Test Server

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## Contents

1 Test Server User's Guide

1.1 Test Server Basics .......................................................... 1
  1.1.1 Introduction ......................................................... 1
  1.1.2 Getting started ...................................................... 2
  1.1.3 Definition of terms .................................................. 2

1.2 Test Structure and Test Specifications .................................. 3
  1.2.1 Test structure ....................................................... 3
  1.2.2 Test specifications .................................................. 3
  1.2.3 Test Specification Files .......................................... 4
  1.2.4 Configuration cases ............................................... 5
  1.2.5 The parallel property and nested configuration cases .......... 5
  1.2.6 Repeated execution of test cases ................................ 6
  1.2.7 Shuffled test case order ........................................... 7
  1.2.8 Skipping test cases ............................................... 7

1.3 Writing Test Suites ........................................................ 8
  1.3.1 Support for test suite authors ................................... 8
  1.3.2 Test suites .......................................................... 8
  1.3.3 Init per test case ................................................... 8
  1.3.4 Test cases .......................................................... 9
  1.3.5 Data and Private Directories ..................................... 9
  1.3.6 Execution environment ............................................ 10

1.4 Running Test Suites ....................................................... 10
  1.4.1 Using the test server controller ................................ 10

1.5 Write you own test server framework .................................. 10
  1.5.1 Introduction ......................................................... 10
  1.5.2 Interfacing the test server controller from Erlang .......... 11
  1.5.3 Interfacing the test server controller from the operating system. 11
  1.5.4 Framework callback functions ................................... 12
  1.5.5 Other concerns ...................................................... 12

1.6 Examples ........................................................................... 12
1.6.1 Test suite ........................................ 12
1.6.2 Test specification file ............................ 14

2 Test Server Reference Manual .............................. 15
  2.1 Test Server Application .............................. 20
  2.2 test_server ........................................ 21
  2.3 The Test Server Controller ......................... 32
Chapter 1

Test Server User’s Guide

Test Server is a portable test server for automated application testing. The server can run test suites on local or remote targets and log progress and results to HTML pages. The main purpose of Test Server is to act as engine inside customized test tools. A callback interface for such framework applications is provided.

1.1 Test Server Basics

1.1.1 Introduction

Test Server is a portable test tool for automated testing of Erlang programs and OTP applications. It provides an interface for running test programs directly with Test Server as well as an interface for integrating Test Server with a framework application. The latter makes it possible to use Test Server as the engine of a higher level test tool application.

It is strongly recommended that Test Server be used from inside a framework application, rather than interfaced directly for running test programs. Test Server can be pretty difficult to use since it’s a very general and quite extensive and complex application. Furthermore, the test_server_ctrl functions are not meant to be used from within the actual test programs. The framework should handle communication with Test Server and deal with the more complex aspects of this interaction automatically so that a higher level interface may be provided for the tester. For test tool usage to be productive, a simpler, more intuitive and (if required) more specific interface is required than what Test Server can provide.

OTP delivers a general purpose framework for Test Server, called Common Test. This application is a tool well suited for automated black box testing of target systems of any kind (not necessarily implemented in Erlang). Common Test is also a very useful tool for white box testing of Erlang programs and OTP applications. Unless a more specific functionality and/or user interface is required (in which case you might need to implement your own framework), Common Test should do the job for you. Please read the Common Test User’s Guide and reference manual for more information.

Under normal circumstances, knowledge about the Test Server application is not required for using the Common Test framework. However, if you want to use Test Server without a framework, or learn how to integrate it with your own framework, please read on...
1.1.2 Getting started

Testing when using Test Server is done by running test suites. A test suite is a number of test cases, where each test case tests one or more things. The test case is the smallest unit that the test server deals with. One or more test cases are grouped together into one ordinary Erlang module, which is called a test suite. Several test suite modules can be grouped together in special test specification files representing whole application and/or system test "jobs".

The test suite Erlang module must follow a certain interface, which is specified by Test Server. See the section on writing test suites for details about this.

Each test case is considered a success if it returns to the caller, no matter what the returned value is. An exception to this is the return value \(\text{skip, Reason}\) which indicates that the test case is skipped. A failure is specified as a crash, no matter what the crash reason is.

As a test suite runs, all information (including output to stdout) is recorded in several different log files. A minimum of information is displayed to the user console. This only include start and stop information, plus a note for each failed test case.

The result from each test case is recorded in an HTML log file which is created for each test run. Every test case gets one row in a table presenting total time, whether the case was successful or not, if it was skipped, and possibly also a comment. The HTML file has links to each test case's logfile, which may be viewed from e.g. Netscape or any other HTML capable browser.

The Test Server consists of three parts:

- The part that executes the test suites on target and provides support for the test suite author is called \texttt{test_server}. This is described in the chapter about writing test cases in this user's guide, and in the reference manual for the \texttt{test_server} module.
- The controlling part, which provides the low level operator interface, starts and stops the target node (if remote target) and slave nodes and writes log files, is called \texttt{test_server_ctrl}. The Test Server Controller should not be used directly when running tests. Instead a framework built on top of it should be used. More information about how to write your own framework can be found in this user's guide and in the reference manual for the \texttt{test_server_ctrl} module.

1.1.3 Definition of terms

\textbf{configuration case} This is a group of test cases which need some specific configuration. A conf case contains an initiation function which sets up a specific configuration, one or more test cases using this configuration, and a cleanup function which restores the configuration. A conf case is specified in a test specification either like this\(\text{conf,InitFunc,ListOfCases,CleanupFunc}\), or this: \(\text{conf,Properties,InitFunc,ListOfCases,CleanupFunc}\).

\textbf{datadir} Data directory for a test suite. This directory contains any files used by the test suite, e.g. additional Erlang modules, C code or data files. If the data directory contains code which must be compiled before the test suite is run, it should also contain a makefile source called \texttt{Makefile.src} defining how to compile.

\textbf{documentation clause} One of the function clauses in a test case. This clause shall return a list of strings describing what the test case tests.

\textbf{execution clause} One of the function clauses in a test case. This clause implements the actual test case, i.e. calls the functions that shall be tested and checks results. The clause shall crash if it fails.

\textbf{major log file} This is the test suites log file.

\textbf{Makefile.src} This file is used by the test server framework to generate a makefile for a datadir. It contains some special characters which are replaced according to the platform currently tested.

\textbf{minor log file} This is a separate log file for each test case.
1.2: Test Structure and Test Specifications

**privdir** Private directory for a test suite. This directory should be used when the test suite needs to write to files.

**skip case** A test case which shall be skipped.

**specification clause** One of the function clauses in a test case. This clause shall return an empty list, a test specification or \{skip, Reason\}. If an empty list is returned, it means that the test case shall be executed, and so it must also have an execution clause. Note that the specification clause is always executed on the controller node, i.e. not on the target node.

**test case** A single test included in a test suite. Typically it tests one function in a module or application. A test case is implemented as a function in a test suite module. The function can have three clauses, the documentation-, specification- and execution clause.

**test specification** A specification of which test suites and test cases to run. There can be test specifications on three different levels in a test. The top level is a test specification file which roughly specifies what to test for a whole application. Then there is a test specification for each test suite returned from the all(suite) function in the suite. And there can also be a test specification returned from the specification clause of a test case.

**test specification file** This is a text file containing the test specification for an application. The file has the extension "spec" or "spec.Platform", where Platform is e.g. "vxworks".

**test suite** An erlang module containing a collection of test cases for a specific application or module.

**topcase** The first "command" in a test specification file. This command contains the test specification, like this: \{topcase, TestSpecification\}

### 1.2 Test Structure and Test Specifications

#### 1.2.1 Test structure

A test consists of a set of test cases. Each test case is implemented as an erlang function. An erlang module implementing one or more test cases is called a test suite.

#### 1.2.2 Test specifications

A test specification is a specification of which test suites and test cases to run and which to skip. A test specification can also group several test cases into conf cases with init and cleanup functions (see section about configuration cases below). In a test there can be test specifications on three different levels:

The top level is a test specification file which roughly specifies what to test for a whole application. The test specification in such a file is encapsulated in a topcase command.

Then there is a test specification for each test suite, specifying which test cases to run within the suite. The test specification for a test suite is returned from the all(suite) function in the test suite module.

And finally there can be a test specification per test case, specifying sub test cases to run. The test specification for a test case is returned from the specification clause of the test case.

When a test starts, the total test specification is built in a tree fashion, starting from the top level test specification.

The following are the valid elements of a test specification. The specification can be one of these elements or a list with any combination of the elements:

- \{Mod, Case\} This specifies the test case Mod:Case/1
- \{dir, Dir\} This specifies all modules \_SUITE in the directory Dir
- \{dir, Dir, Pattern\} This specifies all modules Pattern\_ in the directory Dir
Chapter 1: Test Server User's Guide

{conf, Init, TestSpec, Fin} This is a configuration case. In a test specification file, Init and Fin must be \{Mod, Func\}. Inside a module they can also be just Func. See the section named Configuration Cases below for more information about this.

{conf, Properties, Init, TestSpec, Fin} This is a configuration case as explained above, but which also takes a list of execution properties for its group of test cases and nested sub-groups.

{make, Init, TestSpec, Fin} This is a special version of a conf case which is only used by the test server framework. Init and Fin are make and unmake functions for a data directory. TestSpec is the test specification for the test suite owning the data directory in question. If the make function fails, all tests in the test suite are skipped. The difference between this “make case” and a normal conf case is that for the make case, Init and Fin are given with arguments \{(Mod, Func, Args)\}, and that they are executed on the controller node (i.e. not on target).

Case This can only be used inside a module, i.e. not a test specification file. It specifies the test case CurrentModule:Case.

1.2.3 Test Specification Files

A test specification file is a text file containing the top level test specification (a topcase command), and possibly one or more additional commands. A “command” in a test specification file means a key-value tuple ended by a dot-newline sequence.

The following commands are valid:

{topcase, TestSpec} This command is mandatory in all test specification files. TestSpec is the top level test specification of a test.

{skip, \{Mod, Comment\}} This specifies that all cases in the module Mod shall be skipped. Comment is a string.

{skip, \{Mod, Case, Comment\}} This specifies that the case Mod:Case shall be skipped.

{skip, \{Mod, CaseList, Comment\}} This specifies that all cases Mod:Case, where Case is in CaseList shall be skipped.

{nodes, Nodes} Nodes is a list of nodenames available to the test suite. It will be added to the Config argument to all test cases. Nodes is a list of atoms.

{require, nodenames, Num} Specifies how many nodenames the test suite will need. These will be automatically generated and inserted into the Config argument to all test cases. Num is an integer.

{hosts, Hosts} This is a list of available hosts on which to start slave nodes. It is used when the {remote, true} option is given to the test_server:start_node/3 function. Also, if {require, nodenames, Num} is contained in a test specification file, the generated nodenames will be spread over all hosts given in this Hosts list. The hostnames are atoms or strings.

{diskless, true} Adds \{diskless, true\} to the Config argument to all test cases. This is kept for backwards compatibility and should not be used. Use a configuration case instead.

{ipv6, Hosts} Adds \{ipv6, Hosts\} to the Config argument to all test cases.

All test specification files shall have the extension “.spec”. If special test specification files are needed for Windows or VxWorks platforms, additional files with the extension “.spec.win” and “.spec.vxworks” shall be used. This is useful e.g. if some test cases shall be skipped on these platforms.

Some examples for test specification files can be found in the Examples section of this user’s guide.
1.2.4 Configuration cases

If a group of test cases need the same initialization, a so called configuration or conf case can be used. A conf case consists of an initialization function, the group of test cases needing this initialization and a cleanup or finalization function.

If the init function in a conf case fails or returns \{skip,Comment\}, the rest of the test cases in the conf case (including the cleanup function) are skipped. If the init function succeeds, the cleanup function will always be called, even if some of the test cases in between failed.

Both the init function and the cleanup function in a conf case get the \texttt{Config} parameter as only argument. This parameter can be modified or returned as is. Whatever is returned by the init function is given as \texttt{Config} parameter to the rest of the test cases in the conf case, including the cleanup function. If the \texttt{Config} parameter is changed by the init function, it must be restored by the cleanup function.

Whatever is returned by the cleanup function will be given to the next test case called.

The optional \texttt{Properties} list can be used to specify execution properties for the test cases and possibly nested sub-groups of the configuration case. The available properties are:

\begin{verbatim}
Properties = [parallel | sequence | Shuffle | \{RepeatType,N\}]
Shuffle = shuffle | \{shuffle,Seed\}
Seed = \{integer(),integer(),integer()\}
RepeatType = repeat | repeat_until_all_fail | repeat_until_all_ok |
repeat_until_any_fail | repeat_until_any_ok |
N = integer() | forever
\end{verbatim}

If the \texttt{parallel} property is specified, Test Server will execute all test cases in the group in parallel. If \texttt{sequence} is specified, the cases will be executed in a sequence, meaning if one case fails, all following cases will be skipped. If \texttt{shuffle} is specified, the cases in the group will be executed in random order.

The \texttt{repeat} property orders Common Test to repeat execution of the cases in the group a given number of times, or until any, or all, cases fail or succeed.

Properties may be combined so that e.g. if \texttt{shuffle}, \texttt{repeat_until_all_fail} and \texttt{sequence} are all specified, the test cases in the group will be executed repeatedly and in random order until a test case fails, when execution is immediately stopped and the rest of the cases skipped.

The properties for a group is always printed on the top of the HTML log for the group’s init function. Also, the total execution time for a group can be found at the bottom of the log for the group’s end function.

Configuration cases may be nested so that sets of grouped cases can be configured with the same init- and end functions.

1.2.5 The parallel property and nested configuration cases

If a conf case has a parallel property, its test cases will be spawned simultaneously and get executed in parallel. A test case is not allowed to execute in parallel with the end function however, which means that the time it takes to execute a set of parallel cases is equal to the execution time of the slowest test case in the group. A negative side effect of running test cases in parallel is that the HTML summary pages are not updated with links to the individual test case logs until the end function for the conf case has finished.

A conf case nested under a parallel conf case will start executing in parallel with previous (parallel) test cases (no matter what properties the nested conf case has). Since, however, test cases are never executed in parallel with the init- or the end function of the same conf case, it’s only after a nested group of cases has finished that any remaining parallel cases in the previous conf case get spawned.
1.2.6 Repeated execution of test cases

A conf case may be repeated a certain number of times (specified by an integer) or indefinitely (specified by `forever`). The repetition may also be stopped prematurely if any or all cases fail or succeed, i.e. if the property `repeat_until_any_fail`, `repeat_until_any_ok`, `repeat_until_all_fail`, or `repeat_until_all_ok` is used. If the basic `repeat` property is used, status of test cases is irrelevant for the repeat operation.

It is possible to return the status of a conf case (ok or failed), to affect the execution of the conf case on the level above. This is accomplished by, in the end function, looking up the value of `tc_group` properties in the Config list and checking the result of the finished test cases. If status failed should be returned from the conf case as a result, the end function should return the value `{return_group_result,failed}`. The status of a nested conf case is taken into account by Test Server when deciding if execution should be repeated or not (unless the basic repeat property is used).

The `tc_group` properties value is a list of status tuples, each with the key `ok`, `skipped` and `failed`. The value of a status tuple is a list containing names of test cases that have been executed with the corresponding status as result.

Here’s an example of how to return the status from a conf case:

```prolog
conf_end_function(Config) ->
    Status = ?config(tc_group_result, Config),
    case proplists:get_value(failed, Status) of
        [] -> % no failed cases
            return_group_result,ok;
        Failed -> % one or more failed
            return_group_result,failed
    end.
```

It is also possible in the end function to check the status of a nested conf case (maybe to determine what status the current conf case should return). This is as simple as illustrated in the example above, only the name of the end function of the nested conf case is stored in a tuple `{group_result,EndFunc}`, which can be searched for in the status lists. Example:

```prolog
conf_end_function_X(Config) ->
    Status = ?config(tc_group_result, Config),
    Failed = proplists:get_value(failed, Status),
    case lists:member({group_result,conf_end_function_Y}, Failed) of
        true ->
            return_group_result,failed;
        false ->
            return_group_result,ok
    end;
    ...
```

**Note:**
When a conf case is repeated, the init- and end functions are also always called with each repetition.
1.2.7 Shuffled test case order

The order that test cases in a conf case are executed, is under normal circumstances the same as the order defined in the test specification. With the `shuffle` property set, however, Test Server will instead execute the test cases in random order. The user may provide a seed value (a tuple of three integers) with the `shuffle` property: `{shuffle,Seed}`. This way, the same shuffling order can be created every time the conf case is executed. If no seed value is given, Test Server creates a “random” seed for the shuffling operation (using the return value of `erlang:now()`). The seed value is always printed to the log file of the `init` function so that it can be used to recreate the same execution order in subsequent test runs.

**Note:**
If execution of a conf case with shuffled test cases is repeated, the seed will not be reset in between turns.

If a nested conf case is specified in a conf case with a `shuffle` property, the execution order of the nested cases in relation to the test cases (and other conf cases) is also random. The order of the test cases in the nested conf case is however not random (unless, of course, this one also has a `shuffle` property).

1.2.8 Skipping test cases

It is possible to skip certain test cases, for example if you know beforehand that a specific test case fails. This might be functionality which isn’t yet implemented, a bug that is known but not yet fixed or some functionality which doesn’t work or isn’t applicable on a specific platform.

There are several different ways to state that a test case should be skipped:

- Using the `{skip,What}` command in a test specification file
- Returning `{skip,Reason}` from the `init:per_testcase/2` function
- Returning `{skip,Reason}` from the specification clause of the test case
- Returning `{skip,Reason}` from the execution clause of the test case

The latter of course means that the execution clause is actually called, so the author must make sure that the test case is not run. For more information about the different clauses in a test case, see the chapter about writing test cases.

When a test case is skipped, it will be noted as SKIPPED in the HTML log.
1.3 Writing Test Suites

1.3.1 Support for test suite authors

The test_server module provides some useful functions to support the test suite author. This includes:

- Starting and stopping slave or peer nodes
- Capturing and checking stdout output
- Retrieving and flushing process message queue
- Watchdog timers
- Checking that a function crashes
- Checking that a function succeeds at least m out of n times
- Checking .app files

Please turn to the reference manual for the test_server module for details about these functions.

1.3.2 Test suites

A test suite is an ordinary Erlang module that contains test cases. It’s recommended that the module has a name on the form *SUITE.erl. Otherwise, the directory function will not find the modules (by default).

For some of the test server support, the test server include file test_server.hrl must be included. Never include it with the full path, for portability reasons. Use the compiler include directive instead.

The special function all(suite) in each module is called to get the test specification for that module. The function typically returns a list of test cases in that module, but any test specification could be returned. Please see the chapter about test specifications for details about this.

1.3.3 Init per test case

In each test suite module, the functions init_per_testcase/2 and end_per_testcase/2 must be implemented.

init_per_testcase is called before each test case in the test suite, giving a (limited) possibility for initialization.

end_per_testcase/2 is called after each test case is completed, giving a possibility to clean up.

The first argument to these functions is the name of the test case. This can be used to do individual initialization and cleanup for each test cases.

The second argument is a list of tuples called Config. The first element in a Config tuple should be an atom - a key value to be used for searching. init_per_testcase/2 may modify the Config parameter or just return it as is. Whatever is returned by init_per_testcase/2 is given as Config parameter to the test case itself.

The return value of end_per_testcase/2 is ignored by the test server.
1.3: Writing Test Suites

1.3.4 Test cases

The smallest unit that the test server is concerned with is a test case. Each test case can in turn test many things, for example make several calls to the same interface function with different parameters. It is possible to put many or few tests into each test case. How many things each test case tests is up to the author, but here are some things to keep in mind.

Very small test cases often lead to more code, since initialization has to be duplicated. Larger code, especially with a lot of duplication, increases maintenance and reduces readability.

Larger test cases make it harder to tell what went wrong if it fails, and force us to skip larger portions of test code if a specific part fails. These effects are accentuated when running on multiple platforms because test cases often have to be skipped.

A test case generally consists of three parts, the documentation part, the specification part and the execution part. These are implemented as three clauses of the same function.

The documentation clause matches the argument ‘doc’ and returns a list for strings describing what the test case tests.

The specification clause matches the argument ‘suite’ and returns the test specification for this particular test case. If the test specification is an empty list, this indicates that the test case is a leaf test case, i.e. one to be executed.

Note that the specification clause of a test case is executed on the test server controller host. This means that if target is remote, the specification clause is probably executed on a different platform than the one tested.

The execution clause implements the actual test case. It takes one argument, Config, which contain configuration information like data_dir and priv_dir. See Data and Private Directories [page 9] for more information about these.

The Config variable can also contain the nodenames key, if requested by the require nodenames command in the test suite specification file. All Config items should be extracted using the ?config macro. This is to ensure future compatibility if the Config format changes. See the reference manual for test server for details about this macro.

If the execution clause crashes or exits, it is considered a failure. If it returns {skip, Reason}, the test case is considered skipped. If it returns {comment, String}, the string will be added in the ‘Comment’ field on the HTML result page. If the execution clause returns anything else, it is considered a success, unless it is {‘EXIT’, Reason} or {‘EXIT’, Fid, Reason} which can’t be distinguished from a crash, and thus will be considered a failure.

1.3.5 Data and Private Directories

The data directory (data_dir) is the directory where the test module has its own files needed for the testing. A compiler test case may have source files to feed into the compiler, a release upgrade test case may have some old and new release of something. A graphics test case may have some icons and a test case doing a lot of math with bignums might store the correct answers there. The name of the data_dir is the the name of the test suite and then "data". For example, "some_path/foo_SUITE beam" has the data directory "some_path/foo_SUITE_data/".

The priv_dir is the test suite’s private directory. This directory should be used when a test case needs to write to files. The name of the private directory is generated by the test server, which also creates the directory.

Warning: Do not depend on current directory to be writable, or to point to anything in particular. All scratch files are to be written in the priv_dir, and all data files found in data_dir. If the current directory has to be something specific, it must be set with file:set_cwd/1.
1.3.6 Execution environment

Each time a test case is about to be executed, a new process is created with `spawn_link`. This is so that the test case will have no dependencies to earlier tests, with respect to process flags, process links, messages in the queue, other processes having registered the process, etc. As little as possible is done to change the initial context of the process (what is created by plain `spawn`). Here is a list of differences:

- It has a link to the test server. If this link is removed, the test server will not know when the test case is finished, just wait infinitely.
- It often holds a few items in the process dictionary, all with names starting with `test_server`. This is to keep track of if/where a test case fails.
- There is a top-level catch. All of the test case code is catched, so that the location of a crash can be reported back to the test server. If the test case process is killed by another process (thus the catch code is never executed) the test server is not able to tell where the test case was executing.
- It has a special group leader implemented by the test server. This way the test server is able to capture the io that the test case provokes. This is also used by some of the test server support functions.

There is no time limit for a test case, unless the test case itself imposes such a limit, by calling `test_server:timetrap/1` for example. The call can be made in each test case, or in the `init_per_testcase/2` function. Make sure to call the corresponding `test_server:timetrap_cancel/1` function as well, e.g in the `end_per_testcase/2` function, or else the test cases will always fail.

1.4 Running Test Suites

1.4.1 Using the test server controller

The test server controller provides a low level interface to all the Test Server functionality. It is possible to use this interface directly, but it is recommended to use a framework such as Common Test instead. If no existing framework suits your needs, you could of course build your own on top of the test server controller. Some information about how to do this can be found in the section named “Writing your own test server framework” in the Test Server User’s Guide.

For information about using the controller directly, please see all available functions in the reference manual for `test_server_ctrl`.

1.5 Write your own test server framework

1.5.1 Introduction

The test server controller can be interfaced from the operating system or from within Erlang. The nature of your new framework will decide which interface to use. If you want your framework to start a new node for each test, the operating system interface is very convenient. If your node is already started, going from within Erlang might be a more flexible solution.

The two methods are described below.
1.5.2 Interfacing the test server controller from Erlang

Using the test server from Erlang means that you have to start the test server and then add test jobs. Use `test_server_ctrl:start/0` to start a local target or `test_server_ctrl:start/1` to start a remote target. The test server is stopped by `test_server_ctrl:stop/0`. The argument to `test_server_ctrl:start/1` is the name of a parameter file. The parameter file specifies what type of target to start and where to start it, as well as some additional parameters needed for different target types. See the reference manual for a detailed description of all valid parameters.

Adding test jobs

There are many commands available for adding test cases to the test server's job queue:

- Single test case
  `test_server_ctrl:add_case/2/3`
- Multiple test cases from same suite
  `test_server_ctrl:add_cases/2/3`
- Test suite module or modules
  `test_server_ctrl:add_module/1/2`
- Some or all test suite modules in a directory
  `test_server_ctrl:add_dir/2/3`
- Test cases specified in a test specification file
  `test_server_ctrl:add_spec/1`

All test suites are given a unique name, which is usually given when the test suite is added to the job queue. In some cases, a default name is used, as in the case when a module is added without a specified name. The test job name is used to store logfiles, which are stored in the `name.logs` directory under the current directory.

See the reference manual for details about the functions for adding test jobs.

1.5.3 Interfacing the test server controller from the operating system.

The function `run_test/1` is your interface in the test server controller if you wish to use it from the operating system. You simply start an erlang shell and invoke this function with the `-s` option. `run_test/1` starts the test server, runs the test specified by the command line and stops the test server. The argument to `run_test/1` is a list of command line flags, typically `[KEY1, Value1, KEY2, Value2, ...]`. The valid command line flags are listed in the reference manual for `test_server_ctrl`.

A typical command line may look like this

```
erl -noshell -s test_server Ctrl run_test KEY1 Value1 KEY2 Value2 ... -s erlang halt
```

Or make an alias (this is for unix/tcsh)

```
alias erl_test 'erl -noshell -s test_server Ctrl run_test \!* -s erlang halt'
```

And then use it like this

```
erl_test KEY1 Value1 KEY2 Value2 ...
```

Test Server
Chapter 1: Test Server User’s Guide

An Example

An example of starting a test run from the command line

```
erl -name test_srv -noshell -rsh /home/super/otp/bin/ctrsh
-ps /clearcase/otp/erts/lib/kernel/test
-boot start_sasl -sasl errlog_type error
-s test_server_ctrl run_test SPEC kernel.spec -s erlang halt
```

1.5.4 Framework callback functions

By defining the environment variable `TEST_SERVER_FRAMEWORK` to a module name, the framework callback functions can be used. The framework callback functions are called by the test server in order to let the framework interact with the execution of the tests and to keep the framework up to date with information about the test progress.

The framework callback functions are described in the reference manual for `test_server_ctrl`. Note that this topic is in an early stage of development, and changes might occur.

1.5.5 Other concerns

Some things to think about when writing your own test server framework:

- **emulator version** - Make sure that the intended version of the emulator is started.
- **operating system path** - If test cases use port programs, make sure the paths are correct.
- **recompilation** - Make sure all test suites are fresh compiled.
- **test_server.hrl** - Make sure the `test_server.hrl` file is in the include path when compiling test suites.
- **running applications** - Some test suites require some applications to be running (e.g. sasl). Make sure they are started.

1.6 Examples

1.6.1 Test suite

```
-module(my_SUITE).
-export([all/1,
    not_started/1, not_started_func1/1, not_started_func2/1,
    start/1, stop/1,
    func1/1, func2/1
]).

-export([init_per_testcase/2, end_per_testcase/2]).

-inclusion("test_server.hrl").

-define(default_timeout, ?t:minutes(1)).

init_per_testcase(_Case, Config) ->
    ?line Dog=?t:timetrap(?default_timeout),
```
[watchdog, Dog}|Config].
end_per_testcase(_Case, Config) ->
  Dog=?config(watchdog, Config),
  ?t:timetrap_cancel(Dog),
  ok.

all(suite) ->
  %% Test specification on test suite level
  [not_started,
    {conf, start, [func1, func2], stop}].

not_started(suite) ->
  %% Test specification on test case level
  [not_started_func1, not_started_func2];

not_started(doc) ->
  ["Testing all functions when application is not started"].

%% No execution clause unless the specification clause returns [].

not_started_func1(suite) ->
  [];

not_started_func1(doc) ->
  ["Testing function 1 when application is not started"].

not_started_func1(Config) when list(Config) ->
  ?line {error, not_started} = myapp:func1(dummy_ref,1),
  ?line {error, not_started} = myapp:func1(dummy_ref,2),
  ok.

not_started_func2(suite) ->
  [];

not_started_func2(doc) ->
  ["Testing function 2 when application is not started"].

not_started_func2(Config) when list(Config) ->
  ?line {error, not_started} = myapp:func2(dummy_ref,1),
  ?line {error, not_started} = myapp:func2(dummy_ref,2),
  ok.

%% No specification clause needed for an init function in a conf case!!!

start(doc) ->
  ["Testing start of my application."];

start(Config) when list(Config) ->
  ?line Ref = myapp:start(),
  case erlang:whereis(my_main_process) of
    Pid when pid(Pid) ->
      [{myapp_ref,Ref}|Config];
    undefined ->
      %% Since this is the init function in a conf case, the rest of the
      %% cases in the conf case will be skipped if this case fails.
      ?t:fail("my_main_process did not start")
    end.

func1(suite) ->
[ ];
func1(doc) ->
  ["Test that func1 returns ok when argument is 1 and error if argument is 2"];
func1(Config) when list(Config) ->
  ?line Ref = ?config(myapp_ref,Config),
  ?line ok = myapp:func1(Ref,1),
  ?line error = myapp:func1(Ref,2),
  ok.

func2(suite) ->
  [];
func2(doc) ->
  ["Test that func1 returns ok when argument is 3 and error if argument is 4"];
func2(Config) when list(Config) ->
  ?line Ref = ?config(myapp_ref,Config),
  ?line ok = myapp:func2(Ref,3),
  ?line error = myapp:func2(Ref,4),
  ok.

%%% No specification clause needed for a cleanup function in a conf case!!
stop(doc) ->
  ["Testing termination of my application"];
stop(Config) when list(Config) ->
  ?line Ref = ?config(myapp_ref,Config),
  ?line ok = myapp:stop(Ref),
  case erlang:whereis(my_main_process) of
    undefined ->
      lists:keydelete(myapp_ref,1,Config);
    Pid when pid(Pid) ->
      ?t:fail("my_main_process did not stop")
  end.

1.6.2 Test specification file

myapp.spec:

{topcase, {dir, ".../myapp_test"}}. % Test specification on top level

myapp.spec.vxworks:

{topcase, {dir, ".../myapp_test"}}. % Test specification on top level
{skip,{my_SUITE,func2,"Not applicable on VxWorks"}}.
Test Server Reference Manual

Short Summaries

- Application Test Server Application [page 20] – Test Server for manual or automatic testing of Erlang code
- Erlang Module test [page 21] – This module provides support for test suite authors.
- Erlang Module test_server_ctrl [page 32] – This module provides a low level interface to the Test Server.

Test Server Application

No functions are exported.

test_server

The following functions are exported:

- os_type() -> OSTYPE
  [page 21] Returns the OS type of the target node
- fail()
  [page 21] Makes the test case fail.
- fail(Reason)
  [page 21] Makes the test case fail.
- timetrap(Timeout) -> Handle
  [page 22]
- timetrap_cancel(Handle) -> ok
  [page 22] Cancels a timetrap.
- timetrap_scale_factor() -> ScaleFactor
  [page 22] Returns the scale factor for timeouts
- sleep(MSecs) -> ok
  [page 22] Suspends the calling task for a specified time.
- hours(N) -> MSecs
  [page 22]
- minutes(N) -> MSecs
  [page 22]
- seconds(N) -> MSecs
  [page 23]
- `format(Format) -> ok`
  [page 23]
- `format(Format, Args)`
  [page 23]
- `format(Pri,Format)`
  [page 23]
- `format(Pri, Format, Args)`
  [page 23]
- `capture_start() -> ok`
  [page 23] Captures all output to stdout for a process.
- `capture_stop() -> ok`
  [page 23] Captures all output to stdout for a process.
- `capture_get() -> list()`
  [page 23] Captures all output to stdout for a process.
- `messages_get() -> list()`
  [page 23] Empty the message queue.
- `timecall(M, F, A) -> {Time, Value}`
  [page 23] Measures the time needed to call a function.
- `do_times(N, M, F, A) -> ok`
  [page 24] Calls MFA or Fun N times.
- `do_times(N, Fun)`
  [page 24] Calls MFA or Fun N times.
- `m_out_of_n(M, N, Fun) -> ok | exit({m_out_of_n_failed, [R,left_to_do]})`
- `call_crash(M, F, A) -> Result`
  [page 24] Calls MFA and succeeds if it crashes.
- `call_crash(Time, M, F, A) -> Result`
  [page 24] Calls MFA and succeeds if it crashes.
- `call_crash(Time, Crash, M, F, A) -> Result`
  [page 24] Calls MFA and succeeds if it crashes.
- `temp_name(Stem) -> Name`
- `break(Comment) -> ok`
  [page 25] Cancel all timetraps and wait for call to continue/0.
- `continue() -> ok`
  [page 25] Continue after break/1.
- `run_on_shielded_node(Fun, CArgs) -> term()`
  [page 25] Execute a function a shielded node.
- `start_node(Name, Type, Options) -> {ok, Node} | {error, Reason}`
  [page 26] Start a node.
- `stop_node(NodeName) -> bool()`
  [page 27] Stops a node.
- `is_commercial() -> bool()`
  [page 27] Tests whether the emulator is commercially supported.
- `is_release_available(Release) -> bool()`
  [page 28] Tests whether a release is available.
Test Server

- `is_native(Mod) -> bool()`
  [page 28] Checks whether the module is natively compiled or not

- `app_test(App) -> ok | test_server:fail()`
  [page 28] Checks an applications .app file for obvious errors

- `app_test(App, Mode)`
  [page 28] Checks an applications .app file for obvious errors

- `comment(Comment) -> ok`
  [page 28] Print a comment on the HTML result page

- `all(suite) -> TestSpec | {skip, Comment}`
  [page 29] Returns the module's test specification

- `init_per_suite(Config0) -> Config1 | {skip, Comment}`
  [page 29] Test suite initiation

- `end_per_suite(Config) -> void()`
  [page 29] Test suite finalization

- `init_per_testcase(Case, Config0) -> Config1 | {skip, Comment}`
  [page 29] Test case initiation

- `end_per_testcase(Case, Config) -> void()`
  [page 29] Test case finalization

- `Case(doc) -> [Description]`
  [page 30] A test case

- `Case(suite) -> [] | TestSpec | {skip, Comment}`
  [page 30] A test case

- `Case(Config) -> {skip, Comment} | {comment, Comment} | Ok`
  [page 30] A test case

### test_server_ctrl

The following functions are exported:

- `start() -> Result`
  [page 32] Starts the test server.

- `start(ParameterFile) -> Result`
  [page 32] Starts the test server.

- `stop() -> ok`
  [page 33] Stops the test server immediately.

- `add_dir(Name, Dir) -> ok`
  [page 33] Add a directory to the job queue.

- `add_dir(Name, Dir, Pattern) -> ok`
  [page 33] Add a directory to the job queue.

- `add_dir(Name, [Dir|Dirs]) -> ok`
  [page 33] Add a directory to the job queue.

- `add_dir(Name, [Dir|Dirs], Pattern) -> ok`
  [page 33] Add a directory to the job queue.

- `add_module(Mod) -> ok`
  [page 33] Add a module to the job queue with or without a given name.

- `add_module(Name, [Mod|Mods]) -> ok`
  [page 33] Add a module to the job queue with or without a given name.
- `add_case(Mod, Case) -> ok`
  [page 33] Adds one test case to the job queue.
- `add_case(Name, Mod, Case) -> ok`
  [page 34] Equivalent to `add_case/2`, but with specified name.
- `add_cases(Mod, Cases) -> ok`
  [page 34] Adds a list of test cases to the job queue.
- `add_cases(Name, Mod, Cases) -> ok`
  [page 34] Equivalent to `add_cases/2`, but with specified name.
- `add_spec(TestSpecFile) -> ok | {error, nofile}`
  [page 34] Adds a test specification file to the job queue.
- `add_dir_with_skip(Name, [Dir|Dirs], Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_dir_with_skip(Name, [Dir|Dirs], Pattern, Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_module_with_skip(Mod, Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_module_with_skip(Name, [Mod|Mods], Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_case_with_skip(Mod, Case, Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_case_with_skip(Name, Mod, Case, Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_cases_with_skip(Mod, Cases, Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_cases_with_skip(Name, Mod, Cases, Skip) -> ok`
  [page 34] Same purpose as functions listed above, but with extra Skip argument.
- `add_tests_with_skip(Name, Tests, Skip) -> ok`
  [page 35] Adds different types of jobs to the run queue.
- `abort_current_testcase(Reason) -> ok | {error, no_testcase_running}`
  [page 35] Aborts the test case currently executing.
- `set_levels(Console, Major, Minor) -> ok`
  [page 36] Sets the levels of I/O.
- `get_levels() -> {Console, Major, Minor}`
  [page 36] Returns the current levels.
- `jobs() -> JobQueue`
  [page 36] Returns the job queue.
- `multiply_timetraps(N) -> ok`
  [page 36] All timetraps started after this will be multiplied by N.
- `cover(Application, Analyse) -> ok`
  [page 36] Informs the test server controller that next test shall run with code coverage analysis.
- `cover(CoverFile, Analyse) -> ok`
  [page 36] Informs the test server controller that next test shall run with code coverage analysis.
- `cover(App, CoverFile, Analyse) -> ok`
  [page 36] Informs the test server controller that next test shall run with code coverage analysis.
- `cross_cover_analyse(Level) -> ok`  
  [page 37] Analyse cover data collected from all tests

- `trc(TraceInfoFile) -> ok | {error, Reason}`  
  [page 38] Starts call trace on target and slave nodes

- `stop_trace() -> ok | {error, not_tracing}`  
  [page 38] Stops tracing on target and slave nodes

- `run_test(CommandLine) -> ok`  
  [page 39] Runs the tests specified on the command line.

- `get_suite(Mod, Func) -> TestCaseList`  
  [page 40] Get subcases.

- `init_tc(Mod, Func, Args) -> {ok, Args}`  
  [page 40] Preparation for a test case.

- `end_tc(Mod, Func, Args) -> ok`  
  [page 40] Cleanup after a test case.

- `report(What, Data) -> ok`  
  [page 40] Progress report for test.

- `error_notification(Mod, Case, Args, Error) -> ok`  
  [page 41] Inform framework of crashing testcase.

- `warn(What) -> boolean()`  
  [page 41] Ask framework if test server should issue a warning for What.

- `target_info() -> InfoStr`  
  [page 41] Print info about the target system to the test case log.
Test Server Application

Test Server is a portable test server for automated application testing. The server can run test suites on local or remote targets and log progress and results to HTML pages. The main purpose of Test Server is to act as engine inside customized test tools. A callback interface for such framework applications is provided.

In brief the test server supports:

- Running multiple, concurrent test suites
- Running tests on remote and even diskless targets
- Test suites may contain other test suites, in a tree fashion
- Logging of the events in a test suite, on both suite and case levels
- HTML presentation of test suite results
- HTML presentation of test suite code
- Support for test suite authors, e.g. start/stop slave nodes
- Call trace on target and slave nodes

For information about how to write test cases and test suites, please see the Test Server User's Guide and the reference manual for the test server module.

Common Test is an existing test tool application based on the OTP Test Server. Please read the Common Test User’s Guide for more information.

Configuration

There are currently no configuration parameters available for this application.

SEE ALSO
The `test_server` module aids the test suite author by providing various support functions. The supported functionality includes:

- Logging and timestamping
- Capturing output to stdout
- Retrieving and flushing the message queue of a process
- Watchdog timers, process sleep, time measurement and unit conversion
- Private scratch directory for all test suites
- Start and stop of slave- or peer nodes

For more information on how to write test cases and for examples, please see the Test Server User’s Guide.

**TEST SUITE SUPPORT FUNCTIONS**

The following functions are supposed to be used inside a test suite.

**Exports**

```erlang
os_type() -> OSTYPE

Types:
- OSTYPE = term()
  This is the same as returned from os:type/0

This function can be called on controller or target node, and it will always return the OS type of the target node.

fail()
fail(Reason)

Types:
- Reason = term()
  The reason why the test case failed.

This will make the test suite fail with a given reason, or with `suite_failed` if no reason was given. Use this function if you want to terminate a test case, as this will make it easier to read the log- and HTML files. Reason will appear in the comment field in the HTML log.
```
timetrap(Timeout) -> Handle

Types:
- Timeout = integer() | {hours,H} | {minutes,M} | {seconds,S}
- H = M = S = integer()
- Pid = pid()
  - The process that is to be timetrapped (self() by default)

Sets up a time trap for the current process. An expired timetrap kills the process with reason timetrap_timeout. The returned handle is to be given as argument to timetrap_cancel before the timetrap expires. If Timeout is an integer, it is expected to be milliseconds.

**Note:**
If the current process is trapping exits, it will not be killed by the exit signal with reason timetrap_timeout. If this happens, the process will be sent an exit signal with reason kill 10 seconds later which will kill the process. Information about the timetrap timeout will in this case not be found in the test logs. However, the error_logger will be sent a warning.

timetrap_cancel(Handle) -> ok

Types:
- Handle = term()
  - Handle returned from timetrap

This function cancels a timetrap. This must be done before the timetrap expires.

timetrap_scale_factor() -> ScaleFactor

Types:
- ScaleFactor = integer()

This function returns the scale factor by which all timetraps are scaled. It is normally 1, but can be greater than 1 if the test_server is running cover, using a larger amount of scheduler threads than the amount of logical processors on the system, running under purify, valgrind or in a debug-compiled emulator. The scale factor can be used if you need to scale you own timeouts in test cases with same factor as the test_server uses.

sleep(MSecs) -> ok

Types:
- MSecs = integer() | float() | infinity
  - The number of milliseconds to sleep

This function suspends the calling process for at least the supplied number of milliseconds. There are two major reasons why you should use this function instead of timer:sleep, the first being that the module timer may be unavaliable at the time the test suite is run, and the second that it also accepts floating point numbers.

hours(N) -> MSecs

minutes(N) -> MSecs
seconds(N) -> MSecs

Types:
- N = integer()
  Value to convert to milliseconds.

These functions convert N number of hours, minutes or seconds into milliseconds.
Use this function when you want to test_server:sleep/1 for a number of seconds, minutes or hours(!).

format(Format) -> ok
format(Format, Args)
format(Pri, Format)
format(Pri, Format, Args)

Types:
- Format = string()
  Format as described for io:format.
- Args = list()
  List of arguments to format.

Formats output just like io:format but sends the formatted string to a logfile. If the urgency value, Pri, is lower than some threshold value, it will also be written to the test person’s console. Default urgency is 50, default threshold for display on the console is 1.
Typically, the test person don’t want to see everything a test suite outputs, but is merely interested in if the test cases succeeded or not, wich the test server tells him. If he would like to see more, he could manually change the threshold values by using the test_server:ctrl:set levels/3 function.

capture_start() -> ok
capture_stop() -> ok
capture_get() -> list()

These functions makes it possible to capture all output to stdout from a process started by the test suite. The list of characters captured can be purged by using capture_get.

messages_get() -> list()

This function will empty and return all the messages currently in the calling process’ message queue.

timecall(M, F, A) -> {Time, Value}

Types:
- M = atom()
  The name of the module where the function resides.
- F = atom()
  The name of the function to call in the module.
- A = list()
  The arguments to supply the called function.
- Time = integer()
  The number of seconds it took to call the function.
- Value = term()
  Value returned from the called function.

This function measures the time (in seconds) it takes to call a certain function. The function call is not caught within a catch.

\[
do\text{\_times}(N, M, F, A) -> \text{ok}
do\text{\_times}(N, \text{Fun})
\]

Types:
- \( N = \text{integer()} \)
  Number of times to call \( M:F \).
- \( M = \text{atom()} \)
  Module name where the function resides.
- \( F = \text{atom()} \)
  Function name to call.
- \( A = \text{list()} \)
  Arguments to \( M:F \).

Calls \( M:F \) or \( \text{Fun} \) \( N \) times. Useful for extensive testing of a sensitive function.

\[
\text{m\_out\_of\_n}(M, N, \text{Fun}) -> \text{ok} | \text{exit}\{(\text{m\_out\_of\_n\_failed}, \{R, \text{left\_to\_do}\}\}
\]

Types:
- \( N = \text{integer()} \)
  Number of times to call the \text{Fun}.
- \( M = \text{integer()} \)
  Number of times to require a successful return.

Repeatedly evaluates the given function until it succeeds (doesn't crash) \( M \) times. If, after \( N \) times, \( M \) successful attempts have not been accomplished, the process crashes with reason \( \{\text{m\_out\_of\_n\_failed}, \{R, \text{left\_to\_do}\}\} \), where \( R \) indicates how many cases that was still to be successfully completed.

For example:
\[
\text{m\_out\_of\_n}(1,4,\text{fun()} -> \text{tricky\_test\_case()} \text{end})
\]
Tries to run \text{tricky\_test\_case()} up to 4 times, and is happy if it succeeds once.

\[
\text{m\_out\_of\_n}(7,8,\text{fun()} -> \text{clock\_sanity\_check()} \text{end})
\]
Tries running \text{clock\_sanity\_check()} up to 8 times, and allows the function to fail once.
This might be useful if \text{clock\_sanity\_check/0} is known to fail if the clock crosses an hour boundary during the test (and the up to 8 test runs could never cross 2 boundaries)

\[
call\_crash(M, F, A) -> \text{Result}
call\_crash(\text{Time}, M, F, A) -> \text{Result}
call\_crash(\text{Time}, \text{Crash}, M, F, A) -> \text{Result}
\]

Types:
- \( \text{Result} = \text{ok} | \text{exit\{call\_crash\_timeout\} | exit\{(\text{wrong\_crash\_reason}, \text{Reason})\}} \)
- \( \text{Crash} = \text{term()} \)
  Crash return from the function.
- \( \text{Time} = \text{integer()} \)
  Timeout in milliseconds.
• M = atom()
  Module name where the function resides.
• F = atom()
  Function name to call.
• A = list()
  Arguments to M:F.

Spawns a new process that calls MFA. The call is considered successful if the call crashes with the gives reason (Crash) or any reason if not specified. The call must terminate within the given time (default infinity), or it is considered a failure.

temp_name(Stem) -> Name

Types:
• Stem = string()

Returns a unique filename starting with Stem with enough extra characters appended to make up a unique filename. The filename returned is guaranteed not to exist in the filesystem at the time of the call.

break(Comment) -> ok

Types:
• Comment = string()

Comment is a string which will be written in the shell, e.g. explaining what to do. This function will cancel all timetraps and pause the execution of the test case until the user executes the continue/0 function. It gives the user the opportunity to interact with the erlang node running the tests, e.g. for debugging purposes or for manually executing a part of the test case.

When the break/1 function is called, the shell will look something like this:

--- SEMIAUTOMATIC TESTING ---
The test case executes on process <0.51.0>

"Here is a comment, it could e.g. instruct to pull out a card"

-----------------------------------

Continue with --> test_server:continue().

The user can now interact with the erlang node, and when ready call test_server:continue().

Note that this function can not be used if the test is executed with ts:run/0/1/2/3/4 in batch mode.

continue() -> ok

This function must be called in order to continue after a test case has called break/1.

run_on_shielded_node(Fun, CArgs) -> term()

Types:
• **Fun = function() (arity 0)**
  Function to execute on the shielded node.
• **CArg = string()**
  Extra command line arguments to use when starting the shielded node.

Fun is executed in a process on a temporarily created hidden node with a proxy for communication with the test server node. The node is called a shielded node (should have been called a shield node). If Fun is successfully executed, the result is returned. A peer node (see `start_node/3`) started from the shielded node will be shielded from test server node, i.e. they will not be aware of each other. This is useful when you want to start nodes from earlier OTP releases than the OTP release of the test server node.

Nodes from an earlier OTP release can normally not be started if the test server hasn’t been started in compatibility mode (see the `+R` flag in the `erl(1)` documentation) of an earlier release. If a shielded node is started in compatibility mode of an earlier OTP release than the OTP release of the test server node, the shielded node can start nodes of an earlier OTP release.

**Note:**
You must make sure that nodes started by the shielded node never communicate directly with the test server node.

**Note:**
Slave nodes always communicate with the test server node; therefore, never start slave nodes from the shielded node, always start peer nodes.

```erlang
start_node(Name, Type, Options) -> {ok, Node} | {error, Reason}
```

Types:
• **Name = atom() | string()**
  Name of the slavenode to start (as given to `-sname` or `-name`)
• **Type = slave | peer**
  The type of node to start.
• **Options = [{atom()}, term()]**
  Tuplelist of options

This functions starts a node, possibly on a remote machine, and guarantees cross architecture transparency. Type is set to either `slave` or `peer`.

`slave` means that the new node will have a master, i.e. the slave node will terminate if the master terminates. TTY output produced on the slave will be sent back to the master node and file I/O is done via the master. The master is normally the target node unless the target is itself a slave.

`peer` means that the new node is an independent node with no master.

`Options` is a tuplelist which can contain one or more of
Start the node on a remote host. If not specified, the node will be started on the local host (with some exceptions, as for the case of VxWorks, where all nodes are started on a remote host). Test cases that require a remote host will fail with a reasonable comment if no remote hosts are available at the time they are run.

Arguments passed directly to the node. This is typically a string appended to the command line.

Don’t wait until the node is up. By default, this function does not return until the node is up and running, but this option makes it return as soon as the node start command is given.

Only valid for peer nodes

Returns {error, Reason} rather than failing the test case. Only valid for peer nodes. Note that slave nodes always act as if they had fail_on_error=false

Use an Erlang emulator determined by ReleaseList when starting nodes, instead of the same emulator as the test server is running. ReleaseList is a list of specifiers, where a specifier is either {release, Rel}, {prog, Prog}, or 'this'. Rel is either the name of a release, e.g., "r12b_patched" or 'latest'. 'this' means using the same emulator as the test server. Prog is the name of an emulator executable. If the list has more than one element, one of them is picked randomly. (Only works on Solaris and Linux, and the test server gives warnings when it notices that nodes are not of the same version as itself.)

When specifying this option to run a previous release, use is_release_available/1 function to test if the given release is available and skip the test case if not.

In order to avoid compatibility problems (may not appear right away), use a shielded node (see run_on_shielded_node/2) when starting nodes from different OTP releases than the test server.

Tells the test server not to kill this node if it is still alive after the test case is completed. This is useful if the same node is to be used by a group of test cases.

Env should be a list of tuples {Name, Val}, where Name is the name of an environment variable, and Val is the value it is to have in the started node. Both Name and Val must be strings. The one exception is Val being the atom false (in analogy with os:getenv/1), which removes the environment variable. Only valid for peer nodes. Not available on VxWorks.

Types:
- NodeName = term()
- Name of the node to stop

This function stops a node previously started with start_node/3. Use this function to stop any node you start, or the test server will produce a warning message in the test logs, and kill the nodes automatically unless it was started with the {cleanup, false} option.

Returns {error, Reason} rather than failing the test case. Only valid for peer nodes. Note that slave nodes always act as if they had fail_on_error=false
This function test whether the emulator is commercially supported emulator. The tests for a commercially supported emulator could be more stringent (for instance, a commercial release should always contain documentation for all applications).

is_release_available(Release) -> bool()

Types:
- Release = string() | atom()
  Release to test for

This function test whether the release given by Release (for instance, “r12b.patched”) is available on the computer that the test_server controller is running on. Typically, you should skip the test case if not.

Caution: This function may not be called from the suite clause of a test case, as the test_server will deadlock.

is_native(Mod) -> bool()

Types:
- Mod = atom()
  A module name

Checks whether the module is natively compiled or not

app_test(App) -> ok | test_server:fail()

app_test(App,Mode)

Types:
- App = term()
  The name of the application to test
- Mode = pedantic | tolerant
  Default is pedantic

Checks an applications .app file for obvious errors. The following is checked:

- required fields
- that all modules specified actually exists
- that all requires applications exists
- that no module included in the application has export all
- that all modules in the ebin/ dir is included (If Mode==tolerant this only produces a warning, as all modules does not have to be included)

comment(Comment) -> ok

Types:
- Comment = string()

The given String will occur in the comment field of the table on the HTML result page. If called several times, only the last comment is printed. comment/1 is also overwritten by the return value {comment,Comment} from a test case or by fail/1 (which prints Reason as a comment).
TEST SUITE EXPORTS

The following functions must be exported from a test suite module.

Exports

all(suite) -> TestSpec | {skip, Comment}

Types:
- TestSpec = list()
- Comment = string()
  This comment will be printed on the HTML result page
  This function must return the test specification for the test suite module. The syntax of
  a test specification is described in the Test Server User’s Guide.

init_per_suite(Config0) -> Config1 | {skip, Comment}

Types:
- Config0 = Config1 = [tuple()]
- Comment = string()
  Describes why the suite is skipped
  This function is called before all other test cases in the suite. Config is the configuration
  which can be modified here. Whatever is returned from this function is given as Config
to the test cases.
  If this function fails, all test cases in the suite will be skipped.

end_per_suite(Config) -> void()

Types:
- Config = [tuple()]
  This function is called after the last test case in the suite, and can be used to clean up
  whatever the test cases have done. The return value is ignored.

init_per_testcase(Case, Config0) -> Config1 | {skip, Comment}

Types:
- Case = atom()
- Config0 = Config1 = [tuple()]
- Comment = string()
  Describes why the test case is skipped
  This function is called before each test case. The Case argument is the name of the test
case, and Config is the configuration which can be modified here. Whatever is returned
from this function is given as Config to the test case.

end_per_testcase(Case, Config) -> void()

Types:
- Case = atom()
- **Config = [tuple()]**
  This function is called after each test case, and can be used to clean up whatever the test case has done. The return value is ignored.

**Case(doc) -> [Description]**

**Case(suite) -> [] | TestSpec | {skip, Comment}**

**Case(Config) -> {skip, Comment} | {comment, Comment} | Ok**

**Types:**
- **Description = string()**
  Short description of the test case
- **TestSpec = list()**
- **Comment = string()**
  This comment will be printed on the HTML result page
- **Ok = term()**
- **Config = [tuple()]**
  Elements from the Config parameter can be read with the ?config macro, see section about test suite support macros

The documentation clause (argument doc) can be used for automatic generation of test documentation or test descriptions.

The specification clause (argument spec) shall return an empty list, the test specification for the test case or {skip, Comment}. The syntax of a test specification is described in the Test Server User's Guide.

Note that the specification clause always is executed on the controller host.

The execution clause (argument Config) is only called if the specification clause returns an empty list. The execution clause is the real test case. Here you must call the functions you want to test, and do whatever you need to check the result. If something fails, make sure the process crashes or call test_server:fail/0/1 (which also will cause the process to crash).

You can return {skip, Comment} if you decide not to run the test case after all, e.g. if it is not applicable on this platform.

You can return {comment, Comment} if you wish to print some information in the 'Comment' field on the HTML result page.

If the execution clause returns anything else, it is considered a success, unless it is {'EXIT',Reason} or {'EXIT',Pid,Reason} which can't be distinguished from a crash, and thus will be considered a failure.

A conf test case is a group of test cases with an init and a cleanup function. The init and cleanup functions are also test cases, but they have special rules:

- They do not need a specification clause.
- They must always have the execution clause.
- They must return the Config parameter, a modified version of it or {skip,Comment} from the execution clause.
- The cleanup function may also return a tuple {return_group_result,Status}, which is used to return the status of the conf case to Test Server and/or to a conf case on a higher level. (Status = ok | skipped | failed).
- init_per_testcase and end_per_testcase are not called before and after these functions.
TEST SUITE LINE NUMBERS

If a test case fails, the test server can report the exact line number at which it failed. There are two ways of doing this, either by using the `line` macro or by using the `test_server_line` parse transform.

The `line` macro is described under TEST SUITE SUPPORT MACROS below. The `line` macro will only report the last line executed when a test case failed.

The `test_server_line` parse transform is activated by including the headerfile `test_server_line.hrl` in the test suite. When doing this, it is important that the `test_server_line` module is in the code path of the erlang node compiling the test suite. The parse transform will report a history of a maximum of 10 lines when a test case fails. Consecutive lines in the same function are not shown.

The attribute `-no_lines(FuncList)` can be used in the test suite to exclude specific functions from the parse transform. This is necessary e.g. for functions that are executed on old (i.e. <R10B) OTP releases. `FuncList = [{Func,Arity}]`.

If both the `line` macro and the parse transform is used in the same module, the parse transform will overrule the macro.

TEST SUITE SUPPORT MACROS

There are some macros defined in the `test_server.hrl` that are quite useful for test suite programmers:

The `line` macro, is quite essential when writing test cases. It tells the test server exactly what line of code that is being executed, so that it can report this line back if the test case fails. Use this macro at the beginning of every test case line of code.

The `config` macro, is used to retrieve information from the `Config` variable sent to all test cases. It is used with two arguments, where the first is the name of the configuration variable you wish to retrieve, and the second is the `Config` variable supplied to the test case from the test server.

Possible configuration variables include:

- `data_dir` - Data file directory.
- `priv_dir` - Scratch file directory.
- `nodes` - Nodes specified in the spec file
- `nodenames` - Generated nodenames.
- `Whatever added by conf test cases or init_per_testcase/2`

Examples of the `line` and `config` macros can be seen in the Examples chapter in the user's guide.

If the `line_trace` macro is defined, you will get a timestamp (`erlang:now()`) in your minor log for each `line` macro in your suite. This way you can at any time see which line is currently being executed, and when the line was called.

The `line_trace` macro can also be used together with the `test_server_line` parse transform described above. A timestamp will then be written for each line in the suite, except for functions stated in the `-no_lines` attribute.

The `line_trace` macro can e.g. be defined as a compile option, like this:

```
erlc -W -Dline_trace my_SUITE.erl
```
The Test Server Controller

Erlang Module

The test_server_ctrl module provides a low level interface to the Test Server. This interface is normally not used directly by the tester, but through a framework built on top of test_server_ctrl.

Common Test is such a framework, well suited for automated black box testing of target systems of any kind (not necessarily implemented in Erlang). Common Test is also a very useful tool for white box testing Erlang programs and OTP applications. Please see the Common Test User's Guide and reference manual for more information.

If you want to write your own framework, some more information can be found in the chapter "Writing your own test server framework" in the Test Server User's Guide. Details about the interface provided by test_server_ctrl follows below.

Exports

\[\text{start()} \rightarrow \text{Result}\]
\[\text{start(ParameterFile)} \rightarrow \text{Result}\]

Types:
- Result = ok | {error, {already_started, pid()}}
- ParameterFile = atom() | string()

This function starts the test server. If the parameter file is given, it indicates that the target is remote. In that case the target node is started and a socket connection is established between the controller and the target node.

The parameter file is a text file containing key-value tuples. Each tuple must be followed by a dot-newline sequence. The following key-value tuples are allowed:

\{\text{type,PlatformType}\} This is an atom indicating the target platform type, currently supported: PlatformType = vxworks
  Mandatory
\{\text{target,TargetHost}\} This is the name of the target host, can be atom or string.
  Mandatory
\{\text{slavetargets,SlaveTargets}\} This is a list of available hosts where slave nodes can be started. The hostnames are given as atoms or strings.
  Optional, default SlaveTargets = []
\{\text{longnames,Bool}\} This indicates if longnames shall be used, i.e. if the -name option should be used for the target node instead of -sname
  Optional, default Bool = false
{master, [MasterHost, MasterCookie]} If target is remote and the target node is started as a slave node, this option indicates which master and cookie to use. The given master will also be used as master for slave nodes started with `test_server:start_node/3`. It is expected that the `erl_boot_server` is started on the master node before the `test_server_ctrl:start/1` function is called. Optional, if not given the test server controller node is used as master and the `erl_boot_server` is automatically started.

`stop() -> ok`

This stops the test server (both controller and target) and all its activity. The running test suite (if any) will be halted.

`add_dir(Name, Dir) -> ok`
`add_dir(Name, Dir, Pattern) -> ok`
`add_dir(Name, [Dir|Dirs]) -> ok`
`add_dir(Name, [Dir|Dirs], Pattern) -> ok`

Types:
- `Name = term()`
  The jobname for this directory.
- `Dir = term()`
  The directory to scan for test suites.
- `Dirs = [term()]`
  List of directories to scan for test suites.
- `Pattern = term()`
  Suite match pattern. Directories will be scanned for Pattern SUITE.erl files.

Puts a collection of suites matching (*SUITE) in given directories into the job queue. Name is an arbitrary name for the job, it can be any erlang term. If Pattern is given, only modules matching Pattern* will be added.

`add_module(Mod) -> ok`
`add_module(Name, [Mod|Mods]) -> ok`

Types:
- `Mod = atom()`
- `Mods = [atom()]`
  The name(s) of the module(s) to add.
- `Name = term()`
  Name for the job.

This function adds a module or a list of modules to the test servers job queue. Name may be any Erlang term. When Name is not given, the job gets the name of the module.

`add_case(Mod, Case) -> ok`

Types:
- `Mod = atom()`
  Name of the module the test case is in.
- `Case = atom()`
  Function name of the test case to add.
This function will add one test case to the job queue. The job will be given the
module's name.

\[
\text{add\_case}(\text{Name}, \text{Mod}, \text{Case}) \rightarrow \text{ok}
\]

Types:
- \text{Name} = \text{string()}
  
  Name to use for the test job.

Equivalent to \text{add\_case/2}, but the test job will get the specified name.

\[
\text{add\_cases}(\text{Mod}, \text{Cases}) \rightarrow \text{ok}
\]

Types:
- \text{Mod} = \text{atom()}
  
  Name of the module the test case is in.
- \text{Cases} = [\text{Case}]
- \text{Case} = \text{atom()}
  
  Function names of the test cases to add.

This function will add one or more test cases to the job queue. The job will be given
the module's name.

\[
\text{add\_cases}(\text{Name}, \text{Mod}, \text{Cases}) \rightarrow \text{ok}
\]

Types:
- \text{Name} = \text{string()}
  
  Name to use for the test job.

Equivalent to \text{add\_cases/2}, but the test job will get the specified name.

\[
\text{add\_spec}(\text{TestSpecFile}) \rightarrow \text{ok} \mid \{\text{error, nofile}\}
\]

Types:
- \text{TestSpecFile} = \text{string()}
  
  Name of the test specification file

This function will add the content of the given test specification file to the job queue.
The job will be given the name of the test specification file, e.g. if the file is called
\text{test.spec}, the job will be called \text{test}.

See the reference manual for the test server application for details about the test
specification file.

\[
\text{add\_dir\_with\_skip}(\text{Name}, [\text{Dir|Dirs}], \text{Skip}) \rightarrow \text{ok}
\]
\[
\text{add\_dir\_with\_skip}(\text{Name}, [\text{Dir|Dirs}], \text{Pattern}, \text{Skip}) \rightarrow \text{ok}
\]
\[
\text{add\_module\_with\_skip}(\text{Mod}, \text{Skip}) \rightarrow \text{ok}
\]
\[
\text{add\_module\_with\_skip}(\text{Name}, [\text{Mod| Mods}], \text{Skip}) \rightarrow \text{ok}
\]
\[
\text{add\_case\_with\_skip}(\text{Mod}, \text{Case}, \text{Skip}) \rightarrow \text{ok}
\]
\[
\text{add\_case\_with\_skip}(\text{Name}, \text{Mod}, \text{Case}, \text{Skip}) \rightarrow \text{ok}
\]
\[
\text{add\_cases\_with\_skip}(\text{Mod}, \text{Cases}, \text{Skip}) \rightarrow \text{ok}
\]
\[
\text{add\_cases\_with\_skip}(\text{Name}, \text{Mod}, \text{Cases}, \text{Skip}) \rightarrow \text{ok}
\]

Types:
- Skip = [SkipItem]
  List of items to be skipped from the test.
- SkipItem = {Mod,Comment} | {Mod,Cases,Comment}
- Mod = atom()
  Test suite name.
- Comment = string()
  Reason why suite or case is being skipped.
- Cases = [Case]
- Case = atom()
  Name of test case function.

These functions add test jobs just like the add_dir, add_module, add_case and add_cases functions above, but carry an additional argument, Skip. Skip is a list of items that should be skipped in the current test run. Test job items that occur in the Skip list will be logged as SKIPPED with the associated Comment.

```
add_tests_with_skip(Name, Tests, Skip) -> ok
```

Types:
- Name = term()
  The jobname for this directory.
- Tests = [TestItem]
  List of jobs to add to the run queue.
- TestItem = {Dir,all,all} | {Dir,Mods,all} | {Dir,Mod,Cases}
- Dir = term()
  The directory to scan for test suites.
- Mods = [Mod]
- Mod = atom()
  Test suite name.
- Cases = [Case]
- Case = atom()
  Name of test case function.
- Skip = [SkipItem]
  List of items to be skipped from the test.
- SkipItem = {Mod,Comment} | {Mod,Cases,Comment}
- Comment = string()
  Reason why suite or case is being skipped.

This function adds various test jobs to the test_server_ctrl job queue. These jobs can be of different type (all or specific suites in one directory, all or specific cases in one suite, etc). It is also possible to get particular items skipped by passing them along in the Skip list (see the add_* with skip functions above).

```
abort_current_testcase(Reason) -> ok | {error,no_testcase_running}
```

Types:
- Reason = term()
  The reason for stopping the test case, which will be printed in the log.
When calling this function, the currently executing test case will be aborted. It is the user's responsibility to know for sure which test case is currently executing. The function is therefore only safe to call from a function which has been called (or synchronously invoked) by the test case.

`set_levels(Console, Major, Minor) -> ok`

Types:
- `Console = integer()` Level for I/O to be sent to console.
- `Major = integer()` Level for I/O to be sent to the major logfile.
- `Minor = integer()` Level for I/O to be sent to the minor logfile.

Determines where I/O from test suites/test server will go. All text output from test suites and the test server is tagged with a priority value which ranges from 0 to 100, 100 being the most detailed. (see the section about log files in the user’s guide). Output from the test cases (using `io:format/2`) has a detail level of 50. Depending on the levels set by this function, this I/O may be sent to the console, the major log file (for the whole test suite) or to the minor logfile (separate for each test case).

All output with detail level:
- Less than or equal to `Console` is displayed on the screen (default 1)
- Less than or equal to `Major` is logged in the major log file (default 19)
- Greater than or equal to `Minor` is logged in the minor log files (default 10)

To view the currently set thresholds, use the `get_levels/0` function.

`get_levels() -> {Console, Major, Minor}`

Returns the current levels. See `set_levels/3` for types.

`jobs() -> JobQueue`

Types:
- `JobQueue = [{list()}, pid()]` This function will return all the jobs currently in the job queue.

`multiply_timetraps(N) -> ok`

Types:
- `N = integer() | infinity` This function should be called before a test is started which requires extended timetraps, e.g. if extensive tracing is used. All timetraps started after this call will be multiplied by `N`.

`cover(Application, Analyse) -> ok`
`cover(CoverFile, Analyse) -> ok`
`cover(App, CoverFile, Analyse) -> ok`

Types:
Test Server Reference Manual

- Application = atom()
  OTP application to cover compile
- CoverFile = string()
  Name of file listing modules to exclude from or include in cover compilation. The filename must include full path to the file.
- Analyse = details | overview

This function informs the test_server controller that next test shall run with code coverage analysis. All timetraps will automatically be multiplied by 10 when cover is run.

Application and CoverFile indicates what to cover compile. If Application is given, the default is that all modules in the ebin directory of the application will be cover compiled. The ebin directory is found by adding ebin to code:lib_dir(Application).

A CoverFile can have the following entries:

{exclude, all | ExcludeModuleList}.
{include, IncludeModuleList}.

Note that each line must end with a full stop. ExcludeModuleList and IncludeModuleList are lists of atoms, where each atom is a module name.

If both an Application and a CoverFile is given, all modules in the application are cover compiled, except for the modules listed in ExcludeModuleList. The modules in IncludeModuleList are also cover compiled.

If a CoverFile is given, but no Application, only the modules in IncludeModuleList are cover compiled.

Analyse indicates the detail level of the cover analysis. If Analyse = details, each cover compiled module will be analysed with cover:analyse_to_file/1. If Analyse = overview an overview of all cover compiled modules is created, listing the number of covered and not covered lines for each module.

If the test following this call starts any slave or peer nodes with test_server:start_node/3, the same cover compiled code will be loaded on all nodes. If the loading fails, e.g. if the node runs an old version of OTP, the node will simply not be a part of the coverage analysis. Note that slave or peer nodes must be stopped with test_server:stop_node/1 for the node to be part of the coverage analysis, else the test server will not be able to fetch coverage data from the node.

When the test is finished, the coverage analysis is automatically completed, logs are created and the cover compiled modules are unloaded. If another test is to be run with coverage analysis, test_server_ctrl:cover/2/3 must be called again.

cross_cover_analyse(Level) -> ok

Types:
- Level = details | overview

Analyse cover data collected from all tests. The modules analysed are the ones listed in the cross cover file cross.cover in the current directory of the test server.

The modules listed in the cross.cover file are modules that are heavily used by other applications than the one they belong to. This function should be run after all tests are completed, and the result will be stored in a file called cross_cover.html in the run.<timestamp> directory of the application the modules belong to.

The cross.cover file contains elements like this:

{App, Modules}.

Test Server 37
where \texttt{App} can be an application name or the atom \texttt{all}. The application (or all applications) will cover compile the listed \texttt{Modules}.

\texttt{trc(TraceInfoFile)} \rightarrow \texttt{ok} | \{\texttt{error}, \texttt{Reason}\}

Types:
- \texttt{TraceInfoFile = atom() | string()}  
  Name of a file defining which functions to trace and how

This function starts call trace on target and on slave or peer nodes that are started or will be started by the test suites.

Timetraps are not extended automatically when tracing is used. Use \texttt{multiply_timetraps/1} if necessary.

Note that the trace support in the test server is in a very early stage of the implementation, and thus not yet as powerful as one might wish for.

The trace information file specified by the \texttt{TraceInfoFile} argument is a text file containing one or more of the following elements:

- \{\texttt{SetTP}, \texttt{Module}, \texttt{Pattern}\}
- \{\texttt{SetTP}, \texttt{Module}, \texttt{Function}, \texttt{Pattern}\}
- \{\texttt{SetTP}, \texttt{Module}, \texttt{Function}, \texttt{Arity}, \texttt{Pattern}\}
- \texttt{ClearTP}
- \{\texttt{ClearTP}, \texttt{Module}\}
- \{\texttt{ClearTP}, \texttt{Module}, \texttt{Function}\}
- \{\texttt{ClearTP}, \texttt{Module}, \texttt{Function}, \texttt{Arity}\}

\texttt{SetTP = tp | tpl} This is maps to the corresponding functions in the \texttt{ttb} module in the observer application. \texttt{tp} means set trace pattern on global function calls. \texttt{tpl} means set trace pattern on local and global function calls.

\texttt{ClearTP = ctp | ctpl | ctpg} This is maps to the corresponding functions in the \texttt{ttb} module in the observer application. \texttt{ctp} means clear trace pattern (i.e. turn off) on global and local function calls. \texttt{ctpl} means clear trace pattern on local function calls only and \texttt{ctpg} means clear trace pattern on global function calls only.

\texttt{Module = atom()} The module to trace
\texttt{Function = atom()} The name of the function to trace
\texttt{Arity = integer()} The arity of the function to trace
\texttt{Pattern = [] | match_spec()} The trace pattern to set for the module or function.  
  For a description of the \texttt{match_spec()} syntax, please turn to the User's guide for the runtime system (erts). The chapter “Match Specification in Erlang” explains the general match specification language.

The trace result will be logged in a (binary) file called \texttt{NodeName-test_server} in the current directory of the test server controller node. The log must be formatted using \texttt{ttb:format/1/2}.

This is valid for all targets except the OSF/Delta target for which all nodes will be logged and automatically formatted in one single text file called \texttt{allnodes-test_server}.

\texttt{stop_trace()} \rightarrow \texttt{ok} | \{\texttt{error}, \texttt{not tracing}\}

This function stops tracing on target, and on slave or peer nodes that are currently running. New slave or peer nodes will no longer be traced after this.
FUNCTIONS INVOKED FROM COMMAND LINE

The following functions are supposed to be invoked from the command line using the
-s option when starting the erlang node.

Exports

```
run_test(CommandLine) -> ok
```

Types:

- CommandLine = FlagList

This function is supposed to be invoked from the commandline. It starts the test server,
interprets the argument supplied from the commandline, runs the tests specified and
when all tests are done, stops the test server and returns to the Erlang prompt.

The CommandLine argument is a list of command line flags, typically ['KEY1', Value1,
'KEY2', Value2, ...]. The valid command line flags are listed below.

Under a UNIX command prompt, this function can be invoked like this:
erl -noshell -s test_server_ctrl run_test KEY1 Value1 KEY2 Value2 ... -s
erlang halt

Or make an alias (this is for unix/tcsh)
alias erl_test 'erl -noshell -s test_server_ctrl run_test \!* -s erlang
halt'

And then use it like this
erl_test KEY1 Value1 KEY2 Value2 ...

The valid command line flags are

- DIR dir Adds all test modules in the directory dir to the job queue.
- MODULE mod Adds the module mod to the job queue.
- CASE mod case Adds the case case in module mod to the job queue.
- SPEC spec Runs the test specification file spec.
- SKIPMOD mod Skips all test cases in the module mod
- SKIPCASE mod case Skips the test case case in module mod.
- NAME name Names the test suite to something else than the default name. This does not
apply to SPEC which keeps it’s names.
- PARAMETERS parameterfile Specifies the parameter file to use when starting remote
target
- COVER app cover_file analyse Indicates that the test should be run with cover
analysis. app, cover_file and analyse corresponds to the parameters to
test_server_ctrl:cover/3. If no cover file is used, the atom none should be
given.
- TRACE traceinfofile Specifies a trace information file. When this option is given, call
tracing is started on the target node and all slave or peer nodes that are started.
The trace information file specifies which modules and functions to trace. See the
function trc/1 above for more information about the syntax of this file.
FRAMEWORK CALLBACK FUNCTIONS

A test server framework can be defined by setting the environment variable 

TEST_SERVER_FRAMEWORK to a module name. This module will then be framework 
callback module, and it must export the following function:

Exports

get_suite(Mod,Func) -> TestCaseList

Types:
  • Mod = atom()
  • Func = atom()
  • TestCaseList = [SubCase]

This function is called before a test case is started. The purpose is to retrieve a list of 
subcases. The default behaviour of this function should be to call Mod:Func(suite) and 
return the result from this call.

init_tc(Mod,Func,Args) -> {ok,Args}

Types:
  • Mod = atom()
  • Func = atom()
  • Args = [tuple()]
  Normally Args = [Config]

This function is called when a test case is started. It is called on the process executing 
the test case function (Mod:Func). Typical use of this function can be to alter the input 
parameters to the test case function (Args) or to set properties for the executing process.

end_tc(Mod,Func,Args) -> ok

Types:
  • Mod = atom()
  • Func = atom()
  • Args = [tuple()]
  Normally Args = [Config]

This function is called when a test case is completed. It is called on the process where 
the test case function (Mod:Func) was executed. Typical use of this function can be to 
clean up stuff done by init_tc/3.

report(What,Data) -> ok

Types:
  • What = atom()
  • Data = term()
This function is called in order to keep the framework up to date about the progress of the test. This is useful e.g. if the framework implements a GUI where the progress information is constantly updated. The following can be reported:

- **What = tests\_start, Data = \{Name, NumCases\}**
- **What = tests\_done, Data = \{Ok, Failed, Skipped\}**
- **What = tc\_start, Data = \{Mod, Func\}**
- **What = tc\_done, Data = \{Mod, Func, Result\}**

```erlang
error\_notification(Mod, Case, Args, Error) -> ok
```

**Types:**
- **Mod = atom()**
  - Test suite name.
- **Case = atom()**
  - Name of test case function.
- **Args = [tuple()]**
  - Normally Args = [Config]
- **Error = \{Reason, Location\}**
  - Reason = term()
    - Reason for termination.
  - Location = unknown | [{Mod, Case, Line}]
    - Last known position in Mod before termination.
- **Line = integer()**
  - Line number in file Mod.erl.

This function is called as the result of test case Mod:Case failing with Reason at Location. The function is intended mainly to aid specific logging or error handling in the framework application. Note that for Location to have relevant values (i.e. other than unknown), the `\line` macro or `test_server` `line` parse transform must be used. For details, please see the section about test suite line numbers in the `test_server` reference manual page.

```erlang
warn(What) -> boolean()
```

**Types:**
- **What = processes | nodes**

The test server checks the number of processes and nodes before and after the test is executed. This function is a question to the framework if the test server should warn when the number of processes or nodes has changed during the test execution. If `true` is returned, a warning will be written in the test case minor log file.

```erlang
target\_info() -> InfoStr
```

**Types:**
- **InfoStr = string() \| ""**

The test server will ask the framework for information about the test target system and print InfoStr in the test case log file below the host information.
Index of Modules and Functions

Modules are typed in this way. Functions are typed in this way.

abort_current_testcase/1
   The Test Server Controller, 35
add_case/2
   The Test Server Controller, 33
add_case/3
   The Test Server Controller, 34
add_case_with_skip/3
   The Test Server Controller, 34
add_case_with_skip/4
   The Test Server Controller, 34
add_cases/2
   The Test Server Controller, 34
add_cases/3
   The Test Server Controller, 34
add_cases_with_skip/3
   The Test Server Controller, 34
add_cases_with_skip/4
   The Test Server Controller, 34
add_dir/2
   The Test Server Controller, 33
add_dir/3
   The Test Server Controller, 33
add_dir_with_skip/3
   The Test Server Controller, 34
add_dir_with_skip/4
   The Test Server Controller, 34
add_module/1
   The Test Server Controller, 33
add_module/2
   The Test Server Controller, 33
add_module_with_skip/2
   The Test Server Controller, 34
add_module_with_skip/3
   The Test Server Controller, 34
add_spec/1
   The Test Server Controller, 34
add_tests_with_skip/3
   The Test Server Controller, 35
all/1
   test_server, 29
app_test/1
   test_server, 28
app_test/2
   test_server, 28
break/1
   test_server, 25
call_crash/3
   test_server, 24
call_crash/4
   test_server, 24
call_crash/5
   test_server, 24
capture_get/0
   test_server, 23
capture_start/0
   test_server, 23
capture_stop/0
   test_server, 23
Case/1
   test_server, 30
comment/1
   test_server, 28
continue/0
   test_server, 25
cover/2

Test Server
The Test Server Controller

stop_trace/0

The Test Server Controller

target_info/0

The Test Server Controller

temp_name/1
test

test

all/1, 29
app_test/1, 28
app_test/2, 28
break/1, 25
call_crash/3, 24
call_crash/4, 24
call_crash/5, 24
capture_get/0, 23
capture_start/0, 23
capture_stop/0, 23
Case/1, 30
comment/1, 28
continue/0, 25
do_times/2, 24
do_times/4, 24
end_per_suite/1, 29
end_per_testcase/2, 29
fail/0, 21
fail/1, 21
format/1, 23
format/2, 23
format/3, 23
hours/1, 22
init_per_suite/1, 29
init_per_testcase/2, 29
is_commercial/0, 27
is_native/1, 28
is_release_available/1, 28
m_out_of_n/3, 24
messages_get/0, 23
minutes/1, 22
os_type/0, 21
run_on_shielded_node/2, 25
seconds/1, 23
sleep/1, 22
start_node/3, 26
stop_node/1, 27
temp_name/1, 25
timecall/3, 23
timetrap/1, 22
timetrap_cancel/1, 22
timetrap_scale_factor/0, 22

The Test Server Controller

abort_current_testcase/1, 35
add_case/2, 33
add_case/3, 34
add_case_with_skip/3, 34
add_case_with_skip/4, 34
add_cases/2, 34
add_cases/3, 34
add_cases_with_skip/3, 34
add_cases_with_skip/4, 34
add_dir/2, 33
add_dir/3, 33
add_dir_with_skip/3, 34
add_dir_with_skip/4, 34
add_module/1, 33
add_module/2, 33
add_module_with_skip/2, 34
add_module_with_skip/3, 34
add_spec/1, 34
add_tests_with_skip/3, 35
cover/2, 36
cover/3, 36
cross_cover_analyse/1, 37
daily_tc/3, 40
error_notification/4, 41
get_levels/0, 36
get_suite/2, 40
init_tc/3, 40
jobs/0, 36
multiply_timetraps/1, 36
report/2, 40
run_test/1, 39
set_levels/3, 36
start/0, 32
start/1, 32
stop/0, 33
stop_trace/0, 38
target_info/0, 41
trc/1, 38
warn/1, 41
timecall/3
test_server/23
timetrap/1
test_server/22
timetrap_cancel/1
test_server/22
timetrap_scale_factor/0
test_server/22
trc/1

The Test Server Controller

Test Server

45
warn/1

*The Test Server Controller*, 41