

moviDebug2 features

with a focus on command line

MoviDebug2 features (intro)

- Tcl-based command line interface
- List and monitor state of cores
- RTEMS threads support
- UART output monitoring
- Debug PIPE I/O (inc. socket redirection)
- Loading/running an .elf file.
- Stopping/resuming execution of cores

MoviDebug2 features (intro)

- Call stack
- Instruction/source line stepping (into)
- Stepping over/out of functions
- Stepping out of functions
- Insert/remove SW/HW breakpoints
- Show disassembly (cache aware)
- Show source code
- Lookup symbol and line information

MoviDebug2 features (intro)

- Inspect/change local/global variables (cache aware)
- Inspect/change registers
- Show core execution history
- Reset the board; Initialize DDR
- Load/save memory from/to file
- VCS Hooks support (LEON)

MoviDebug2 features (intro)

- Control GPIO pins (MA2150, MA2100)
- CPR control registers MA2x[05]x
- Memory map
- Core state update customisation
- Memory access safety

Command line options

```
hpp@hpp-i7:~/WORK/mdk$ ~/WORK/tools/Latest/linux64/bin/moviDebug2 --help
Usage:
  moviDebug2 [OPTION...] [--] [FILE...]
Available OPTIONS:
  --server[-host] HOST
  -serverIP:HOST
  -srvIP:HOST          Specify host to connect to
  Defaults to `localhost`.

  --[server-]port PORT
  -serverPort:PORT
  -srvPort:PORT         Specify TCP port of server to connect to
  If not specified (or set to zero), the debugger will try to connect
  to port 30000 (first, and then to port 30001) at library initialisation.

  --chip-version CHIPVERSION
  -cv CHIPVERSION
  -cv:CHIPVERSION       Specify chip version
  e.g: ma2100, ma2150, ma2x5x, ma2450, ma2480.
  Affects default DDR initialisation ELF file.
  Affects which Tcl script from the `cv` directory will be `source`d.

  Note: if the server reports an incompatible chip version (e.g ma2x8x
  instead of ma2450), it will override this parameter.

  --verbose
  -verbose              Enable verbose mode
  Enables verbose TCF log and CLI output.
```

- Select server/port
- Set chip version
- Enable/disable components
 - TCF
 - Tcl
 - UART polling, state update
- Run Tcl (init) scripts

More information:

- use --help
- see PDF

The prompt

Processor #

Processor type:
ASIC
Simulator
FPGA
VCS
?Unknown

Target
Root (All)
LeonOS
LeonRT
Shave_N
Leons (ALL)
Shaves (ALL)
LeonXX:Tthread-id

```
-TAG IDCODER : IIIc  
Enabling register block cache  
Disable by defining MV_DBG2  
Starting TCF agent...
```

P0:ALOS%

% Tcl commands go here

Interactive console features

- completion (press TAB multiple times)
- history (up and down arrows); saved in text file
- reverse-i-search (Ctrl+R)
- limited text attributes support (full lines)
- Ctrl+D to leave (end of file) or `exit` command
- Ctrl+C handling

Resetting the board; loading an Elf file

```
P0:ALOS% breset
Leon halt status: ok
P0:ALOS% loadfile -elf output/moviDebug2_features.elf
Loading section <.text> start = 0x70040000 length = 138168 bytes.
Loading section <.text.eh_frame> start = 0x70061BC0 length = 176 bytes.
Loading section <.ctors> start = 0x70061C70 length = 8 bytes.
Loading section <.dtors> start = 0x70061C78 length = 8 bytes.
Loading section <.rodata> start = 0x70061C80 length = 10624 bytes.
Loading section <.init> start = 0x70064600 length = 32 bytes.
Loading section <.fini> start = 0x70064620 length = 24 bytes.
Loading section <.rtemsroset> start = 0x70064638 length = 80 bytes.
Loading section <.data> start = 0x70064688 length = 2204 bytes.
Loading section <.lrt.text> start = 0x701B0000 length = 149448 bytes.
Loading section <.lrt.text.eh_frame> start = 0x701D47D0 length = 1432 bytes.
Loading section <.lrt.ctors> start = 0x701D4D68 length = 24 bytes.
Loading section <.lrt.dtors> start = 0x701D4D80 length = 4 bytes.
Loading section <.lrt.rodata> start = 0x701D4D88 length = 14968 bytes.
Loading section <.lrt.init> start = 0x701D8800 length = 92 bytes.
Loading section <.lrt.fini> start = 0x701D885C length = 68 bytes.
Loading section <.lrt.data> start = 0x701D88A0 length = 1364 bytes.
Loading section <.lrt.heapSection> start = 0x701D8E00 length = 6144 bytes.
Loading section <S.shv0.cmx.text> start = 0x70000000 length = 29487 bytes.
Loading section <S.shv0.cmx.data> start = 0x70008000 length = 1183 bytes.
Loading section <.ddr_direct.data> start = 0x80000980 length = 204880 bytes.
Loading section <.cmx.data> start = 0x70188000 length = 4 bytes.
Total bytes loaded = 560422.
```

Control application output

```
Total bytes loaded = 560422.  
P0:ALOS% pipe create LOS -readsym mvConsoleTxQueue -stdout  
P0:ALOS% pipe create LRT -readsym lrt_mvConsoleTxQueue -stdout  
P0:ALOS% uart silent on  
1  
P0:ALOS% █
```

- Standard Output pipes are taken care of by MDK run/debug
- Pipes are deleted when board is reset.
- `uart off` only works before board reset (or `--no-uart`), loopback mode is set by default, so app will block
- `uart silent on|off` will suppress/show messages

Initialise the DDR controller

```

P0:ALOS% breset
Leon halt status: ok
P0:ALOS% mdump DDR_BASE_ADR 16
Memory range not accessible
  while executing
"mget $where {*}$options"
  (procedure "mdump" line 12)
  invoked from within
"mdump DDR_BASE_ADR 16"
P0:ALOS% ddrinit
P0:ALOS% mdump DDR_BASE_ADR 16
[80000000] = 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF
[80000010] = 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF
[80000020] = 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF
[80000030] = 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF 0xDEADBEEF
P0:ALOS%
  
```

$i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p$
 $i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p$
 $i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p$
 $i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p i\frac{3}{4} \cdot p$

- usually not required (done automatically during load or by application)
- separate ELF file run to call `DrvDdrInitialize()` function

Running the loaded elf file

```
P0:ALOS% run
LOS: LeonOS (P0:ALOS) is running...
LOS: LeonOS (P0:ALOS) suspended at 0x70041110 (Application terminated successfully)
PIPE:LOS: RTEMS POSIX Started
PIPE:LRT: [0] 0
PIPE:LOS: Thread startLRT created.
PIPE:LRT: [1] 1
PIPE:LOS: LeonRT Start Addr: 0x701B1000
PIPE:LRT: [2] true
PIPE:LOS: LeonRT Started.
PIPE:LRT: [3] 0x1
PIPE:LOS:
PIPE:LRT: [4] "short string"
PIPE:LOS: LeonRT Stop.
PIPE:LRT: [5] "string longer than 16 characters"
PIPE:LRT: [6] 0x701da8d0
PIPE:LRT: [7] 0x701da8d4
PIPE:LRT: [8]
PIPE:LRT: [9] 2.000000
PIPE:LRT: [10] 1.000000
P0:ALOS%
```

- does not wait app to finish
- use `run -wait` when necessary
- load ELF again to run again!

View the state of the cores (and threads)

```

P0:ALOS% state
ID      NAME    STATE      PC          SUSPEND REASON
P0:ALOS LeonOS  Suspended  0x70041110 Application terminated successfully
P0:ALOS% state -all
ID      NAME    STATE      PC          SUSPEND REASON
P0:AA   MA2150 [P0:AA] [output/moviDebug2_features.elf]
P0:ALALL Leon Cores
P0:ALOS  LeonOS   Suspended  0x70041110 Application terminated successfully
P0:ALRT  LeonRT   Suspended  0x701B1158 Application terminated successfully
P0:ASALL Shave Cores
P0:AS0   Shave 0   Suspended  0x7000000AD Halted, Exited
P0:AS1   Shave 1   No clock
P0:AS2   Shave 2   No clock
P0:AS3   Shave 3   No clock
P0:AS4   Shave 4   No clock
P0:AS5   Shave 5   No clock
P0:AS6   Shave 6   No clock
P0:AS7   Shave 7   No clock
P0:AS8   Shave 8   No clock
P0:AS9   Shave 9   No clock
P0:AS10  Shave 10  No clock
P0:AS11  Shave 11  No clock
P0:ALOS:RTEMS LeonOS RTEMS Threads
P0:ALOS:T0B010001 [Thread 0xb010001]   Suspended  0x70041110 Suspended
P0:ALOS%

```

Note:

The processor core states are updated asynchronously. Threads are only updated when core is suspended.

Stop at main function

```
P0:ALOS% loadelf -quiet -breset -stopatmain -run -wait output/moviDebug2_features.elf
Leon halt status: ok
LOS: LeonOS (P0:ALOS) suspended at 0x700467F0 (Breakpoint)
P0:ALOS% state -pc -sym -file -line
0x700467F0 POSIX_Init leon/main.cpp 36
P0:ALOS% listsource -2 +4
FILE
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon/main.cpp
LINE      SOURCE
34      extern "C"
35      void *POSIX_Init (void * /*args*/)
36 *  {
37          s32 sc = initClocksAndMemory();
38
39          if(sc) {
40              puts("initClocksAndMemory failed");
P0:ALOS%
```

Source level stepping (LEON)

```

P0:ALOS% loadelf -quiet -breset -stopatmain -run -wait output/moviDebug2_features.elf
Leon halt status: ok
LOS: LeonOS (P0:ALOS) suspended at 0x700467F0 (Breakpoint)
P0:ALOS% pipe create LOS -readsym mvConsoleTxQueue -stderr
P0:ALOS% step -line
LOS: LeonOS (P0:ALOS) suspended at 0x700467F4 (Step)
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon/main.cpp:37
    s32 sc = initClocksAndMemory();
P0:ALOS% step -line
LOS: LeonOS (P0:ALOS) suspended at 0x70046714 (Step)
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon/app_config.cpp:46
    };
P0:ALOS% state -function
initClocksAndMemory
P0:ALOS% step out
LOS: LeonOS (P0:ALOS) suspended at 0x700467FC (Step)
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon/main.cpp:39
    if(sc) {
P0:ALOS% state -function
POSIX_Init
P0:ALOS% step over -line
LOS: LeonOS (P0:ALOS) suspended at 0x70046824 (Step)
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon/main.cpp:44
    DrvDdrInitialise(NULL);
P0:ALOS% step over -line
LOS: LeonOS (P0:ALOS) suspended at 0x7004682C (Step)
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon/main.cpp:46
    puts("RTEMS POSIX Started");
P0:ALOS% step over -line
LOS: LeonOS (P0:ALOS) suspended at 0x70046838 (Step)
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon/main.cpp:69
    int sc = pthread_attr_init(&attr);
PIPE:LOS: RTEMS POSIX Started
P0:ALOS%
  
```

- synchronous by default

Adding breakpoints, continue execution

```

P0:ALOS% loadelf -quiet -breset -stopatmain -run -wait output/moviDebug2_features.elf
Leon halt status: ok
LOS: LeonOS (P0:ALOS) suspended at 0x700467F0 (Breakpoint)
P0:ALOS% pipe create LOS -readsym mvConsoleTxQueue -stderr; pipe create LRT -readsym lrt_mvConsoleTxQueue -stdout
P0:ALOS% breakpoint add -file leon/main.cpp -line 105
===== Breakpoint added =====
[BPID] TARGET IDs TYPE SOURCE LOCATION
[#1] P0:ALOS [SW] leon/main.cpp:105
=====
#1
LOS: Planted software breakpoint for LeonOS (P0:ALOS) at 0x7004679C (file: leon/main.cpp, line 105)
P0:ALOS% cont -wait
LOS: LeonOS (P0:ALOS) suspended at 0x7004679C (Breakpoint; IDs: #1)
PIPE:LOS: RTEMS POSIX Started
PIPE:LOS: Thread startLRT created.
P0:ALOS% state -children LOS:RTEMS
ID          NAME      STATE      PC           SUSPEND REASON
P0:ALOS:T0B010001 [Thread 0x0b010001] Suspended 0x7004EC5C Suspended
P0:ALOS:T0B010002 [Thread 0x0b010002] Suspended 0x7004679C Suspended
P0:ALOS% █

```

- the breakpoint **properties** determine the way the breakpoints will be physically **planted**.
- bonus example: list RTEMS threads

Managing breakpoints

```

P0:ALOS% breakpoint add leon_rt/leonrt_main.cpp:67
#2
===== Breakpoint added =====
[BPID] TARGET IDs TYPE SOURCE LOCATION
[#2] P0:ALOS [SW] leon_rt/leonrt_main.cpp:67
=====
LOS: Breakpoint error (Unresolved source line information)
P0:ALOS% breakpoint change #2 -target LRT
===== Breakpoint changed =====
[BPID] TARGET IDs TYPE SOURCE LOCATION
[#2] P0:ALRT [SW] leon_rt/leonrt_main.cpp:67
=====
LRT: Planted software breakpoint for LeonRT (P0:ALRT) at 0x701D0C48 (file: leon_rt/leonrt_main.cpp, line 67)
P0:ALOS% breakpoint remove #1
LOS: Unplanted software breakpoint from LeonOS (P0:ALOS) at 0x7004679C (file: leon/main.cpp, line 105)
===== Breakpoint removed =====
[BPID] TARGET IDs TYPE SOURCE LOCATION
[#1] P0:ALOS [SW] leon/main.cpp:105
=====
P0:ALOS% breakpoint list
=====
[BPID] TARGET IDs TYPE SOURCE LOCATION
[#2] P0:ALRT [SW] leon_rt/leonrt_main.cpp:67
=====
Context Type Address Hit# Source / Error
P0:ALRT [SW] 0x701D0C48 0 /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon_rt/leonrt_main.cpp:67
=====
P0:ALOS% breakpoint change #2 -type hardware
===== Breakpoint changed =====
[BPID] TARGET IDs TYPE SOURCE LOCATION
[#2] P0:ALRT [HW] leon_rt/leonrt_main.cpp:67
=====
LRT: Planted hardware breakpoint for LeonRT (P0:ALRT) at 0x701D0C48 (file: leon_rt/leonrt_main.cpp, line 67)
LRT: Unplanted software breakpoint from LeonRT (P0:ALRT) at 0x701D0C48 (file: leon_rt/leonrt_main.cpp, line 67)
P0:ALOS%
  
```

- add
- change
- remove
- list

(not shown)

- enable
- disable
- ...

Halting; changing targets

```

LRT: Planted software breakpoint for LeonRT (P0:ALRT) at 0x701D0C48 (file: leon_rt/leonrt_main.cpp, line 67)
P0:ALOS% contw
LRT: LeonRT (P0:ALRT) suspended at 0x701D0C48 (Breakpoint; IDs: #1)
LOS: LeonOS (P0:ALOS) is running...
PIPE:LOS: RTEMS POSIX Started
PIPE:LOS: Thread startLRT created.
PIPE:LOS: LeonRT Start Addr: 0x701B1000
P0:ALOS% state -isrunning
1
P0:ALOS% halt
LOS: LeonOS (P0:ALOS) suspended at 0x700449FC (Debug Mode, trap 0x0B <watchpoint_detected>)
P0:ALOS% state -isrunning
0
P0:ALOS% state -issuspended
1
P0:ALOS% target lrt
P0:ALRT
P0:ALRT% state
ID      NAME      STATE      PC          SUSPEND REASON
P0:ALRT  LeonRT   Suspended  0x701D0C48  Breakpoint
P0:ALRT% listsource
FILE
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon_rt/leonrt_main.cpp
LINE SOURCE
  67  globalVariableTest();
P0:ALRT%

```



Inspecting global variables

P0:ALRT% mget variantArray

| ADDRESS | NAME | VALUE | SIZE | TYPE_NAME | CONTEXT_ID |
|------------|--------------|----------------------------|------|--------------------|-------------|
| 0x80000080 | variantArray | `class Variant [11] {...}` | 264 | class Variant [11] | FP0.P0:ALRT |

P0:ALRT% mget variantArray -depth 1

| ADDRESS | NAME | VALUE | SIZE | TYPE_NAME | CONTEXT_ID |
|------------|--------------|----------------------------|------|--------------------|-------------|
| 0x80000080 | variantArray | `class Variant [11] {...}` | 264 | class Variant [11] | FP0.P0:ALRT |
| 0x80000080 | [0] | `class Variant {...}` | 24 | class Variant | |
| 0x80000098 | [1] | `class Variant {...}` | 24 | class Variant | |
| 0x800000B0 | [2] | `class Variant {...}` | 24 | class Variant | |
| 0x800000C8 | [3] | `class Variant {...}` | 24 | class Variant | |
| 0x800000E0 | [4] | `class Variant {...}` | 24 | class Variant | |
| 0x800000F8 | [5] | `class Variant {...}` | 24 | class Variant | |
| 0x80000110 | [6] | `class Variant {...}` | 24 | class Variant | |
| 0x80000128 | [7] | `class Variant {...}` | 24 | class Variant | |
| 0x80000140 | [8] | `class Variant {...}` | 24 | class Variant | |
| 0x80000158 | [9] | `class Variant {...}` | 24 | class Variant | |
| 0x80000170 | [10] | `class Variant {...}` | 24 | class Variant | |

P0:ALRT% mget {variantArray[0]} -depth 2

| ADDRESS | NAME | VALUE | SIZE | TYPE_NAME |
|------------|-----------------|-------------------------|------|------------------|
| 0x80000080 | variantArray[0] | `class Variant {...}` | 24 | class Variant |
| 0x80000080 | .type | VAR_INT | 4 | enum VariantType |
| 0x80000088 | . | `union {} {...}` | 16 | union {} |
| 0x80000088 | .boolValue | false | 1 | enum bool |
| 0x80000088 | .charValue | '\000' | 1 | char |
| 0x80000088 | .intValue | 0 | 4 | int |
| 0x80000088 | .uintValue | 0x00000000 | 4 | unsigned int |
| 0x80000088 | .floatValue | 0.0 | 4 | float |
| 0x80000088 | .doubleValue | 1.1945302443632241e+103 | 8 | double |
| 0x80000088 | .str | `char [16] {...}` | 16 | char [16] |
| 0x80000088 | .cstr | 0x00000000 | 4 | char * |
| 0x80000088 | .ptr | 0x00000000 | 4 | void * |

P0:ALRT% listsource -2 +5

FILE

/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/

LINE SOURCE

```

86     static void globalVariableTest()
87     {
88 *      for (size_t volatile i = 0; i < count_of(
89 *          {
90             Variant & element = variantArray[i];
91             printf("[%d] %s\n", i, element.to_str
92         }
93     }

```

P0:ALRT% listsource 42 50

FILE

/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/

LINE SOURCE

```

42 // 4: Static Local Data
43 // -----
44 static int glob;
45 static int glob2;
46
47 __attribute__((section(".ddr.bss")))
48 static Variant variantArray[] = {
49     0, 1, true, lu, "short string", "string"
50 };

```

Manipulating local variables

```
P0:ALRT% step over -line
LRT: LeonRT (P0:ALRT) suspended at 0x701D0E98 (Step
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_feature
    Variant & element = variantArray[i];
P0:ALRT% mset i 5
P0:ALRT% step over -line -quiet
LRT: LeonRT (P0:ALRT) suspended at 0x701D0EB8 (Step
P0:ALRT% step over -line -quiet
LRT: LeonRT (P0:ALRT) suspended at 0x701D0F24 (Break
PIPE:LRT: <local> [5] "five five five five five"
```

```
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon_rt/leonrt_main.cpp
LINE SOURCE
95 static void localVariableTest(void)
96 {
97     // This should shadow the global variable
98 *     Variant variantArray[] = { 0, 1u, 2.0f, 3.0, "4", "five five five five five" };
99
100    for (size_t volatile i = 0; i < count_of(variantArray); ++i)
101    {
102        Variant & element = variantArray[i];
103        printf("<local> [%d] %s\n", i, element.to_string().c_str());
104    }
105 }
```

```
P0:ALRT% mget variantArray\[5\] -depth 2
=====
```

| ADDRESS | NAME | VALUE | SIZE | TYPE_NAME |
|------------|-----------------|------------------------|------|------------------|
| 0x701E7D08 | variantArray[5] | `class Variant {...}` | 24 | class Variant |
| 0x701E7D08 | .type | VAR_CSTR | 4 | enum VariantType |
| 0x701E7D10 | . | `union {} {...}` | 16 | union {} |
| 0x701E7D10 | .boolValue | -40 | 1 | enum bool |
| 0x701E7D10 | .charValue | 'xD8' | 1 | char |
| 0x701E7D10 | .intValue | 1880986072 | 4 | int |
| 0x701E7D10 | .uintValue | 0x701d91d8 | 4 | unsigned int |
| 0x701E7D10 | .floatValue | 1.950618432678224e+29 | 4 | float |
| 0x701E7D10 | .doubleValue | 1.127437874612011e+232 | 8 | double |
| 0x701E7D10 | .str | `char [16] {...}` | 16 | char [16] |
| 0x701E7D10 | .cstr | 0x701D91D8 | 4 | char * |
| 0x701E7D10 | .ptr | 0x701D91D8 | 4 | void * |

```
P0:ALRT% mget variantArray\[5\].cstr -asciiiz
five five five five five
```

- cache aware

Call stack

```

P0:ALOS% loadelf -quiet -breset output/moviDebug2_features.elf
Leon halt status: ok
P0:ALOS% breakpoint add -quiet -target S0 -location ackermann -skip-prologue
#1
S0: Planted software breakpoint for Shave 0 (P0:AS0) at 0x700000D3 (file: shave/shave_main.cpp, line 34)
P0:ALOS% run -wait; target S0
S0: Shave 0 (P0:AS0) suspended at 0x700000D3 (Breakpoint; IDs: #1)
LOS: LeonOS (P0:ALOS) is running...
P0:AS0
UART: SHAVE Started.
UART: Table cleared.
P0:AS0% repeat 5 cont -wait
S0: Shave 0 (P0:AS0) suspended at 0x700000D3 (Breakpoint; IDs: #1)
S0: Shave 0 (P0:AS0) suspended at 0x700000D3 (Breakpoint; IDs: #1)
S0: Shave 0 (P0:AS0) suspended at 0x700000D3 (Breakpoint; IDs: #1)
S0: Shave 0 (P0:AS0) suspended at 0x700000D3 (Breakpoint; IDs: #1)
UART: ackermann(3,4)
UART: ackermann(3,3)
UART: ackermann(3,2)
UART: ackermann(3,1)
UART: ackermann(3,0)
S0: Shave 0 (P0:AS0) suspended at 0x700000D3 (Breakpoint; IDs: #1)
P0:AS0% callstack
=====
# IP          Symbol      Source location    ReturnAddr   Frame Ptr.  Level  Details
0 0x700000D3  ackermann+0x13  shave/shave_main.cpp:34  0x70000382  0x7001FE60    8    Top frame, CFI
1 0x70000382  ackermann+0x2c2  shave/shave_main.cpp:47  0x700003BA  0x7001FEA8    7    CFI
2 0x700003BA  ackermann+0x2fa  shave/shave_main.cpp:49  0x700003BA  0x7001FFE0    6    CFI
3 0x700003BA  ackermann+0x2fa  shave/shave_main.cpp:49  0x700003BA  0x7001FF38    5    CFI
4 0x700003BA  ackermann+0x2fa  shave/shave_main.cpp:49  0x700003BA  0x7001FF80    4    CFI
5 0x700003BA  ackermann+0x2fa  shave/shave_main.cpp:49  0x70000086  0x7001FFC8    3    CFI
6 0x70000086  shave_start+0x86  shave/shave_main.cpp:67  0x700003E5  0x70020000    2    CFI
7 0x700003E5  ackermann+0x325  shave/shave_main.cpp:50  0x01000000  0x70020048    1    CFI
8 0x01000000
=====

P0:AS0% 
```

$$A(m, n) = \begin{cases} n + 1 & \text{if } m = 0 \\ A(m - 1, 1) & \text{if } m > 0 \text{ and } n = 0 \\ A(m - 1, A(m, n - 1)) & \text{if } m > 0 \text{ and } n > 0. \end{cases}$$

Call Stack (II.)

P0:ALOS% callstack

| # | IP | Symbol | Source location | ReturnAddr | Frame Ptr. | Level | Details |
|---|------------|--|---|------------|------------|-------|-------------------|
| 0 | 0x70044A00 | DrvLeonRTWaitExecution +0x30 | ../../../../common/drivers/myriad2/socDrivers/leon/ bm/src/DrvLeon.c:221 | 0x700467D0 | 0x7006D538 | 5 | Top frame, CFI |
| 1 | 0x700467D0 | startLRT+0x38 | leon/main.cpp:112 | 0x70053944 | 0x7006D598 | 4 | CFI |
| 2 | 0x70053944 | _Thread_Entry_adaptor_poin ter+0x10 | threadentryadaptorpointer.c:25 | 0x700576E8 | 0x7006D5F8 | 3 | CFI |
| 3 | 0x700576E8 | _Thread_Handler+0x8c | ../../../../cpukit/../../../../ma2x5x/lib/include/rtems/ score/userextimpl.h:293 | 0x70057664 | 0x7006D658 | 2 | CFI |
| 4 | 0x70057664 | _Thread_Handler+0x8 | threadhandler.c:38 | 0x00000008 | | 1 | CFI |
| 5 | 0x00000008 | | | | | 0 | |

P0:ALOS% callstack lrt

| # | IP | Symbol | Source location | ReturnAddr | Frame Ptr. | Level | Details |
|---|------------|--------------------------|--|------------|------------|-------|-------------------|
| 0 | 0x701D36C8 | DrvSvuSwiHalted +0x30 | ../../../../common/drivers/myriad2/socDrivers/leon/bm/ include/DrvSvu.h:216 | 0x701D3A54 | 0x701E7C90 | 4 | Top frame, CFI |
| 1 | 0x701D3A54 | swcWaitShave+0x50 | ../../../../common/swCommon/myriad2/src/swcShaveLoader.c: 735 | 0x701D241C | 0x701E7CF8 | 3 | CFI |
| 2 | 0x701D241C | wait+0x1c | leon_rt/Shave.cpp:89 | 0x701D0CA4 | 0x701E7D58 | 2 | CFI |
| 3 | 0x701D0CA4 | main+0x7c | leon_rt/leonrt_main.cpp:78 | 0x701B1128 | 0x701E7DC0 | 1 | CFI |
| 4 | 0x701B1128 | lrt_exit | ../../../../common/drivers/myriad2/system/leon/bm/asm/ crt0.S:154 | | | 0 | |

P0:ALOS% callstack -target S0 -count 4

| # | IP | Symbol | Source location | ReturnAddr | Frame Ptr. | Details |
|---|------------|-----------------|-------------------------|------------|------------|----------------|
| 0 | 0x700000D3 | ackermann+0x13 | shave/shave_main.cpp:34 | 0x70000382 | 0x7001FE60 | Top frame, CFI |
| 1 | 0x70000382 | ackermann+0x2c2 | shave/shave_main.cpp:47 | 0x700003BA | 0x7001FEA8 | CFI |
| 2 | 0x700003BA | ackermann+0x2fa | shave/shave_main.cpp:49 | 0x700003BA | 0x7001FEF0 | CFI |
| 3 | 0x700003BA | ackermann+0x2fa | shave/shave_main.cpp:49 | 0x700003BA | 0x7001FF38 | CFI |

Call Stack (RTEMS)

```
P0:ALOS% target LOS:T0B010001
P0:ALOS:T0B010001
P0:ALOS:T0B010001% callstack
```

| # | IP | Symbol | Source location | ReturnAddr | Frame Ptr. | Level | Details |
|---|------------|------------------------------------|---|------------|------------|-------|----------------|
| 0 | 0x7004EC5C | pthread_join+0xf0 | ../../../../ma2x5x/lib/include/rtems/posix posixapi.h:67 | 0x7004EC5C | 0x7006C548 | 8 | Top frame, CFI |
| 1 | 0x7004EC5C | pthread_join+0xf0 | ../../../../cpukit/ma2x5x/lib/include/rtems/posix posixapi.h:67 | 0x7004EC5C | 0x7006C548 | 7 | CFI |
| 2 | 0x7004EC5C | pthread_join+0xf0 | ../../../../cpukit/ma2x5x/lib/include/rtems/posix posixapi.h:67 | 0x7004EC5C | 0x7006C548 | 6 | CFI |
| 3 | 0x7004EC5C | pthread_join+0xf0 | ../../../../cpukit/ma2x5x/lib/include/rtems/posix posixapi.h:67 | 0x700468B4 | 0x7006C548 | 5 | CFI |
| 4 | 0x700468B4 | POSIX_Init+0xc4 | leon/main.cpp:62 | 0x70053944 | 0x7006C5F8 | 4 | CFI |
| 5 | 0x70053944 | _Thread_Entry_adaptor_pointer+0x10 | threadentryadaptorpointer.c:25 | 0x700576E8 | 0x7006C658 | 3 | CFI |
| 6 | 0x700576E8 | _Thread_Handler+0x8c | ../../../../cpukit/ma2x5x/lib/include/rtems/score/userextimpl.h:293 | 0x70057664 | 0x7006C6B8 | 2 | CFI |
| 7 | 0x70057664 | _Thread_Handler+0x8 | threadhandler.c:38 | 0x00000008 | | 1 | CFI |
| 8 | 0x00000008 | | | | | 0 | |

```
P0:ALOS:T0B010001% target LOS:T0B010002
P0:ALOS:T0B010002
P0:ALOS:T0B010002% callstack
```

| # | IP | Symbol | Source location | ReturnAddr | Frame Ptr. | Level | Details |
|---|------------|------------------------------------|---|------------|------------|-------|----------------|
| 0 | 0x70044A00 | DrvLeonRTWaitExecution+0x30 | ../../../../common/drivers/myriad2/socDrivers/leon/bm/src/DrvLeon.c:221 | 0x700467D0 | 0x7006D538 | 5 | Top frame, CFI |
| 1 | 0x700467D0 | startLRT+0x38 | leon/main.cpp:112 | 0x70053944 | 0x7006D598 | 4 | CFI |
| 2 | 0x70053944 | _Thread_Entry_adaptor_pointer+0x10 | threadentryadaptorpointer.c:25 | 0x700576E8 | 0x7006D5F8 | 3 | CFI |
| 3 | 0x700576E8 | _Thread_Handler+0x8c | ../../../../cpukit/ma2x5x/lib/include/rtems/score/userextimpl.h:293 | 0x70057664 | 0x7006D658 | 2 | CFI |
| 4 | 0x70057664 | _Thread_Handler+0x8 | threadhandler.c:38 | 0x00000008 | | 1 | CFI |
| 5 | 0x00000008 | | | | | 0 | |

Symbol list

```
P0:ALOS% loadelf -symbols-only output/moviDebug2_features.elf
Symbols loaded.
P0:ALOS% sym list -full m*
=====
ADDRESS      NAME          SIZE  CLASS
0x70046BEC  myriad2_tc_is_pending    24   FUNCTION
0x70046C04  myriad2_tc_at_tick     52   FUNCTION
0x70065DB0  myriad2_tc           64   REFERENCE
0x70046CE4  myriad2_tc_get_timecount 88   FUNCTION
0x700487D0  memfile_alloc_block    52   FUNCTION
0x70048A30  memfile_free_blocks_in_table 116  FUNCTION
0x70048CA4  memfile_ftruncate     104  FUNCTION
0x70048D0C  memfile_read          436  FUNCTION
0x70049200  memfile_write         100  FUNCTION
0x7005D9C8  memmove              328  FUNCTION
0xC0000980  mvConsoleRxQueue     51220 REFERENCE
0x7004A020  mknod                92   FUNCTION
0x700412D8  mvQueueAdd           160  FUNCTION
0x700581E4  memcpy                248  FUNCTION
0x700582DC  memset                284  FUNCTION
0x7004A07C  mount                 872  FUNCTION
0xC000D194  mvConsoleTxQueue     51220 REFERENCE
0x70049F58  mkdir                  28   FUNCTION
0x7005D8A8  memchr                288  FUNCTION
0x70058140  memcmp                164  FUNCTION
0x70041390  mvQueueGet            116  FUNCTION
0x700469C4  myriad2_power_down_loop 4     FUNCTION
0x70066214  memfile_blocks_allocated 4   REFERENCE
0x70049F08  malloc                80   FUNCTION
=====
```

P0:ALOS%

- information comes directly from ELF file

Memory dump

- cache aware

```
P0:ALRT% mdump variantArray 68
[80000080] = 0x00001717 0x55555555 0x00000000 0x55555555      ....UUUU....UUUU
[80000090] = 0x55555555 0x55555555 0x0001717 0x55555555      UUUUUUUUUU....UUUU
[800000A0] = 0x00000001 0x54555555 0x55555555 0x55555555      ....UUUTUUUUUUUUU
[800000B0] = 0x0000B001 0x55555555 0x555555501 0x55555555     .°...UUUU.UUUUUUUU
[800000C0] = 0x55555555 0x55555555 0x00111717 0x55555555      UUUUUUUUUU....UUUU
[800000D0] = 0x00000001 0x55555555 0x55555555 0x55555555      ....UUUUUUUUUUUUUUU
[800000E0] = 0x00057816 0x55555555 0x726F6873 0x74732074     .x..UUUshort st
[800000F0] = 0x676E6972 0x00000000 0x0000C578 0x55555555      ring....xÅ..UUUU
[80000100] = 0x701D90A8 0x55555555 0x55555555 0x55555555      "...pUUUUUUUUUUUUUUU
[80000110] = 0x00000978 0x55555555 0x701DAB70 0x55555555      x...UUUUUp«.pUUUU
[80000120] = 0x55555555 0x55555555 0x00000978 0x55555555      UUUUUUUUUx...UUUU
[80000130] = 0x701DAB74 0x55555555 0x55555545 0x55555555      t«.pUUUUUEUUUUUUUUU
[80000140] = 0x00000000 0x55555555 0x55555555 0x55555555      ....UUUUUUUUUUUUUUU
[80000150] = 0x55555555 0x55555555 0x000F10A7 0x55555555      UUUUUUUUU$...UUUU
[80000160] = 0x40000000 0x55555555 0x55555555 0x55555555      ...@UUUUUUUUUUUUUUU
[80000170] = 0xD011B1E 0x55555555 0x00000000 0x3FF00000      ....UUU.....ð?
[80000180] = 0x55555555 0x55555555 0x55555555 0x55555555      UUUUUUUUUUUUUUUUUU
```

```
P0:ALOS% mdump LHB_ROM_BASE ADR 32
[7FF00000] = 0x108016D2 0x81D82000 0x6F430A0D 0x69727970      ò.... Ø...Copyri
[7FF00010] = 0x20746867 0x20294328 0x34313032 0x6F4D202C      ght (C) 2014, Mo
[7FF00020] = 0x69646976 0x4C207375 0x0D2E6474 0x6C6C410A      vidius Ltd...All
[7FF00030] = 0x67697220 0x20737468 0x65736572 0x64657672      rights reserved
[7FF00040] = 0x1A0A0D2E 0x00000000 0x20150701 0x00183925      .....%9..
[7FF00050] = 0x04030000 0xDEADBEF 0x000000AA 0xFFFFFFFF      ..i³..þ¤...ÿÿÿ
[7FF00060] = 0x2E228099 0x99004400 0x003E22A0 0xF45E0700      ..."D.. ">...^ô
[7FF00070] = 0x00204000 0x00000100 0xF45E0880 0x01204010      .@ .....^ô.@ .
```

Fill memory range

```

P0:ALOS% mfill DDRC_BASE_ADR -size 1024 -format i 0xCAFEBABE
P0:ALOS% mdump DDR_BASE_ADR 16
[80000000] = 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE
[80000010] = 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE
[80000020] = 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE
[80000030] = 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE 0xCAFEBABE
P0:ALOS% mfill DDRC_BASE_ADR -size 1024 HELLO!
P0:ALOS% mdump DDR_BASE_ADR 16
[80000000] = 0x4C4C4548 0x4548214F 0x214F4C4C 0x4C4C4548
[80000010] = 0x4548214F 0x214F4C4C 0x4C4C4548 0x4548214F
[80000020] = 0x214F4C4C 0x4C4C4548 0x4548214F 0x214F4C4C
[80000030] = 0x4C4C4548 0x4548214F 0x214F4C4C 0x4C4C4548
P0:ALOS% mfill DDRC_BASE_ADR -size 1024 -zero
P0:ALOS% mdump DDR_BASE_ADR 16
[80000000] = 0x00000000 0x00000000 0x00000000 0x00000000
[80000010] = 0x00000000 0x00000000 0x00000000 0x00000000
[80000020] = 0x00000000 0x00000000 0x00000000 0x00000000
[80000030] = 0x00000000 0x00000000 0x00000000 0x00000000

```

LEON-specific registers

```
P0:ALOS% state -reg -F
    INS   LOCALS   OUTS   GLOBALS
0: 0x00000000 0xF3001FC2 0x701B1004 0x00000000
1: 0x7006A170 0x70055D04 0x701B1000 0x78188000
2: 0x70064AB4 0x70055D08 0x70064A18 0x00000001
3: 0x70069BC8 0xF30010C2 0x70066400 0x34000020
4: 0x7352A11E 0x00000000 0x70066380 0x34400010
5: 0x00146D68 0x00000020 0x10F00000 0x00000000
6: 0x7006D598 0x00000000 0x7006D4E8 0x70066940
7: 0x7005393C 0x00000000 0x700467C8 0x00000000

    FLOATS
0: 0x7323A312 1.296466e+31 6.157073167623295e+94
1: 0x53098469 1.353063e+12 -----
2: 0x0AF67D7 2.430578e-32 -1.511021424676309e-190
3: 0x98858828 -3.452021e-24 -----
4: 0x50301209 1.181589e+10 -4.761823509792433e+18
5: 0xC3D08559 -417.0418 -----
6: 0x49E1185C 1843980 1.263475742990542e-125
7: 0x2601B100 4.479246e-16 -----
8: 0x00000000 0.0 0.0
9: 0x00000000 0.0 -----
10: 0x8D5BC87C -6.801274e-31 -7.427243165222076e-127
11: 0x5AC016A8 -3.332204e-16 -----
12: 0x0805B8AC 4.024031e-34 6.137187805212316e+137
13: 0x5C8A62F0 3.116186e+17 -----
14: 0x9246A756 -6.268404e-28 -1.748397078607544e-136
15: 0xA3C04424 -2.084555e-17 -----
16: 0x4DB38F7C 3.765656e+08 1.646219582617494e-256
17: 0x0AD3C641 2.039314e-32 -----
18: 0x0DF64EA7 -5.546346e+17 -8.704903976664534e-300
19: 0x81D75185 -7.90955e-38 -----
20: 0xCD1A6766 -1.619042e+08 2.266020216514745e-305
21: 0x00AF0D37 1.614698e-38 -----
22: 0xED708378 -4.65221e+27 9.79770823184491e+306
23: 0x7FABE7A0 sNaN -----
24: 0x88FFC561 -1.539366e-33 1.980414352741647e-74
25: 0x0301AE53 1.178089e-09 -----
26: 0x83A356E4 -9.600228e-37 7.933599230067896e-80
27: 0x2F82D05C 2.379491e-10 -----
28: 0x7FAEF75A sNaN -4.466240582290848e-211
29: 0x9442CB5F -9.834605e-27 -----
30: 0xB78873D5 -1.62664e-05 2.795503504865029e-115
31: 0x28260799 9.216499e-15 -----
```

FSR=0x00440000: cexc=[- - - - -] TEM=[- - - - -] fft=-
aexc=[- - - - -] fcc=EQ NS=1 RD=near qne=0

PC=0x700449F4
NPC=0x700449F8
PSR=0xF39010E2: icc=[N-C] EF=1 CWP=2 ET=1 PIL=0x0 S=1 PS=1
WIM=0x00000008: invalid=[----3---]
TBR=0x70040880: TBA=0x70040000 tt=0x8B (sw_trap_0x8B)
Y=0x00000000

| [BPID] | TARGET IDs | TYPE | LOCATION | |
|---|------------|--|---|------------|
| [#1] | P0:ALRT | [HW] | lrt_ZL18globalVariableTestv | |
| Context | Type | Address | Hit# Source / Error | |
| P0:ALRT | [HW] | 0x701D0CCC | 1 /home/hpp/WORK/mdk/examples/Demo/moviDebug2_f | |
| P0:ALOS% state -reg -asr -target LRT | | | | |
| | INS | LOCALS | OUTS | GLOBALS |
| 0: | 0x00000000 | 0x00000060 | 0x00000000 | 0x00000000 |
| 1: | 0x70000000 | 0x701D0F58 | 0x70000000 | 0x00000000 |
| 2: | 0x701D9228 | 0x701D0F5C | 0x00000000 | 0x20F00000 |
| 3: | 0x00000001 | 0x00000000 | 0x00000000 | 0x70020000 |
| 4: | 0x701D91D8 | 0x00000000 | 0x00000001 | 0x00000000 |
| 5: | 0x701E7D3C | 0x701E7C90 | 0x701D5040 | 0x00000080 |
| 6: | 0x701E7CF8 | 0x00000000 | 0x701E7C90 | 0x00000080 |
| 7: | 0x701D2414 | 0x00000000 | 0x701D3A4C | 0xF3401FC4 |
| ASR | | | | |
| 17: | 0x10006587 | [SVT=1 DWT=1 INDEX=1 NWIN=7 NWP=4 CS=0 CF=0 LD=0 FPU=1 M=0 V8=1] | | |
| 24: | 0x701D0CCC | [WADDR = 0x701d0ccc IF=1] | | |
| 25: | 0xFFFFFFF0 | [WMASK = 0xfffffffffc DL=0 DS=0] | | |
| 26: | 0x00000000 | [WADDR = 0x00000000 IF=0] | | |
| 27: | 0x00000000 | [WMASK = 0x00000000 DL=0 DS=0] | | |
| 28: | 0x00000000 | [WADDR = 0x00000000 IF=0] | | |
| 29: | 0x00000000 | [WMASK = 0x00000000 DL=0 DS=0] | | |
| 30: | 0x00000000 | [WADDR = 0x00000000 IF=0] | | |
| 31: | 0x00000000 | [WMASK = 0x00000000 DL=0 DS=0] | | |
| PC=0x701D36DC | | | | |
| NPC=0x701D3A54 | | | | |
| PSR=0xF3401FE4: icc=[-Z--] EF=1 CWP=4 ET=1 PIL=0xF S=1 PS=1 | | | | |
| WIM=0x00000008: invalid=[----3---] | | | | |
| TBR=0x701B0060: TBA=0x701B0000 tt=0x06 (window_underflow) | | | | |
| Y=0x00000000 | | | | |

SHAVE-specific registers

| P0:AS0% | state | -reg | IRF | V[0] | V[1] | V[2] | V[3] |
|---------|------------|------|------------|------------|-------------|------------|------|
| 0: | 0x70000399 | | 0xA5C1EBBD | 0xB5F3DA8 | 0xBF51FF7D | 0xCB5D676B | |
| 1: | 0xFFFFFFFF | | 0xA9E9E8C4 | 0xD4DFE488 | 0x7DBC9169 | 0xFEC80D8E | |
| 2: | 0xFFFFFFFF | | 0x66AC63FB | 0xA06F0AC0 | 0x51E93C63 | 0x558AB59E | |
| 3: | 0xFFFFFFFF | | 0xCB4A415F | 0x0FB329C8 | 0xF5BEA4BD | 0xADFFAA9B | |
| 4: | 0x20E00080 | | 0xD981B035 | 0xE4BF2D26 | 0x7B9FD776 | 0xFDAB8D88 | |
| 5: | 0x20E0007C | | 0x73C591BD | 0x7F632DEA | 0xCD33B890 | 0xCB4C20E2 | |
| 6: | 0x20000000 | | 0x2D62E97C | 0xF7DE046 | 0xF5656622 | 0x15D98B80 | |
| 7: | 0x7FF17FF8 | | 0xE5C34335 | 0xB5BE5A8D | 0x7F65FCB7 | 0xDEDDA5EF | |
| 8: | 0xE0000000 | | 0xDCD4E0FB | 0x70FCFEF5 | 0xB7FDDEB6 | 0x4FE8FDCB | |
| 9: | 0x80000188 | | 0xED2528F1 | 0xBB9FAB92 | 0xDC5EE5E8 | 0x4FCF48EA | |
| 10: | 0x00000004 | | 0xD463A3C1 | 0x3DFF2FE9 | 0x79FF9EFB | 0xDFEFE9FA | |
| 11: | 0xFFFFFFFF | | 0x40C3EB73 | 0xB52EFAE0 | 0x3BE9B64F | 0xEBAF4B1A | |
| 12: | 0x00000000 | | 0xCEA7717B | 0xA17F9CCD | 0xBFB6E4BD | 0xAFEF9CDE | |
| 13: | 0x0000000F | | 0xF569E29D | 0xFBFE9A99 | 0xF919E03E | 0x9B1F9783 | |
| 14: | 0x00000002 | | 0xC3E68193 | 0xDFEFBBEB | 0x67AFCC8F | 0x6E7523CE | |
| 15: | 0x00000009 | | 0xF6E1823D | 0xAFD533E9 | 0xFFFFE7A4 | 0xFFE90DEB | |
| 16: | 0x00000000 | | 0x1EE9E0E5 | 0xFB7F3EC8 | 0xF735F2FF | 0x2DA73768 | |
| 17: | 0x00000004 | | 0xD68A6398 | 0xD7AEF3C8 | 0x5F15F41F | 0x2FC629AA | |
| 18: | 0x0000000F | | 0xE167C177 | 0x48F6D4B | 0x7BEBEDAA | 0xA12B8D93 | |
| 19: | 0x7001FF80 | | 0xE760E9FF | 0xA62C4DCB | 0xEB76AC9A | 0xBEA8C50A | |
| 20: | 0x7000849F | | 0x89E3A1FC | 0x74B73AE8 | 0xFC6585DB | 0xFBFD85EA | |
| 21: | 0x00000000 | | 0xFDEDE931 | 0xF7EF5FE0 | 0xFEBDD3F | 0xFBAD9EDA | |
| 22: | 0xFFFFFFFF | | 0xB58BB977 | 0xFBBF7BCB | 0xD6FBC2F | 0x9FCED76E | |
| 23: | 0x7000811C | | 0xC1A9ABF0 | 0x0BF7AB6A | 0xE73F852E | 0x547D96B | |
| 24: | 0x70008120 | | 0xFFC7F8FC | 0x8DEDBFC0 | 0x717DBE19 | 0xDDD19F3E | |
| 25: | 0x00000002 | | 0x5F65E103 | 0x7001FCAE | 0xEFEEEE6A | 0xADEFACCE | |
| 26: | 0x7001FD48 | | 0xB7E54B7D | 0xC76F8AE8 | 0x3DBBFDFB | 0x904680CF | |
| 27: | 0x700083CD | | 0xD8022335 | 0x25DF7FC8 | 0x44E2ACEF | 0xDEEFFBE6 | |
| 28: | 0x00000000 | | 0xF34B4AFD | 0x3FEF3FC0 | 0xEDFDF7B0 | 0x5FA1F5EE | |
| 29: | 0x00000025 | | 0x7001FC43 | 0xB7B26AEC | 0xEEF10172 | 0x8FEDF948 | |
| 30: | 0x70000107 | | 0x5562E376 | 0xB7BA5AE0 | 0x DCC56C7D | 0x5D4E785C | |
| 31: | 0x657BB0FE | | 0x2F223075 | 0x3B7F0D08 | 0xC8F99D75 | 0x568D4DCE | |

IP = 0x70000399 INEXT = 0x7000039E

- for low level debugging

Disassembly (LEON)

```
P0:ALRT% listsources +2
FILE
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/leon_rt/leonrt_main.cpp
LINE      SOURCE
 87 *  {
 88     for (size_t volatile i = 0; i < count_of(variantArray); ++i)
 89     {
P0:ALRT% dasm 20
Address      Instruction
0x701D0CCC  save %sp, 0xFFFFF80, %sp
0x701D0CD0  clr [%fp + 0xFFFFFE0]
0x701D0CD4  sethi 0x80000000, %g1
0x701D0CD8  or %g1, 0x00000080, %o0
0x701D0CDC  call 0x701D110C <count_of<Variant, 11u>>
0x701D0CE0  nop
0x701D0CE4  mov %o0, %g2
0x701D0CE8  ld [%fp + 0xFFFFFE0], %g1
0x701D0CEC  cmp %g1, %g2
0x701D0CF0  addx %g0, 0x00000000, %g1
0x701D0CF4  and %g1, 0x000000FF, %g1
0x701D0CF8  cmp %g1, 0x00000000
0x701D0CFc  be 0x701D0D94 <globalVariableTest+0xc8>
0x701D0D00  nop
0x701D0D04  ld [%fp + 0xFFFFFE0], %g2
0x701D0D08  mov %g2, %g1
0x701D0D0C  sll %g1, 0x00000001, %g1
0x701D0D10  add %g1, %g2, %g1
0x701D0D14  sll %g1, 0x00000003, %g1
0x701D0D18  sethi 0x80000000, %g2
```

- cache aware
- breakpoints are hidden

Disassembly (SHAVE)

```

S0: Shave 0 (P0:AS0) suspended at 0x70000399 (Step)
/home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/shave/shave_main.cpp:49
    int tmp = ackermann(m, n - 1);

P0:AS0% dasm -opcodes -count 25
Address Opcode Instruction
0x70000399 C2 22 67 71 00 LSU0.LD0.32 I18, I19, 0X38
0x7000039E 50 SLOT_IDC[5] (NOP 6)
0x7000039F C2 A2 66 69 00 LSU0.LD0.32 I10, I19, 0X34
0x700003A4 50 SLOT_IDC[5] (NOP 6)
0x700003A5 C6 43 FD FF IAU.INCS I10, 0X3FFF
0x700003A9 81 A4 22 00 CMU.CPII I17, I10
0x700003AD 89 F2 C0 00 LSU1.LDIL I30, 0xC0
0x700003B1 82 F3 00 70 LSU0.LDIH I30, 0x7000
0x700003B5 47 F2 02 BRU.SWP I30, 2
0x700003B8 40 SLOT_IDC[4] (NOP 5)
0x700003B9 07 NOP
0x700003BA C9 26 67 59 00 LSU1.ST0.32 I18, I19, 0X2C
0x700003BF C2 A2 66 71 00 LSU0.LD0.32 I10, I19, 0X38
0x700003C4 50 SLOT_IDC[5] (NOP 6)
0x700003C5 C6 43 FD FF IAU.INCS I10, 0X3FFF
0x700003C9 C9 26 67 29 00 LSU1.ST0.32 I18, I19, 0X14
0x700003CE 81 A4 24 00 CMU.CPII I18, I10
0x700003D2 C2 12 67 29 00 LSU0.LD0.32 I17, I19, 0X14
0x700003D7 50 SLOT_IDC[5] (NOP 6)
0x700003D8 89 F2 C0 00 LSU1.LDIL I30, 0xC0
0x700003DC 82 F3 00 70 LSU0.LDIH I30, 0x7000
0x700003E0 47 F2 02 BRU.SWP I30, 2
0x700003E3 40 SLOT_IDC[4] (NOP 5)
0x700003E4 07 NOP
0x700003E5 C2 A2 66 61 00 LSU0.LD0.32 I10, I19, 0X30

```

- cache aware
- breakpoints are hidden

Show core execution history

```

P0:ALOS% hist
[Time_Tag] PC Disassembly Res./Store Trap
[049DE7D9] 0x7018208C or %o7, %g0, %g1 0x7018D0C4
[049DE7EA] 0x70182090 call 0x70182158 0x70182090
[049DE7FC] 0x70182094 or %g1, %g0, %o7 0x7018D0C4
[049DE80D] 0x70182158 mov 0x00000000, %o0 0x00000000
[049DE80E] 0x7018215C or %o7, %g0, %g1 0x7018D0C4
[049DE80F] 0x70182160 call 0x701810E4 0x70182160
[049DE81B] 0x70182164 or %g1, %g0, %o7 0x7018D0C4
[049DE81C] 0x701810E4 mov %psr, %g1 0xF3001FE5
[049DE81D] 0x701810E8 bclr 0x00000020, %g1 0xF3001FC5
[049DE81F] 0x701810EC mov %g1, %psr 0xF3001FC5
[049DE820] 0x701810F0 sethi 0x7FF17C00, %g2 0x7FF17C00
[049DE821] 0x701810F4 bset 0x0000003FC, %g2 0x7FF17FFC
[049DE822] 0x701810F8 mov 0xFFFFFFF, %g1 0xFFFFFFFF
[049DE823] 0x701810FC st %g1, [%g2] 0x7FF17FFC
[049DE824] 0x70181100 mov 0x00000001, %g1 0x00000001
[049DE825] 0x70181104 t 0x00000080 0x00000000 <TRAP>

P0:ALOS% t s0
P0:AS0
P0:AS0% hist
PC Disassembly Branch taken Predicate
0x7000019E SLOT_IDC[5] <NOP 6>
0x7000019E SLOT_IDC[5] <NOP 6>
0x7000019E SLOT_IDC[5] <NOP 6>
0x7000019F IAU.ADD I6, I5, I6
0x700001A3 IAU.ADD I6, I6, 0x2 <PRED>

```

Debug Line Information

```

ID      NAME      STATE      PC      SUSPEND REASON
P0:AS0  Shave 0  Suspended  0x700000D3  Breakpoint
P0:AS0% linenumbers -show-source
ADDRESS      SIZE   FILE
0x700000D3    5     /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/shave/shave_main.cpp  LINE  Extra information
LINE      SOURCE
34          printf("ackermann(%d,%d)\n", m, n);  34  <statement> <prologue end>
P0:AS0% linenumbers -list-files *.cpp
=====
FILE PATH          BASE DIRECTORY
shave/shave_main.cpp  /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features
=====
P0:AS0% linenumbers -target LRT -list-files *.cpp
=====
FILE PATH          BASE DIRECTORY
leon_rt/leonrt_main.cpp  /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features
leon_rt/Variant.cpp    /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features
leon_rt/Shave.cpp     /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features
=====
P0:AS0%
  
```

- based on .debug_lines section information

Memory Map

P0:AA% memmap A

| ADDRESS | NAME | SIZE | BSS | RWX | FILE NAME | FILE | OFFSET | FILE SIZE |
|-------------|--------------------|--------|-----|-----|---|--------|--------|-----------|
| 0x700040000 | .text | 138168 | | r-x | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 196608 | 138168 | |
| 0x700061BC0 | .text.eh_frame | 176 | | r-- | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 334784 | 176 | |
| 0x700061C70 | .ctors | 8 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 334960 | 8 | |
| 0x700061C78 | .dtors | 8 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 334968 | 8 | |
| 0x700061C80 | .rodata | 10624 | | r-- | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 334976 | 10624 | |
| 0x700064600 | .init | 32 | | r-x | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 345600 | 32 | |
| 0x700064620 | .fini | 24 | | r-x | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 345632 | 24 | |
| 0x700064638 | .rtemsroset | 80 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 345656 | 80 | |
| 0x700064688 | .data | 2204 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 345736 | 2204 | |
| 0x700064F28 | .bss | 8584 | BSS | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 347940 | | |
| 0x7000670B0 | .stack | 888144 | BSS | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 347940 | | |
| 0x701B00000 | .lrt.text | 150036 | | r-x | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 393216 | 150036 | |
| 0x701D04A20 | .lrt.text.eh_frame | 1432 | | r-- | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 543264 | 1432 | |
| 0x701D4FB8 | .lrt.ctors | 24 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 544696 | 24 | |
| 0x701D4FD0 | .lrt.dtors | 4 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 544720 | 4 | |
| 0x701D4FD8 | .lrt.rodata | 15040 | | r-- | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 544728 | 15040 | |
| 0x701D8AA0 | .lrt.init | 92 | | r-x | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 559776 | 92 | |
| 0x701D8AFC | .lrt.fini | 68 | | r-x | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 559868 | 68 | |
| 0x701D8B40 | .lrt.data | 1364 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 559936 | 1364 | |
| 0x701D90A00 | .lrt.heapSection | 6144 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 561312 | 6144 | |
| 0x701DA8A0 | .lrt.bss | 1176 | BSS | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 567456 | | |
| 0x701DAD38 | .lrt.stack | 53448 | BSS | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 567456 | | |
| 0x701E7E00 | .lrt.sys.bss | 256 | BSS | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 567456 | | |
| 0x700000000 | S.shv0.cmx.text | 29487 | | r-x | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 131072 | 29487 | |
| 0x700080000 | S.shv0.cmx.data | 1183 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 163840 | 1183 | |
| 0x20FC0028 | .cmx.ctrl | 16 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 65576 | 16 | |
| 0x800000000 | .ddr.bss | 2424 | BSS | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 589824 | | |
| 0xC0000980 | .ddr.direct.data | 204880 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 592256 | 204880 | |
| 0x70188000 | .cmx.data | 4 | | rwx | /home/hpp/WORK/mdk/examples/Demo/moviDebug2_features/output/moviDebug2_features.elf | 360448 | 4 | |

Based on ELF file sections data
 Separate memory map for each core
 Executable bit - code sections
 Cache access goes through Instruction Cache
 required for setting software breakpoint.
 SHAVE Window register aware filter and search options

GPIO

```
P0:ALOS% gpio findpins *debug.*
ID Mode 0 Mode 1 Mode 2 Mode 3 Mode 4 Mode 5 Mode 6
0 --- debug_0 ---
1 --- debug_1 ---
2 --- debug_2 ---
3 --- debug_3 ---
4 --- debug_4 ---
5 --- debug_5 ---
6 --- debug_6 ---
7 --- debug_7 ---
8 --- debug_8 ---
9 --- debug_9 ---
10 --- debug_10 ---
11 --- debug_11 ---
28 --- --- debug_0 ---
29 --- --- debug_1 ---
30 --- --- debug_2 ---
31 --- --- debug_3 ---
32 --- --- debug_4 ---
33 --- --- debug_5 ---
34 --- --- debug_6 ---
35 --- --- debug_7 ---
36 --- --- debug_8 ---
37 --- --- debug_9 ---
38 --- --- debug_10 ---
39 --- --- debug_11 ---
40 --- --- debug_12 ---
41 --- --- debug_13 ---
42 --- --- debug_14 ---
43 --- --- debug_15 ---
79 --- --- debug_12 ---
80 --- --- debug_13 ---
83 --- --- debug_14 ---
84 --- --- debug_15 ---

P0:ALOS% gpio configure 0..9 -mode 2
P0:ALOS% gpio status 0..9
INDEX MODE STATUS RAW VOLT DRIVE SLEW PUP SMT WAK INU DATA_INU REN
0 debug_0 output = 0 raw 1 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
1 debug_1 output = 0 raw 1 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
2 debug_2 output = 0 raw 1 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
3 debug_3 output = 0 raw 1 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
4 debug_4 output = 0 raw 0 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
5 debug_5 output = 0 raw 0 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
6 debug_6 output = 0 raw 0 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
7 debug_7 output = 0 raw 0 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
8 debug_8 output = 0 raw 0 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
9 debug_9 output = 0 raw 1 1.8V 2mA Slow No pull No SCHMITT Disable OFF OFF REN
```

Hardware Mutex control

```
P0:AS0% mutex status 0..4
INDEX USED OWNER
 0 USED LOS
 1 USED LRT
 2 FREE
 3 USED S0
 4 FREE
P0:AS0% mutex unlock 3
P0:AS0% mutex status 0..4
INDEX USED OWNER
 0 USED LOS
 1 USED LRT
 2 FREE
 3 FREE
 4 FREE
```

- 32 hardware mutexes for MA2150
- lock/unlock mutex from current context
- show mutex status and ownership

CPR Summary

System Clocks:

CPU Subsystem (CSS)

| LeonOS: | System Bus: | Peripheral: | LeonRT | Busses | Peripherals |
|------------------|--------------------|---------------------|---------------------|------------------------|-------------------|
| CSS_L0S : ON | CSS_LAHB_CTRL : ON | CSS_AHB_DMA : ON | MSS_CP_LRT : ON | MSS_CP_RTBRIDGE : ON | MSS_CP_SPMP : ... |
| CSS_ROM : ON | CSS_MAHB_CTRL : ON | CSS_USB : ON | MSS_CP_LRT_DSU : ON | MSS_CP_RTAHB_CTRL : ON | MSS_CP_CIF0 : ... |
| CSS_L0S_L2C : ON | CSS_SAHB_CTRL : ON | CSS_SDIO : ON | MSS_CP_LRT_L2C : ON | MSS_CP_APB_SLV : ON | MSS_CP_CIF1 : ... |
| CSS_L0S_ICB : ON | CSS_LAHB2SHB : ON | CSS_BIST2 : ON | MSS_CP_LRT_ICB : ON | MSS_CP_APB2_CTRL : ON | MSS_CP_LCD : ... |
| CSS_L0S_DSU : ON | CSS_SAHB2MAHB : ON | CSS_GETH : ON | MSS_CP_TIM : ON | MSS_CP_AXI_BRIDGE : ON | MSS_CP_AMC : ... |
| CSS_L0S_TIM : ON | CSS_APB1_CTRL : ON | CSS_BIST : ON | | MSS_CP_MXI_CTRL : ON | MSS_CP_NAL : ... |
| CSS_GPIO : ON | CSS_APB3_CTRL : ON | CSS_USB_APPSLV : ON | | MSS_CP_MXI_DEFLV : ... | |
| CSS_JTAG : ON | CSS_APB4_CTRL : ON | CSS_AON : ON | | MSS_CP_AXI_MON : ... | |

Serial DDR MSS/UPA SIPP (HWF suffixes skipped)

| | | | | | |
|---------------|------------------|------------------|----------------------|--------------------------|--|
| CSS_I2C0 : ON | CSS_DSS_APB : ON | CSS_MSS_MAS : ON | MSS_SP_SIGMA : --- | MSS_SP_HARRIS : ... | |
| CSS_I2C1 : ON | CSS_DSS_BUS : ON | CSS_UPA_MAS : ON | MSS_SP_LSC : --- | MSS_SP_UPFIORDN0 : ... | |
| CSS_I2C2 : ON | | | MSS_SP_RAW : --- | MSS_SP_UPFIORDN1 : ... | |
| CSS_UART : ON | | | MSS_SP_DBYR : --- | MSS_SP_UPFIORDN2 : ... | |
| CSS_SPI0 : ON | | | MSS_SP_DOGL : --- | MSS_SP_MIPI_TX0 : ... | |
| CSS_SPI1 : ON | | | MSS_SP_LUMA : --- | MSS_SP_MIPI_TX1 : ... | |
| CSS_SPI2 : ON | | | MSS_SP_SHARPEN : --- | MSS_SP_MIPI_RX0 : ... | |
| CSS_I2S0 : ON | | | MSS_SP_CGEN : --- | MSS_SP_MIPI_RX1 : ... | |
| CSS_I2S1 : ON | | | MSS_SP_MED : --- | MSS_SP_MIPI_RX2 : ... | |
| CSS_I2S2 : ON | | | MSS_SP_CHROMA : --- | MSS_SP_MIPI_RX3 : ... | |
| | | | MSS_SP_CC : --- | MSS_SP_MIPI : ... | |
| | | | MSS_SP_LUT : --- | MSS_SP_SIPP : ... | |
| | | | MSS_SP_EDGE_OP : --- | MSS_SP_SIPP_APPSLV : ... | |
| | | | MSS_SP_CONV : --- | MSS_SP_APB_SLV : ... | |

UPA Subsystem (UPA)

| System Frequencies | | | | | |
|--------------------|----------------|-------------------|----------------------|--|--|
| UPA_Sh0 : ON | UPA_Sh6 : --- | UPA_Shave_L2 : ON | System Freq : 264Mhz | | |
| UPA_Sh1 : --- | UPA_Sh7 : --- | UPA_CDMA : ON | PLL0 Freq : 264Mhz | | |
| UPA_Sh2 : --- | UPA_Sh8 : --- | UPA_BIC : --- | PLL1 Freq : 264Mhz | | |
| UPA_Sh3 : --- | UPA_Sh9 : --- | UPA_CTRL : ON | | | |
| UPA_Sh4 : --- | UPA_Sh10 : --- | | | | |
| UPA_Sh5 : --- | UPA_Sh11 : --- | | | | |

P0_AS0% cpr summary
 PLL0 Status: (LOCKED ,ENABLED) PLL Internals: <0x0015820>
 FIN : 12Mhz NF: 88 [Feedback]
 FREF : 12Mhz NR: 4 [Output Div]
 FVCO : 126Mhz Source: refclk0 / osc1
 System Freq : 264Mhz MasterDiv: 1/1
 PLL1 Status: (LOCKED ,ENABLED) PLL Internals: <0x0015820>
 FIN : 12Mhz NF: 84 [Feedback]
 FREF : 12Mhz NR: 4 [Output Div]
 FVCO : 1856Mhz Source: refclk0 / osc1
 PLL Freq : 264MHz MasterDiv: 1/1

Non-auto-deasserting resets:

Auxiliary resets:
 CSS_AUX_DDR_CORE_CTRL : deasserted
 CSS_AUX_DDR_CORE_PHY : deasserted

UPA Subsystems (UPA)
 UPA_Sh0 : deasserted UPA_Sh1 : asserted UPA_Shave_L2 : deasserted
 UPA_Sh2 : asserted UPA_Sh3 : asserted UPA_CDMA : asserted
 UPA_Sh4 : asserted UPA_Sh5 : asserted UPA_BIC : asserted
 UPA_Sh6 : asserted UPA_Sh7 : asserted UPA_CTRL : asserted
 UPA_Sh8 : asserted UPA_Sh9 : asserted UPA_CDMS : asserted
 UPA_Sh10 : asserted UPA_Sh11 : asserted UPA_AXI : asserted

Media Subsystem (MSS)
 LeonOS Busses Peripherals
 MSS_SP_LRT : deasserted MSS_SP_RTBRIDGE : deasserted MSS_SP_SPMP : asserted
 MSS_SP_LRT_DSU : deasserted MSS_SP_CDMA : deasserted MSS_SP_CIF0 : ...
 MSS_SP_LRT_L2C : deasserted MSS_SP_APB_SLV : deasserted MSS_SP_CIF1 : ...
 MSS_SP_LRT_ICB : deasserted MSS_SP_APB_CTRL : deasserted MSS_SP_LCD : asserted
 MSS_SP_TIM : deasserted MSS_SP_AXI_CTRL : deasserted MSS_SP_MXI : asserted
 MSS_SP_AXI : deasserted MSS_SP_MXI_CTRL : deasserted MSS_SP_NAL : asserted
 MSS_SP_AXI_DEFSLV : asserted MSS_SP_AXI_MON : asserted

Other Resets:
 CSS_DSS_APB_RST_PHY : deasserted

System Clocks:

CPU Subsystem (CSS)

| LeonOS: | System Bus: | Peripheral: | LeonRT | Busses | Peripherals |
|------------------|--------------------|---------------------|---------------------|-------------------------|-------------------|
| CSS_L0S : ON | CSS_MAHB_CTRL : ON | CSS_SDIO : ON | MSS_SP_LRT : ON | MSS_SP_CDMA : ON | MSS_SP_CIF0 : ... |
| CSS_ROM : ON | CSS_MAHB_CTRL : ON | CSS_USB : ON | MSS_SP_LRT_DSU : ON | MSS_SP_RTAHB_CTRL : ON | MSS_SP_CIF1 : ... |
| CSS_L0S_L2C : ON | CSS_SAHB_CTRL : ON | CSS_BIST : ON | MSS_SP_LRT_L2C : ON | MSS_SP_APB_SLV : ON | MSS_SP_MXI : ... |
| CSS_L0S_DSU : ON | CSS_SAHB2MAHB : ON | CSS_GETH : ON | MSS_SP_LRT_ICB : ON | MSS_SP_APB_CTRL : ON | MSS_SP_NAL : ... |
| CSS_L0S_TIM : ON | CSS_APB1_CTRL : ON | CSS_BIST : ON | MSS_SP_TIM : ON | MSS_SP_AXI_CTRL : ON | MSS_SP_AXI : ... |
| CSS_GPIO : ON | CSS_APB3_CTRL : ON | CSS_USB_APPSLV : ON | | MSS_SP_MXI_CTRL : ON | MSS_SP_NAL : ... |
| CSS_JTAG : ON | CSS_APB4_CTRL : ON | CSS_AON : ON | | MSS_SP_AXI_DEFSLV : ... | |
| | | | | MSS_SP_AXI_MON : ... | |

Serial DDR MSS/UPA SIPP (HWF suffixes skipped)

| | | | | | |
|---------------|------------------|------------------|----------------------|--------------------------|--|
| CSS_I2C0 : ON | CSS_DSS_APB : ON | CSS_MSS_MAS : ON | MSS_SP_SIGMA : --- | MSS_SP_HARRIS : ... | |
| CSS_I2C1 : ON | CSS_DSS_BUS : ON | CSS_UPA_MAS : ON | MSS_SP_LSC : --- | MSS_SP_UPFIORDN0 : ... | |
| CSS_I2C2 : ON | | | MSS_SP_RAW : --- | MSS_SP_UPFIORDN1 : ... | |
| CSS_UART : ON | | | MSS_SP_DBYR : --- | MSS_SP_UPFIORDN2 : ... | |
| CSS_SPI0 : ON | | | MSS_SP_DOGL : --- | MSS_SP_MIPI_TX0 : ... | |
| CSS_SPI1 : ON | | | MSS_SP_LUMA : --- | MSS_SP_MIPI_TX1 : ... | |
| CSS_SPI2 : ON | | | MSS_SP_SHARPEN : --- | MSS_SP_MIPI_RX0 : ... | |
| CSS_I2S0 : ON | | | MSS_SP_CGEN : --- | MSS_SP_MIPI_RX1 : ... | |
| CSS_I2S1 : ON | | | MSS_SP_MED : --- | MSS_SP_MIPI_RX2 : ... | |
| CSS_I2S2 : ON | | | MSS_SP_CHROMA : --- | MSS_SP_MIPI_RX3 : ... | |
| | | | MSS_SP_CC : --- | MSS_SP_MIPI : ... | |
| | | | MSS_SP_LUT : --- | MSS_SP_SIPP : ... | |
| | | | MSS_SP_EDGE_OP : --- | MSS_SP_SIPP_APPSLV : ... | |
| | | | MSS_SP_CONV : --- | MSS_SP_APB_SLV : ... | |

UPA Subsystem (UPA)

| System Frequencies | | | | | |
|--------------------|----------------|-------------------|----------------------|--------------------|--------------------|
| UPA_Sh0 : ON | UPA_Sh6 : --- | UPA_Shave_L2 : ON | System Freq : 264Mhz | PLL0 Freq : 264Mhz | PLL1 Freq : 264Mhz |
| UPA_Sh1 : --- | UPA_Sh7 : --- | UPA_CDMA : ON | PLL0 Freq : 264Mhz | | |
| UPA_Sh2 : --- | UPA_Sh8 : --- | UPA_BIC : --- | PLL1 Freq : 264Mhz | | |
| UPA_Sh3 : --- | UPA_Sh9 : --- | UPA_CTRL : ON | | | |
| UPA_Sh4 : --- | UPA_Sh10 : --- | | | | |
| UPA_Sh5 : --- | UPA_Sh11 : --- | | | | |

P0_AS0% cpr summary
 PLL0 Status: (LOCKED ,ENABLED) PLL Internals: <0x0015820>

FIN : 12Mhz NF: 88 [Feedback]

FREF : 12Mhz NR: 4 [Output Div]

FVCO : 126Mhz Source: refclk0 / osc1

System Freq : 264Mhz MasterDiv: 1/1

PLL1 Status: (LOCKED ,ENABLED) PLL Internals: <0x0015820>

FIN : 12Mhz NF: 84 [Feedback]

FREF : 12Mhz NR: 4 [Output Div]

FVCO : 1856Mhz Source: refclk0 / osc1

PLL Freq : 264MHz MasterDiv: 1/1

Help

```
P0:AS0% help
COMMAND
help
breset
ddrinit
startupcore
getexitcode
getprogramcounter
registers
loadfile
savefile
target
targetid
run
dasm
halt
cont
wait
breakpoint
linenumbers
listsource
step
sym
mget
mset
mfill
mdump
mget/i
memmap
jtag
pipe
state
callstack
hist
uart
cpr
gpio
repeat
alias
eval%
coreconfig
displaystate
mutex

DESCRIPTION
Show help
Board reset.
Initialise DDR.
Set/get the startup core for subsequent load/run operations
Gets the exit code for the application
Get Program Counter.
TCF Registers
File load/verify/run operations.
Save memory to file.
Get or set current target
Get canonical TCF context ID of (current) target
Run application.
Disassemble instructions.
Break execution of target(s).
Continue execution of target.
Wait a time period or event(s).
Manage breakpoints.
Show line number information at address or source location
List source code.
Step-by-step execution.
Retrieve symbol information.
Get value from memory location.
Set value to memory location.
Fill memory location with pattern.
Dump memory in a canonical hexdump-like format.
Interactive 'mget' session
Show memory map for target
Direct JTAG interface.
Debug pipe management.
Processor and thread state.
Get call stack for current target.
Execution history.
UART management.
CPR management.
GPIO pin state management
Repeat command or script.
Define command shortcut.
Pseudo-interactive script evaluation
Configure core settings
Control context state display
Hardware mutex operations.
```

```
P0:AS0% help coreconfig
COMMAND
coreconfig - Configure core settings

SYNOPSIS
coreconfig ?{safety|stateupdate|help}? ?args?...

DESCRIPTION
Configure core settings

ARGUMENTS
Type "help coreconfig safety" to get help on arguments.

EXAMPLES
Do not allow any memory operations while running:
% coreconfig safety strict
Make an exception to allow disassembly from uncached memory:
% coreconfig safety -dasm bypass
We still want to stop the core when setting the breakpoints:
% coreconfig safety -breakpoint safe

Specify all three at once for LeonOS:
% coreconfig safety -target LOS -default strict -breakpoint safe -dasm bypass

Enable live RTEMS thread list update (from L2 cache data):
% coreconfig safety LOS -l1dread bypass -l2read unsafe
% coreconfig safety LRT -l1dread bypass -l2read unsafe

Restore default TCF behaviour:
% coreconfig safety LOS default

P0:AS0%
```

Pipe communication

```
P0:ALOS% listsources leon/main.c 32 end
LINE SOURCE
32 static char dataBuffer [1024] = {};
33
34 int main(void)
35 {
36     initClocksAndMemory();
37
38     printf("\n\nHello from LEON!\n\n\n");
39
40     while (strcmp(dataBuffer, "exit") != 0)
41     {
42         gets(dataBuffer);
43         puts(dataBuffer);
44     }
45
46     return 0;
47 }
48
P0:ALOS% run
LOS: LeonOS (P0:ALOS) is running...
P0:ALOS% pipe create LOS -stdout -readsym mvConsoleTxQueue -writesym mvConsoleRxQueue
PIPE:LOS:
PIPE:LOS:
PIPE:LOS: Hello from LEON!
PIPE:LOS:
PIPE:LOS:
P0:ALOS% pipe puts LOS -nonewline "Hello"
P0:ALOS% pipe puts LOS -nonewline " "
P0:ALOS% pipe puts LOS "pipe!"
PIPE:LOS: Hello pipe!
P0:ALOS% pipe puts LOS exit
LOS: LeonOS (P0:ALOS) suspended at 0x7018032C (Application terminated successfully)
PIPE:LOS: exit
P0:ALOS%
```

RTEMS Threads

```

UART: LOS.Thread 8 <0x0B010009>
LOS: LeonOS <P0:ALOS> suspended at 0x70003370 <Suspended>
UART: LOS.Thread 1 <0x0B010002>
UART: LOS.Thread 2 <0x0B010003>
P0:ALOS% state -children LOS:RTEMS
ID          NAME          STATE      PC      SUSPEND REASON
P0:ALOS:T0B010001 [Thread 0xb010001] Suspended 0x70009BA0 Suspended
P0:ALOS:T0B010002 LOS.Thread 1 <0x0B010002> Suspended 0x70020C98 Suspended
P0:ALOS:T0B010003 LOS.Thread 2 <0x0B010003> Suspended 0x70020C98 Suspended
P0:ALOS:T0B010004 LOS.Thread 3 <0x0B010004> Suspended 0x70020C98 Suspended
P0:ALOS:T0B010005 LOS.Thread 4 <0x0B010005> Suspended 0x70020C98 Suspended
P0:ALOS:T0B010006 LOS.Thread 5 <0x0B010006> Suspended 0x70020C98 Suspended
P0:ALOS:T0B010007 LOS.Thread 6 <0x0B010007> Suspended 0x70020C98 Suspended
P0:ALOS:T0B010008 LOS.Thread 7 <0x0B010008> Suspended 0x70020C98 Suspended
P0:ALOS:T0B010009 LOS.Thread 8 <0x0B010009> Suspended 0x70020C98 Suspended
P0:ALOS% state -children LRT:RTEMS
ID          NAME          STATE      PC      SUSPEND REASON
P0:ALRT:T0B010001 [Thread 0xb010001] Suspended 0x701163E8 Suspended
P0:ALRT:T0B010002 LRT: functionJ Suspended 0x7011710C Suspended
P0:ALRT:T0B010003 LRT: functionC Suspended 0x7012053C Suspended
P0:ALRT:T0B010004 LRT: functionD Suspended 0x7012053C Suspended
P0:ALRT:T0B010005 LRT: functionE Suspended 0x7012053C Suspended
P0:ALRT:T0B010006 LRT: functionF Suspended 0x7012053C Suspended
P0:ALRT:T0B010007 LRT: functionG Suspended 0x7012053C Suspended
P0:ALRT:T0B010008 LRT: functionH Suspended 0x7012053C Suspended
P0:ALRT:T0B010009 LRT: functionI Suspended 0x70110A88 Suspended

```

VCS Hooks support

```
DEBUG: (70010000,7018A560) : CD,CA (diff)
DEBUG: (70010001,7018A561) : CD,FE (diff)
DEBUG: (70010002,7018A562) : CD,BA (diff)
DEBUG: (70010003,7018A563) : CD,BE (diff)
DEBUG: (70010004,7018A564) : CD,14 (diff)
DEBUG: (70010005,7018A565) : CD,15 (diff)
DEBUG: (70010006,7018A566) : CD,16 (diff)
DEBUG: (70010007,7018A567) : CD,17 (diff)
DEBUG: unitTestMemCompare() : (70010000 vs 7018A560 l:00000008) => FAIL (0000008 bytes diff)
DEBUG: unitTestAssert() : (value:0x00000000) => FAIL
DEBUG: unitTestCompare() : (0xDCDCDCDC,0xBEBAFeca) => FAIL
DEBUG: unitTestCompare64() : (0xDCDCDCDCDCDCDC,0x17161514BEBAFeca) => FAIL
DEBUG: unitTestCrcCheck() : (addr:0x70010000,0x00000008,0xF47ED237)[START]
DEBUG: unitTestCrcCheck() : (addr:0x70010000 len:0x00000008) => FAIL (A:0x13697602 E:0xF47ED237)
DEBUG: unitTestReadWordCheck(): (addr:0x70010000 0xDCDCDCDC,0xBEBAFeca) => FAIL
DEBUG: unitTestReadHalfCheck(): (addr:0x70010000 0x0000CDC,0x0000Feca) => FAIL
DEBUG: unitTestReadByteCheck(): (addr:0x70010000 0x000000CD,0x000000CA) => FAIL
DEBUG: unitTestReadBitCheck() : (addr:0x70010000 0x0000005C,0x0000006C) => FAIL
DEBUG:
DEBUG: unitTestFramework - Positive Testing Enabled.. Tests Are Expected to PASS! -----
DEBUG:
DEBUG:
DEBUG: moviUnitTest:PASSED

DEBUG:
LOS: LeonOS (P0:ALOS) suspended at 0x7018032C (Application terminated successfully)
P0:ALOS%
```

Other commands

- **breakpoint add ... -read -write**
 - support for data breakpoints
- **coreconfig stateupdate**
 - control asynchronous state update
- **coreconfig safety**
 - control memory
- **displaystate**
 - control state change display verbosity
- **loadfile -bin; savefile**
 - load and save chunks of memory from/to files
- **alias**
 - define shortcuts
- **pipe interval**
 - control pipe polling interval
- **pipe configure ... -tcp**
 - redirect pipe to TCP/IP stream
- **registers**
 - access TCF register information available to Eclipse registers view
- **scripting**
 - **eval%** - evaluate command with echo and simulated prompt
 - **wait** - wait a time period or event(s).