

# Take Off!



## **Ada** for Automation

Freedom and Power for Control Engineers

### Ada for Automation Demo Application

*010 a4a\_piano*

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# Chapter 1. Description

## 1.1. Ada for Automation

[Ada for Automation](#) (A4A in short) is a framework for designing industrial automation applications using the Ada language.

It makes use of the [libmodbus](#) library to allow building a ModbusTCP client or server, or a Modbus RTU master or slave.

It can also use [Hilscher](#) communication boards allowing to communicate on field buses like AS-Interface, CANopen, CC-Link, DeviceNet, PROFIBUS, EtherCAT, Ethernet/IP, Modbus TCP, PROFINET, Sercos III, POWERLINK, or VARAN.

With the help of [GtkAda](#), the binding to the [Graphic Tool Kit](#), one can design Graphical User Interfaces.

Thanks to [Gnoga](#), built on top of [Simple Components](#), it is also possible to provide a Web User Interface.

Nice addition is the binding to the [Snap7](#) library which allows to communicate with SIEMENS S7 PLCs using S7 Communication protocol ISO on TCP (RFC1006).

Of course, all the Ada ecosystem is available.

Using Ada bindings, C, C++, Fortran libraries can also be used.

And, since it is Ada, it can be compiled using the same code base to target all major platforms.

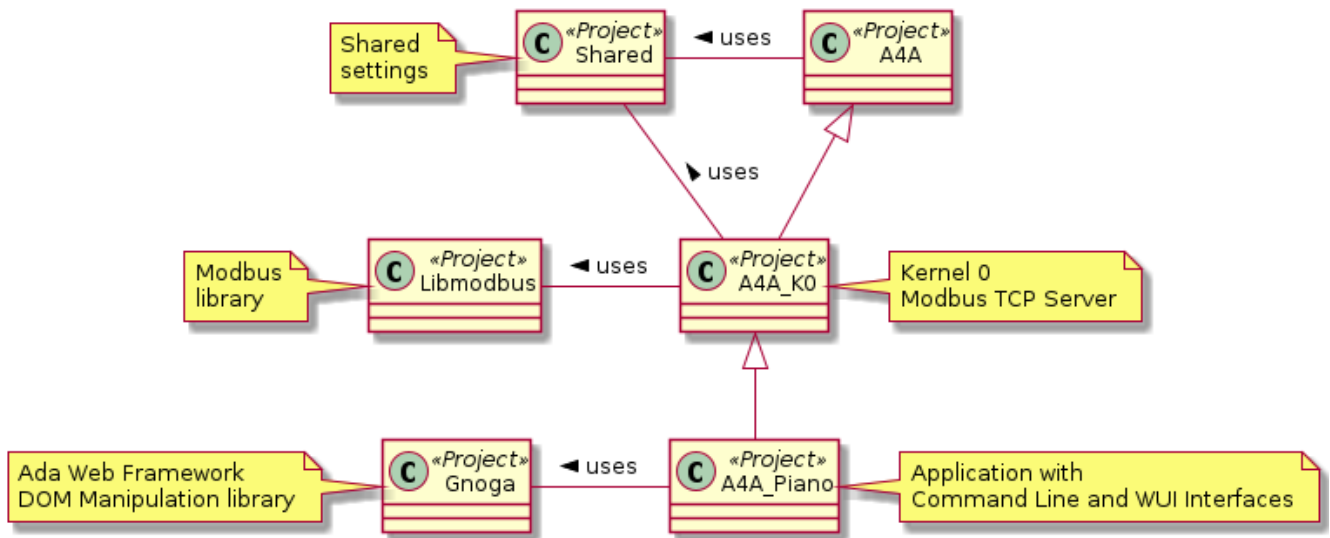
## 1.2. This demo application

This is a demo application featuring:

- a basic command line interface,
- a basic web user interface making use of Gnoga,
- a kernel with a Modbus TCP Server (K0),
- a trivial application that mimics 16 push buttons and 16 LEDs with a web interface.

# Chapter 2. Projects diagram

The following picture shows the diagram of projects :



# Chapter 3. License

Those files are included in the **Ada for Automation** root folder :

## **COPYING3**

The GPL License you should read carefully. GNU GENERAL PUBLIC LICENSE Version 3, 29 June 2007

## **COPYING.RUNTIME**

GCC RUNTIME LIBRARY EXCEPTION Version 3.1, 31 March 2009

Hence, each source file contains the following header :

```
-----  
--                               Ada for Automation                               --  
--                               --                                               --  
--                               Copyright (C) 2012-2023, Stephane LOS          --  
--                               --                                               --  
-- This library is free software; you can redistribute it and/or modify it --  
-- under terms of the GNU General Public License as published by the Free --  
-- Software Foundation; either version 3, or (at your option) any later --  
-- version. This library is distributed in the hope that it will be useful, --  
-- but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHAN- --  
-- TABILITY or FITNESS FOR A PARTICULAR PURPOSE.                               --  
--                               --                                               --  
-- As a special exception under Section 7 of GPL version 3, you are granted --  
-- additional permissions described in the GCC Runtime Library Exception, --  
-- version 3.1, as published by the Free Software Foundation.                 --  
--                               --                                               --  
-- You should have received a copy of the GNU General Public License and --  
-- a copy of the GCC Runtime Library Exception along with this program; --  
-- see the files COPYING3 and COPYING.RUNTIME respectively. If not, see --  
-- <http://www.gnu.org/licenses/>. --  
--                               --                                               --  
-----
```

# Chapter 4. Building

The provided makefile uses [GPRbuild](#) and provides six targets:

- `all` : builds the executable,
- `app_doc` : creates the documentation of the source code,
- `clean` : cleans the space.

Additionally one can generate some documentation using [Asciidoctor](#) with :

- `read_me_html` : generates the README in HTML format,
- `read_me_pdf` : generates the README in PDF format,
- `read_me` : generates the README in both formats.

# Chapter 5. Running

Of course, this application is of interest only if a Modbus TCP Client application is talking to it.

Good candidates are a SCADA or a PLC but, if none is at your disposal, you could use one of :

- 020 a4a-k1-cli,
- 021 a4a-k1-gui,
- 022 a4a-k1-wui,
- your own.

In a console:

Build the application:

```
make
```

Optionally create the documentation:

```
make app_doc
```

Run the application:

```
make run
```

Use Ctrl+C to exit.

Optionally clean all:

```
make clean
```

# Chapter 6. Directories

## **bin**

Where you will find the executable.

## **doc**

The place where [GNATdoc](#) would create the documentation.

## **obj**

Build artifacts go here.

## **src**

Application source files.

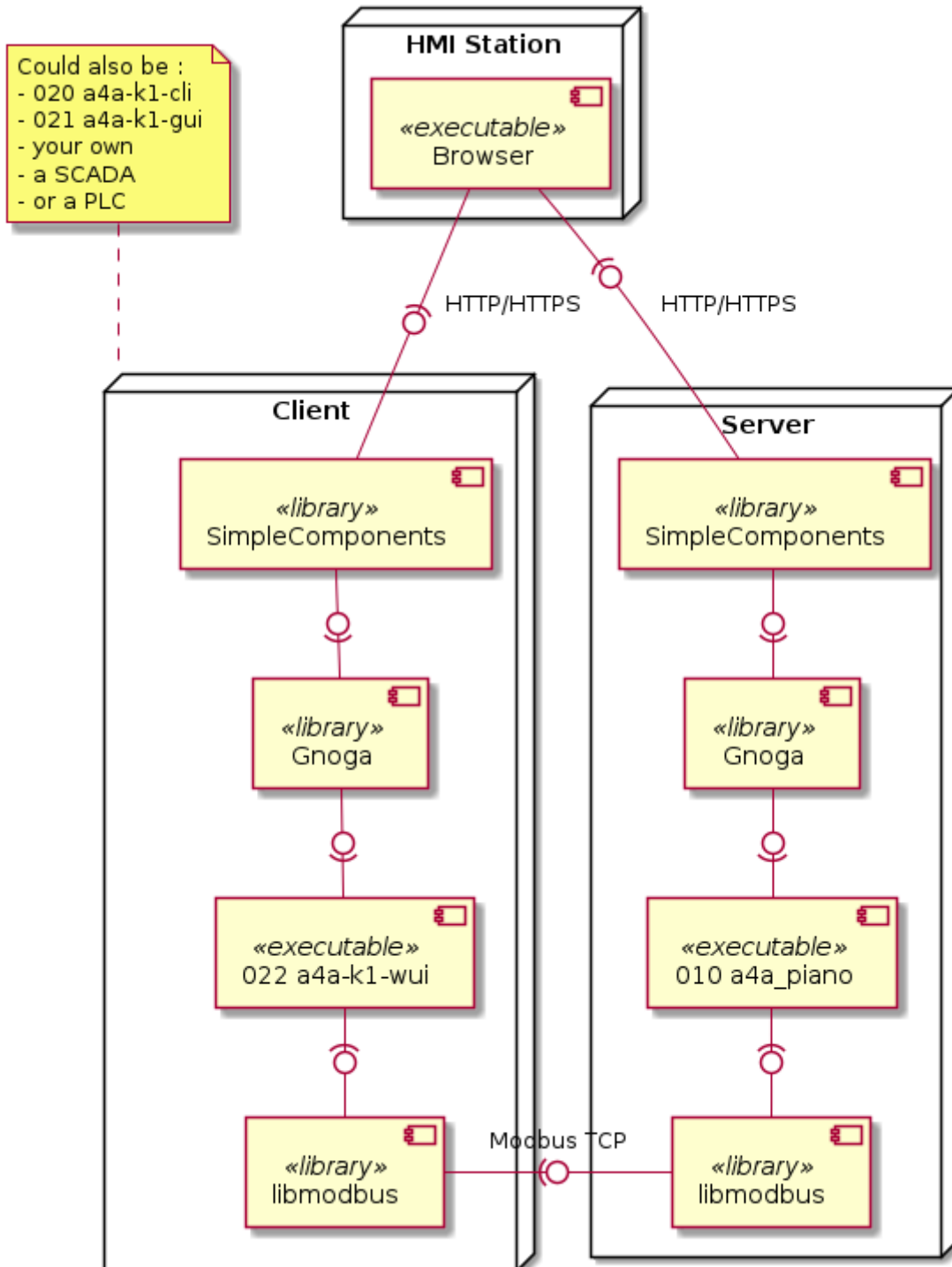


# Chapter 7. Application

This is a basic **Ada for Automation** application which implements a Modbus TCP Server that mimics 16 push buttons and 16 LEDs with a web interface.

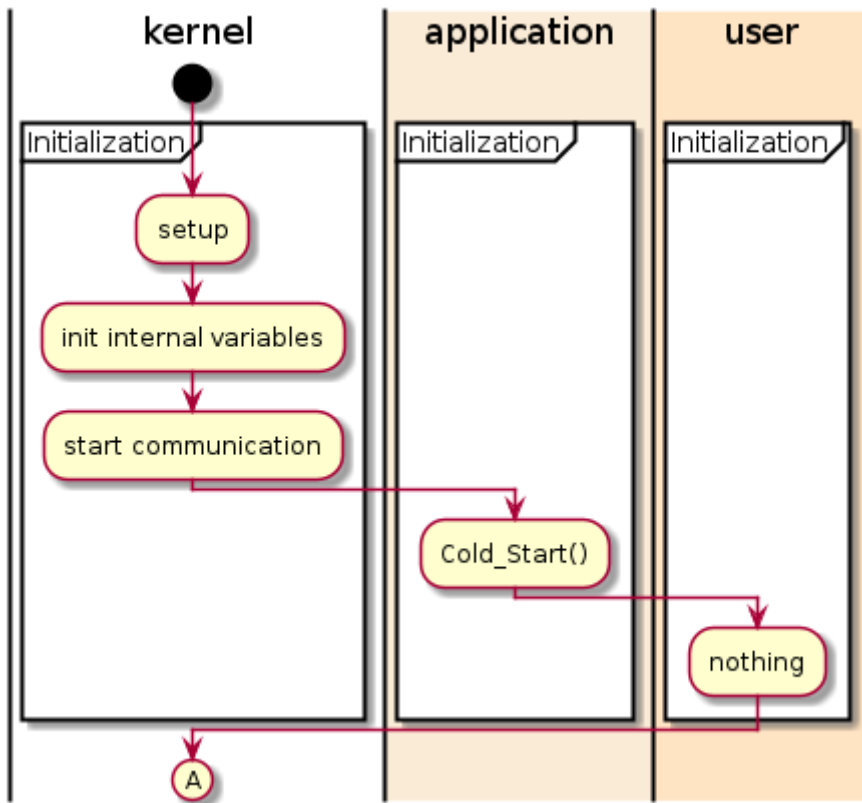
It has a Command Line and Web User Interfaces and listen to Modbus TCP requests.

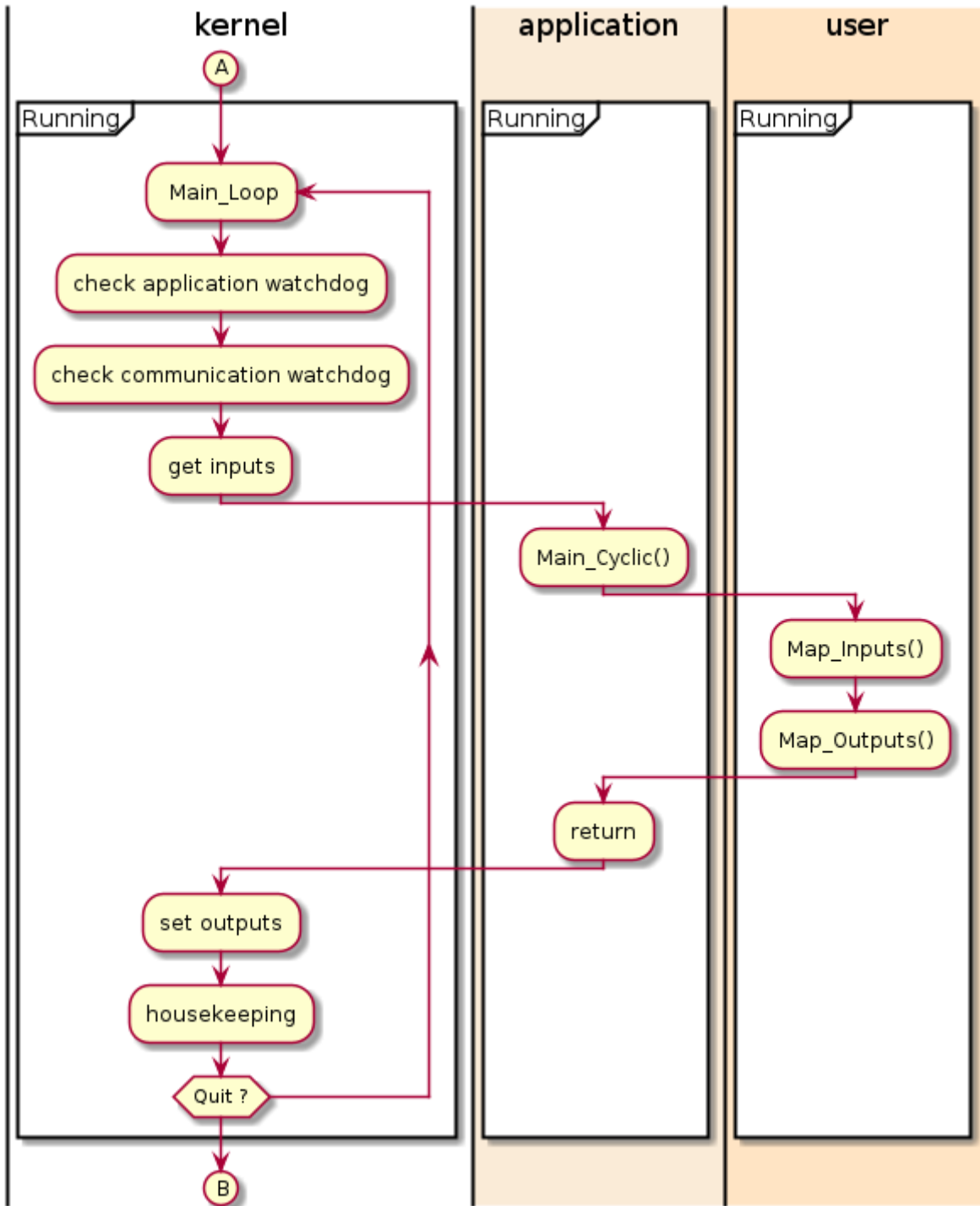
## 7.1. Deployment diagram

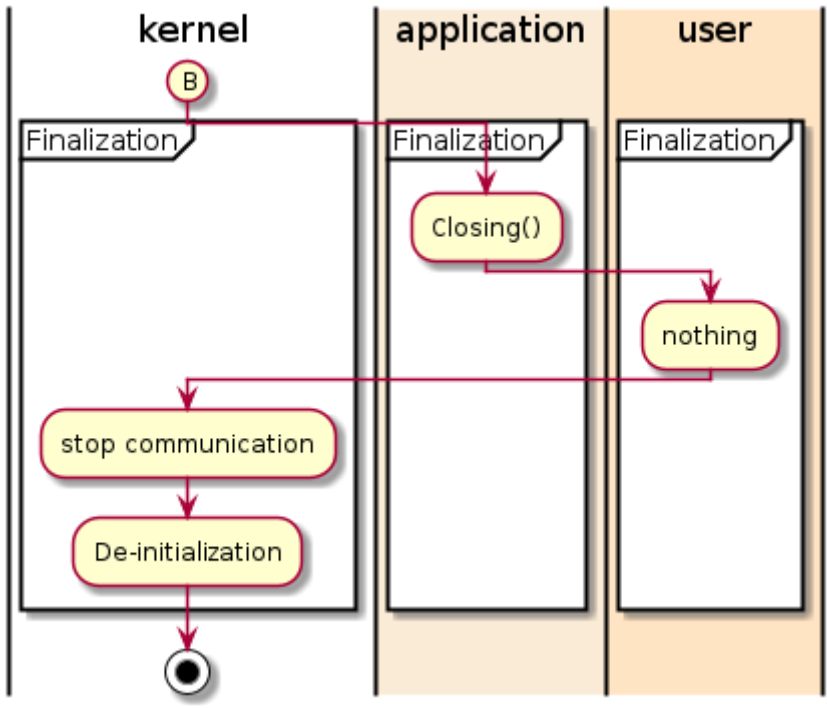


## 7.2. Activity diagram

The Kernel manages the communication channel and provides an interface to it, namely the package "A4A.Memory.MBTCP\_IOSlave".







## 7.3. Modbus TCP Server Configuration

"/src/a4a-application-mbtcp\_server\_config.ads"

```
package A4A.Application.MBTCP_Server_Config is

-----
-- Modbus TCP Server configuration
-----

package Server is new A4A.MBTCP_Server
(Coils_Number          => 65536,
 Input_Bits_Number    => 65536,
 Input_Registers_Number => 65536,
 Registers_Number     => 65536);

Config1 : aliased Server.Server_Configuration :=
(Server_Enabled      => True,
 Debug_On           => True,
 Retries            => 3,
 Server_IP_Address  => To_Bounded_String ("0.0.0.0"),
 Server_TCP_Port    => 1504); -- ①

end A4A.Application.MBTCP_Server_Config;
```

① Modbus TCP Server port : 1504

## 7.4. User objects Definition

"/src/a4a-user\_objects.ads"

```
package A4A.User_Objects is

-----
-- User Objects creation
-----

-----
-- Inputs
-----

Input_Bits : Bool_Array (0 .. 15) := (others => False); -- ①

-----
-- Outputs
-----

Coils      : Bool_Array (0 .. 15) := (others => False); -- ②

end A4A.User_Objects;
```

- ① An array of 16 Input bits that a Modbus TCP client can read is defined.
- ② As well, an array of 16 Coils can be written by the client.

## 7.5. User Functions

"/src/a4a-user\_functions.adb"

```
package body A4A.User_Functions is

-----
-- User functions
-----

procedure Map_Inputs is -- ①
begin

    Coils := MBTCP_IOServer.Bool_Coils (Coils'First .. Coils'Last);

end Map_Inputs;

procedure Map_Outputs is -- ②
begin

    MBTCP_IOServer.
        Bool_Inputs (Input_Bits'First .. Input_Bits'Last) := Input_Bits;

end Map_Outputs;

procedure Map_HMI_Inputs is
begin

    null;

end Map_HMI_Inputs;

procedure Map_HMI_Outputs is
begin

    -- Modified to test Modbus / Bokeh
    MBTCP_IOServer.
        Input_Registers (0 .. 9) := MBTCP_IOServer.Registers (0 .. 9);

end Map_HMI_Outputs;

end A4A.User_Functions;
```

User functions are defined to :

- ① get the inputs from the server,
- ② set server outputs.

## 7.6. User Application

*"/src/a4a-application.adb"*

```
package body A4A.Application is

  procedure Cold_Start is
  begin

    null;

  end Cold_Start;

  procedure Closing is
  begin

    null;

  end Closing;

  procedure Main_Cyclic is
    My_Ident : constant String := "A4A.Application.Main_Cyclic";
  begin
    A4A.Log.Logger.Put
      (Who      => My_Ident,
       What     => "Yop ! *****",
       Log_Level => Level_Verbose);

    Map_Inputs; -- ①

    Map_HMI_Inputs;

    -- Playing with tasks interface
    Main_Outputs.X := Main_Inputs.A;
    Main_Outputs.Y := Main_Inputs.B;
    Main_Outputs.Z := Main_Inputs.C;

    Map_Outputs; -- ②

    Map_HMI_Outputs;

  exception

    when Error : others =>
      A4A.Log.Logger.Put (Who => My_Ident,
                         What => Exception_Information (Error));

      Program_Fault_Flag := True;

  end Main_Cyclic;
```



```

procedure Periodic1_Cyclic is
  My_Ident : constant String := "A4A.Application.Periodic1_Cyclic";
begin
  A4A.Log.Logger.Put (Who      => My_Ident,
                    What      => "Hi !",
                    Log_Level => Level_Verbose);

  -- Do something useful here
  -- Could be simulate

  -- Playing with tasks interface
  Periodic1_Outputs.A := not Periodic1_Inputs.X;
  Periodic1_Outputs.B := Periodic1_Inputs.Y + 2;
  Periodic1_Outputs.C := Periodic1_Inputs.Z + 1;

exception

  when Error : others =>
    A4A.Log.Logger.Put (Who => My_Ident,
                      What => Exception_Information (Error));

    Program_Fault_Flag := True;

end Periodic1_Cyclic;

function Program_Fault return Boolean is
begin
  return Program_Fault_Flag;
end Program_Fault;

end A4A.Application;

```

The application cyclically :

- ① gets the inputs from the server,
- ② sets server outputs.

## 7.7. Web server and User Interface

Hereafter is a diagram showing architecture and information flow for the Web UI.

An article is available, in French though :

[https://slo-ist.fr/ada4automation/a4a-modbus-tcp-server-web-hmi-a4a\\_piano](https://slo-ist.fr/ada4automation/a4a-modbus-tcp-server-web-hmi-a4a_piano)

