

Introduction

This document describes the MutekH build system configuration files and is intended for kernel developers.

Be sure to first read the [BuildSystem](#) page which contains more basic information.

MutekH has a component-based architecture where each module declares its configuration tokens.

Tokens are declared in **configuration description files** which are located at various places in the MutekH source tree. These constraints configuration files have a different syntax from the build configuration files. They are designed to declare configuration tokens, express relationships between available tokens and describe associated constraints.

Declared tokens may be assigned in build configuration files to build with a given configuration. Their values can later be tested from source code and `Makefile` files using C macros and make variables.

The `.config` files syntax

Configuration description and constraints files contains blocks. Each block begins with `%config` or `%init` and declares a new token. See examples below for syntax details.

Configuration tokens declaration

There are several types of configuration tokens:

- normal features enabling tokens which can be either defined or undefined in build configuration files.
- meta tokens which can only get defined through definition of other tokens.
- value tokens which can have any value.

Token flags

Several flags can be attached to tokens, most important ones are:

`value`

Indicate the token is a value token. Value tokens can not have dependencies but can take values other than `defined` and `undefined`

`meta`

Indicate the token is a meta token which may only be defined by an other token using the `provide` tag.

`auto`

Indicate the token may be automatically defined to satisfy dependencies.

Other flags can be attached to tokens:

`harddep`

Indicate the token can not be safely undefined due to a unsatisfied dependency.

`mandatory`

Indicate the token can not be undefined at all. Useful to enforce requirements on other tokens, mainly for mandatory modules.

`root`

Indicate the token has no parent.

`internal`

Indicate the token is for internal use and can not be defined in build configuration file directly.

`noexport`

Indicate the token should not be written out in generated files.

`private`

Indicate the token can not be used with `parent`, `depend` or `provide` tag from an other `.config` file.

Some flags may be used with value tokens to instruct how `provide` conflicts must be handled instead of producing an error:

`maxval`

Keep the maximum value.

`minval`

Keep the minimum value.

`sumval`

Compute the sum of provided values.

Constraint tags

For each configuration token, one may use the following tags:

`desc` Description string without quotes

Short description about the token, multiple `desc` tags will be concatenated.

`flags` FLAGS [?]

Set some flags with special meaning for the token (see above).

`parent` CONFIG_TOKEN

Hierarchical dependency, it ensures all token with a parent gets silently undefined if the parent is undefined. This prevents options enabled by default to stay enabled if the parent is disabled; this way it avoids errors due to unneeded requirements. This is also used to hide irrelevant tokens from the help screen if the parent token is undefined.

`default` value

Set the token default value. `defined` and `undefined` values act as booleans. `default` value is `undefined` if this line is omitted.

`module` name [long name]

The feature token is associated with a module name. A module with the given name and the actual config file directory will be considered for building when the token gets defined.

The following tags may be used to specify features constraints:

`depend` CONFIG_TOKEN [?]

The tag must be used to express feature dependencies, at least one of the given feature tokens is required.

Unsatisfied dependency undefine the current token and emit a notice, unless flags modify this behavior.

`single` CONFIG_TOKEN [?]

Same as `depend` with the additional constraint that only one of the given tokens may be defined.

`exclude` CONFIG_TOKEN

Specify excluded tokens, the current token must not be defined at the same time as any given token.

`when` CONFIG_TOKEN_CONDITION [?]

The current feature token will be automatically defined if all specified conditions are met. Missing dependencies will emit a notice as if it was defined in the build configuration file.

`provide` CONFIG_TOKEN

Define a meta token if the current token is defined.

Some tags may be used to deals with values tokens. Value tokens must have the `value` flag set:

```
require CONFIG_TOKEN_CONDITION [?]
```

Requirements on value tokens, having at least one condition evaluates to true on the line is mandatory if the current token is defined.

```
provide CONFIG_TOKEN=value
```

Set a value token to the specified value if the current token is defined.

Some tags can be used to give some configurations advice to the user when building MutekH:

```
suggest CONFIG_TOKEN_CONDITION
```

Defining the current feature token suggest the given condition to the user.

```
suggest_when CONFIG_TOKEN_CONDITION [?]
```

The current token will be suggested to the user if dependencies are actually satisfied and all given conditions are met.

The CONFIG_TOKEN_CONDITION might check different conditions:

- Token definition check: CONFIG_TOKEN or CONFIG_TOKEN!
- Token value equality check: CONFIG_TOKEN=value
- Token numerical value magnitude check: CONFIG_TOKEN<value or CONFIG_TOKEN>value

The configuration tool will check both constraint rules consistency and build configuration file respect of the rules when building MutekH.

Example

Configuration constraints example:

```
%config CONFIG_FEATURE
desc This is a great module for MutekH
depend CONFIG_MUTEK_SCHEDULER
module great The great library
require CONFIG_CPU_MAXCOUNT>1
%config end

%config CONFIG_FEATURE_DEBUG
desc Enable debug mode for the great feature
parent CONFIG_FEATURE
provide CONFIG_FEATURE_STACK_SIZE=4096
when CONFIG_DEBUG
%config end

%config CONFIG_FEATURE_STACK_SIZE
desc This is the thread stack size for the great feature
parent CONFIG_FEATURE
flags value
default 512
%config end
```

Initialization tokens declaration

Initialization order of different software components at system start needs close attention. Having all modules and features initialized in proper order is challenging in a modular and configurable project like MutekH.

The configuration tool offers a way to specify initialization code ordering constraints and to associate them to configuration tokens. This has several advantages:

- It allows inserting external modules initialization code in the right place without patching the main tree.
- It avoids the burdensome work of maintaining initialization function calls and associated `#ifdef` directives.
- It ensures initialization function invocations do not get badly reordered to satisfy a new constraint, while ignoring an older constraints.

Initialization tokens can be declared for that purpose, each specifying a different stage in the MutekH initialization process. These tokens live in a separate name space from configuration tokens and are not exported in the configuration header output. Instead a set of function prototypes and properly ordered function calls code are written as C macros which can then be invoked at the right place in the kernel code. An error will be emitted if constraints can not be satisfied.

The MutekH startup process based on this tool is described in the [KernelStartUp](#) page.

Constraint tags

For each configuration token, one may use the following tags:

`parent CONFIG_TOKEN`

Defines the parent configuration token associated to the initialization token. The initialization is disabled if the associated configuration token is not defined.

`condition CONFIG_TOKEN_CONDITION [?]`

This tag can be used to define some conditions which have to be true for the initialization to actually take place. When Multiple condition tag lines are specified, the initialization token is enabled if at least one of lines define a set of conditions which are all true.

`after INIT_TOKEN`

This tag imposes the requirement that the code from current token be executed **after** the code associated with `INIT_TOKEN`.

`before INIT_TOKEN`

This tag imposes the requirement that the code from current token be executed **before** the code associated with `INIT_TOKEN`.

`during INIT_TOKEN`

This tag makes the current token inherits from constraints expressed for the given `INIT_TOKEN`. This tag is used to define a hierarchy between initialization tokens.

`function init_function_name cleanup_function_name`

This tag associates some initialization and cleanup C function names to the token. The cleanup function is optional. When this tag is not present, the token is a place holder token.

`prototype type arg0, type *arg1`

This tag sets a list of arguments used as init and cleanup functions prototype. It may be used on place holder tokens so that the prototype is valid for all function provided by inheriting tokens in the hierarchy.

`flags calls`

This flag specifies that C macros with names such as `token_PROTOTYPES`, `token_INIT` and `token_CLEANUP` must be generated. The generated macros contain prototypes and function calls for all enabled inheriting tokens.

`flags notempty`

This flag can be used to prevent an initialization stage to be empty. When this flag is present and the token is enabled, at least one function call must be generated by an other enabled inheriting token in the hierarchy.

Example

Initialization constraints example:

```
%init INIT_LIBRARIES
  parent CONFIG_MUTEK
```

Initialization tokens declaration

```

    after INIT_SCHEDULER
    before INIT_APPLICATION
    flags calls
%init end

%init INIT_FEATURE
    parent CONFIG_FEATURE
    during INIT_LIBRARIES
    after INIT_LIBC_STDIO      # an explanation why this is needed
    function great_feature_init great_feature_cleanup
%init end

```

This will generate the following C macros for use in the kernel source code, provided that the CONFIG_FEATURE token is defined in the build configuration:

```

#define INIT_LIBRARIES_PROTOTYPES \
    void great_feature_init(); \
    void great_feature_cleanup();

#define INIT_LIBRARIES_INIT(...) \
    great_feature_init(__VA_ARGS__); \

#define INIT_LIBRARIES_CLEANUP(...) \
    great_feature_cleanup(__VA_ARGS__); \

```

The [BuildSystem](#) page describes how to display active initialization tokens for a given configuration along with function calls order and tokens hierarchy.

Source tree Makefile syntax and rules

Makefiles in source directories may use the following variables:

`objs`
A list of `.o` files compiled from `.c`, `.s` or `.S` files

`meta`
A list of files that may be translated from `.m4`, `.cpp` or `.def` files

`copy`
A list of files that must be copied verbatim from source directory to object directory

`subdirs`
A list of subdirectories where more files are to be processed. These directories must exist and contain a Makefile.

`doc_headers`
A list of header files which must be parsed to generate the [MutekH API reference manual](#), see [header documentation](#) for details.

Makefiles may contain optional flags that may be used for compilation:

`file.o_CFLAGS=?`
CFLAGS to use for a given object

`DIR_CFLAGS=?`
CFLAGS to use for all the objects compiled by the current Makefile. Flags added by this setting add-up with the object-specific ones above.

Moreover, one may use `ifeq` (`?, ?`) make constructs to conditionally compile different things. Configuration tokens are usable.

Example:

```
objs = main.o

ifeq ($(CONFIG_SRL_SOCLIB), defined)
objs += barrier.o sched_wait.o srl_log.o hw_init.o
else
objs += posix_wait_cycles.o
endif

main.o_CFLAGS = -O0 -ggdb
```

The arch/ and cpu/ specific parts

Architecture and CPU directories have some special files which are injected in the building process:

- `config.mk`, included by make. It can define some compilation flags
- `ldscript`, invoked at link-time.
 - ◆ Architecture `ldscript` must create a loadable binary
 - ◆ CPU `ldscript` usually only specifies the entry point name

The `config.mk` file

The `arch config.mk` may override the following variables:

```
ARCHCFLAGS
    C-compiler flags
ARCHLDFLAGS
    Linker flags
LD_NO_Q
    Linker for the current architecture does not support -q switch, this slightly changes the linking process.
HOSTCPPFLAGS
    Flags to give to host's cpp (HOSTCPP) program. This is only used for expansion of .def files.
```

The `cpu config.mk` may override the following variables:

```
CPUCFLAGS
    C-compiler flags
CPULDFLAGS
    Linker flags
```

The `ldscript` file

Try `info ld` for a guide through `ldscripts`?

This `ldscript` is taken from architecture's object directory, thus it may be obtained from either:

- copy
- m4 processing
- cpp processing

See `arch/emu/ldscript`, `arch/soclib/ldscript.m4`, and `arch/simple/ldscript.cpp` for the three flavors !

Notes

Prerequisites

The MutekH build-system is based on GNU Make features. It makes intensive use of:

- includes
- `$(foreach)` `$(subst)` `$(eval)` `$(call)` macros
- macro definitions

Therefore, a Make-3.81 at least is mandatory.

The configuration script requires perl ≥ 5.8 .