace contains c++ wrappers for <cstdio> functionality.

Typedefs

- template<class SetT , auto Value>
  using sys::io::contains_t = typename contains< SetT, Value >::type

  Check whether a set type contains a value.
- template<class LSetT , class RSetT >
  using sys::io::is_superset_of_t = typename is_superset_of< LSetT, RSetT >::type

  Check whether the left hand set is a superest of the right hand set.

Enumerations

- enum sys::io::feature { sys::io::feature::read, sys::io::feature::write, sys::io::feature::seek }

    Feature flags for file type composition.
- enum sys::io::ownership { sys::io::ownership::own, sys::io::ownership::link }

    Ownership relation to the underlying FILE object.

Variables

- template<class SetT , auto Value>
  constexpr const auto sys::io::contains_v = contains<SetT, Value>::value

    Check whether a set type contains a value.
- template<class LSetT , class RSetT >
  constexpr const auto sys::io::is_superset_of_v = is_superset_of<LSetT, RSetT>::value

    Check whether the left hand set is a superest of the right hand set.
- file< link, write > sys::io::ferr {stderr}

    File access instances for stderr.
- file< link, write > sys::io::fout {stdout}

    File access instances for stdout.
- file< link, read > sys::io::fin {stdin}

    File access instances for stdin.

15.13.1 Detailed Description

Implements c++ wrappers for <cstdio> I/O functionality.

15.13.2 Class Documentation

15.13.2.1 class sys::io::file

template<ownership Ownership, feature ... Features>
class sys::io::file< Ownership, Features >

Produces file access types around the C file handling facilities.

Template Parameters

Ownership	Determine the ownership relationship to the underlying FILE object
Features	A list of features the file type supports

See also

ownership
feature
file<own, Features ...>
file<link, Features ...>
file_feature

15.13.2.2 struct sys::io::set

template<auto ... Set>
struct sys::io::set< Set >

Pack a set of integral values in a type.

Template Parameters

Set	A set of integral values

15.13.2.3 struct sys::io::contains

template<class SetT, auto Value>
struct sys::io::contains< SetT, Value >

Check whether a set type contains a value.

Template Parameters

SetT	A set of integral values packed in io::set
Value	The value to look up

15.13.2.4 struct sys::io::is_superset_of

template<class LSetT, class RSetT>
struct sys::io::is_superset_of< LSetT, RSetT >

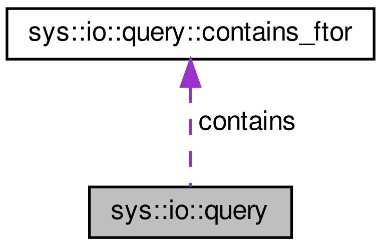
Check whether the left hand set is a superest of the right hand set.

Template Parameters

LSetT,RSetT	Two io::set instances

15.13.2.5 struct sys::io::query Ask questions about the contents of a string.

Collaboration diagram for sys::io::query:



Class Members

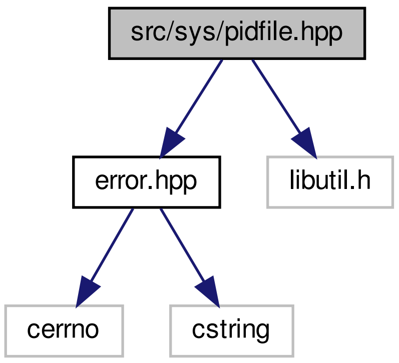
struct contains_ftor	contains	Query the string for characters.

15.14 src/sys/pidfile.hpp File Reference

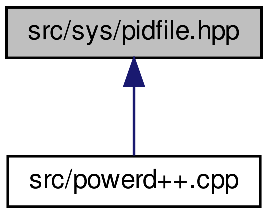
Implements safer c++ wrappers for the pidfile_∗() interface.

```
#include "error.hpp"
#include <libutil.h>
```

Include dependency graph for pidfile.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct sys::pid::error

  The domain error type. More...
- class sys::pid::Pidfile

  A wrapper around the pidfile_∗ family of commands implementing the RAII pattern.

Namespaces

- sys

  Wrappers around native system interfaces.
- sys::pid

  This namespace contains safer c++ wrappers for the pidfile_∗() interface.

15.14.1 Detailed Description

Implements safer c++ wrappers for the pidfile_∗() interface.

Requires linking with -lutil.

15.14.2 Class Documentation

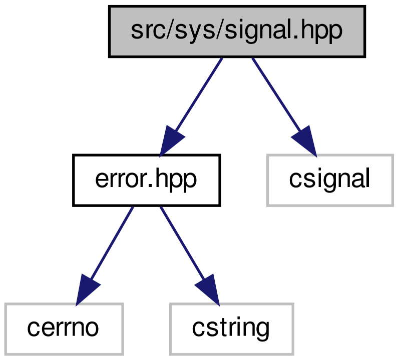
15.14.2.1 struct sys::pid::error The domain error type.

15.15 src/sys/signal.hpp File Reference

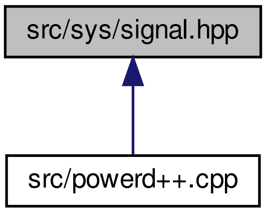
Implements a c++ wrapper for the signal(3) call.

```
#include "error.hpp"
#include <csignal>
```

Include dependency graph for signal.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct sys::sig::error

    The domain error type. More...
- class sys::sig::Signal

    Sets up a given signal handler and restores the old handler when going out of scope.

Namespaces

- sys

    Wrappers around native system interfaces.
- sys::sig

    This namespace provides c++ wrappers for signal(3).

Typedefs

- using sys::sig::sig_t = void(∗)(int)

  Convenience type for signal handlers.

15.15.1 Detailed Description

Implements a c++ wrapper for the signal(3) call.

15.15.2 Class Documentation

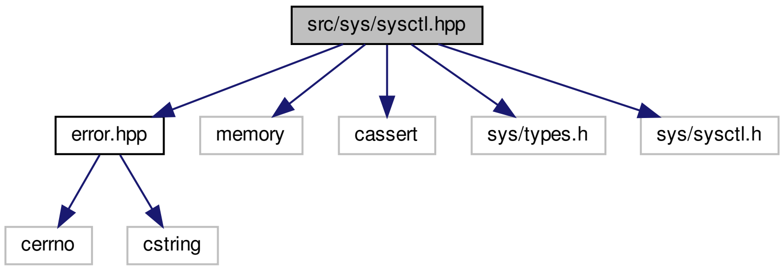
15.15.2.1 struct sys::sig::error The domain error type.

15.16 src/sys/sysctl.hpp File Reference

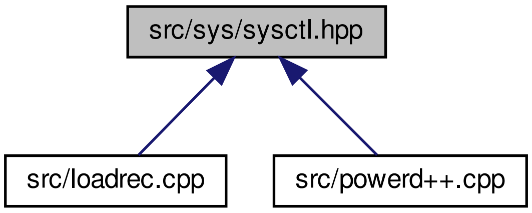
Implements safer c++ wrappers for the sysctl() interface.

```
#include "error.hpp"
#include <memory>
#include <cassert>
#include <sys/types.h>
#include <sys/sysctl.h>
```

Include dependency graph for sysctl.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- struct sys::ctl::error

    The domain error type. More...
- class sys::ctl::Sysctl< MibDepth >

    Represents a sysctl MIB address.
- class sys::ctl::Sysctl< 0 >

    This is a specialisation of Sysctl for sysctls using symbolic names.
- class sys::ctl::Sync< T, SysctlT >

    This is a wrapper around Sysctl that allows semantically transparent use of a sysctl.
- class sys::ctl::Once< T, SysctlT >

    A read once representation of a Sysctl.

Namespaces

- sys

    Wrappers around native system interfaces.
- sys::ctl

    This namespace contains safer c++ wrappers for the sysctl() interface.

Typedefs

- typedef int sys::ctl::mib_t

    Management Information Base identifier type (see sysctl(3)).
- template<typename T , size_t MibDepth = 0>
  using sys::ctl::SysctlSync = Sync< T, Sysctl< MibDepth > >

    A convenience alias around Sync.
- template<typename T , size_t MibDepth = 0>
  using sys::ctl::SysctlOnce = Once< T, Sysctl< MibDepth > >

    A convenience alias around Once.

Functions

- void sys::ctl::sysctl_raw (mib_t const ∗name, u_int const namelen, void ∗const oldp, size_t ∗const oldlenp, void const ∗const newp, size_t const newlen)

    A wrapper around the sysctl() function.
- template<size_t MibDepth>
  void sys::ctl::sysctl_get (mib_t const (&mib)[MibDepth], void ∗const oldp, size_t &oldlen)

    Returns a sysctl() value to a buffer.
- template<size_t MibDepth>
  void sys::ctl::sysctl_set (mib_t const (&mib)[MibDepth], void const ∗const newp, size_t const newlen)

    Sets a sysctl() value.
- template<typename ... ArgTs>
  sys::ctl::Sysctl (mib_t const, ArgTs const ...) -> Sysctl<(1+sizeof...(ArgTs))>

    Create a Sysctl from a set of predefined MIBs.
- sys::ctl::Sysctl (char const ∗const) -> Sysctl< 0 >

    Create a Sysctl<0> by name.
- sys::ctl::Sysctl () -> Sysctl< 0 >

    Default construct a Sysctl<0>.

15.16.1 Detailed Description

Implements safer c++ wrappers for the sysctl() interface.

15.16.2 Class Documentation

15.16.2.1 struct sys::ctl::error

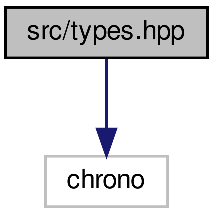
The domain error type.

15.17 src/types.hpp File Reference

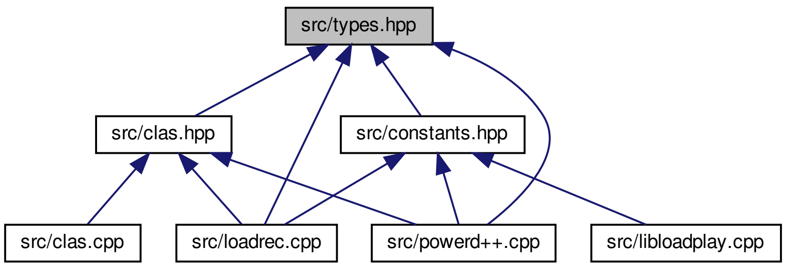
A collection of type aliases.

`#include <chrono>`

Include dependency graph for types.hpp:



This graph shows which files directly or indirectly include this file:



Namespaces

- types

    A collection of type aliases.

Typedefs

- typedef std::chrono::milliseconds types::ms

    Millisecond type for polling intervals.
- typedef int types::coreid_t

    Type for CPU core indexing.
- typedef unsigned long types::cptime_t

    Type for load counting.
- typedef unsigned int types::mhz_t

    Type for CPU frequencies in MHz.
- typedef int types::decikelvin_t

    Type for temperatures in dK.

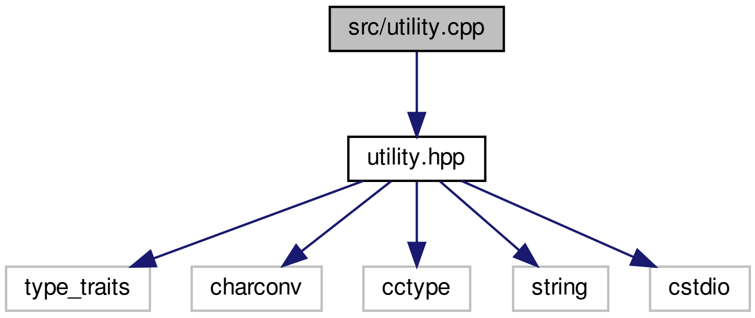
15.17.1 Detailed Description

A collection of type aliases.

15.18 src/utility.cpp File Reference

Implements generally useful functions not intended for inlining.

`#include "utility.hpp"`
Include dependency graph for utility.cpp:



15.18.1 Detailed Description

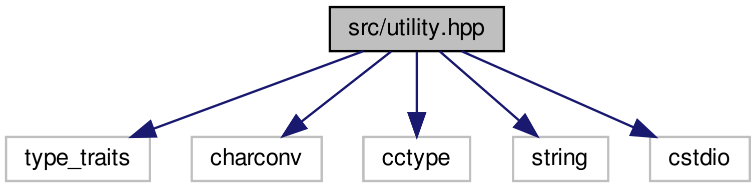
Implements generally useful functions not intended for inlining.

15.19 src/utility.hpp File Reference

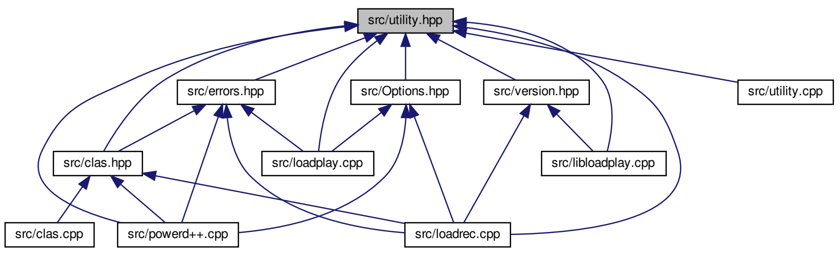
Implements generally useful functions.

```
#include <type_traits>
#include <charconv>
#include <cctype>
#include <string>
#include <cstdio>
```

Include dependency graph for utility.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- class utility::Formatter< BufSize >

  A formatting wrapper around string literals.
- class utility::Sum< T >

  A simple value container only allowing += and copy assignment.
- class utility::Min< T >

  A simple value container that provides the minimum of assigned values.
- class utility::Max< T >

  A simple value container that provides the maximum of assigned values.
- struct utility::FromChars

  A functor for reading numerical values from a string or character array.
- struct utility::Underlined

  A line of text and an underlining line.

Namespaces

- utility

  A collection of generally useful functions.
- utility::literals

  Contains literal operators.

Functions

- template<typename T , size_t Count>
  constexpr size_t utility::countof (T(&)[Count])

  Like sizeof(), but it returns the number of elements an array consists of instead of the number of bytes.
- template<typename... Args>
  void utility::sprintf (Args...)

  This is a safeguard against accidentally using sprintf().
- template<size_t Size, typename... Args>
  int utility::sprintf_safe (char(&dst)[Size], char const ∗const format, Args const ... args)

  A wrapper around snprintf() that automatically pulls in the destination buffer size.
- template<class ET , typename VT = typename std::underlying_type<ET>::type>
  constexpr VT utility::to_value (ET const op)

  Casts an enum to its underlying value.
- constexpr Formatter< 16384 > utility::literals::operator""_fmt (char const ∗const fmt, size_t const)

  Literal to convert a string literal to a Formatter instance.
- Underlined utility::highlight (std::string const &str, ptrdiff_t const offs, ptrdiff_t const len=1)

  Underline the given number of characters.

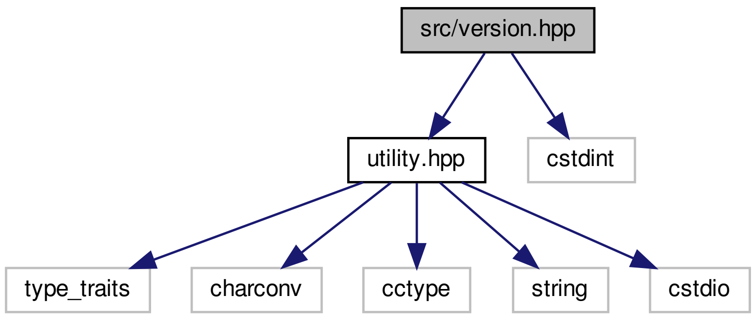
15.19.1 Detailed Description

Implements generally useful functions.

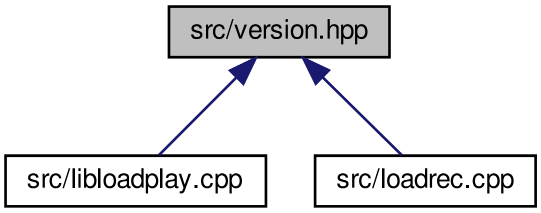
15.20 src/version.hpp File Reference

Defines types and constants used for version management.

```
#include "utility.hpp"
#include <cstdint>
```
Include dependency graph for version.hpp:



This graph shows which files directly or indirectly include this file:



Namespaces

- version
  Version information constants and types.
- version::literals
  Literals to set flag bits.

Typedefs

- typedef uint64_t version::flag_t
  The data type to use for feature flags.

Enumerations

- enum version::LoadrecBits { version::LoadrecBits::FREQ_TRACKING }
  Feature flags for load recordings.

Functions

- constexpr flag_t version::literals::operator""_FREQ_TRACKING (unsigned long long int value)
  Set the FREQ_TRACKING bit.

Variables

- const char ∗const version::LOADREC_FEATURES = "usr.app.powerdxx.loadrec.features"
  The pseudo MIB name for the load recording feature flags.

15.20.1 Detailed Description

Defines types and constants used for version management.

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