

Embedded Programming with Ada

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 Twitter : @DesChips

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Ravenscar Tasking

Ravenscar Tasking

A.K.A There's a mini-RTOS in my language¹

- Tasks (threads)
- Time handling
 - Clock
 - Delays
- Protected Objects:
 - Mutual exclusion
 - Synchronization between tasks
 - Interrupt handling

¹blog.adacore.com/theres-a-mini-rtos-in-my-language

Tasks

```
-- Task type declaration
task type My_Task (Prio : System.Priority)
    with Priority => Prio;
```

```
T1 : My_Task (Prio => 1);
T2 : My_Task (Prio => 2);
```

Time

```
task body My_Task is
    Period      : constant Time_Span := Milliseconds (100);

    Next_Release : Time := Clock + Period;
    -- Set Initial release time

begin
    loop
        -- Suspend My_Task until the Clock is greater
        -- than Next_Release.
        delay until Next_Release;
        -- Compute the next release time
        Next_Release := Next_Release + Period;

        -- Do something really cool at 10Hz...
    end loop;
end My_Task;
```

Mutual exclusion and shared resources

```
protected My_Protected_Object
  with Priority => 3
is

  procedure Set_Data (Data : Integer);
  -- Protected procedures can read and/or modify the
  -- protected data.

  function Data return Integer;
  -- Protected functions can only read the protected data

private
  -- Protected data are declared in the private part
  PO_Data : Integer := 0;
end;
```

Synchronization 1/2

```
protected My_Protected_Object is
    entry Wait_For_Signal;
    procedure Send_Signal;
private
    We_Have_A_Signal : Boolean := False;
end My_Protected_Object;
```

Synchronization 2/2

```
protected body My_Protected_Object is

    entry Wait_For_Signal when We_Have_A_Signal is
        begin
            We_Have_A_Signal := False;
        end Wait_For_Signal;

    procedure Send_Signal is
        begin
            We_Have_A_Signal := True;
        end Send_Signal;

end My_Protected_Object;
```

Interrupt handling 1/2

```
protected My_Protected_Object
  with Interrupt_Priority => 255
is
  entry Get_Next_Character (C : out Character);

private
  procedure UART_Interrupt_Handler
    with Attach_Handler => UART_Interrupt;

  Received_Character : Character := ASCII.NUL;
  We_Have_A_Character : Boolean := False;
end;
```

Interrupt handling 2/2

```
protected body My_Protected_Object is

    entry Get_Next_Character (C : out Character)
        when We_Have_A_Character
    is
        begin
            C := Received_Character;
            We_Have_A_Char := False;
        end Get_Next_Character;

procedure UART_Interrupt_Handler is
begin
    Received_Character := A_Character_From_UART_Device;
    We_Have_A_Character := True;
end UART_Interrupt_Handler;
end;
```

Runtimes profiles

Ada standard run-time

Ravenscar Full

Ravenscar Small FootPrint (SFP)

Zero FootPrint (ZFP)

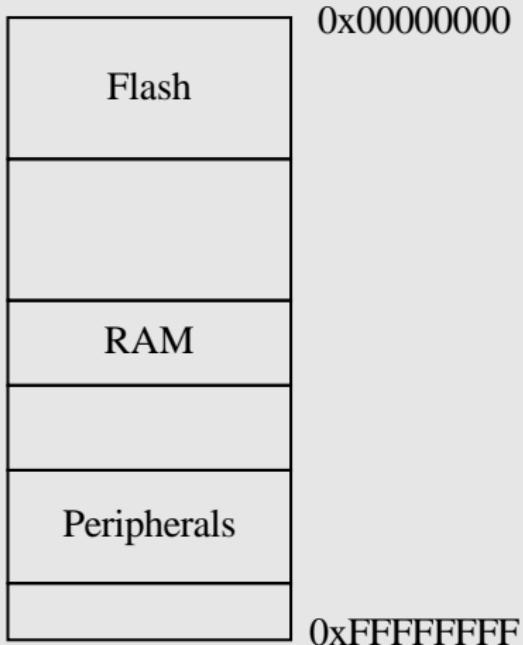
Hardware mapping

Hardware mapping

```
-- High level view of the type
type Servo_Angle is range -90 .. 90

-- Hardware representation of the type
with Size      => 8,
     Alignment => 16;
```

Memory mapped registers



Hardware mapping

| | | | | | | | |
|----------|---|-------|---|---|---|----------|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | Sense | | | | Reserved | |

Sense: Pin sensing mechanism

0: Disabled

2: Sense for high level

3: Sense for low level

Hardware mapping

```
#define SENSE_MASK      (0x30)
#define SENSE_POS        (4)

#define SENSE_DISABLED  (0)
#define SENSE_HIGH      (2)
#define SENSE_LOW       (3)

uint8_t *register = 0x80000100;

// Clear Sense field
*register &= ~SENSE_MASK;
// Set sense value
*register |= SENSE_DISABLED << SENSE_POS;
```

Hardware mapping

```
-- High level view of the Sense field
type Pin_Sense is
  (Disabled,
   High,
   Low)
with Size => 2;

-- Hardware representation of the Sense field
for Pin_Sense use
  (Disabled => 0,
   High      => 2,
   Low       => 3);
```

Hardware mapping

```
-- High level view of the register
type IO_Register is record
    Reserved_A : UInt4;
    SENSE      : Pin_Sense;
    Reserved_B : UInt2;
end record;

-- Hardware representation of the register
for IO_Register use record
    Reserved_A at 0 range 0 .. 3;
    SENSE      at 0 range 4 .. 5;
    Reserved_B at 0 range 6 .. 7;
end record;
```

Hardware mapping

```
Register : IO_Register  
  with Address => 16#8000_0100#;
```

```
Register.SENSE := Disabled;
```

SVD -> Ada

```
<field>
  <name>SENSE</name>
  <description>Pin sensing mechanism.</description>
  <lsb>16</lsb> <msb>17</msb>
  <enumeratedValues>
    <enumeratedValue>
      <name>Disabled</name>
      <description>Disabled.</description>
      <value>0x00</value>
    </enumeratedValue>
  [...]
```

github.com/AdaCore/svd2ada

Interfacing with C / Assembly

Interfacing with C / Assembly

```
with Interfaces.C; use Interfaces.C;

[...]

function My_C_Function (A : int) return int;
pragma Import (C, My_C_Function, "my_c_function");

function My_Ada_Function (A : int) return int;
pragma Export (C, My_Ada_Function, "my_ada_function");
```

Interfacing with C / Assembly

```
int my_ada_function(int a);

void adainit(void);

void adafinal(void);

void main(void) {
    adainit();

    my_ada_function(42);

    adafinal();
}
```

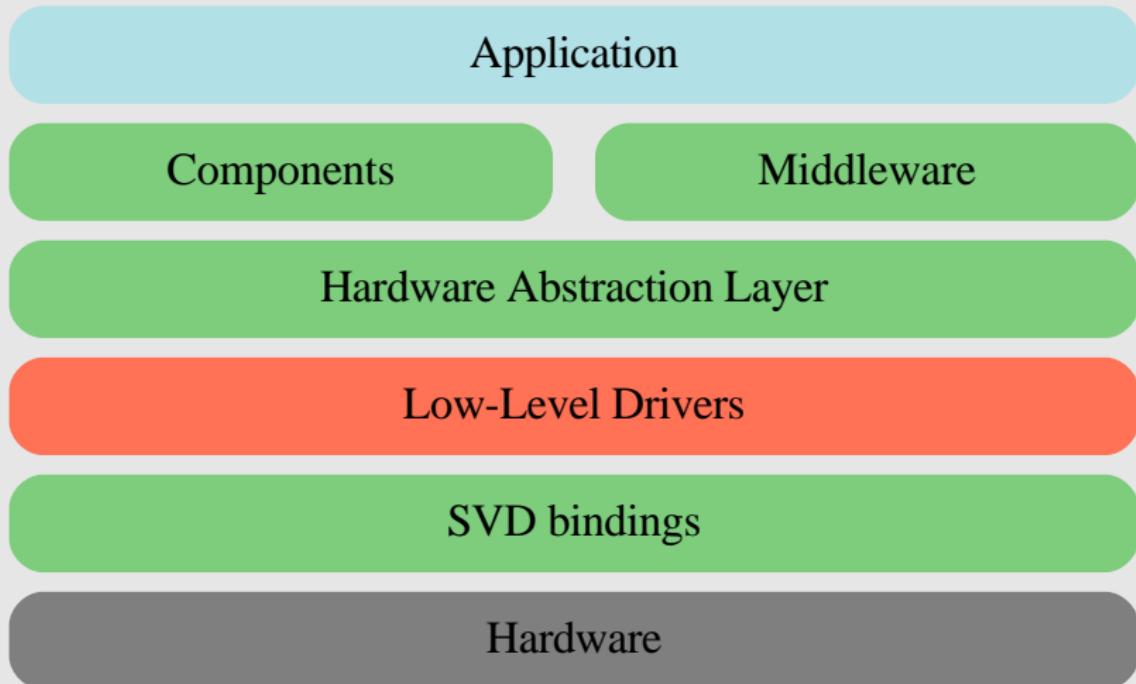
The Ada Drivers Library

Ada Drivers Library

- Firmware library
- Hardware and vendor independent
- 100% Ada
- Hosted on GitHub:

`github.com/AdaCore/Ada_Drivers_Library`

Architecture



Supported platforms

ARM



Getting started demo

Download and install the tools: adacore.com/community

Download GNAT Community Edition

For free software developers, hobbyists, and students.

x86-64 GNU Linux (64 bits)

GNAT GPL Ada

[gnat-gpl-2017-x86_64-linux-bin.tar.gz](#)
SHA-1: 9682e2a1f2f232ce03fe21d77b14c37a0de5649b

496.34 MB May 17 2017

SPARK Discovery

[spark-discovery-gpl-2017-x86_64-linux-bin.tar.gz](#)
SHA-1: a70d75c71508ed3ab0ecb4a34fcc1dff9a9d9089

104.06 MB May 29 2017

ARM ELF (hosted on linux)



GNAT GPL Ada

[gnat-gpl-2017-arm-elf-linux-bin.tar.gz](#)
SHA-1: 71b5830d0242dfeb294d8895960f969bbc5c2417

548.9 MB May 17 2017

Download Ada Drivers Library

This screenshot shows the GitHub repository page for AdaCore / Ada_Drivers_Library. The page displays various statistics and a list of pull requests.

Key statistics shown:

- 1,179 commits
- 22 branches
- 0 releases
- 15 contributors
- BSD-3-Clause license

The pull request list includes:

- pat-rogers Merge pull request #200 from AdaCore/add_gpio_drive ... (3 months ago)
- arch add conversion from condition to condition for a pin (2 months ago)
- boards robust, safer version of GPIO_Port_Setup_Io (2 months ago)
- components SGTL5000: Fix some typos (5 months ago)
- docs docs/filesystem.md: Add doc for directory handling (3 months ago)
- examples Examples: Bring back the blinky and serial examples for the STM32F4 d... (2 months ago)
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- scripts Examples: Bring back the blinky and serial examples for the STM32F4 d... (2 months ago)
- testsuite Monitor_Block_Drivers: Show data size (5 months ago)
- .gitignore Use new GPRbuild attribute: Create_Missing_Dirs (7 months ago)

On the right side, there is a "Clone with HTTPS" section with a "Download ZIP" button.

| File | Description | Age |
|---|----------------|-----|
| pat-rogers Merge pull request #200 from AdaCore/add_gpio_drive ... | (3 months ago) | |
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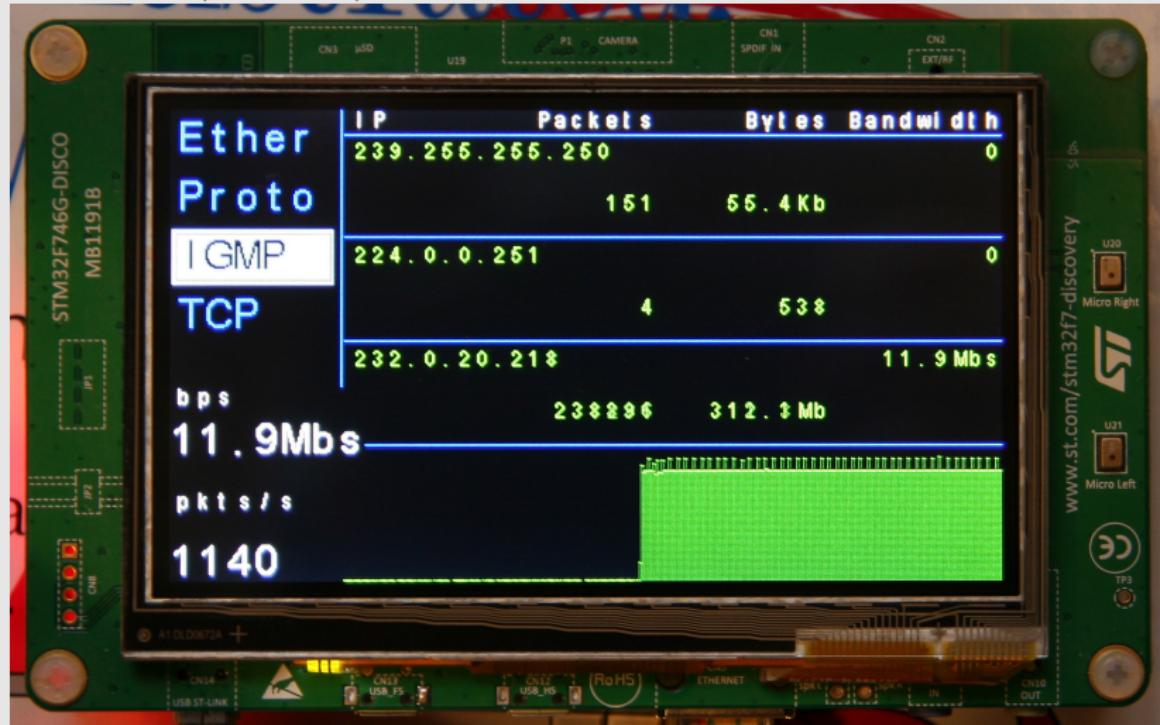
The Make with Ada Competition

- Embedded software project competition
- Open to everyone
- ~8000 euros in prize
- makewithada.org (Twitter @adaprogrammers)



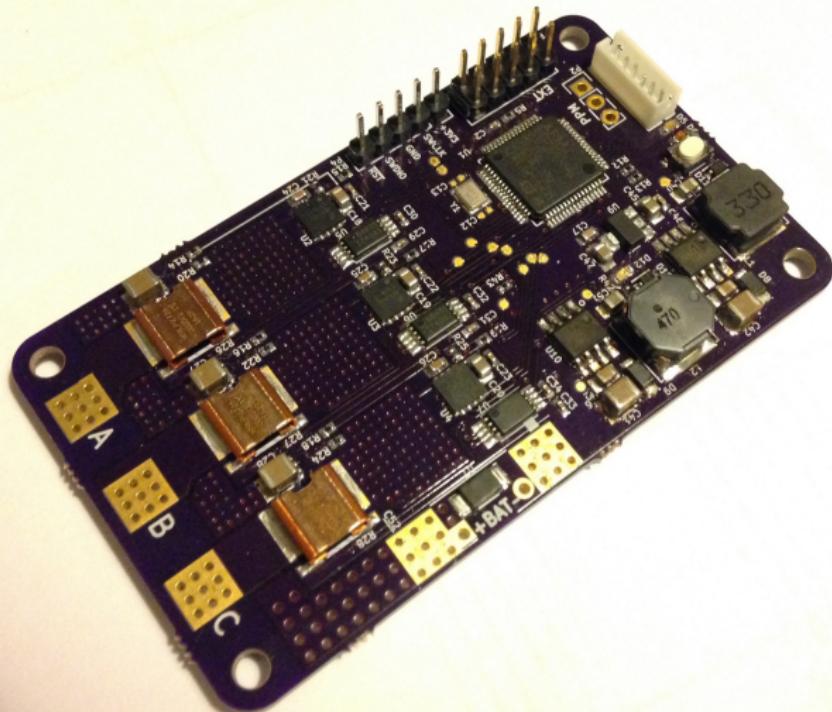
2016 Winner project (Stephane Carrez)

github.com/stcarrez/etherscope



2017 Winner project (Jonas Attertun)

blog.adacore.com/make-with-ada-2017-brushless-dc-motor-controller



Some projects base on the Ada Drivers Library

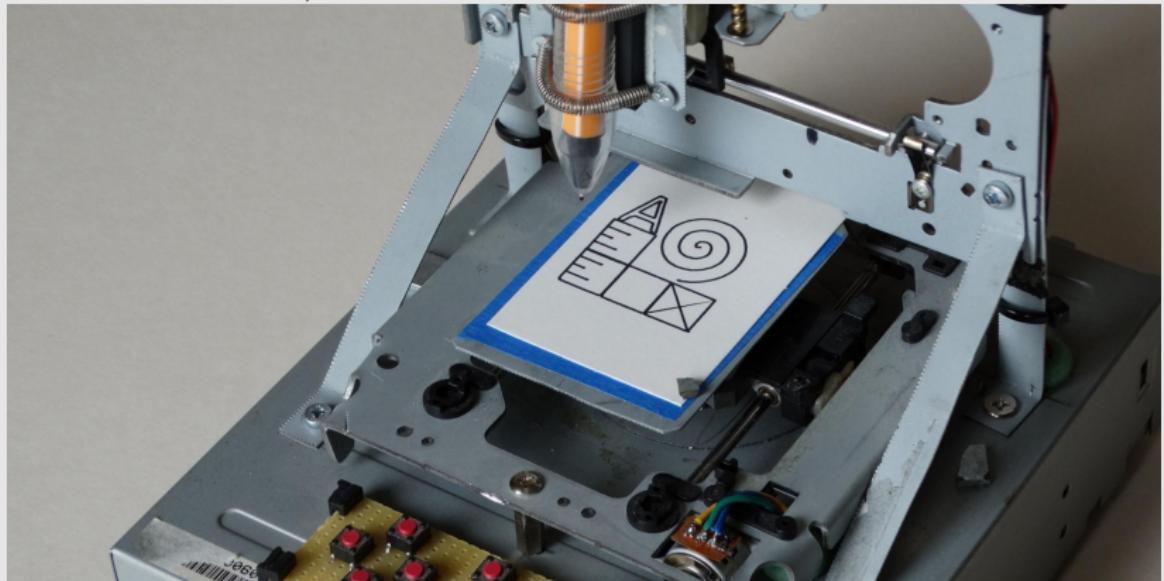
Crazyflie 2.0 Flight controller

blog.adacore.com/how-to-prevent-drone-crashes-using-spark



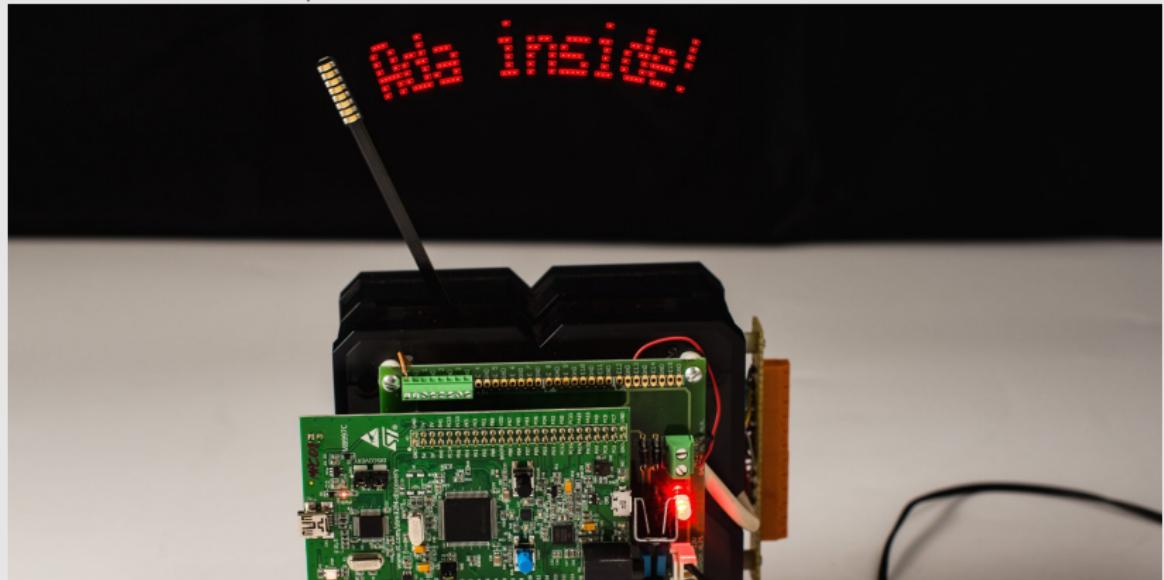
CNC Controller

blog.adacore.com/make-with-ada-arm-cortex-m-cnc-controller



Pendulum clock LED

blog.adacore.com/writing-on-air



DIY instant camera

blog.adacore.com/make-with-ada-diy-instant-camera



Wolf

github.com/lambourg/Ada_Bare_Metal_Demos



AdaCore

Wee Noise Maker

github.com/Fabien-Chouteau/Wee-Noise-Maker

