

# **Embedded Java IDE**

**Embedded Java IDE is a plugin for NetBeans 7 framework. With some moderate efforts it can be converted into MPLAB X IDE extension.**

# Embedded Java project

Embedded Java project is an extension of conventional MPLAB X project, compatible upside down. We can see additional folder “Java Files”, which contains Java subproject with Java sources.

We can open MPLAB X project in this IDE , of course without Java part. And we can open Embedded Java projects in MPLAB X IDE, in this case Java subfolder will be represented as ordinary file tree and during debugging all Java structures will be represented as their C counterparts.

# Embedded Java project

The screenshot displays the NetBeans IDE 7.3.1 interface for an Embedded Java project. The top menu bar includes File, Edit, View, Navigate, Source, Refactor, Run, Debug, Profile, Team, Tools, Window, and Help. A search bar is located in the top right corner.

The **Projects** window on the left shows the project structure:

- Header Files
- Important Files
- Java Files
- Source Packages
  - <default package>
  - Consumer.java
  - GCTest.java
  - HeapTest2.java
  - LED.java
  - Main.java
  - Main2.java
  - PCFixed.java
  - Producer.java
  - Q.java
  - Test.java
- com.sun.ddc.io
- com.sun.midp.io
- com.sun.midp.io.j2me.datagram
- com.sun.midp.lcd.ui
- device
- device.pic32
- java.io
- java.lang
- java.text
- java.util
- javax.com
- javax.microedition.io
- javax.microedition.lcd.ui
- javax.microedition.midlet

The **main Navigator** at the bottom left shows the members of the **Main** class:

- main()
- threadTest()
- BASE\_PERIOD : int
- PERIOD\_SHIFT : int
- ButtonHandler : KeyboardEventHandler
- ButtonHandler(OutputPort led)
- actionPerformed(int keyCode)
- led : OutputPort
- LEDBlink : TimerTask

The central editor shows the **Main.java** file with the following code:

```
76 {
77     led.toggleValue();
78 }
79 }
80 }
81 }
82 }
83 }
84 public static void main()
85 {
86     OutputPort led1 = new OutputPort(PIC32Defs.PORTE1);
87     OutputPort led2 = new OutputPort(PIC32Defs.PORTE0);
88     OutputPort led3 = new OutputPort(PIC32Defs.PORTE11);
89
90     threadTest();
91
92     LightweightTimer.getSystemTimer().schedule(new LEDBlink(led1), 1000, 310);
93     LightweightTimer.getSystemTimer().schedule(new LEDBlink(led2), 600, 190);
94     LightweightTimer.getSystemTimer().schedule(new LEDBlink(led3), 1600, 100);
95
96     for (;;)
97     {
98     }
99 }
100
101 static class USARHandler extends DMI
102 {
103     OutputPort led;
104
105     USARHandler(OutputPort led)
106     {
107         this.led = led;
108     }
109
110     public void run()
111     {
112         led.toggleValue();
113     }
114 }
115
116 static class ButtonHandler extends KeyboardEventHandler
117 {
118     OutputPort led;
```

The **Breakpoints** window at the bottom right shows two breakpoints set in the **Main.java** file:

| Name   | Context |
|--|---------|
| Line C:\jvm\RT.X\java\MicroJ2ME\src\Main.java:36 |         |
| Line C:\jvm\RT.X\java\MicroJ2ME\src\Main.java:90 |         |

The status bar at the bottom right indicates the current line is 95 of 5, and the file is named **INS**.

# Project Build

Then we can build entire project. In this figure we can see all stages of building process:

- Build Java subproject
- Java to Native (MIPS assembler) compilation
- Build Native (C & asm language subproject)

# Project Build

JvmRT - NetBeans IDE 7.3.1

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

default

Projects Files Classes Services

main2.c Main.java Output - JvmRT (Java Build, Java Compile, ...)

Source Packages

- <default package>
- Consumer.java
- GCTest.java
- HeapTest.java
- LED.java
- Main.java
- Main2.java
- PCFixed.java
- Producer.java
- Q.java
- Test.java

com.sun.ddc.io

com.sun.midp.io

com.sun.midp.io.j2me.datagram

com.sun.midp.lcd.ui

device

device.pic32

java.io

java.lang

java.text

java.util

javax.com

javax.microedition.io

javax.microedition.lcd.ui

javax.microedition.midlet

Libraries

Linker Files

Source Files

device

drivers

java

java.s

main2.c

ports

resources

Libraries

Loadables

Navigator

Members

<empty>

Main

- main()
- threadTest()
- BASE\_PERIOD : int
- PERIOD\_SHIFT : int
- ButtonHandler :: KeyboardEventHandler
- ButtonHandler(OutputPort led)
- actionPerformed(int keyAction, int keyCode)
- led : OutputPort
- LEDBlink :: TimerTask

```
ant -f C:\d\JmRT.X\java\MicroJ2ME\jar
init:
Deleting: C:\d\JmRT.X\java\MicroJ2ME\build\build-jar.properties
deps-jar:
Updating property file: C:\d\JmRT.X\java\MicroJ2ME\build\build-jar.properties
Compiling 1 source file to C:\d\JmRT.X\java\MicroJ2ME\build\classes
compile:
Copying 1 file to C:\d\JmRT.X\java\MicroJ2ME\build
Nothing to copy.
Building jar: C:\d\JmRT.X\java\MicroJ2ME\dist\MicroJ2ME.jar
To run this application from the command line without Ant, try:
java -jar "C:\d\JmRT.X\java\MicroJ2ME\dist\MicroJ2ME.jar"
jar:
BUILD SUCCESSFUL (total time: 4 seconds)

Java to Native compiler
Number of classes: 32
JAVA TO NATIVE COMPILE SUCCESSFUL (total time : 2.124 seconds)

make -f nbproject\Makefile-default.mk SUBPROJECTS= .build-conf
make[1]: Entering directory 'C:/d/JmRT.X'
make -f nbproject\Makefile-default.mk dist/default/production/JmRT.X.production.hex
make[2]: Entering directory 'C:/d/JmRT.X'
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/device/dmi.o.d -o build/default/production/Src/device/dmi.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/ISR.o.d -o build/default/production/Src/ports/PIC32/ISR.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/java/lang/native.o.d -o build/default/production/Src/java/lang/native.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/java/lang/string.o.d -o build/default/production/Src/java/lang/string.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/java/lang/support.o.d -o build/default/production/Src/java/lang/support.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/java/lang/Thread.o.d -o build/default/production/Src/java/lang/Thread.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/java/lang/gc.o.d -o build/default/production/Src/java/lang/gc.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/java/util/TimerTaskSmall.o.d -o build/default/production/Src/java/util/TimerTaskSmall.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/port.o.d -o build/default/production/Src/ports/PIC32/port.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude -MMD -MF build/default/production/Src/ports/PIC32/int_vec.o.d -o build/default/production/Src/ports/PIC32/int_vec.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude -MMD -MF build/default/production/Src/ports/PIC32/crt0.o.d -o build/default/production/Src/ports/PIC32/crt0.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/USART.o.d -o build/default/production/Src/ports/PIC32/USART.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/SPI.o.d -o build/default/production/Src/ports/PIC32/SPI.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/OutputPort.o.d -o build/default/production/Src/ports/PIC32/OutputPort.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/InputPort.o.d -o build/default/production/Src/ports/PIC32/InputPort.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/InterruptPort.o.d -o build/default/production/Src/ports/PIC32/InterruptPort.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/ADC.o.d -o build/default/production/Src/ports/PIC32/ADC.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/I2C.o.d -o build/default/production/Src/ports/PIC32/I2C.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/PWM.o.d -o build/default/production/Src/ports/PIC32/PWM.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/ports/PIC32/PeriodicTimer.o.d -o build/default/production/Src/ports/PIC32/PeriodicTimer.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/resources/fonts.o.d -o build/default/production/Src/resources/fonts.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/resources/Arial.o.d -o build/default/production/Src/resources/Arial.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -g -x c -c -mprocessor=32MX340F512H -IInclude/java/lang -IInclude/drivers -IInclude -MMD -MF build/default/production/Src/main2.o.d -o build/default/production/Src/main2.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -c -mprocessor=32MX340F512H -IInclude -o build/default/production/asm/java.o asm/java.s -Ws,--defsym=__MPLAB_BUILD=1,-gdwarf-2,-MD=build/default/production/asm/java.o
"C:\Program Files\Microchip\MPLAB C32 Suite\bin\pic32-gcc.exe" -mprocessor=32MX340F512H -nostartfiles -o dist/default/production/JmRT.X.production.elf build/default/production/Src/device/dmi.o build/default/production/Src/ports/PIC32/ISR.o build/default/production/Src/java/lang/native.o build/default/production/Src/java/lang/string.o build/default/production/Src/java/lang/support.o build/default/production/Src/java/lang/Thread.o build/default/production/Src/java/lang/gc.o build/default/production/Src/java/util/TimerTaskSmall.o build/default/production/Src/ports/PIC32/port.o build/default/production/Src/ports/PIC32/int_vec.o build/default/production/Src/ports/PIC32/crt0.o build/default/production/Src/ports/PIC32/USART.o build/default/production/Src/ports/PIC32/SPI.o build/default/production/Src/ports/PIC32/OutputPort.o build/default/production/Src/ports/PIC32/InputPort.o build/default/production/Src/ports/PIC32/InterruptPort.o build/default/production/Src/ports/PIC32/ADC.o build/default/production/Src/ports/PIC32/I2C.o build/default/production/Src/ports/PIC32/PWM.o build/default/production/Src/ports/PIC32/PeriodicTimer.o build/default/production/Src/resources/fonts.o build/default/production/Src/resources/Arial.o build/default/production/Src/main2.o build/default/production/asm/java.o
make[2]: Leaving directory 'C:/d/JmRT.X'
make[1]: Leaving directory 'C:/d/JmRT.X'

BUILD SUCCESSFUL (total time: 10s)
```

93 | 3 | JNS



# Board connection

After build, real board with PIC32 can be connected. *Current version supports PicKit 2 and PicKit 3 adapters, this list can be easily extended.*

PIC32 will be programmed, and debugger starts.

Program stops on breakpoint from Java source file.

# Board connection

MicroJ2ME - NetBeans IDE 7.3.1

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

PC: 0x9D008CB8 216.9/294.2MB

Search (Ctrl+I)

Projects Files Classes Services

main2.c Main.java Output

```
66 {
67     this.led = led;
68     this.period = period;
69 }
70
71 public void run()
72 {
73     for (;;)
74     {
75         for (int i = 0; i < period; i++)
76         {
77             led.toggleValue();
78         }
79     }
80 }
81
82
83
84 public static void main()
85 {
86     OutputPort led1 = new OutputPort(PIC32Defs.PORT1);
87     OutputPort led2 = new OutputPort(PIC32Defs.PORT0);
88     OutputPort led3 = new OutputPort(PIC32Defs.PORT11);
89
90     threadTest();
91
92     LightweightTimer.getSystemTimer().schedule(new LEDBlink(led1), 1000, 310);
93     LightweightTimer.getSystemTimer().schedule(new LEDBlink(led2), 600, 190);
94     LightweightTimer.getSystemTimer().schedule(new LEDBlink(led3), 1600, 100);
95
96     for (;;)
97     {
98     }
99 }
100
101 static class USARHandler extends DMI
102 {
103     OutputPort led;
104
105     USARHandler(OutputPort led)
106     {
107         this.led = led;
108     }
109 }
```

Navigator

Members

Main

- main()
- threadTest()
- BASE\_PERIOD : int
- PERIOD\_SHIFT : int
- ButtonHandler :: KeyboardEventHandler
- ButtonHandler(OutputPort led)
- actionPerformed(int keyAction, int keyCode)
- led : OutputPort
- LEDBlink :: TimerTask

Breakpoints Variables Call Stack

Name

Main.main at C:/JmRT.X/java/MicroJ2ME/src/Main.java:90

JmRT (Java Build, Java Compile, ...)

90 | 1 INS

# Disassembler Window

Now we can switch to Disassembler Window and see PIC32 assembler code (*this is code with maximum debugging capabilities, not for evaluation of compiler optimizations*).

In Disassembler Window we can toggle breakpoints of two different types – Java/C Source line breakpoints and Address breakpoints, system automatically choose which type of breakpoint will be toggled. If disassembly line has mapping from Java/C source, then Source line breakpoint will be added/removed, otherwise – Address breakpoint, which can be seen only in Disassembler of Breakpoints window



# Disassembler Window

NetBeans IDE 7.3.1

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

default PC: 0x9D008CB8 183.8/300.3MB

Projects Files Classes Services

main2.c Main.java Output Disassembly

31 9d008c70 24050040 li a1, 64  
32 9d008c74 0f4026f8 jal device\_OutputPort\_OutputPort\_I\_  
33 9d008c78 00000000 nop  
34 9d008c7c 8fc20028 lw v0, 40(fp)  
35 9d008c80 afc2001c sw v0, 28(fp)  
36 // OutputPort led3 = new OutputPort(PIC32Defs.PORTD11);  
37 9d008c84 3c029d01 lui v0, 0x9d01  
38 9d008c88 2442d5d0 addiu v0, v0, -10800  
39 9d008c8c 00402021 addu a0, v0, zero  
40 9d008c90 0f40023f jal newObject  
41 9d008c94 00000000 nop  
42 9d008c98 afc2002c sw v0, 44(fp)  
43 9d008c9c 8fc2002c lw v0, 44(fp)  
44 9d008ca0 00402021 addu a0, v0, zero  
45 9d008ca4 2405003b li a1, 59  
46 9d008ca8 0f4026f8 jal device\_OutputPort\_OutputPort\_I\_  
47 9d008cac 00000000 nop  
48 9d008cb0 8fc2002c lw v0, 44(fp)  
49 9d008cb4 afc20020 sw v0, 32(fp)  
50 //  
51 // threadTest();  
52 9d008cb8 0f402171 jal Main\_threadTest  
53 9d008cbc 00000000 nop  
54 //  
55 // LightweightTimer.getSystemTimer().schedule(new LEDBlink(led1), 1000, 310);  
56 9d008cc0 3c029d01 lui v0, 0x9d01  
57 9d008cc4 2442d6b0 addiu v0, v0, -10576  
58 9d008cc8 00402021 addu a0, v0, zero  
59 9d008ccc 0f40023f jal newObject  
60 9d008cd0 00000000 nop  
61 9d008cd4 afc20030 sw v0, 48(fp)  
62 9d008cd8 8fc20030 lw v0, 48(fp)  
63 9d008cdc 00402021 addu a0, v0, zero  
64 9d008ce0 8fc20018 lw v0, 24(fp)  
65 9d008ce4 00402821 addu a1, v0, zero  
66 9d008ce8 0f402747 jal Main\_LEDBlink\_Main\_LEDBlink  
67 9d008cec 00000000 nop  
68 9d008cf0 0f402579 jal device\_LightweightTimer\_getSystemTimer  
69 9d008cf4 00000000 nop  
70 9d008cf8 afc2003c sw v0, 60(fp)  
71 9d008cfc 8fc2003c lw v0, 60(fp)  
72 9d008d00 00402021 addu a0, v0, zero  
73 9d008d04 8fc20030 lw v0, 48(fp)  
74 9d008d08 00402821 addu a1, v0, zero  
75 9d008d0c 240203e8 li v0, 1000  
76 9d008d10 00001821 addu v1, zero, zero

Disassembly - Navigator

Main.main

Breakpoints Variables Call Stack

Name Context

- Line C:\j\JvMRT.X\java\MicroJ2ME\src\Main.java:36
- Line C:\j\JvMRT.X\java\MicroJ2ME\src\Main.java:90
- Address 9D008CD8
- Line C:\j\JvMRT.X\java\MicroJ2ME\src\Main.java:88

JvMRT (Java Build, Java Compile, ...) 62 | 1 INS

# Processor registers window

Processor registers window contains nothing special, its slightly more convenient than in MPLAB X because it can tree representation of different register groups (peripherals included).

# Processor registers window

MicroJ2ME - NetBeans IDE 7.3.1

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

Search (Ctrl+F)

PC: 0x9D008A94 228.4/300.3MB

Projects Files Classes Services

main2.c Main.java Registers Output

Register Value Format

| Register                       | Value    | Format |
|--------------------------------|----------|--------|
| Core Registers                 |          |        |
| zero                           | 00000000 | Hex    |
| at                             | 01010101 | Hex    |
| v0                             | a0002360 | Hex    |
| v1                             | a0002360 | Hex    |
| a0                             | a0002360 | Hex    |
| a1                             | a0002360 | Hex    |
| a2                             | a000266c | Hex    |
| a3                             | 000002bc | Hex    |
| t0                             | 08080808 | Hex    |
| t1                             | 09090909 | Hex    |
| t2                             | 10101010 | Hex    |
| t3                             | 11111111 | Hex    |
| t4                             | 12121212 | Hex    |
| t5                             | 13131313 | Hex    |
| t6                             | 14141414 | Hex    |
| t7                             | 15151515 | Hex    |
| s0                             | 16161616 | Hex    |
| s1                             | 17171717 | Hex    |
| s2                             | 18181818 | Hex    |
| s3                             | 19191919 | Hex    |
| s4                             | 20202020 | Hex    |
| s5                             | 21212121 | Hex    |
| s6                             | 22222222 | Hex    |
| s7                             | 23232323 | Hex    |
| t8                             | 24242424 | Hex    |
| t9                             | 25252525 | Hex    |
| k0                             | 26262626 | Hex    |
| k1                             | 27272727 | Hex    |
| gp                             | a0007ff0 | Hex    |
| sp                             | a000055c | Hex    |
| fp                             | a000055c | Hex    |
| ra                             | 9d008a8c | Hex    |
| hi                             | 00000000 | Hex    |
| lo                             | 00000000 | Hex    |
| pc                             | 9d008a94 | Hex    |
| System Control Coprocessor CP0 |          |        |

threadTest - Navigator

Members

Main

- main()
- threadTest()
- BASE\_PERIOD : int
- PERIOD\_SHIFT : int
- ButtonHandler :: KeyboardEventHandler
- ButtonHandler(OutputPort led)
- actionPerformed(int keyAction, int keyCode)
- led : OutputPort
- LEDBlink :: TimerTask

Breakpoints Variables Call Stack

Name Context

- ☒ Line C:\d\JvmtRT.X\java\MicroJ2ME\src\Main.java:36

JvmtRT (Java Build, Java Compile, ...)

# Runtime Heap Window

Some useful window, which represent runtime Heap.

- Green color – free memory blocks.
- Black color – dynamically allocated Java objects
- Blue color – special allocated regions (for example, processor thread stacks).

If we click on some black region, we can see some information of allocated object (address, size and Java Class of this object)

# Runtime Heap Window

MicroJ2ME - NetBeans IDE 7.3.1

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

PC: 0x9D008A94 215.3/315.0MB

Projects Files Classes Services

main2.c Main.java Output

```
21 OutputPort led10 = new OutputPort(PIC32Defs.PORTD4);
22
23 OutputPort aux_led = new OutputPort(PIC32Defs.PORTF1);
24
25 Thread thr1 = new LEDThread(1, led1, BASE_PERIOD);
26 Thread thr2 = new LEDThread(1, led2, BASE_PERIOD + PERIOD_SHIFT* 1);
27 Thread thr3 = new LEDThread(1, led3, BASE_PERIOD + PERIOD_SHIFT* 2);
28 Thread thr4 = new LEDThread(1, led4, BASE_PERIOD + PERIOD_SHIFT* 3);
29 Thread thr5 = new LEDThread(1, led5, BASE_PERIOD + PERIOD_SHIFT* 4);
30 Thread thr6 = new LEDThread(1, led6, BASE_PERIOD + PERIOD_SHIFT* 5);
31 Thread thr7 = new LEDThread(1, led7, BASE_PERIOD + PERIOD_SHIFT* 6);
32 Thread thr8 = new LEDThread(1, led8, BASE_PERIOD + PERIOD_SHIFT* 7);
33 Thread thr9 = new LEDThread(1, led9, BASE_PERIOD + PERIOD_SHIFT* 8);
34 Thread thr10 = new LEDThread(1, led10, BASE_PERIOD + PERIOD_SHIFT* 9);
35
36
37 thr1.start();
38 thr2.start();
39 thr3.start();
40 thr4.start();
41 thr5.start();
42 thr6.start();
43 thr7.start();
44 thr8.start();
45 thr9.start();
46 thr10.start();
47
48 for (;;)
49
```

threadTest

Heap Breakpoints Variables Call Stack

Total bytes : 13000  
Free bytes : 3836  
Allocated objects : 26

Selected object :  
Class : Main.LEDThread  
Address : 0xa0000dd0  
Size : 84

threadTest - Navigator

Members

Main

- main()
- threadTest()
- BASE\_PERIOD : int
- PERIOD\_SHIFT : int
- ButtonHandler :: KeyboardEventHandler
- ButtonHandler(OutputPort led)
- actionPerformed(int keyAction, int keyCode)
- led : OutputPort
- LEDLink :: TimerTask

JvmRT (Java Build, Java Compile, ...)

36 | 1 | INS

# Runtime Status

Another useful information about runtime status. We can see how many object of which Java class are allocated in this execution point.



# Runtime Status

MicroJ2ME - NetBeans IDE 7.3.1

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

PC: 0x9D008A94 174.5/315.0MB

Search (Ctrl+I)

Projects Files Classes Services

main2.c Main.java Output

```
21 OutputPort led10 = new OutputPort(PIC32Defs.PORTD4);
22
23 OutputPort aux_led = new OutputPort(PIC32Defs.PORTF1);
24
25 Thread thr1 = new LEDThread(1, led1, BASE_PERIOD);
26 Thread thr2 = new LEDThread(1, led2, BASE_PERIOD + PERIOD_SHIFT* 1);
27 Thread thr3 = new LEDThread(1, led3, BASE_PERIOD + PERIOD_SHIFT* 2);
28 Thread thr4 = new LEDThread(1, led4, BASE_PERIOD + PERIOD_SHIFT* 3);
29 Thread thr5 = new LEDThread(1, led5, BASE_PERIOD + PERIOD_SHIFT* 4);
30 Thread thr6 = new LEDThread(1, led6, BASE_PERIOD + PERIOD_SHIFT* 5);
31 Thread thr7 = new LEDThread(1, led7, BASE_PERIOD + PERIOD_SHIFT* 6);
32 Thread thr8 = new LEDThread(1, led8, BASE_PERIOD + PERIOD_SHIFT* 7);
33 Thread thr9 = new LEDThread(1, led9, BASE_PERIOD + PERIOD_SHIFT* 8);
34 Thread thr10 = new LEDThread(1, led10, BASE_PERIOD + PERIOD_SHIFT* 9);
35
36 thr1.start();
37 thr2.start();
38 thr3.start();
39 thr4.start();
40 thr5.start();
41 thr6.start();
42 thr7.start();
43 thr8.start();
44 thr9.start();
45 thr10.start();
46
47 for (;;)
48
```

threadTest

Loaded Classes Breakpoints Variables Call Stack

| Class Name              | Instances [%] | Instances  |
|-------------------------|---------------|------------|
| device.OutputPort       | 14 (53.8%)    | 14 (53.8%) |
| Main.LEDThread          | 10 (38.5%)    | 10 (38.5%) |
| device.LightweightTimer | 1 (3.8%)      | 1 (3.8%)   |
| java.util.TaskQueue     | 1 (3.8%)      | 1 (3.8%)   |
| device.DMI              | 0 (0%)        | 0 (0%)     |
| java.lang.Object        | 0 (0%)        | 0 (0%)     |
| device.Device           | 0 (0%)        | 0 (0%)     |
| java.lang.Thread        | 0 (0%)        | 0 (0%)     |

threadTest - Navigator

Members

- Main
  - main()
  - threadTest()
  - BASE\_PERIOD : int
  - PERIOD\_SHIFT : int
  - ButtonHandler :: KeyboardEventHandler
  - ButtonHandler(OutputPort led)
  - actionPerformed(int keyAction, int keyCode)
  - led : OutputPort
  - LEDblink :: TimerTask

[Class Name Filter]

JvmRT (Java Build, Java Compile, ...)

36 | 18 INS

# Variables and Watches Windows

Variables and Watches Windows contain nothing special. System will show variable according with current execution point. If we stopped on Java source, all variables and watches will be Java types and classes. If we stopped on C source, there will be native C structures or native counterparts to Java classes.

# Variables and Watches Windows

MicroJ2ME - NetBeans IDE 7.3.1

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

Search (Ctrl+F)

PC: 0x9D008A94 152.8/315.0MB

Projects Files Classes Services

main2.c Main.java Output

```
29 Thread thr5 = new LEDThread(1, led5, BASE_PERIOD + PERIOD_SHIFT* 4);
30 Thread thr6 = new LEDThread(1, led6, BASE_PERIOD + PERIOD_SHIFT* 5);
31 Thread thr7 = new LEDThread(1, led7, BASE_PERIOD + PERIOD_SHIFT* 6);
32 Thread thr8 = new LEDThread(1, led8, BASE_PERIOD + PERIOD_SHIFT* 7);
33 Thread thr9 = new LEDThread(1, led9, BASE_PERIOD + PERIOD_SHIFT* 8);
34 Thread thr10 = new LEDThread(1, led10, BASE_PERIOD + PERIOD_SHIFT* 9);
35
36 thr1.start();
37 thr2.start();
38 thr3.start();
39 thr4.start();
40 thr5.start();
41 thr6.start();
42 thr7.start();
```

Loaded Classes Breakpoints Variables Call Stack

| Name         | Type              | Value         |
|--------------|-------------------|---------------|
| led1         | device.OutputPort |               |
| Inherited    | device.Device     |               |
| channel      | int               | 65            |
| led2         | device.OutputPort |               |
| Inherited    | device.Device     |               |
| channel      | int               | 64            |
| led3         | device.OutputPort |               |
| led4         | device.OutputPort |               |
| led5         | device.OutputPort |               |
| led6         | device.OutputPort |               |
| led7         | device.OutputPort |               |
| led8         | device.OutputPort |               |
| led9         | device.OutputPort |               |
| led10        | device.OutputPort |               |
| aux_led      | device.OutputPort |               |
| thr1         | Main.LEDThread    |               |
| id           | int               | 0             |
| led          | device.OutputPort |               |
| period       | int               | 5000          |
| Inherited    | java.lang.Thread  |               |
| curStack     | int               | 0xa000a2c     |
| stack        | int               | 0xa000800     |
| name         | java.lang.String  | "?"           |
| value        | char[]            | (length = 22) |
| offset       | int               | 8             |
| count        | int               | 2             |
| daemon       | boolean           | true          |
| interrupting | boolean           | false         |
| stackSize    | short             | 700           |
| priority     | byte              | 2             |
| state        | byte              | 0             |
| prev         | java.lang.Thread  | null          |

threadTest - Navigator

Members

Main

- main()
- threadTest()
- BASE\_PERIOD : int
- PERIOD\_SHIFT : int
- ButtonHandler :: KeyboardEventHandler
- ButtonHandler(OutputPort led)
- actionPerformed(int keyAction, int keyCode)
- led : OutputPort
- LEDLink :: TimerTask

JvmRT (Java Build, Java Compile, ...)

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# Native Methods Debugging

We stopped on Java native method implementation. Call Stack Window reflects this situation: it shows Java methods and also native methods and C functions.

# Native Methods Debugging

The screenshot shows the NetBeans IDE 7.3.1 interface. The main editor displays the C code for the `device_outputPort_init` and `device_outputPort_toggleValue` functions. The left sidebar shows the project structure for `JvmRT`, including `Header Files`, `Important Files`, `Java Files`, `Linker Files`, `Source Files`, `device`, `drivers`, `java`, `java.s`, `main2.c`, `ports`, `PIC32`, `ADC.c`, `Capture.c`, `crt0.S`, `I2C.c`, `InputPort.c`, `int_vec.S`, `InterruptPort.c`, `LightweightTimer.c`, `os_cpu_a.S`, `OutputPort.c`, `PeriodicTimer.c`, `port.c`, `PWM.c`, `SPI.c`, `USART.c`, `resources`, `Libraries`, and `Loadables`.

The main editor displays the following C code:

```
21 {
22     LATSET_BASE[port_num]= bit_mask;
23 }
24 else
25 {
26     LATCLR_BASE[port_num]= bit_mask;
27 }
28 }
29
30 void device_outputPort_toggleValue(struct Hdevice_OutputPort* this)
31 {
32     int port_num;
33     int bit_mask;
34     int channel;
35
36     channel= this->channel;
37     port_num= channel & 0xF0;
38     bit_mask= 1 << (channel & 0xF);
39     LATINV_BASE[port_num]= bit_mask;
40 }
41
42 void device_outputPort_init(struct Hdevice_OutputPort* this, jboolean open_drain, jint initialValue)
43 {
44     int port_num;
45     int bit_mask;
46     int channel;
47
48     channel= this->channel;
49     port_num= channel & 0xF0;
50     bit_mask= 1 << (channel & 0xF);
51     if (open_drain)
52         ODCSET_BASE[port_num]= bit_mask;
53     else ODCCLR_BASE[port_num]= bit_mask;
54     TRISCLR_BASE[port_num]= bit_mask;
55     device_outputPort_setValue(this, initialValue);
56 }
57
58
```

The bottom pane shows the Breakpoints and Call Stack. The Call Stack is active, showing the following entries:

- device\_outputPort\_init at C:/d/JvmRT.X/src/ports/PIC32/OutputPort.c:55
- device\_outputPort.OutputPort at C:/d/JvmRT.X/java/MicroJ2ME/src/device/OutputPort.java:8
- device\_outputPort.OutputPort at C:/d/JvmRT.X/java/MicroJ2ME/src/device/OutputPort.java:18
- Main.main at C:/d/JvmRT.X/java/MicroJ2ME/src/Main.java:86

# Native Methods Debugging

Then we can open original Java class source from which its native method was implemented and see some methods in current calling sequence.



# Native Methods Debugging

The screenshot displays the NetBeans IDE 7.3.1 interface. The top menu bar includes File, Edit, View, Navigate, Source, Refactor, Run, Debug, Profile, Team, Tools, Window, and Help. The toolbar contains various icons for file operations and debugging. The status bar at the top right shows the PC address as 0x9D005F30 and memory usage as 179.1 / 315.0 MB.

The left sidebar shows the Project Explorer with the following structure:

- JvmRT
  - Header Files
  - Important Files
  - Java Files
    - Source Packages
      - <default package>
      - com.sun.ddc.io
      - com.sun.midp.io
      - com.sun.midp.io.j2me.datagram
      - com.sun.midp.lcd.ui
      - device
        - ADC.java
        - Button.java
        - Capture.java
        - CaptureHandler.java
        - DML.java
        - DataReceivedHandler.java
        - Device.java
        - EEPROM.java
        - I2C.java
        - InputPort.java
        - InterruptPort.java
        - KeyboardEventHandler.java
        - Keypad.java
        - LightweightTimer.java
        - OutputPort.java
        - PWM.java
        - PeriodicTimer.java
        - SDSPI.java
        - SPI.java
        - ServoOut.java
        - TouchPanelHandler.java
        - USART.java
        - WheelEncoder.java
        - WheelEncoderEventHandler.java
      - device.pic32
      - java.io
      - java.lang
      - java.text
      - java.util
      - javax.com
      - javax.microedition.io

The main editor window displays the `OutputPort.java` file. The code is as follows:

```
1 package device;
2
3 public class OutputPort extends Device
4 {
5     public OutputPort(int channel, boolean openDrain, int initValue)
6     {
7         super(channel);
8         init(openDrain, initValue);
9     }
10
11     public OutputPort(int channel, int initValue)
12     {
13         this(channel, false, initValue);
14     }
15
16     public OutputPort(int channel)
17     {
18         this(channel, false, 0);
19     }
20
21     public native void setValue(int value);
22
23     public native void toggleValue();
24
25     private native void init(boolean multi, int initValue);
26 }
27
```

The bottom of the IDE features the **OutputPort.java - Navigator** and **Breakpoints** panels. The **Members** panel shows the following methods:

- OutputPort :: Device
  - OutputPort(int channel)
  - OutputPort(int channel, int initValue)
  - OutputPort(int channel, boolean openDrain, int initValue)
  - init(boolean multi, int initValue)
  - setValue(int value)
  - toggleValue()

The **Breakpoints** panel shows the following breakpoints:

- device.OutputPort\_init at C:/d/JvmRT.X/src/ports/PIC32/OutputPort.c:55
- device.OutputPort.OutputPort at C:/d/JvmRT.X/java/MicroJ2ME/src/device/OutputPort.java:8
- device.OutputPort.OutputPort at C:/d/JvmRT.X/java/MicroJ2ME/src/device/OutputPort.java:18
- Main.main at C:/d/JvmRT.X/java/MicroJ2ME/src/Main.java:86

The status bar at the bottom indicates the current state: JvmRT (Java Build, Java Compile, ...).