OS Awareness Manual eCos

MANUAL

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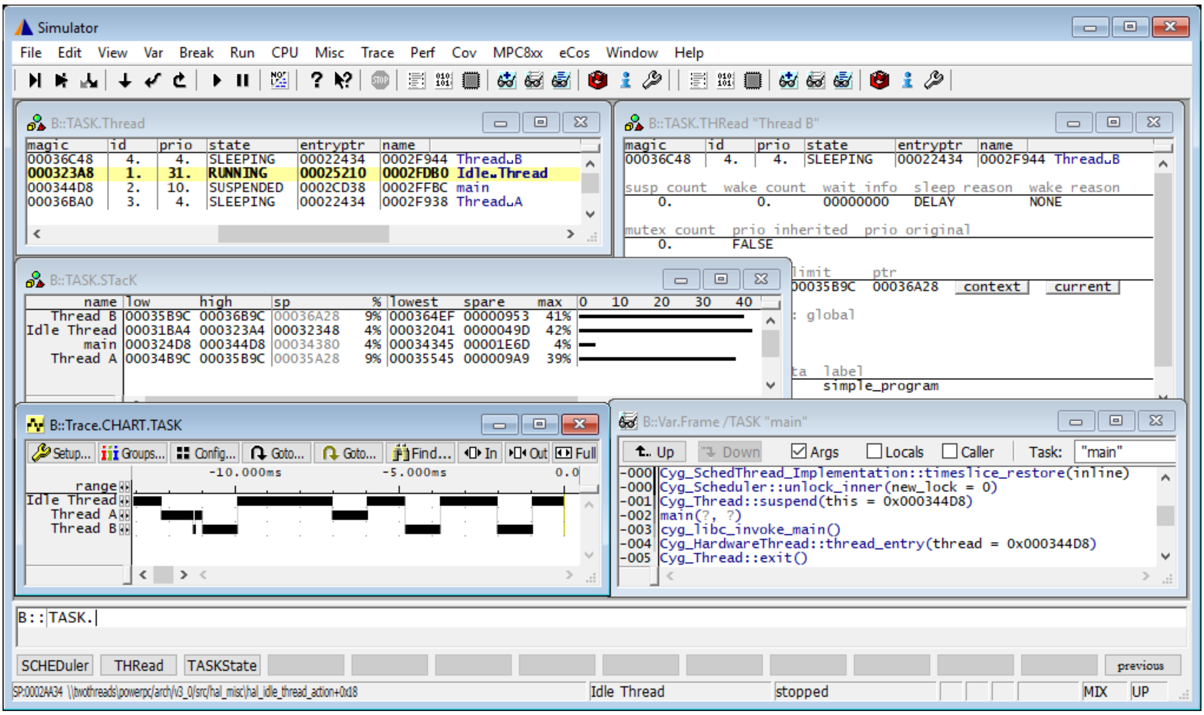
Version 06-Jun-2024

History

04-Feb-21 Removing legacy command TASK.TASKState.

Overview



The OS Awareness for eCos contains special extensions to the TRACE32 Debugger. This manual describes the additional features, such as additional commands and statistic evaluations.

Terminology

eCos uses the term “threads”. If not otherwise specified, the TRACE32 term “task” corresponds to eCos threads.

Brief Overview of Documents for New Users

Architecture-independent information:

- **"Training Basic Debugging"** (training_debugger.pdf): Get familiar with the basic features of a TRACE32 debugger.
- **"T32Start"** (app_t32start.pdf): T32Start assists you in starting TRACE32 PowerView instances for different configurations of the debugger. T32Start is only available for Windows.
- **"General Commands"** (general_ref_<*x*>.pdf): Alphabetic list of debug commands.

Architecture-specific information:

- **"Processor Architecture Manuals"**: These manuals describe commands that are specific for the processor architecture supported by your Debug Cable. To access the manual for your processor architecture, proceed as follows:
  - Choose **Help** menu > **Processor Architecture Manual**.
- **"OS Awareness Manuals"** (rtos_<*os*>.pdf): TRACE32 PowerView can be extended for operating system-aware debugging. The appropriate OS Awareness manual informs you how to enable the OS-aware debugging.

Supported Versions

Currently eCos is supported for the following versions:

- eCos V1.3, V2.0 and V3.0 on ARM/Cortex, ColdFire, MIPS, NIOS-II and PowerPC

Configuration

The **TASK.CONFIG** command loads an extension definition file called “ecos.t32” (directory “~~/demo/<*processor*>/kernel/ecos”). It contains all necessary extensions.

Automatic configuration tries to locate the eCos internals automatically. For this purpose all symbol tables must be loaded and accessible at any time the OS Awareness is used.

If you want to have dual port access for the display functions (display “On The Fly”), you have to map emulation or shadow memory to the address space of all used system tables.

For system resource display and trace functionality, you can do an automatic configuration of the OS Awareness. For this purpose it is necessary that all system internal symbols are loaded and accessible at any time, the OS Awareness is used. Each of the **TASK.CONFIG** arguments can be substituted by '0', which means that this argument will be searched and configured automatically. For a fully automatic configuration omit all arguments:

```
TASK.CONFIG ecos
```

See also the example “~~/demo/<*processor*>/kernel/ecos/ecos.cmm”.

Quick Configuration Guide

To get a quick access to the features of the OS Awareness for eCos with your application, follow this roadmap:

1. Copy the files `ecos.t32` and “`ecos.men`” to your project directory

   (from TRACE32 directory “~~/demo/<*processor*>/kernel/ecos”).

2. Start the TRACE32 Debugger.

3. Load your application as normal.

4. Execute the command:

   ```
   TASK.CONFIG ecos
   ```

   See “**Configuration**”.

5. Execute the command:

   ```
   MENU.ReProgram ecos
   ```

   See “**eCos Specific Menu**”.

6. Start your application.

Now you can access the eCos extensions through the menu.

In case of any problems, please carefully read the previous Configuration chapters.

Hooks & Internals in eCos

No hooks are used in the kernel.

For detecting the current running task, the kernel symbol “Cyg_Scheduler_Base::current_thread” is used.

For retrieving the kernel data structures, the OS Awareness uses the global kernel symbols and structure definitions (Cyg_*). Ensure that access to those structures is possible every time when features of the OS Awareness are used.

The OS Awareness for eCos needs a linked thread list to operate correctly. To ensure this, the configuration of eCos must include the `#define` macro `CYGVAR_KERNEL_THREADS_LIST`. Using the eCos Configuration Tool, enable “Configuration -> eCos kernel -> Thread-related options -> Keep track of all threads using a linked list”.

Features

The OS Awareness for eCos supports the following features.

Display of Kernel Resources

The extension defines new commands to display various kernel resources. Information on the following eCos components can be displayed:

TASK.SCHEDuler	Scheduler
TASK.THRead	Threads

For a description of the commands, refer to chapter "**eCos Commands**".

When working with emulation memory or shadow memory, these resources can be displayed "On The Fly", i.e. while the target application is running, without any intrusion to the application. If using this dual port memory feature, be sure that emulation memory is mapped to all places, where eCos holds its tables.

When working only with target memory, the information will only be displayed if the target application is stopped.

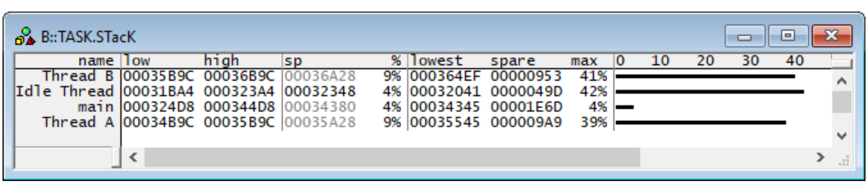
Task Stack Coverage

For stack usage coverage of tasks, you can use the **TASK.STacK** command. Without any parameter, this command will open a window displaying with all active tasks. If you specify only a task magic number as parameter, the stack area of this task will be automatically calculated.

To use the calculation of the maximum stack usage, a stack pattern must be defined with the command **TASK.STacK.PATtern** (default value is zero).

To add/remove one task to/from the task stack coverage, you can either call the **TASK.STacK.ADD** or **TASK.STacK.ReMove** commands with the task magic number as the parameter, or omit the parameter and select the task from the **TASK.STacK.*** window.

It is recommended to display only the tasks you are interested in because the evaluation of the used stack space is very time consuming and slows down the debugger display.



Task-Related Breakpoints

Any breakpoint set in the debugger can be restricted to fire only if a specific task hits that breakpoint. This is especially useful when debugging code which is shared between several tasks. To set a task-related breakpoint, use the command:

Break.Set *<address>*|*<range>* [**/***<option>*] **/TASK** *<task>*	Set task-related breakpoint.

- Use a magic number, task ID, or task name for *<task>*. For information about the parameters, see **"What to know about the Task Parameters"** (general_ref_t.pdf).
- For a general description of the **Break.Set** command, please see its documentation.

By default, the task-related breakpoint will be implemented by a conditional breakpoint inside the debugger. This means that the target will *always* halt at that breakpoint, but the debugger immediately resumes execution if the current running task is not equal to the specified task.

NOTE:	Task-related breakpoints impact the real-time behavior of the application.

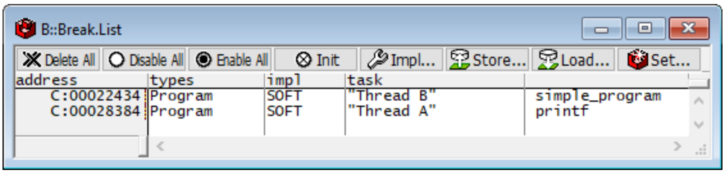
On some architectures, however, it is possible to set a task-related breakpoint with *on-chip* debug logic that is less intrusive. To do this, include the option **/Onchip** in the **Break.Set** command. The debugger then uses the on-chip resources to reduce the number of breaks to the minimum by pre-filtering the tasks.

For example, on ARM architectures: *If* the RTOS serves the Context ID register at task switches, and *if* the debug logic provides the Context ID comparison, you may use Context ID register for less intrusive task-related breakpoints:

Break.CONFIG.UseContextID ON	Enables the comparison to the whole Context ID register.
Break.CONFIG.MatchASID ON	Enables the comparison to the ASID part only.
TASK.List.tasks	If **TASK.List.tasks** provides a trace ID (**traceid** column), the debugger will use this ID for comparison. Without the trace ID, it uses the magic number (**magic** column) for comparison.

When single stepping, the debugger halts at the next instruction, regardless of which task hits this breakpoint. When debugging shared code, stepping over an OS function may cause a task switch and coming back to the same place - but with a different task. If you want to restrict debugging to the current task, you can set up the debugger with **SETUP.StepWithinTask ON** to use task-related breakpoints for single stepping. In this case, single stepping will always stay within the current task. Other tasks using the same code will not be halted on these breakpoints.

If you want to halt program execution as soon as a specific task is scheduled to run by the OS, you can use the **Break.SetTask** command.



Task Context Display

You can switch the whole viewing context to a task that is currently not being executed. This means that all register and stack-related information displayed, e.g. in **Register**, **Data.List**, **Frame** etc. windows, will refer to this task. Be aware that this is only for displaying information. When you continue debugging the application (**Step** or **Go**), the debugger will switch back to the current context.

To display a specific task context, use the command:

Frame.TASK [<*task*>]	Display task context.

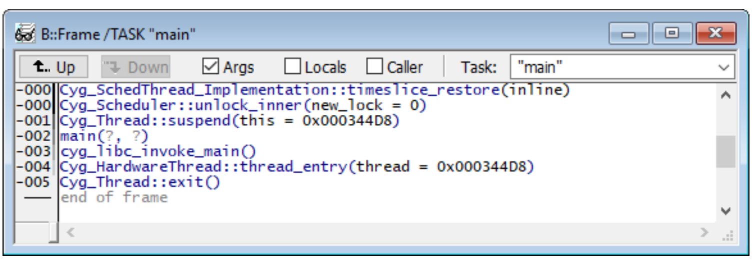
- Use a magic number, task ID, or task name for <*task*>. For information about the parameters, see **"What to know about the Task Parameters"** (general_ref_t.pdf).
- To switch back to the current context, omit all parameters.

To display the call stack of a specific task, use the following command:

Frame /Task <*task*>	Display call stack of a task.

If you'd like to see the application code where the task was preempted, then take these steps:

1. Open the **Frame /Caller /Task** <*task*> window.
2. Double-click the line showing the OS service call.



SMP Support

The OS Awareness supports symmetric multiprocessing (SMP).

An SMP system consists of multiple similar CPU cores. The operating system schedules the threads that are ready to execute on any of the available cores, so that several threads may execute in parallel. Consequently an application may run on any available core. Moreover, the core at which the application runs may change over time.

To support such SMP systems, the debugger allows a “system view”, where one TRACE32 PowerView GUI is used for the whole system, i.e. for all cores that are used by the SMP OS. For information about how to set up the debugger with SMP support, please refer to the **Processor Architecture Manuals**.

All core relevant windows (e.g. **Register.view**) show the information of the current core. The state line of the debugger indicates the current core. You can switch the core view with the **CORE.select** command.

Target breaks, be they manual breaks or halting at a breakpoint, halt all cores synchronously. Similarly, a **Go** command starts all cores synchronously. When halting at a breakpoint, the debugger automatically switches the view to the core that hit the breakpoint.

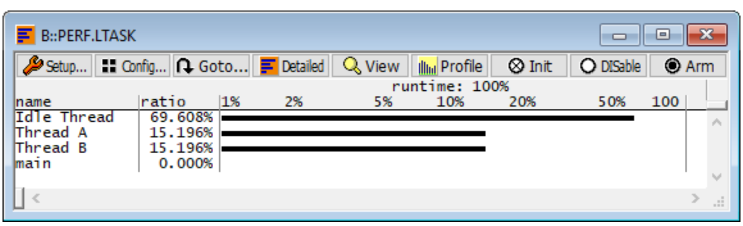
Because it is undetermined, at which core an application runs, breakpoints are set on all cores simultaneously. This means, the breakpoint will always hit independently on which core the application actually runs.

Dynamic Task Performance Measurement

The debugger can execute a dynamic performance measurement by evaluating the current running task in changing time intervals. Start the measurement with the commands **PERF.Mode TASK** and **PERF.Arm**, and view the contents with **PERF.ListTASK**. The evaluation is done by reading the ‘magic’ location (= current running task) in memory. This memory read may be non-intrusive or intrusive, depending on the **PERF.METHOD** used.

If **PERF** collects the PC for function profiling of processes in MMU-based operating systems (**SYStem.Option.MMUSPACES ON**), then you need to set **PERF.MMUSPACES**, too.

For a general description of the **PERF** command group, refer to **“General Commands Reference Guide P”** (general_ref_p.pdf).



Task Runtime Statistics

NOTE:	This feature is *only* available, if your debug environment is able to trace task switches (program flow trace is not sufficient). It requires either an on-chip trace logic that is able to generate task information (eg. data trace), or a software instrumentation feeding one of TRACE32 software based traces (e.g. **FDX** or **Logger**). For details, refer to **“OS-aware Tracing”** (glossary.pdf).

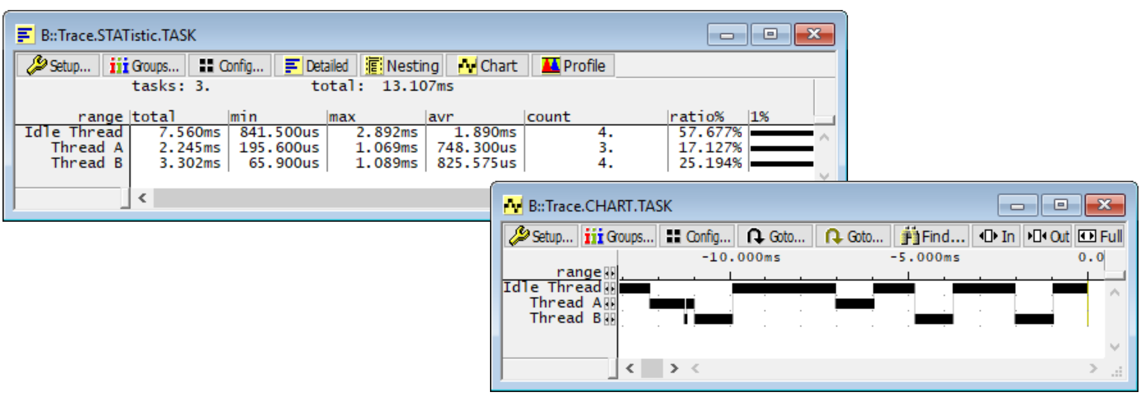
Based on the recordings made by the **Trace** (if available), the debugger is able to evaluate the time spent in a task and display it statistically and graphically.

To evaluate the contents of the trace buffer, use these commands:

Trace.List List.TASK DEFault	Display trace buffer and task switches
Trace.STATistic.TASK	Display task runtime statistic evaluation
Trace.Chart.TASK	Display task runtime timechart
Trace.PROfileSTATistic.TASK	Display task runtime within fixed time intervals statistically
Trace.PROfileChart.TASK	Display task runtime within fixed time intervals as colored graph
Trace.FindAll Address TASK.CONFIG(magic)	Display all data access records to the “magic” location
Trace.FindAll CYcle owner OR CYcle context	Display all context ID records

The start of the recording time, when the calculation doesn’t know which task is running, is calculated as “(unknown)”.

All kernel activities up to the task switch are added to the calling task. The start of the recording time, when the calculation doesn’t know, which task is running, is calculated as “(root)”.



NOTE:	This feature is *only* available, if your debug environment is able to trace task switches and data accesses (program flow trace is not sufficient). It requires either an on-chip trace logic that is able to generate a data trace, or a software instrumentation feeding one of TRACE32 software based traces (e.g. **FDX** or **Logger**). For details, refer to **"OS-aware Tracing"** (glossary.pdf).

The time different tasks are in a certain state (running, ready, suspended or waiting) can be evaluated statistically or displayed graphically.

This feature requires that the following data accesses are recorded:

- All accesses to the status words of all tasks
- Accesses to the current task variable (= magic address)

Adjust your trace logic to record all data write accesses, or limit the recorded data to the area where all TCBs are located (plus the current task pointer).

Example: This script assumes that the TCBs are located in an array named TCB_array and consequently limits the tracing to data write accesses on the TCBs and the task switch.

```
Break.Set Var.RANGE(TCB_array) /Write /TraceData
Break.Set TASK.CONFIG(magic) /Write /TraceData
```

To evaluate the contents of the trace buffer, use these commands:

Trace.STATistic.TASKState	Display task state statistic
Trace.Chart.TASKState	Display task state timechart

The start of the recording time, when the calculation doesn't know which task is running, is calculated as "(unknown)".

All kernel activities up to the task switch are added to the calling task. The start of the recording time, when the calculation doesn't know, which task is running, is calculated as "(root)".

NOTE:	This feature is *only* available, if your debug environment is able to trace task switches (program flow trace is not sufficient). It requires either an on-chip trace logic that is able to generate task information (eg. data trace), or a software instrumentation feeding one of TRACE32 software based traces (e.g. **FDX** or **Logger**). For details, refer to **“OS-aware Tracing”** (glossary.pdf).

All function-related statistic and time chart evaluations can be used with task-specific information. The function timings will be calculated dependent on the task that called this function. To do this, in addition to the function entries and exits, the task switches must be recorded.

To do a selective recording on task-related function runtimes based on the data accesses, use the following command:

```
; Enable flow trace and accesses to the magic location
Break.Set TASK.CONFIG(magic) /TraceData
```

To do a selective recording on task-related function runtimes, based on the Arm Context ID, use the following command:

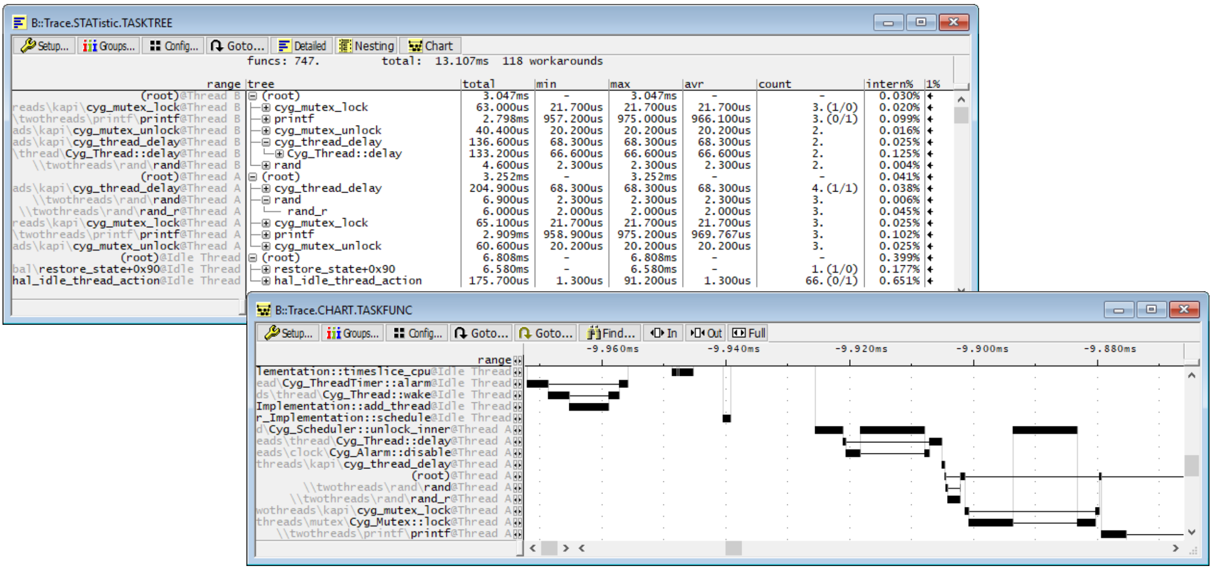
```
; Enable flow trace with Arm Context ID (e.g. 32bit)
ETM.ContextID 32
```

To evaluate the contents of the trace buffer, use these commands:

Trace.ListNesting	Display function nesting
Trace.STATistic.Func	Display function runtime statistic
Trace.STATistic.TREE	Display functions as call tree
Trace.STATistic.sYmbol /SplitTASK	Display flat runtime analysis
Trace.Chart.Func	Display function timechart
Trace.Chart.sYmbol /SplitTASK	Display flat runtime timechart

The start of the recording time, when the calculation doesn’t know which task is running, is calculated as “(unknown)”.

All kernel activities up to the task switch are added to the calling task.



eCos specific Menu

The menu file “ecos.men” contains a menu with eCos specific menu items. Load this menu with the **MENU.ReProgram** command.

You will find a new menu called **eCos**.

- The **Display** menu items launch the kernel resource display windows.
- The **Stack Coverage** submenu starts and resets the eCos specific stack coverage and provides an easy way to add or remove tasks from the stack coverage window.

In addition, the menu file (*.men) modifies these menus on the TRACE32 main menu bar:

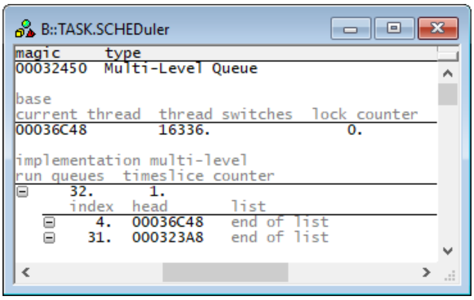
- The **Trace** menu is extended. In the **List** submenu, you can choose if you want a trace list window to show only task switches (if any) or task switches together with default display.
- The **Perf** menu contains additional submenus for task runtime statistics, task-related function runtime statistics or statistics on task states.

TASK.SCHEDuler

Display scheduler information

Format:	**TASK.SCHEDuler**

Displays detailed information about the used scheduler.



"magic" is a unique ID, used by the OS Awareness to identify the scheduler (address of the scheduler object).

The fields "magic" and "head" are mouse sensitive, double clicking on them opens appropriate windows.

TASK.THRead

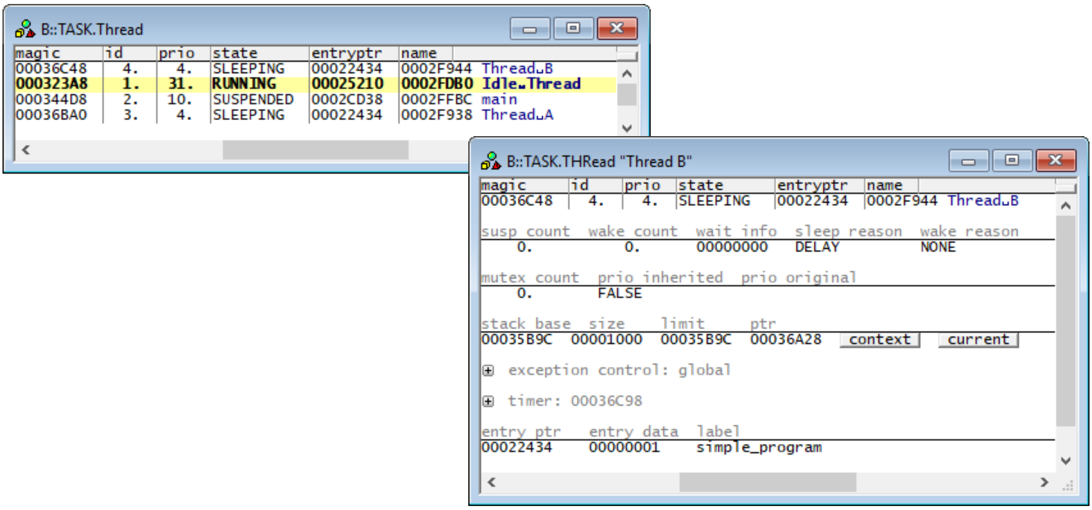
Display threads

Format:	**TASK.THRead** [<*thread*>]

Displays the thread table of eCos or detailed information about one specific thread.

Without any arguments, a table with all created threads will be shown.

Specify a thread name or magic number to display detailed information on that thread.



"magic" is a unique ID, used by the OS Awareness to identify a specific thread (address of the thread object).

The "magic" field and various other fields are mouse sensitive. Double-clicking on them opens appropriate windows. Right clicking on the "magic" will show a local menu.

eCos PRACTICE Functions

There are special definitions for eCos specific PRACTICE functions.

TASK.CONFIG() OS Awareness configuration information

Syntax: **TASK.CONFIG(magic | magicsize)**

Parameter and Description:

magic	**Parameter Type**: String (***without*** quotation marks). Returns the magic address, which is the location that contains the currently running task (i.e. its task magic number).
magicsize	**Parameter Type**: String (***without*** quotation marks). Returns the size of the task magic number (1, 2 or 4).

Return Value Type: Hex value.