LAUTERBACH
DEVELOPMENT TOOLS

OS Awareness Manual OS-9

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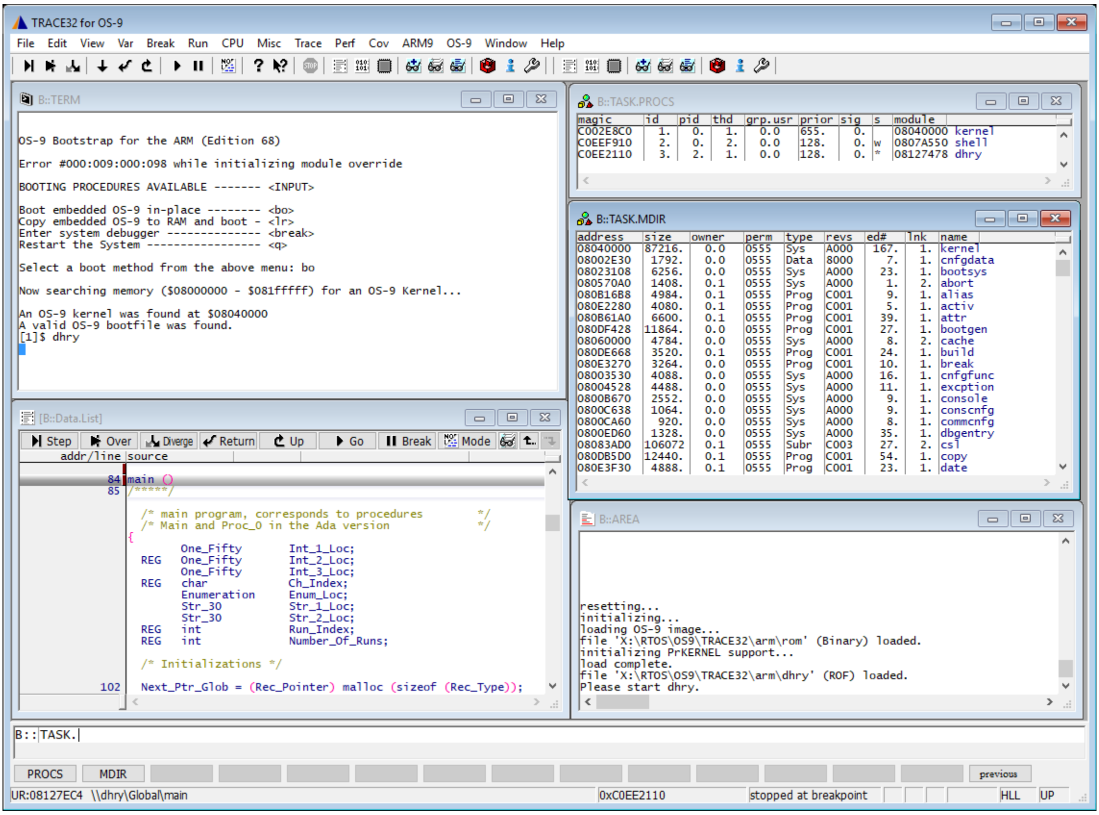
Version 06-Jun-2024

Overview


TRACE32 for OS-9
File Edit View Var Break Run CPU Misc Trace Perf Cov ARM9 OS-9 Window Help
B::TERM
B::TASK.PROCS
B::TASK.MDIR
[B::Data.List]
Step Over Diverge Return Up Go Break Mode
B::AREA
PROCS MDIR previous
UR:08127EC4 \\dhry\Global\main
0xC0EE2110
stopped at breakpoint
HLL UP

```
OS-9 Bootstrap for the ARM (Edition 68)

Error #000:009:000:098 while initializing module override

BOOTING PROCEDURES AVAILABLE ------- <INPUT>

Boot embedded OS-9 in-place -------- <bo>
Copy embedded OS-9 to RAM and boot - <lr>
Enter system debugger -------------- <break>
Restart the System ----------------- <q>

Select a boot method from the above menu: bo

Now searching memory ($08000000 - $081fffff) for an OS-9 Kernel...

An OS-9 kernel was found at $08040000
A valid OS-9 bootfile was found.
[1]$ dhry
```

```
magic    id   pid  thd  grp.usr prior sig  s module
C002E8C0   1.   0.   1.   0.0   655.   0.    08040000 kernel
C0EEF910   2.   0.   2.   0.0   128.   0. w  0807A550 shell
C0EE2110   3.   2.   1.   0.0   128.   0. *  08127478 dhry
```

```
address  size    owner perm type revs  ed#  lnk name
08040000 87216.   0.0  0555 Sys  A000  167.  1. kernel
08002E30  1792.   0.0  0555 Data 8000    7.  1. cnfgdata
08023108  6256.   0.0  0555 Sys  A000   23.  1. bootsys
080570A0  1408.   0.1  0555 Sys  A000    1.  2. abort
080B16B8  4984.   0.1  0555 Prog C001    9.  1. alias
080E2280  4080.   0.1  0555 Prog C001    5.  1. activ
080B61A0  6600.   0.1  0555 Prog C001   39.  1. attr
080DF428 11864.   0.0  0555 Prog C001   27.  1. bootgen
08060000  4784.   0.0  0555 Sys  A000    8.  2. cache
080DE668  3520.   0.1  0555 Prog C001   24.  1. build
080E3270  3264.   0.0  0555 Prog C001   10.  1. break
08003530  4088.   0.0  0555 Sys  A000   16.  1. cnfgfunc
08004528  4488.   0.0  0555 Sys  A000   11.  1. excption
0800B670  2552.   0.0  0555 Sys  A000    9.  1. console
0800C638  1064.   0.0  0555 Sys  A000    9.  1. conscnfg
0800CA60   920.   0.0  0555 Sys  A000    8.  1. commcnfg
0800ED60  1328.   0.0  0555 Sys  A000   35.  1. dbgentry
08083AD0 106072   0.1  0555 Subr C003   27.  2. csl
080DB5D0 12440.   0.1  0555 Prog C001   54.  1. copy
080E3F30  4888.   0.1  0555 Prog C001   23.  1. date
```

```
    addr/line source

           84 main ()
           85 /*****/

                /* main program, corresponds to procedures        */
                /* Main and Proc_0 in the Ada version             */
              {
                      One_Fifty        Int_1_Loc;
                REG   One_Fifty        Int_2_Loc;
                      One_Fifty        Int_3_Loc;
                REG   char             Ch_Index;
                      Enumeration      Enum_Loc;
                      Str_30           Str_1_Loc;
                      Str_30           Str_2_Loc;
                REG   int              Run_Index;
                REG   int              Number_Of_Runs;

                /* Initializations */

          102   Next_Ptr_Glob = (Rec_Pointer) malloc (sizeof (Rec_Type));
```

```
resetting...
initializing...
loading OS-9 image...
file 'X:\RTOS\OS9\TRACE32\arm\rom' (Binary) loaded.
initializing PrKERNEL support...
load complete.
file 'X:\RTOS\OS9\TRACE32\arm\dhry' (ROF) loaded.
Please start dhry.
```

```
B::TASK.
```

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 OS-9 is supported for the following versions:

- OS-9 for ARM version 4.1
- OS-9 for PowerPC version 1.4
- OS-9 for 68K version 1.2

Configuration

The PRACTICE script '~~/demo/m68k/kernel/os9/pos9.cmm' patches the kernel and configures the OS Awareness. The macros defined at the beginning of the file define the address of the kernel, the address of the global system variables and the vectors which are used to enter the kernel (e.g. clock interrupt). These values have to been checked and modified if necessary. The emulation memory has to mapped into the address space used by OS-9 to access the information by dual-port memory.

Format: **TASK.CONFIG os9** *<magic_address> <sleep> <globals> <system_call_gate>*

<magic_address> Specifies a memory location that contains the current running task.

<sleep> The argument for *<sleep>* is currently not used. Specify “0”.

<globals> This argument must be the address of the system-global variables, which is used to display the tables.

<system_call_gate> This argument is the address of the system call entry point, which is used by the command when executing system calls.

If the task selective debugging features are not used, the patching of the kernel is not required. The first two arguments are then not required. The following PRACTICE script will configure the command for data table display:

```
&globals=0cxxxx

TASK.CONFIG os9 0x0 0x0 &globals 0x0
```

TIP: The command **SETUP.DIS** can be used to display the OS-9 traps correctly in the disassembler windows.

The PRACTICE script '~~/demo/m68k/kernel/os9/pos9.cmm' can make the required patches to OS/9 and configure the display command:

```
DO pos9 nopatch                ; configures only display functions
                               ; no patches are made (TASK.OFF)

DO pos9 notask                 ; enables display and analyzer
                               ; functions task selective debugging
                               ; is off

DO pos9                        ; patches VRTX32 for task selective
                               ; debugging
```

The PRACTICE file must be modified according the software running on the target. The address of the system globals the memory for patching must be defined.

Hooks in OS-9

When the task selective debugging is used the entry and exit of the kernel must lead to a multitask breakpoint. To determine the entry of a task, patching the OS-9 kernel is required. All returns to the task context (usually RTE instructions) are patched to pass control to the multitask monitor. The patch writes the current executing process table address to the magic word of the OS Awareness and runs to a breakpoint.

The entries to OS-9 are patched directly in the vector table. The patches write the value 1 to the magic word and run to a breakpoint.

The correct setting of the breakpoints can be checked as follows:

1. Boot OS-9
2. Break program with 'break'
3. Execute 'patchos9.cmm'
4. Continue with 'go'
5. Disable debugging for the kernel
6. Set 'write'-breakpoints to the os-9 global-variables
7. The program should continue without breaking or spotting

Features

Display of Kernel Resources

The extension defines new commands to display various kernel resources. Information on the following OS9 components can be displayed:

TASK.SYSGLOB	Globals and time
TASK.PROCS	Processes
TASK.PROCSL	Processes (extended)
TASK.QUEUES	Event table
TASK.EVENTS	Porcess queues
TASK.ALARMS	Alarm table
TASK.MDIR	Module directory
TASK.MFREE	Free memory
TASK.DEVS	Devices
TASK.IRQS	IRQ table

Symbol Relocation

The processes of OS9 use position independent code and data. The symbols need to be relocated, when they get a new address from OS9. The OS9 awareness provides a method to relocate the symbols automatically when necessary. This method extracts a table from the target memory which defines the locatio nof the position independent code and data sections. It will be called automatically after any program break, or by manually execute the command **sYmbol.RELOCate.Auto**.

Programs that are not active can be relocated to an unused address, when the command **sYmbol.RELOCate.Passive** is active. Without this command symbols of currently not used programs will stay at the last known location. Correct relocation requires knowledge about the base address for position independent data used by the linker. This address must be defined by the **sYmbol.RELOCate.Base** command. The identification of programs can either be done by a unique number, defined by the **sYmbol.RELOCate.Magic** command or based on an address in the code area of a program.

See the sYmbol.RELOCate commands in the **OS-9 Command** section

Example for automatic relocation of symbols for OS/9 (partial program):

```
TASK.CONFIG os9 0x0 0x0 0x1000

sYmbol.RELOCate.Passive 0x0ffff0000
sYmbol.RELOCate.Base 0x0ffff0000
sYmbol.RELOCate.Auto ON

Data.LOAD.ROF modul1 0x18000 0x0ffff8000
```

Task Runtime Analysis

The time spend in a task can be analyzed by marking the access to a word holding a pointer to the current tasks tcb. This can either be in the kernel or in the patch programs. In the first case the runtime in the kernel will be added to the last task which called the kernel. If the 'magic' word in the patch program is marked, the kernel is treated like another task. Task selective debugging should not be used when statistics are made, as this would cause an error in the measurements. The example script 'taskfunc.cmm' can be used to make the measurement for this analysis.

Analyzer.STATistic.TASK	Display task runtime statistic
Analyzer.Chart.TASK	Display task runtime time chart

Task State Analysis

The time different tasks are is a certain state (running, ready, suspended or waiting) can be displayed as a statistic or in graphical form. This feature is implemented by recording all accesses to the status byte of all tasks. The example script 'taskstat.cmm' makes a task state analysis with the demo application. NOTE: The analysis will only show task which were existent when the file is executed and after the measurement has completed.

Analyzer.STATistic.TASKState	Display task state statistic
Analyzer.Chart.TASKState	Display task state time chart

Function Runtime Statistics

All function related statistic and time chart functions can be used with or without patching the kernel. The difference is whether the kernel will be seen like another task or as part of the task who called the kernel. Task selective debugging should not be used when statistics are made, as this would cause an error in the measurements. The task switch can be displayed in the analyzer list with the **List.TASK** keyword. The example script 'taskfunc.cmm' makes a task-selective performance analysis for the demo application.

Analyzer.STATistic.TASKFunc	Display function runtime statistic
Analyzer.STATistic.TASKTREE	Display functions as tree
Analyzer.Chart.TASKFunc	Display function time chart
Analyzer.List	List.TASK FUNC Display function nesting in analyzer

Task Selective Debugging

Task selective debugging allows to disable or enable the analyzer and the trigger system for specific tasks and to stop one task while others continue to operate. This function has an impact on the response time of the multitask kernel. The feature should not be used when making performance or time measurements or with extremely time critical applications. Task selective debugging is currently not available on CPU32 and CPU32+ processors.

System Calls

Manually executing system calls requires a small program on the target, which makes the system call and stops execution after the call. Such a program is part of the standard patch procedure (pos9.cmm). The memory at the system parameter buffer (a part of the patch area) must be mapped internal.

## sYmbol.RELOCate.Auto		Control automatic relocation

Format:		**sYmbol.RELOCate.Auto** [**ON** | **OFF**]

Enables or disables the automatic relocation process. Without argument the command forces an immediate relocation base on the current values of the target. This manual triggered relocation is useful when the target can not be stopped, but analyzer or breakpoint features will be used. It can also be useful when the read of the relocation information structure of the target is time consuming and should not be performed after each breakpoint or step.

```
sYmbol.RELOCate.Auto           ; perform one single relocation

sYmbol.RELOCate.Auto ON        ; turn automatic relocation on
```

See chapter **Symbol Relocation**.

## sYmbol.RELOCate.Base		Define base address

Format:		**sYmbol.RELOCate.Base** *<class>***:***<base>*] [*<symbol_path>*|*<range>*]

Defines the current base address for one or more programs. The symbol path limits the definition to special symbols of a module or a program. If an address range is given, only the symbols in this range will be set. The memory class **P:** or **D:** defines which base address (program or data) is set. This program doesn't relocate symbols. The command is used after loading the symbols, when the default base address in the table doesn't match. The default program base is the first location of the program, the database is zero.

```
sYmbol.RELOCate.Base d:0x400000      ; assume all position independent
                                     ; data was linked to address 400000
```

See chapter **Symbol Relocation**.

sYmbol.RELOCate.List List relocation info

Format: **sYmbol.RELOCate.List**

Displays information about the automatic relocation of symbols.

The magic column displays is the identifier of a program, zero means that the program is identified by an address inside the code area. The 'prog' and 'data' columns show the current base address for code and data. The 'active' field is set when the program is currently alive.

See chapter **Symbol Relocation**.

sYmbol.RELOCate.Magic Define program magic number

Format: **sYmbol.RELOCate.Magic** *<program_magic>* [*<symbol_path>*|*<range>*]

Defines the program magic number for one or more programs. The symbol path limits the definition to special symbols of a module or a program. If an address range is given, only the symbols in this range will be set. The magic number can be used to identify a program and get a relation between task numbers in the target and program names. A magic number of zero (default) will use the program address as an identifier.

```
sYmbol.RELOCate.Magic 0x665f0 \\MODUL1     ; assignes the magic number
                                            ; 665f0 to the program MODUL1
```

See chapter **Symbol Relocation**.

sYmbol.RELOCate.Passive Define passive base address

Format: **sYmbol.RELOCate.Passive** *<class>***:***<base>*

When a program is currently not used in the target, the code or data symbols are relocate to the address defined by this command. The memory class **P:** or **D:** defines which base address (program or data) is set. A base address of zero (default) turns the relocation off. In this case the symbols of not used (passive) programs stay where they are.

```
sYmbol.RELOCate.Passive d:0x0ffff0000      ; unused data symbols will be
                                           ; relocated to address
                                           ; 0ffff0000
```

See chapter **Symbol Relocation**.

TASK.SYSGLOB — Display time

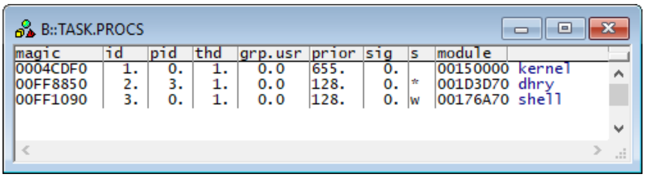
Format: **TASK.SYSGLOB**

Displays the current time and tick.

TASK.PROCS — Process table

Format: **TASK.PROCS**

Displays the process table.



```
magic    |id |pid |thd |grp.usr|prior|sig |s |module
0004CDF0 | 1.|  0.|  1.|  0.0  |655. |  0.|  |00150000 kernel
00FF8850 | 2.|  3.|  1.|  0.0  |128. |  0.|* |001D3D70 dhry
00FF1090 | 3.|  0.|  1.|  0.0  |128. |  0.|w |00176A70 shell
```

TASK.PROCSL — Extended process table

Format: **TASK.PROCSL**

Displays the process table in an extended format.

TASK.QUEUES Process queues

Format: **TASK.QUEUES**

TASK.EVENTS Event table

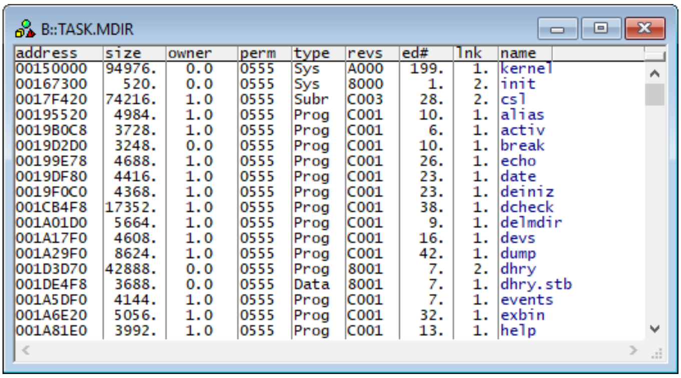
Format: **TASK.EVENTS**

TASK.ALARMS Alarm table

Format: **TASK.ALARMS**

TASK.MDIR Module table

Format: **TASK.MDIR**



```
address  size   owner  perm type revs  ed#   lnk  name
00150000 94976.  0.0   0555 Sys  A000  199.   1.  kernel
00167300   520.  0.0   0555 Sys  8000    1.   2.  init
0017F420 74216.  1.0   0555 Subr C003   28.   2.  csl
00195520  4984.  1.0   0555 Prog C001   10.   1.  alias
0019B0C8  3728.  1.0   0555 Prog C001    6.   1.  activ
0019D2D0  3248.  0.0   0555 Prog C001   10.   1.  break
00199E78  4688.  1.0   0555 Prog C001   26.   1.  echo
0019DF80  4416.  1.0   0555 Prog C001   23.   1.  date
0019F0C0  4368.  1.0   0555 Prog C001   23.   1.  deiniz
001CB4F8 17352.  1.0   0555 Prog C001   38.   1.  dcheck
001A01D0  5664.  1.0   0555 Prog C001    9.   1.  delmdir
001A17F0  4608.  1.0   0555 Prog C001   16.   1.  devs
001A29F0  8624.  1.0   0555 Prog C001   42.   1.  dump
001D3D70 42888.  0.0   0555 Prog 8001    7.   2.  dhry
001DE4F8  3688.  0.0   0555 Data 8001    7.   1.  dhry.stb
001A5DF0  4144.  1.0   0555 Prog C001    7.   1.  events
001A6E20  5056.  1.0   0555 Prog C001   32.   1.  exbin
001A81E0  3992.  1.0   0555 Prog C001   13.   1.  help
```

TASK.MFREE Free memory

Format: **TASK.MFREE**

TASK.DEVS Device table

Format: **TASK.DEVS**

TASK.IRQS Interrupt polling table

Format: **TASK.IRQS**

TASK.CCTL Cache control

Format: **TASK.CCTL** <*option_word*>

Calls the F$Cttl function. The meaning of the bits induced the *option-word* is described in the OS-9 manual.

TASK.EXIT Exit system call

Format: **TASK.EXIT**

The current process is terminated by an OS-9 F$Exit call.

TASK.SEND Send signal

Format: **TASK.SEND** [<*id*>] [<*signal*>]

Sends a signal to one specific or all processes (F$Send).

```
task.send 5. 0.                ; kill task 5.
```

TASK.SysCall Generic system call

Format: **TASK.SysCall** <*code*> [<*d0*> … <*d4*> <*a0*> <*a1*> <*a2*>]

Executes any OS-9 system call. If the system call hangs the kernel, you can try to break manually and use the command **Register.SWAP** to restore the CPU registers in front of the system call. After the system call has been executed the system register set contains the values returned by the system call. The values of

D0..D4 and A0..A2 are displayed in the message line. This command if the most dangerous of the OS Awareness, as wrong arguments may cause the kernel to crash down. Use this command if it's really necessary only.

TASK.MDIR.ADDRESS() Program base address from module directory

Syntax: **TASK.MDIR.ADDRESS(***<module_name>***)**

Extracts the base address of a process from the module directory.

Parameter Type: String (*with* quotation marks).

Return Value Type: Hex value.