Freescale Semiconductor
Application Note

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Debugging Linux Kernel and Modules using CodeWarrior for QorIQ LS series - ARM V7 ISA

Contents

1. Introduction

This document describes the steps required for debugging the Linux kernel and modules using the CodeWarrior for QorIQ LS series - ARM V7 ISA.

This document includes the following sections:

- Preliminary background
- Creating an ARMv7 project
- Linux kernel debug support
- Debugging Linux kernel and modules

2. Preliminary background

This section describes the steps required to compile Linux image for the LS1 boards.

2.1. Download SDK

To debug Linux kernel and modules using CodeWarrior, download the latest QorIQ SDK from www.freescale.com.

2.2. Install SDK

To install SDK on the host machine, perform these steps:

1. Mount the ISO on your machine as illustrated below:

```
$ sudo mount -o loop LS1021A-SDK-<version>-<target>-<yyyymmdd>-
yocto.iso /mnt/cdrom
```

2. Install the SDK as a non-root user, using the following commands:

```
$ cd /mnt/cdrom
$ ./install
```

3. On seeing the prompt to input the install path, check and ensure that the current user has the appropriate permissions for the installation path.

NOTE	There are no uninstall scripts. To uninstall Yocto, you need to remove the *<yocto_install_path>/LS1021A-SDK-<version>-<target>-<yyyymmdd>-yocto* folder manually.

2.3. Prepare host environment for Yocto

Yocto requires some packages to be installed on the host folder. Prepare Yocto for the host environment using the commands below:

```
$ cd <yocto_install_path>
$ ./scripts/host-prepare.sh
$ source ./fsl-setup-poky -m <machine>
```

Below is an illustration of this command:
For example, for LS1021AQDS board, the above command will be:
$ source ./fsl-setup-poky -m ls1021aqds -j 4 -t 4, where *-j* is the number of jobs to spawn during the compilation stage and *-t* is the number of BitBake tasks that can be issued in parallel.

2.4. Build Packages

To build various packages, run the following commands:

```
$ cd <yocto_install_path>/
$ source ./build_<machine>_release/SOURCE_THIS
$ bitbake <package-recipe>
```

NOTE	U-Boot, RCW, kernel, DTB, and rootfs images can be found in: *build_<machine>_release/tmp/deploy/images/<machine>*

2.5. Configure and rebuild Linux kernel

In some cases, it is necessary to configure and rebuild the Linux kernel. In this case, it is necessary for adding the debug symbols. To configure and rebuild the Linux kernel:

1. Run the *bitbake* command with *menuconfig*:

   ```
   $ bitbake -c menuconfig virtual/kernel
   ```

2. On the kernel configuration window that opens, go to **Kernel hacking > Compile-time checks and compiler option** and select the **Compile the kernel with debug info** checkbox.
3. Save the new configuration and rebuild the Linux kernel using the command below:

   ```
   $ bitbake virtual/kernel
   ```

NOTE	You can find the *vmlinux* image, with debug symbols, in the following folder: *build_<machine>_release/tmp/work/<machine>-fsl-linux-gnueabi/ linux-layerscape-sdk/3.12-r0/git/*

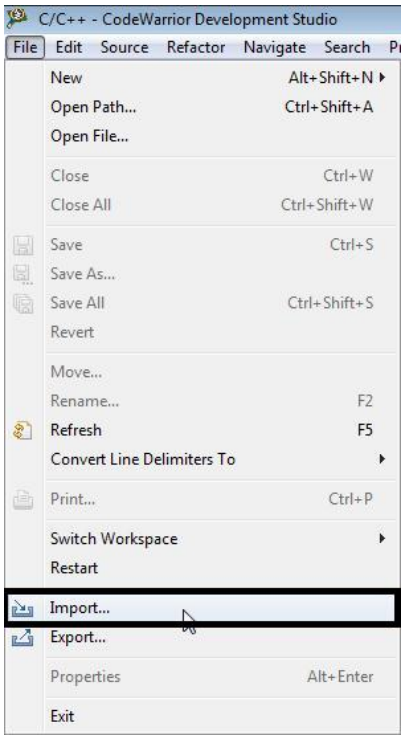
The *vmlinux* ELF file will be imported into CodeWarrior for QorIQ LS series - ARM V7 ISA.

3. Creating an ARMv7 project

To create an ARMv7 project for debugging the Linux kernel, follow these steps:

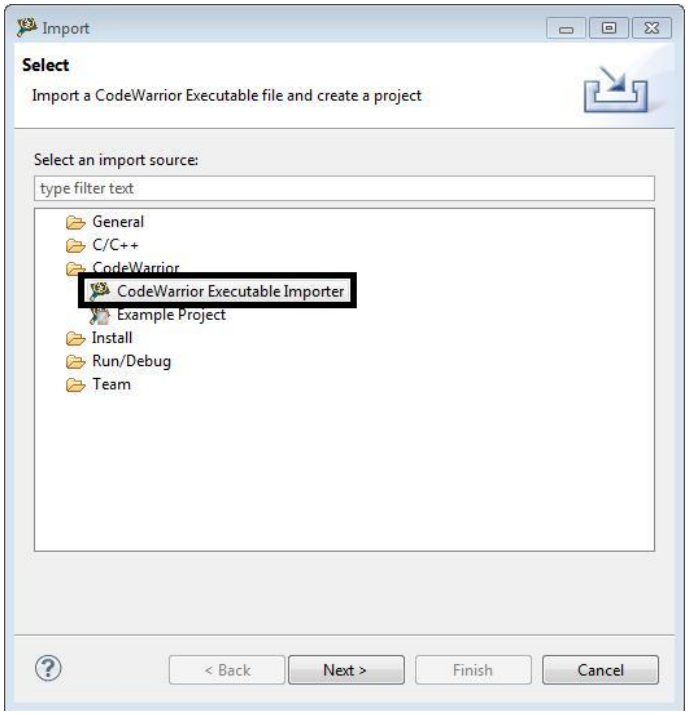
1. Start CodeWarrior for QorIQ LS series - ARM V7 ISA.
2. Select **File** > **Import** to import the *vmlinux* executable file generated during the Linux kernel compilation. For details, see Configure and rebuild Linux kernel.

Figure 1. CodeWarrior File menu



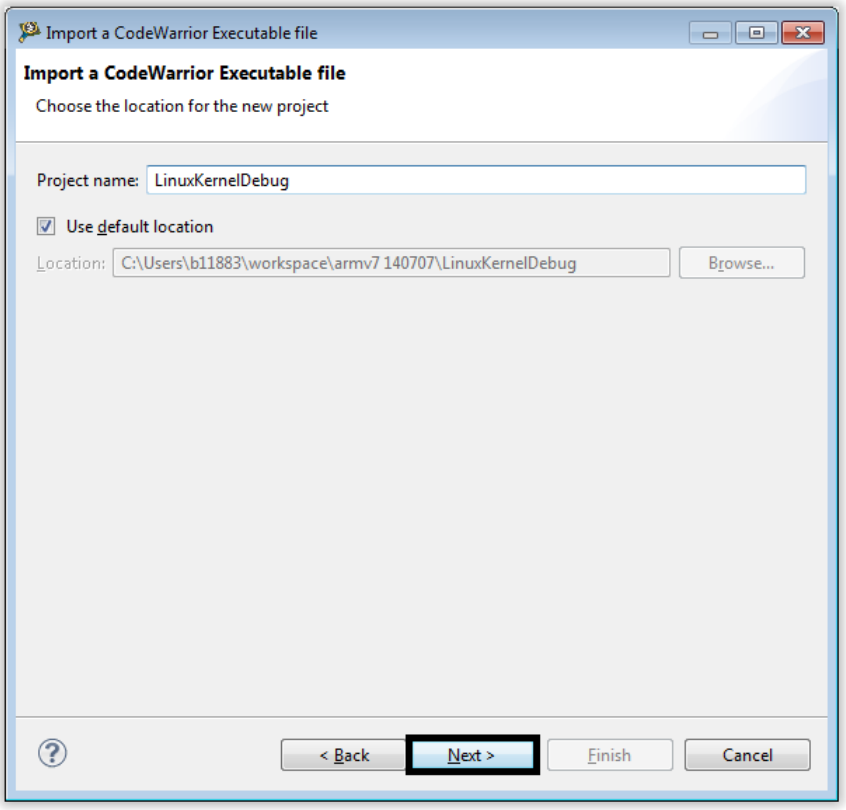
3. On the **Select** page of the **Import** wizard, choose the source to be imported and click **Next**.

Figure 2. Import wizard



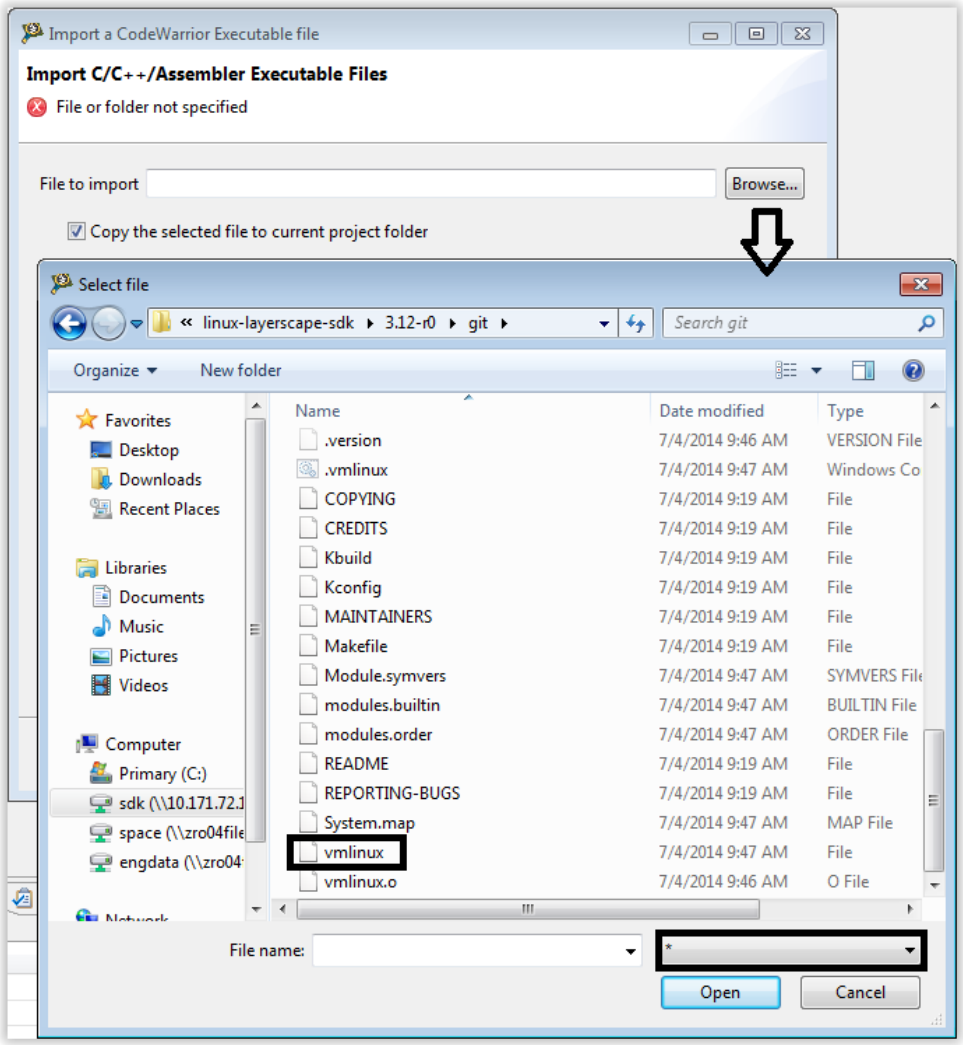
4. On the **Import a CodeWarrior Executable file** page, specify the project name.
5. Specify a location for the new project in the **Location** field or choose to use the default location.
6. Click **Next**.

Figure 3. Import a CodeWarrior Executable file page



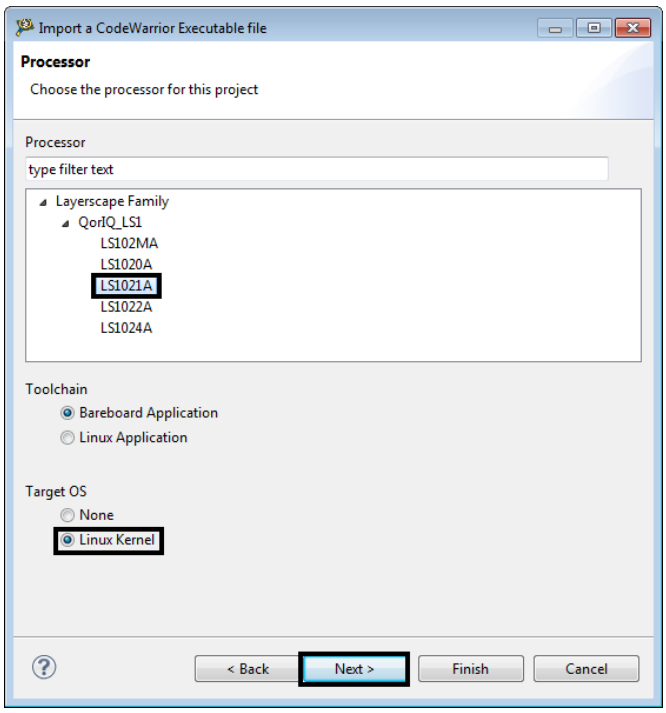
7. Browse to the *vmlinux* executable file and select **Open**.
8. By default, CodeWarrior looks for an *.elf* extension. Therefore, change the file type in the lower right corner of the **Select file** dialog, as shown in the figure below.

Figure 4. Select a vmlinux executable file



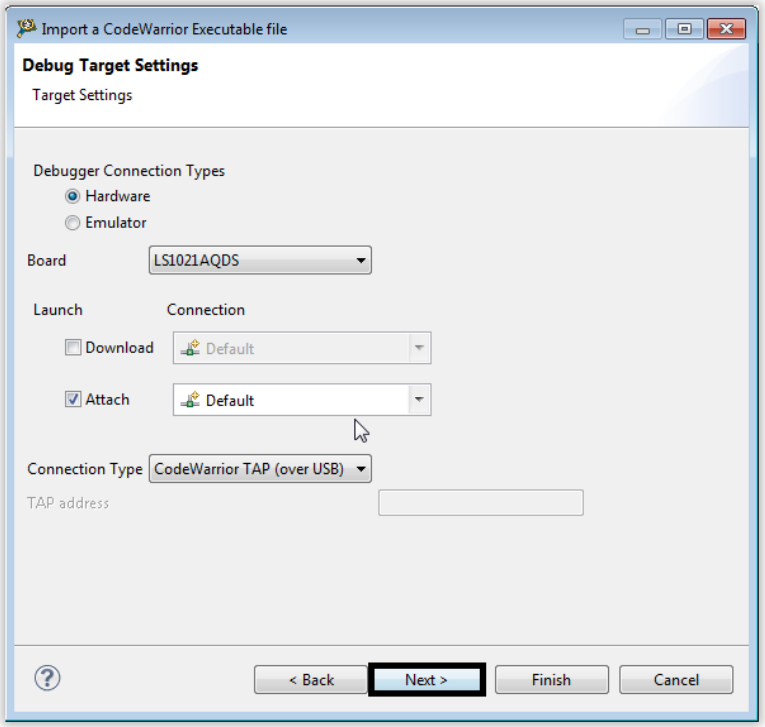
9. On the **Processor** page that appears, select the processor type.
10. Under **Target OS**, choose **Linux Kernel** and click **Next**.

Figure 5. Processor page



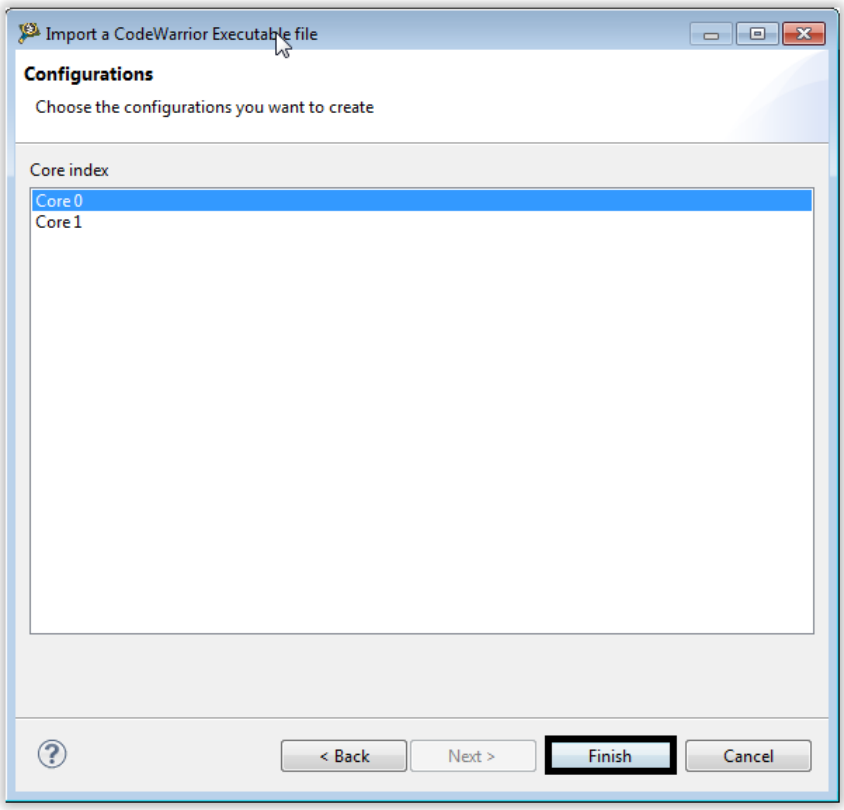
11. On the **Debug Target Settings** page that appears, select debugger connection type, board, launch configuration, and connection type, and click **Next**.

Figure 6. Debug Target Settings page



12. On the **Configurations** page that appears, select the configurations that you want to create and click **Finish** to close the wizard.

Figure 7. Configurations page



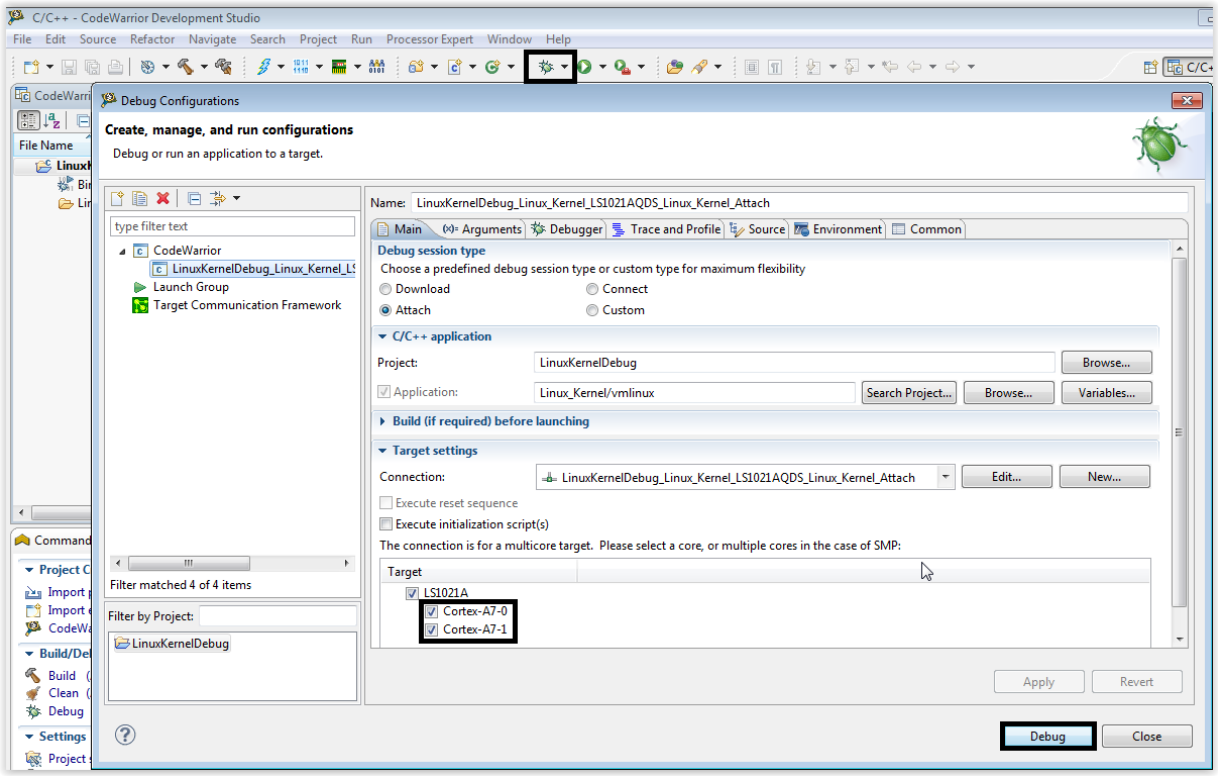
4. Linux kernel debug support

This section describes the debugger settings for Linux kernel debugging.
The *vmlinux* executable file generated during the Linux kernel compilation should be imported as CodeWarrior project (for more information, see Creating an ARMv7 project).

After the CodeWarrior project is created, perform these steps to start Linux kernel debugging:

1. Select **Run** > **Debug configurations** to open the **Debug configurations** dialog and click **Debug**.

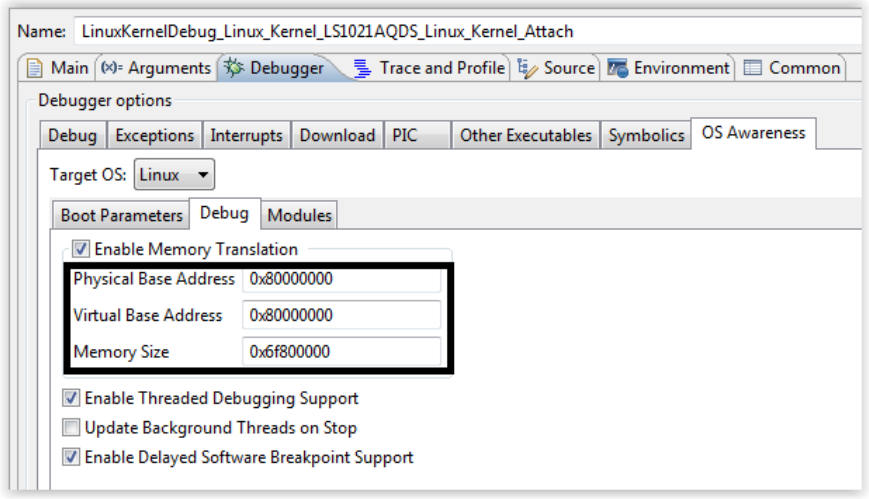
Figure 8. Debug Configurations dialog



NOTE Ensure that no initialization file is used.

2. On the **Debugger** tab, open the **OS Awareness** tab.
3. Deselect all the checkboxes, because an Attach launch configuration is used to attach to a running Linux kernel.
4. On the **Debug** tab, select the **Enable Memory Translation** checkbox.
5. Configure the remaining settings as shown in the figure below.

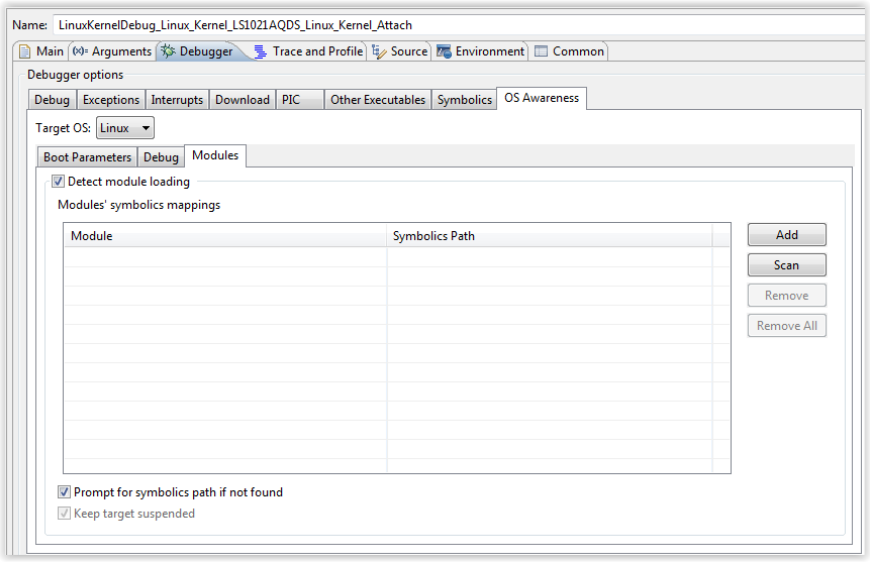
Figure 9.OS Awareness – Debug tab



6. On the **Modules** tab, select the checkboxes labeled “Detect module loading” and “Prompt for symbolics path if not found”.

NOTE	These options are required for detecting automatic insertion/removal of kernel modules. If multiple modules are inserted at Linux boot, then you are recommended to activate these options only when connecting to Linux for module debugging.

Figure 10. OS Awareness – Modules tab



5. Debugging Linux kernel and modules

This section explains how to debug Linux kernel and Linux modules.

5.1. Debugging Linux kernel

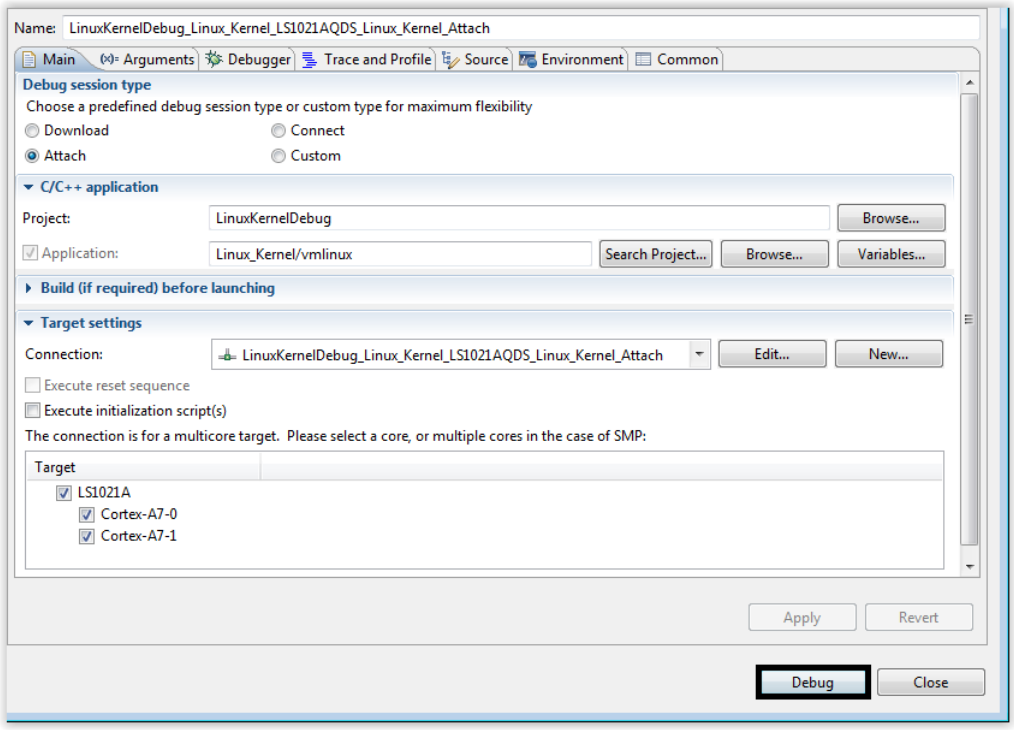
1. Power on the board and stop at the U-Boot console.

Figure 11. Target stopped at U-Boot prompt

```
Hit any key to stop autoboot:  0
=>
```

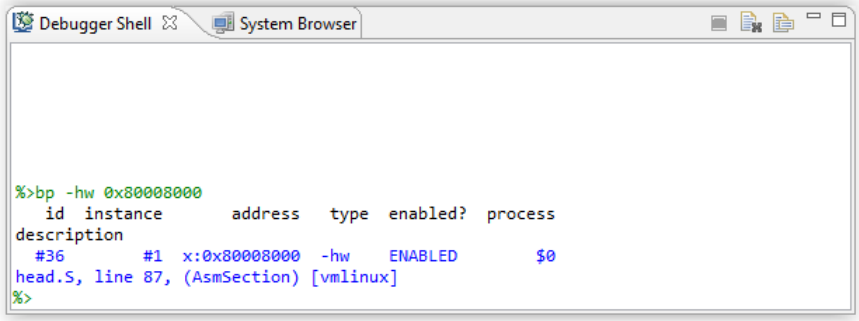
2. Attach to U-Boot using Attach launch configuration, as shown in the figure below.

Figure 12. Attach launch configuration



3. Set a breakpoint at kernel entry point, using Debugger Shell command *bp –hw 0x80008000*

Figure 13. Set breakpoint at entry point in Debugger Shell



NOTE	This example was created on an LS1021ATWR board. For other LS1 boards, the kernel entry point address may differ.

4. Start kernel from the U-Boot console.

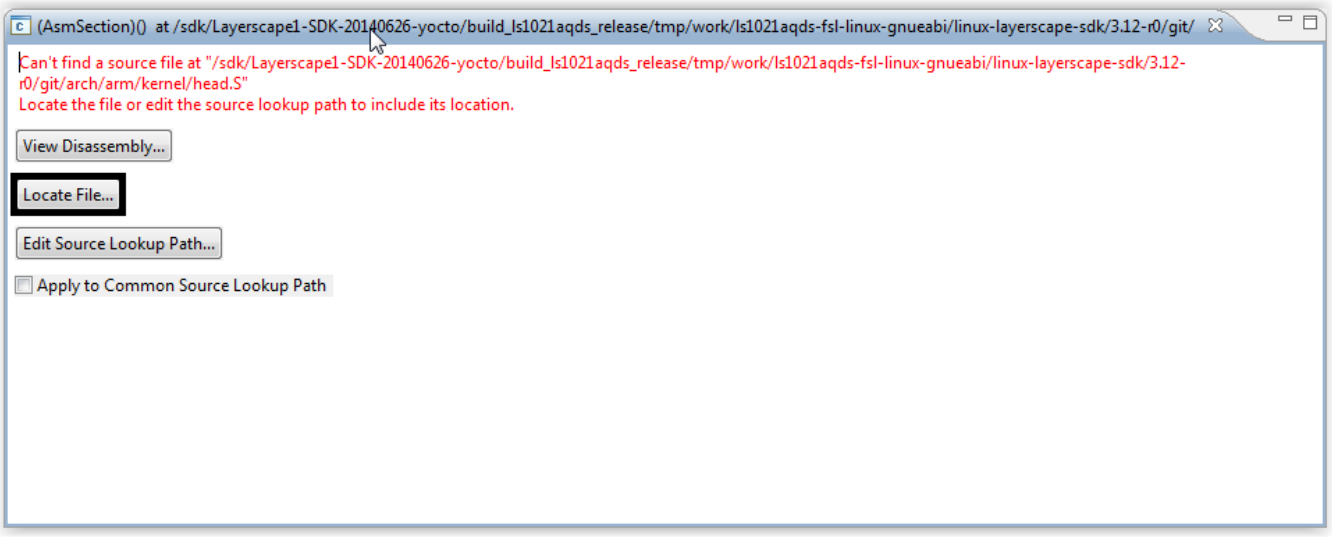
Figure 14. U-Boot log - Prepare images for starting Linux kernel

```
## Booting kernel from Legacy Image at 82000000 ...
   Image Name:   Linux-3.12.0+
   Image Type:   ARM Linux Kernel Image (uncompressed)
   Data Size:    3053688 Bytes = 2.9 MiB
   Load Address: 80008000
   Entry Point:  80008000
   Verifying Checksum ... OK
## Loading init Ramdisk from Legacy Image at 88000000 ...
   Image Name:   fsl-image-core-ls1021aqds-201406
   Image Type:   ARM Linux RAMDisk Image (gzip compressed)
   Data Size:    19170910 Bytes = 18.3 MiB
   Load Address: 00000000
   Entry Point:  00000000
   Verifying Checksum ... OK
## Flattened Device Tree blob at 8f000000
   Booting using the fdt blob at 0x8f000000
   Loading Kernel Image ... OK
   Loading Ramdisk to cedb7000, end cffff65e ... OK
   Loading Device Tree to cedae000, end cedb6a91 ... OK

Starting kernel ...
```

The breakpoint set above will be hit and CodeWarrior will prompt for the location of the Linux kernel sources to make a path mapping between the original location of the sources and the new location.
For example, in the illustration below, the Linux kernel sources were copied from a Linux machine to a Windows machine.

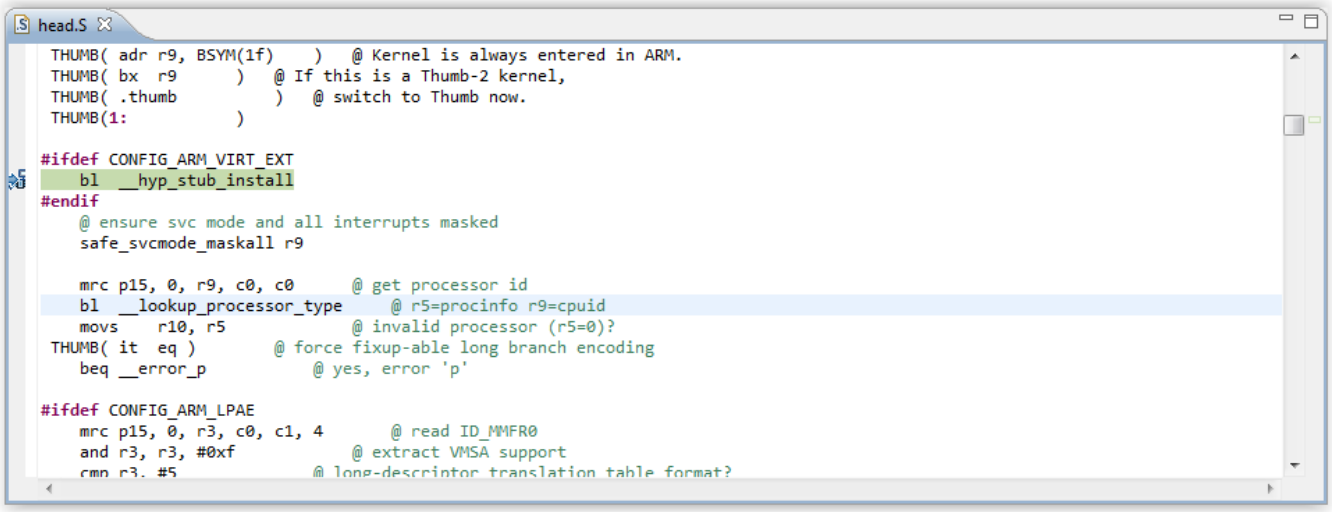
Figure 15. Source file not found when target is stopped at kernel entry point



After the missing file is located, the actual source file will open in CodeWarrior.

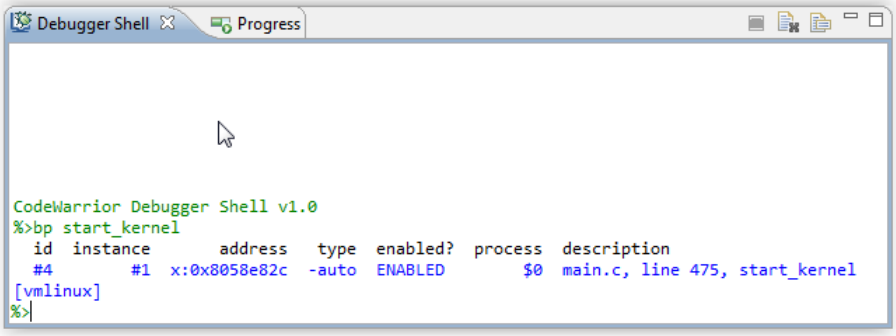
NOTE	This example was created on an LS1021ATWR board. For other LS1 boards, you may need to instruct the debugger to reload the symbols with the position independent code (PIC) load address.

Figure 16. Target stopped at entry point, after path mapping was performed



5. To start kernel debug from *start_kernel* symbol, set a breakpoint at *start_kernel*, using Debugger Shell command *bp start_kernel*.

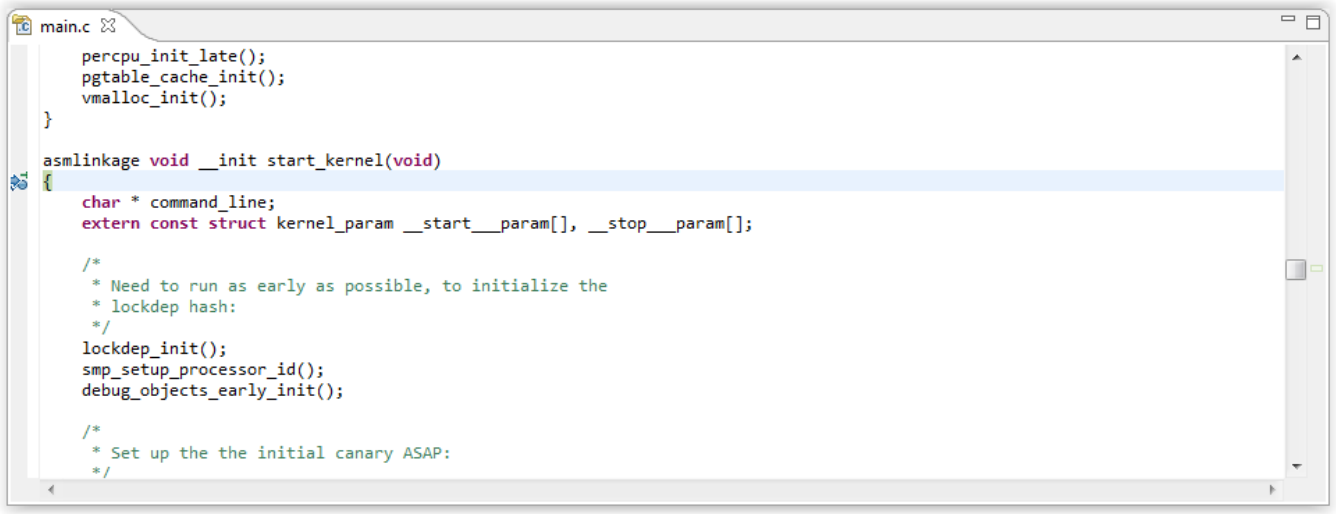
Figure 17. Set a breakpoint from Debugger Shell at “start_kernel” method



NOTE	This example was created on an LS1021ATWR board. For other LS1 boards, you may need to use a different command for starting the kernel.

6. Resume debugging using F8 or the Debugger Shell command *go*.
   The breakpoint will be hit and you can perform kernel debugging from *start_kernel*.

Figure 18. Target stopped at “start_kernel” method



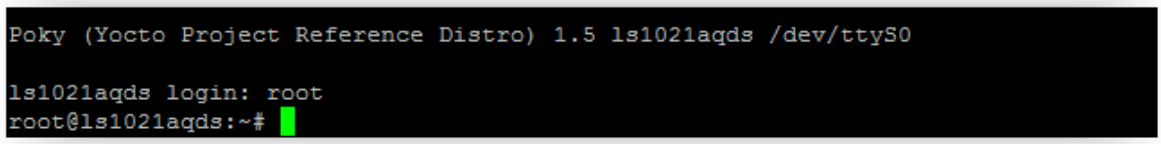
At this point, you can perform a full Linux kernel debug using run control (step/run/suspend), set/remove breakpoints, read/write memory/registers/variables, and so on.

5.2. Debugging Linux modules

To debug the Linux modules, perform the following steps:

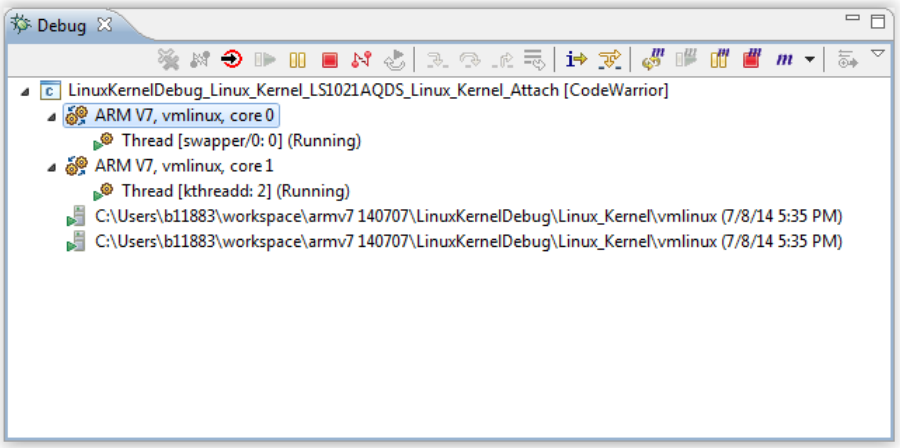
1. Log in to Linux.

Figure 19. Linux prompt after login



2. Check to see if debugger is already attached to the target. If not, attach it to Linux using the Attach launch configuration.

Figure 20. CodeWarrior attached to two running cores



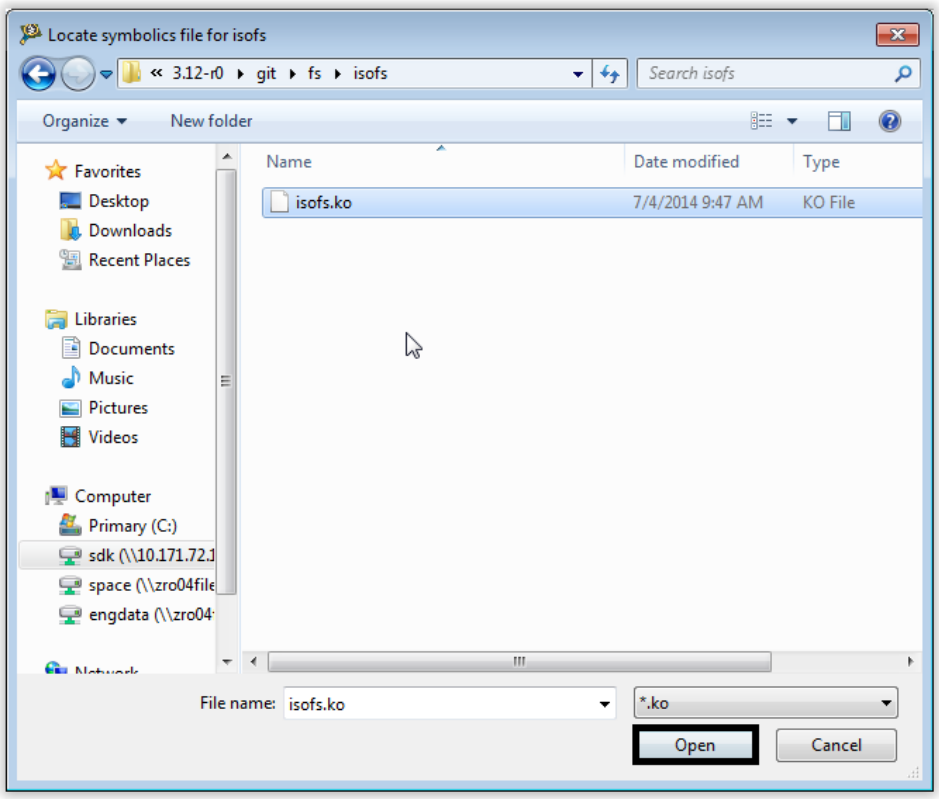
3. Insert a module into Linux.

```
root@ls1021aqds:~# modprobe isofs
```

CodeWarrior will automatically detect any *insmod/modprobe/rmmod* operation. A pop-up window appears for locating the module debug symbols.

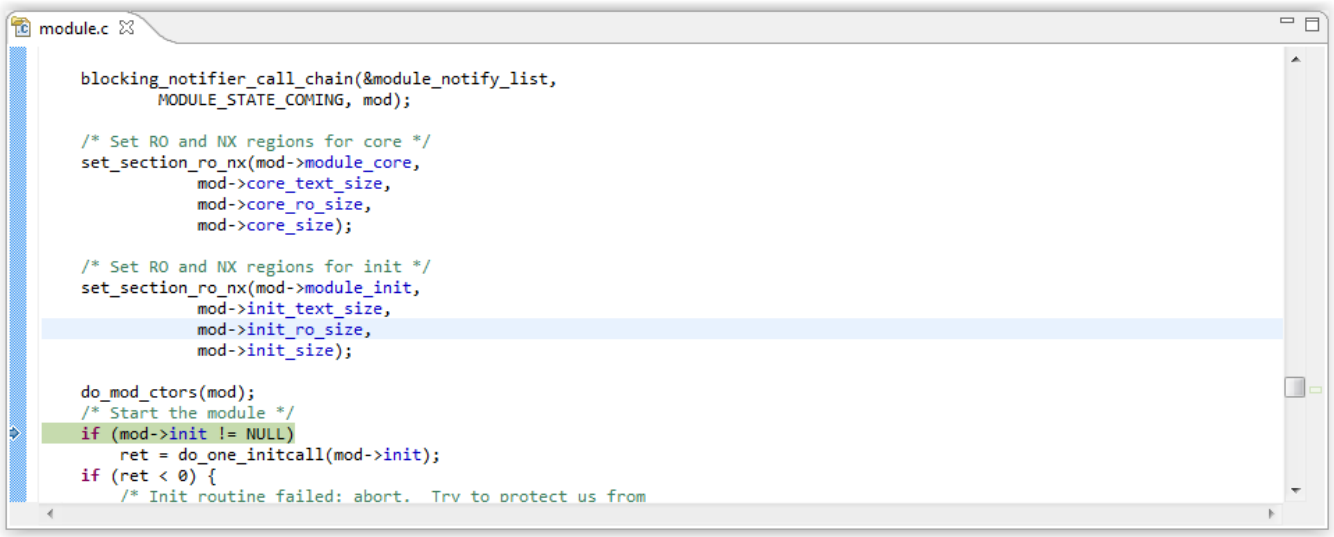
NOTE	To detect insertion/removal of kernel modules, CodeWarrior needs to be configured accordingly in the **Debug Configurations** dialog (on **Modules** tab under **Debugger** tab > **OS Awareness** tab).

Figure 21. Locate “isofs” symbolics file



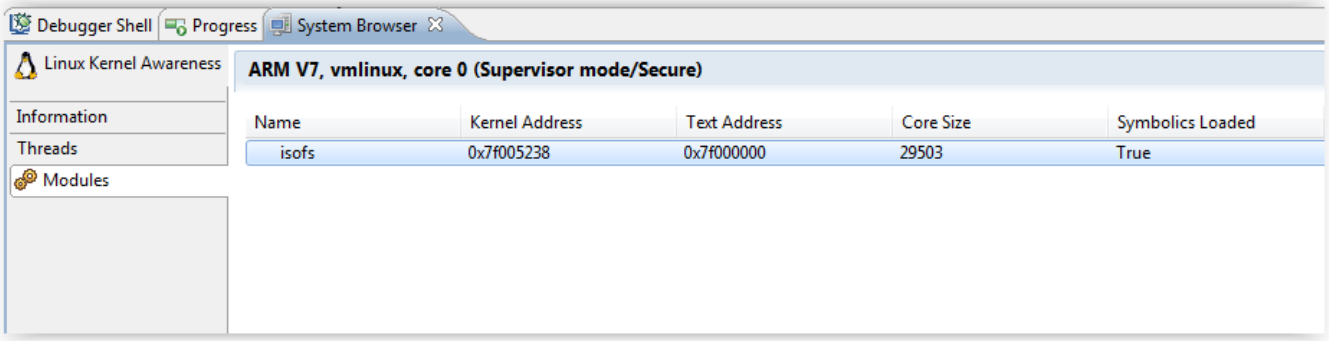
NOTE	It is mandatory that the kernel image running on the target is the same as the vmlinux image on debugger, to have the kernel modules insertion/removal detection enabled.

Figure 22. Target stopped at do_init_module after detection that an insmod/modprobe was performed



4. Use the **System Browser** view to see the information about kernel version, modules, and threads running on each core.

Figure 23. Kernel modules list displayed in System Browser



5. For module debug, open the module's sources in CodeWarrior. Debugging (step, run, or breakpoint) can be done for the inserted modules.

NOTE	Sometimes when the *`remove module`* command is executed, CodeWarrior may lose connection to the target. In such a case, ensure that all breakpoints are removed.

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