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Software Development with uMPS
Part 3
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uMPS software development

Developing software with uMPS requires:

- basic knowledge of UNIX environment and commands
- knowledge of the uMPS architecture, GUI, and software development conventions
- setup of an effective debugging environment

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uMPS simulator main commands:

- `umps`: the simulator itself
- `umps-elf2umps`: to convert the output of the compiler to files the simulator will understand
- `umps-objdump`: to analyze these files
- `umps-mkdev`: to build disks and tapes for the simulator

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uMPS simulator-related files:

In the `support/` and `example*/` directory:

- `*.rom.umps`: the ROM files
- `*.core.umps`: the kernel to be loaded
- `*.stab.umps`: the kernel *symbol table*
- `*.aout.umps`: for programs other than kernel

other `*.umps` files (`term0.umps`, `printer0.umps`...): files associated to devices

`/etc/umpsrc` and `.umpsrc` (`ls -a` to see it): the simulator configuration file

`elf32*.x` files: configuration files for the cross-compiler

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uMPS other essential components:

some libraries (XForms, libelf) for building the simulator

`libumps.e` (and `libumps.o`) under `support/`: uMPS library for interfacing with ROM services, **CP0** registers and issue TLB-related and SYSCALL instructions

`crtso.o` and `crti.o`: kernel and program startup functions

`const.h` and `types.h` under `support/h`: some useful types and constants (eg. processor state definition)

a *cross-compiler* based on GNU gcc:

`mipsel-linux-gcc` for little-endian uMPS (on x86)

`mips-linux-gcc` for big-endian uMPS (on PPC)

the *make* utility

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libumps: uMPS support library

`libumps` acts as a wrapper, allowing to:

access ROM routines

access special **CP0** registers

issue TLB-related and SYSCALL instructions

`libumps` is composed by two parts:

`libumps.e`: to be included in C programs source (see it for library description and details)

`libumps.o`: to be linked with other object files to make an executable file

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Common issues in uMPS development:

setup of critical registers (esp. **\$gp**, **\$sp**, **PC**, **CP0.Status**):
check values and bit masks

data structure corruption: it's easy to make coding mistakes or forget to (re-)initialize data structures

overlapping of stack spaces among different processes

unwanted compiler optimizations:

use `volatile` (esp. when accessing device registers)

use subroutines

do not optimize (no `-O` flags)

no `printf()`!

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Breakpoint, Suspect and Trace: the debugger's tools of trade

Breakpoint: a position (an address) in the code; simulation stops when reaches it (may be referred to with a *symbol* + offset)

Suspect area: a memory range (a set of addresses) containing data (array, variables...) under exam; may be a *Read* suspect and/or a *Write* suspect (may be referred with a *symbol*)

Suspect: simulation stops when an access of the appropriate type (R, W) is made to the suspect area

Traced range: a range of memory addresses selected for showing addresses may be physical or virtual ones

only physical addresses may be traced in uMPS

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Advanced uMPS debugging strategies

how to replace `printf()`:

- initialize a global character array and provide some basic access function able to write contents (copy chars) into it
- trace the array (= show it in the GUI)
- set a write suspect on the array (or a breakpoint on the access function)
- see `pltest.c` for an example

how to check internal variables and execution flow: use *debugging functions*

- define debugging functions and insert them into the code
- set breakpoints on debugging functions
- variables to be shown can be passed as parameters

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Debugging functions: an example

```
void debug(int where, int var1)
{
    return;
}
...
var_to_check = some_complex_calculation;
debug(10, (int)var_to_check);
...
then check $a0-$a1 for values when breakpoint is reached
```

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Debugging functions: an example (cont'd)

```
if (some_condition) {
    debug(14, TRUE);
    ...
} else {
    debug(15, FALSE);
    ...
}
```

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General software development strategies:

- define your goals (make a top-down analysis)
- share opinions with other group members
- keep a log; printing helps
- take your time: practice makes perfect
- backup, backup, backup
- know your tools (or know how to know...)
- "do not fear the machine"
- read the manual! (and the documentation, and the newsgroup, and...)
- look at examples (and Google...)
- be creative and curious
- (when all else fails) ask for help

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How to set up an effective debugging environment:

Basic UNIX tools:

command reference: `man` and `info`

show and search: `more/less`, `diff` and `grep`

editor: `vi`, `emacs`, `joe`, ...

compilation: `make` and `makefile`

compiler flags: `-v -E -S -c -o -ansi -pedantic -Wall`

backup: `cp` and `tar` (plus `mv` and `rm`)

log: `>&`, `script` and `history`

Advanced code development tools:

source control: `rcs`, `cvs`, `subversion`, ...