MuntsOS Embedded Linux

Application Note #21: Ada Extension Programs

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Introduction

This Application Note describes, with a worked example, how to write, deploy and install a self-contained ***MuntsOS Embedded Linux*** extension program written in the Ada programming language.

Extension Programs are one of three ways of extending a MuntsOS Embedded Linux installation (the other ways two are extension packages installed from `/boot/extensions` and tar balls unpacked from `/boot/tarballs`).

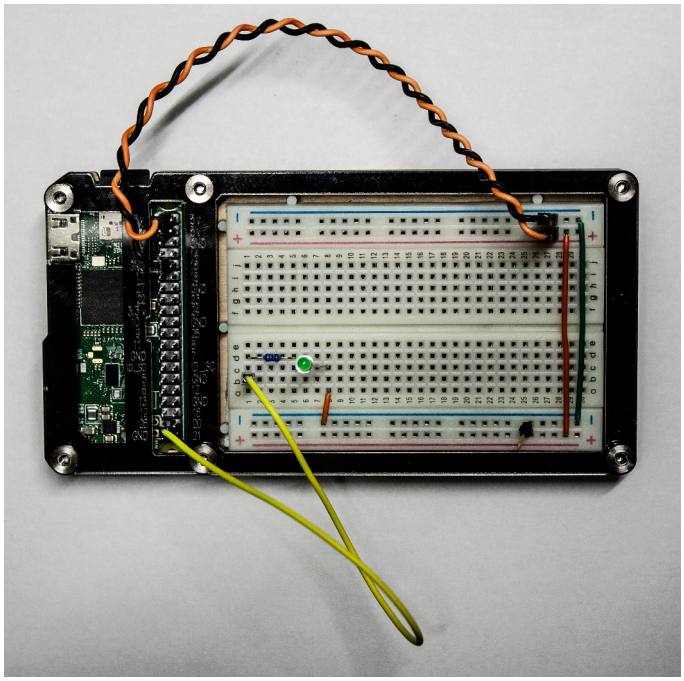
Prerequisites

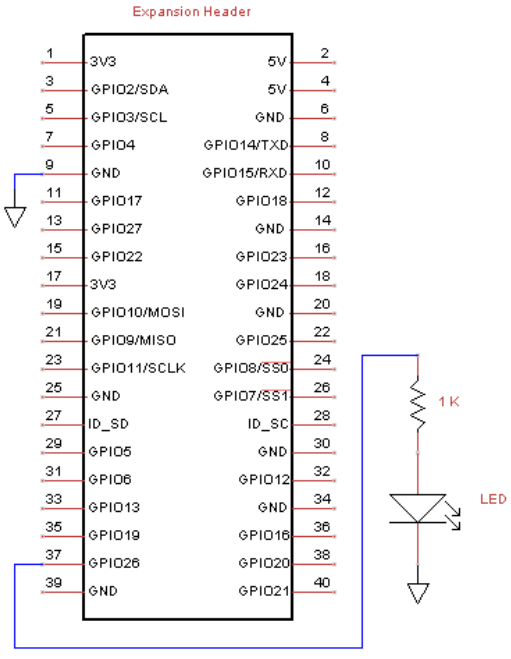
The ***MuntsOS Embedded Linux*** software development environment must be installed on your Linux development computer (AppNote #1 or AppNote #2).

The `alr` command line tool for ***Alire*** must be installed on your Linux development computer (either by following the procedure specified at https://alire.ada.dev/docs/#installation *or* by installing from the ***Munts Technologies Debian Package Repository*** at https://repo.munts.com/debian12).

MuntsOS Embedded Linux must be installed on your target computer (AppNote #3).

Target Computer Hardware





The target computer for the purposes of this application note consists of a Raspberry Pi Zero 2 Wireless mounted in a Zebra Zero Plus Breadboard case. The orange and black jumper wires connect `+3.3V` and `GND` on the Raspberry Pi expansion header to the breadboard power rails. The yellow jumber connects `GPIO26` to a 1K ohm current limiting resistor and an LED.

Ada Extension Program Template

https://git.munts.com/muntsos/examples/ada/programs/extension_program_template.adb.

```
1     WITH Ada.Text_IO; USE Ada.Text_IO;
2     WITH Debug;
3     WITH libLinux;
4     WITH Watchdog.libsimpleio;
5
6     PROCEDURE extension_program_template IS
7
8       err : Integer;
9       wd  : Watchdog.Timer;
10
11      -- Add your application specific data declarations here
12
13    BEGIN
14      Put_Line("Starting Ada Extension Program");
15
16      IF NOT Debug.Enabled THEN
17        -- Run as background process
18        libLinux.Detach(err);
19
20        -- Create a watchdog timer device object
21        wd := Watchdog.libsimpleio.Create;
22        wd.SetTimeout(5.0);
23      END IF;
24
25      -- Add your application specific initialization code here
26
27      LOOP
28        -- Add your application specific event handling code here
29
30        IF NOT Debug.Enabled THEN
31          -- Reset the watchdog timer
32          wd.Kick;
33        END IF;
34      END LOOP;
35    END extension_program_template;
```

Source Code Annotations

Line 1: Pulls in package **`Ada.Text_IO`**.

Line 2: Pulls in package **`Debug`**, which provides some overloaded text output procedures named **`Debug.Put`** that are qualified by the **`DEBUGLEVEL`** environment variable. If **`DEBUGLEVEL`** is set to an integer value greater than zero, output to **`stderr`** is enabled. You also can qualify your own code blocks in the same manner with the boolean function **`Debug.Enabled`**.

Line 3: Pulls in package **`libLinux`**. The procedure **`libLinux.Detach`** disconnects the calling program from its controlling terminal and switches to background execution

Line 4: Pulls in package **`Watchdog.libsimpleio`**, which provides hardware watchdog timer services.

Lines 8-9: Declares an error return variable for **`libLinux.Detach`** and a watchdog timer object.

Line 11: Your application specific data declarations can go here, including one or more Ada tasks that will do all the real work.

Line 14: Startup banner.

Lines 16-23 If **`Debug.Enabled`** is **`False`**, call **`libLinux.Detach`** to switch to background execution. Then start the watchdog timer and set its period to 5 seconds. All ***MuntsOS Embedded Linux*** kernels configure the watchdog timer for unstoppable mode. If the program hangs for any reason or terminates for any reason (including an unhandled exception or signal), the watchdog timer will issue a hardware reset after 5 seconds and restart the system.

Line 25: Your application initialization code can go here. This may include starting one or more Ada tasks that do all the real work.

Line 27: Beginning of the event loop, which is supposed to run forever.

Line 28: Your application specific event handling code can go here.

Line 30-33: If **`Debug.Enabled`** is **`False`**, reset the watchdog timer for another 5 seconds.

Line 34: End of the event loop.

Create the Ada Extension Program Project

Use the following procedure to create your Ada extension program project using Alire:

```
alr -n init --bin myextension
cd myextension
alr -n with muntsos_aarch64
cp
/usr/local/share/muntsos/examples/ada/programs/extension_program_templ
ate.adb src/myextension.adb
alr -n action -r post-fetch
```

Now edit `src/myextension.adb` with your favorite Linux text editor:

1. Change the program name from `extension_program_template` to `myextension` with a "find and replace all" operation.
2. Add the following package reference after line 2:

```
   WITH GPIO.libsimpleio;
```

3. Add the following package reference after line 3:

```
  WITH RaspberryPi;
```

4. Add a declaration for an LED object by adding the following at line 11:

```
  LED : GPIO.Pin;
```

5. Add code to initialize the LED object by adding the following at line 25:

```
  LED := GPIO.libsimpleio.Create(RaspberryPi.GPIO26, GPIO.Output);
```

6. Add code to flash the LED inside the event loop by adding the following at line 28:

```
    LED.Put(NOT LED.Get);
    DELAY 0.5;
```

Test the Ada Extension Program

1. Build, install temporarily, and run **`myextension`**:

```
alr build
scp bin/myextension root@snoopy:.
ssh root@snoopy
./myextension
```

The LED should begin flashing once a second.

2. After a while, kill **`myextension`** on the target computer:

```
killall myextension
```

After 5 seconds, the target computer should reboot.

Permanent Installation

You can install your extension program permanently to the target computer by copying the extension program file to **`/boot/autoexec.d`**, using commands like the following:

```
alr build
scp bin/myextension root@snoopy:.
ssh root@snoopy
mount -orw /boot
mkdir -p /boot/autoexec.d
mv myextension /boot/autoexec.d
umount /boot
reboot
```

The ***MuntsOS Embedded Linux*** startup script **`/etc/rc`** will load and execute extension programs from either **`/boot/autoexec.d`** or **`/boot/extensions`**. The "best practices" recommendation is to install custom extension programs to **`/boot/autoexec.d`** and only install curated extension programs (*i.e.* using **`sysconfig`**) to **`/boot/extensions`**.