Stood 5.2

AADL
Tutorial

Pierre Dissaux
Ellidiss Technologies

Contents

1 Introduction

The purpose of this document is to describe the standard modelling process to be used to build a new **AADL** project with **Stood**. It is not a complete tutorial or user manual for **Stood** and knowledge about the **AADL** is a prerequisite for using this document. Please refer to the official **AADL** web site (www.aadl.info) to learn more about this standard.

In addition to the various modelling concepts defined by the **AADL** standard, we need to introduce the following additional ones that are more development process oriented:

A **Stood Design** is the main modelling entry point. It represents the root of a hierarchy of components or packages. A **Design** may be used to define the overall system, a particular set of concrete components describing an executable software application, or a library of abstract components. In the first case, the **Design** is directly associated to an **AADL** system instance. In the second one, it will represent an **AADL** process instance, whereas in the last case, it will represent an **AADL** package. A fourth case, still subject to deeper investigations, concerns the software to hardware binding activity, for which the current entry point is an **AADL** processor.

A **Stood Project** refers to a set of **Designs** that collaborate in a common realization. The **Project** specifies the scope of the realization, and restricts the access to other non-referenced **Designs**.

A **Stood Session** begins when a user launches the tool and ends when **Stood** is closed. **Stood** is a multi-user environment, so that several **Sessions** may be opened on a same **Project**, or even on a same **Design**.

A **Stood Workspace** is a user-defined disk area where **Projects** and **Designs** can be stored.

This tutorial includes the following sections:

1. Define a **Workspace**, launch **Stood** and create a **Project**
2. Create a **Design** representing an **AADL** system
3. Create a **Design** representing an **AADL** package
4. Create a **Design** representing an **AADL** process

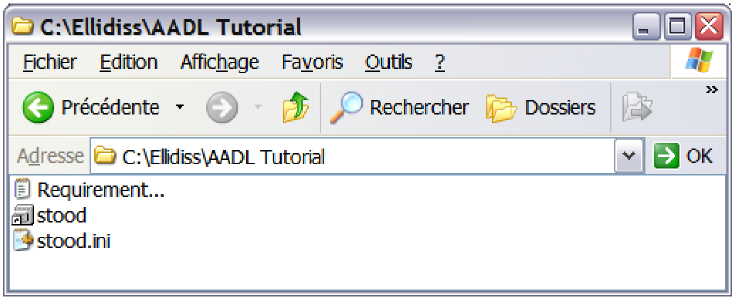
2 Define a workspace

It is possible to launch **Stood** from the start-up menu or from the desktop icon that are created by the **Windows** installer program. However in that case, any customization of the tool requires altering the original distribution, which may be an issue if several users or several **Projects** require different customizations.

This is the reason why it is often recommended to launch **Stood** from a **Workspace** that can be dedicated to each user or **Project**. Such a **Workspace** consists in a simple directory that must contain at least two elements:

- a shortcut to the **Stood** executable file (under **Windows**) or a redirecting shell script (under **Unix**)
- a local initialization file (`stood.ini` under **Windows** or `.stoodrc` under **Unix**)

In addition, this **Workspace** may contain other **Project** related data such as lists of textual requirements or subdirectories with legacy source code to be reused in the **Project**.


C:\Ellidiss\AADL Tutorial
Fichier Edition Affichage Favoris Outils ?
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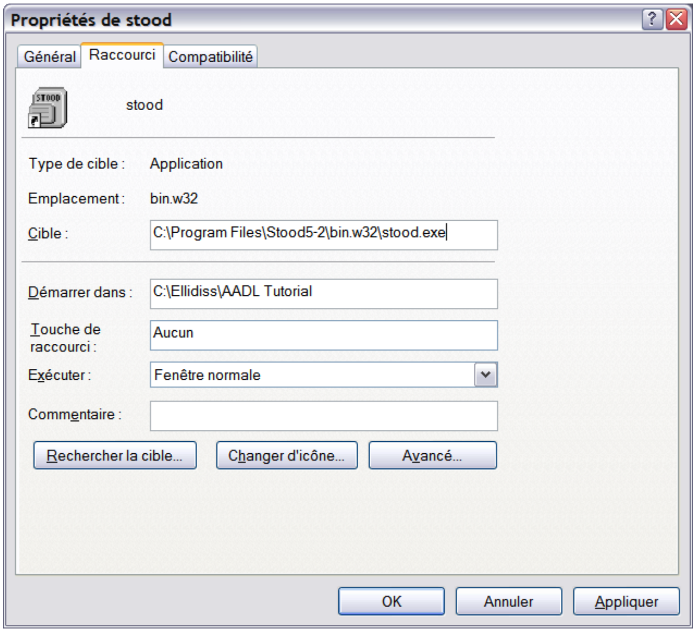
OK

Requirement...
stood
stood.ini

2.1 Stood shortcut

Stood shortcut must be created by one of the standard **Windows** procedures. However, it is necessary to customize it so that the **Workspace** can be used as the default storage area for the new created **Projects** when **Stood** is actually launched from there.

Open the *properties* box of the shortcut, select the *shortcut* tab, and modify the *target* field so that it points to the current **Workspace** directory instead of the installation one.



stood

Type de cible : Application

Emplacement : bin.w32

Cible : C:\Program Files\Stood5-2\bin.w32\stood.exe

Démarrer dans : C:\Ellidiss\AADL Tutorial

Touche de raccourci : Aucun

Exécuter : Fenêtre normale

Commentaire :

2.2 Stood initialization file

The second customization that may be required consists in modifying one or several of the properties that are specified in the **Stood** initialization file (`stood.ini` under **Windows** or `.stoodrc` under **Unix**). A complete specification of these properties is provided in the *Stood Administrator Manual*.

Only the properties that differ from the default initialization file located in the installation directory must be specified locally. All the other properties will be automatically inherited. Typical properties that may be customized locally are the various environment variables that are used by **Stood** to interact with external tools, such as compilers or verification tools.

```
[Environment]
ADA_PATH=C:\cygwin\bin
C_PATH=C:\cygwin\bin
CPP_PATH=C:\cygwin\bin
REQTIFY_PATH=C:\reqtify\bin.w32
OSATE_PATH=/cygdrive/C/topcased/eclipse/eclipse.exe
CHEDDAR_PATH=/cygdrive/C/CHEDDAR-2.0/cheddar.exe
```

2.3 Requirements file

The **Workspace** directory may also contain one or several **Project** specific textual requirements files that may be imported into **Stood**. Once imported, it will be possible to specify requirements coverage for each modelling entity.

The internal format for **Stood** compliant requirements files is quite simple as it consists in plain **ASCII** text declaring one requirement per line. Each requirement is expressed by a unique identifier and a free comment, separated by a `tab` character.

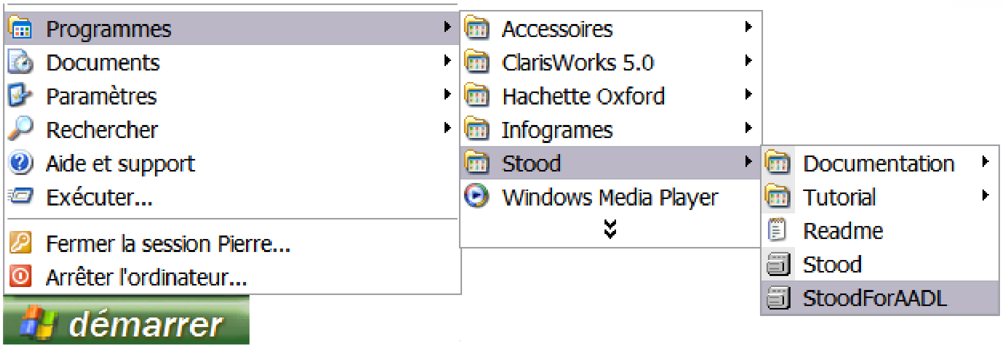
```
CALC101    interact with the Keyboard
CALC102    interact with the Screen
CALC111    define integer type
CALC112    define real type
CALC121    add integers
CALC122    add reals
CALC123    sub integers
CALC124    sub reals
CALC131    scan the Keyboard
CALC132    perform the operation
CALC133    display on Screen
```

Such a requirements file may be easily generated by a requirements management tool such as **Doors™**. Note that thanks to a specific connection feature, it is also possible to directly import requirements and export coverage information from and to a traceability graph defined in the **Reqtify™** tool.

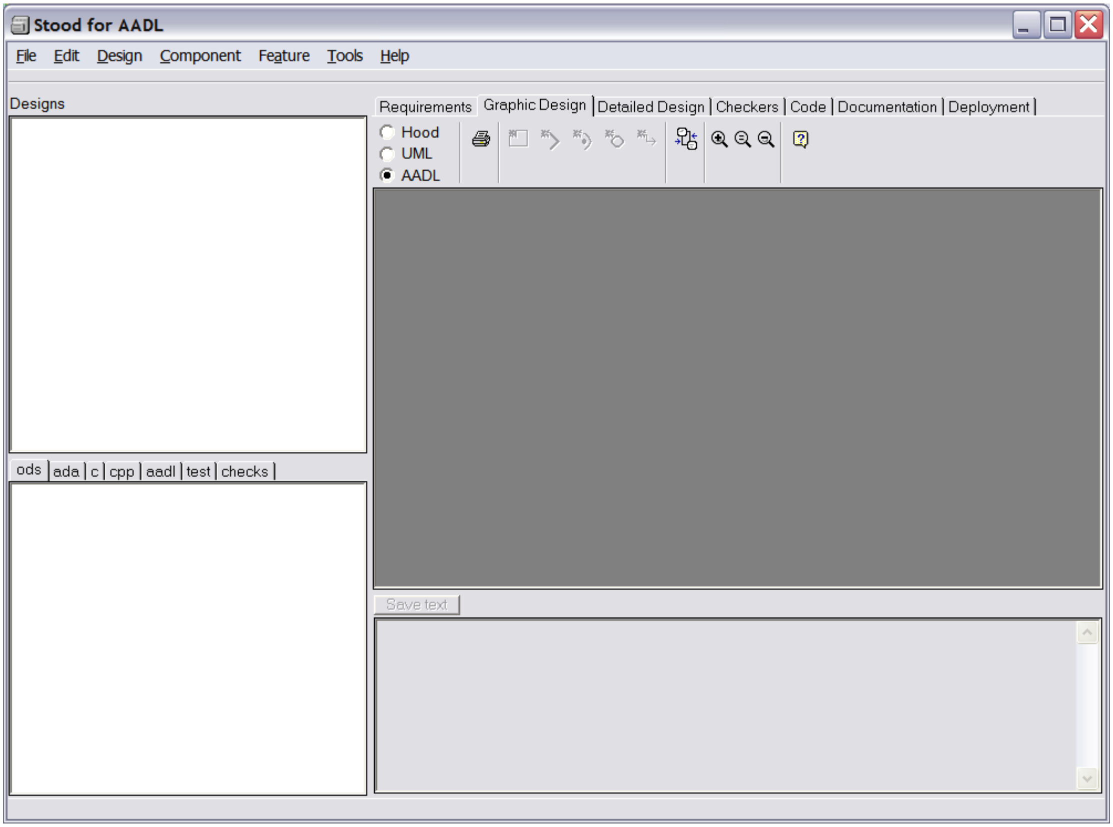
2.4 Launching Stood

If not launched from the **Workspace** shortcut, it is also possible to launch **Stood** either from the desktop shortcut or from the standard **Windows** start up menu.

Note that these two options will not be available if the corresponding set up has been deactivated during the installation process.



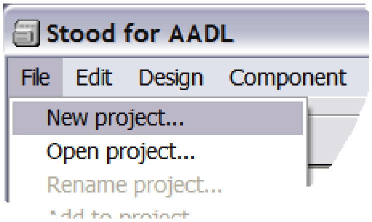
When launched, **Stood** shows a start up screen during its initialization phase, and then opens its main windows, which looks as the picture below:

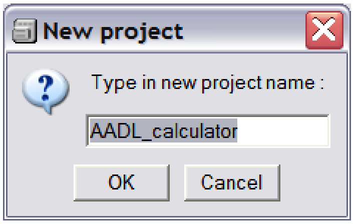


2.5 Create a Stood project

First step of the modelling process consists in either opening an existing **Project** or creating a new one. **Projects** can be managed from the *File* menu.

For the purpose of this tutorial, we create a new **Project** and specify its name in the dialog box.





Type in new project name :

AADL_calculator

We can now import existing **Designs** within the scope of our **Project** thanks to the *File/Add to project* menu, create new **Designs** from existing source code thanks to the *Design/New design from…* menus or create new local **Designs** with the *Design/New design* menu.

This last choice offer several options. The new created **Design** may be profiled as a **HOOD Design**, in which case one of the options *design*, *generic* or *virtual node* must be chosen, or as an **AADL Design**, in which case one of the options *aadl package*, *aadl system*, *aadl process* or *aadl processor* must be selected.

This tutorial explains how to create in a context of a consistent **Project**:

- **AADL Systems** to define concrete system wide architectures composed of hardware and software components.
- **AADL Packages** to specify libraries of abstract components, and especially abstract **Data** components to be used as classifiers for ports and parameters.
- **AADL Processes** to perform complete software design activities including architectural design, detailed design and coding, model analysis, source code and design documentation generation.

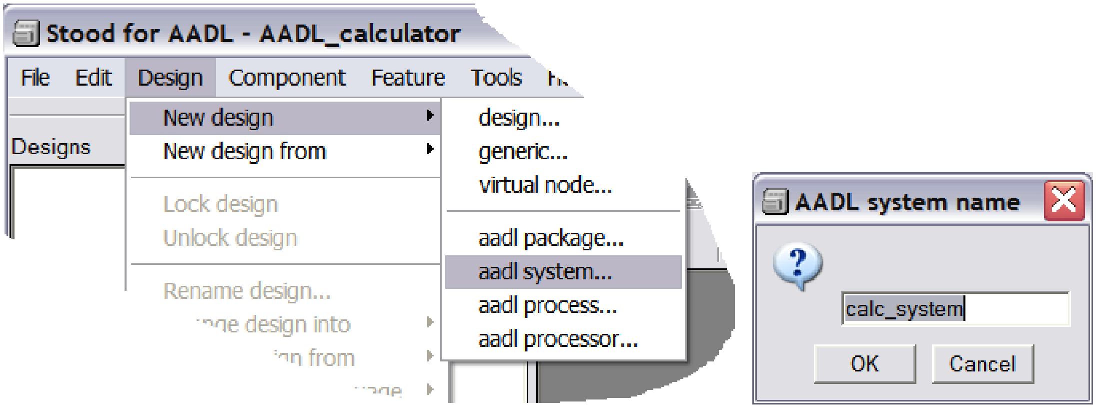
These three modelling processes are described in the next three sections. The last section explains how to quit **Stood**.

3 Create an AADL system

Specifying a **System** with **Stood** consists in effect in building a **System Instance**. Instead of creating abstract component types, component implementations and then instantiating them as subcomponents, the designer can directly define subcomponents in a hierarchical way, and then specify whether they correspond to instances of already defined abstract components or of anonymous abstract components that will have to be automatically created while producing the textual **AADL** specification.

3.1 Create a new design of kind "aadl system"

To create a new **System** inside the current **Project** (cf.§2.5), use the menu *Design/New design/aadl system…* and then specify its name in the dialog box.



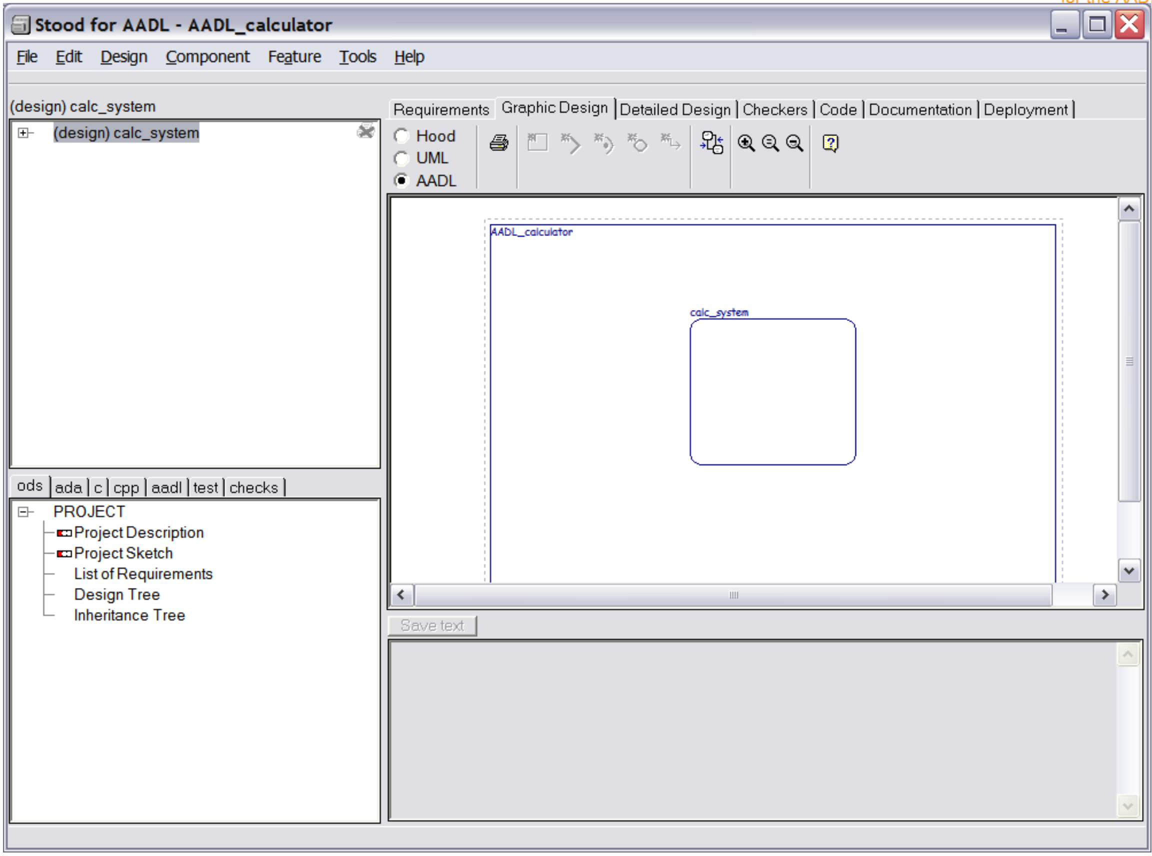
AADL system name

calc_system

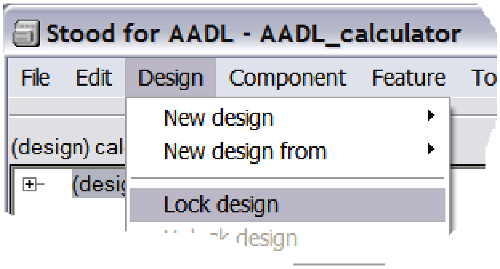
Note that a **Design** name in **Stood** must be alphanumeric (i.e. only contain characters ‘a’ to ‘z’, ‘A’ to ‘Z’, ‘0’ to ‘9’ or the underscore character ‘_’).

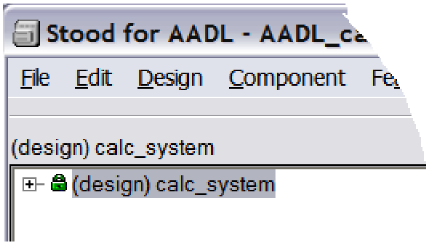
3.2 Lock the system to enter edit mode

When it has just been created, the new **System** design is automatically loaded and it is shown in the **AADL** graphical editor as an empty box at the middle of a larger one representing the **Project**.



However, this **System** design is set to read-only mode by default. To enable performing modifications on this **System**, it is necessary to "lock" it so that no other user will be allowed to get a concurrent write access to the model.

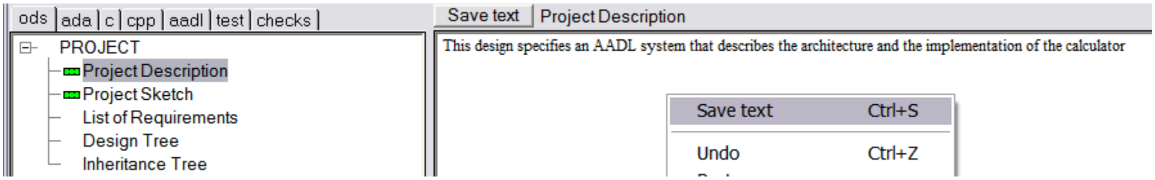

Stood for AADL - AADL_calculator
File Edit Design Component Feature To
(design) cal
(desig
New design
New design from
Lock design
design



When a **System** design is locked (may be modified in the current **Session**), a green padlock is shown at the left of its name.

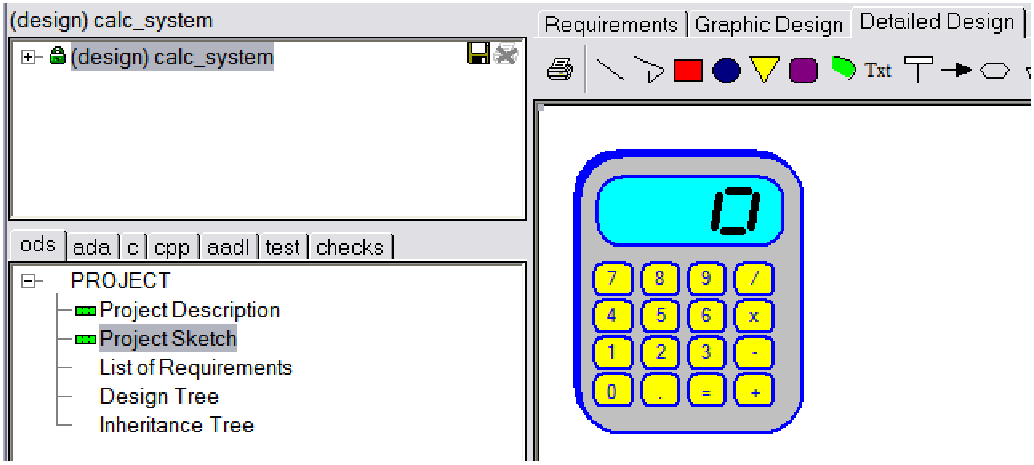
3.3 Document the project

When the **System** design is selected in the upper left list of **Stood** window, the lower left list shows description sections for the local view of the **Project**. Default sections are a textual descriptions and a graphical sketch that will be included inside the design documentation.



This design specifies an AADL system that describes the architecture and the implementation of the calculator

Note that each time some text is entered in the text input area, it must be saved by pressing the *Save text* button, or using the corresponding contextual menu or the *Ctrl-S* keyboard shortcut.

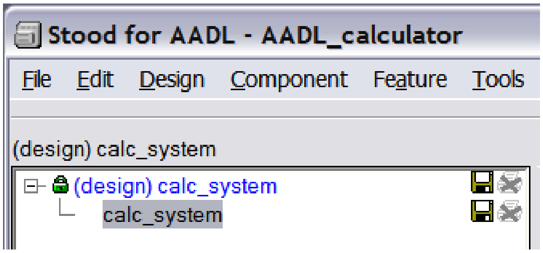


Note that the sketches are provided for documentation purpose only and that they do not carry any semantic information.

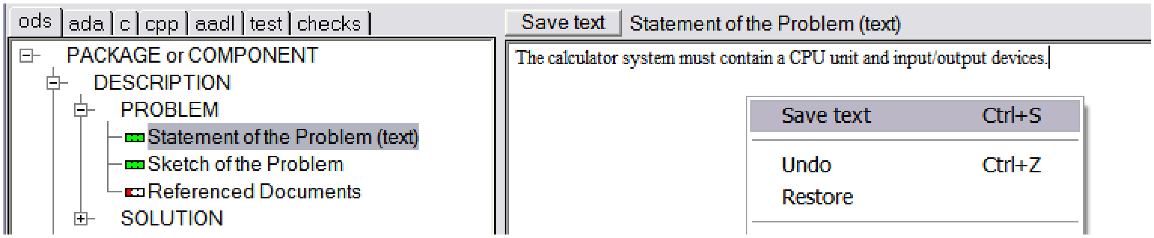
Note also that the other sections *List of Requirements*, *Design Tree* and *Inheritance Tree* are automatically filled in by **Stood**.

3.4 Document the system

When the **System** design tree is deployed in the upper left list, it shows another line with the same name. This corresponds to the **System** component instance to be edited.



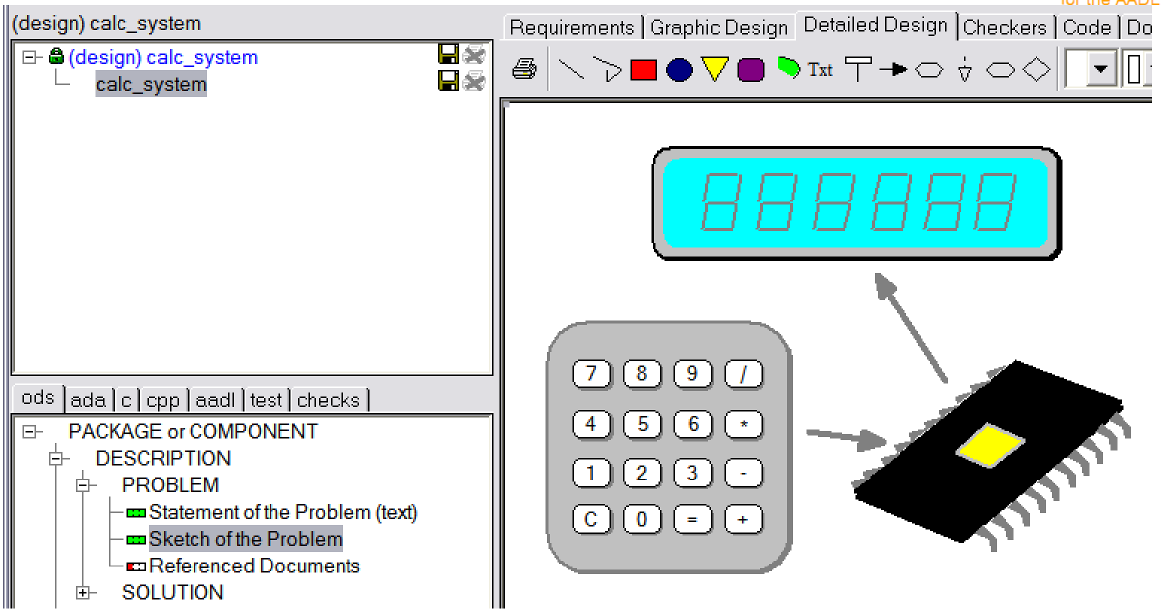
Note that when a component is selected in the upper left list, current selection of the graphical editor and contents of the lower left list are automatically updated. It is thus possible to fill in the textual sections and sketches that are available to describe each component individually.



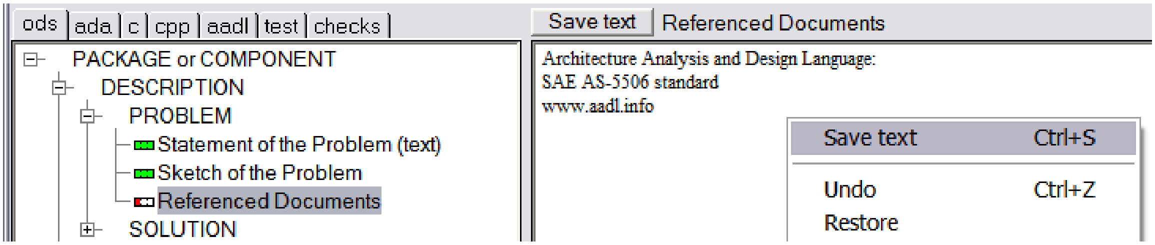
The calculator system must contain a CPU unit and input/output devices.

The *Statement of the Problem* section (see the figure above) must be used to provide textual details about how the currently selected component contributes in solving a particular modelling problem.

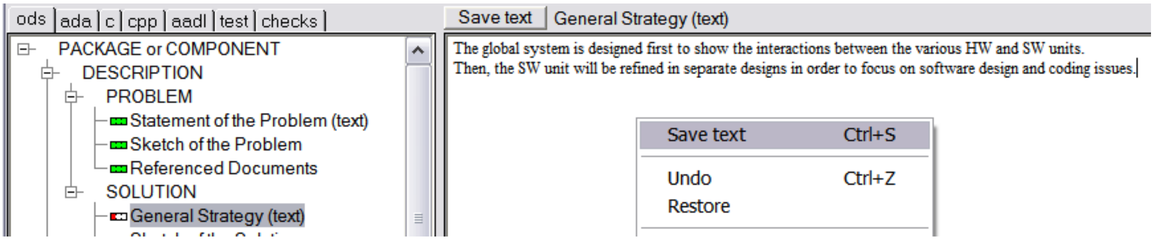
The *Sketch of the Problem* section (see figure below) can be used to complete this information by an informal drawing that will be included into the design documentation.



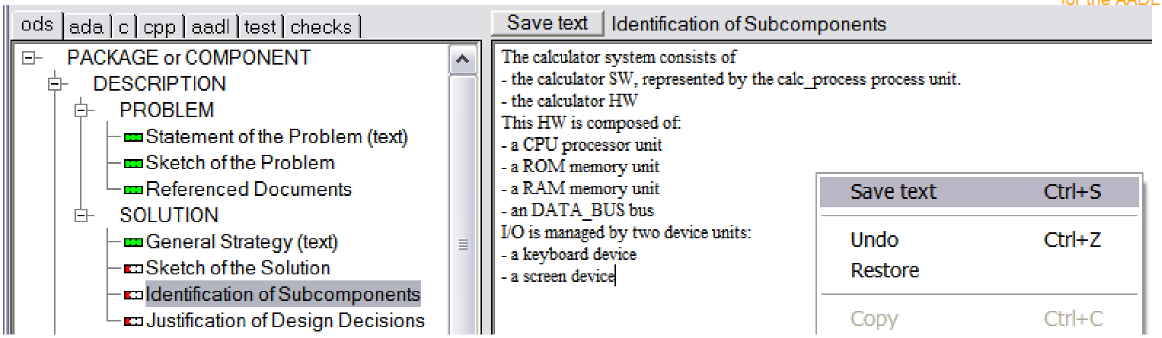
Next figures show other examples of documentation sections that can be filled in for each component individually.



Architecture Analysis and Design Language:
SAE AS-5506 standard
www.aadl.info



The global system is designed first to show the interactions between the various HW and SW units.
Then, the SW unit will be refined in separate designs in order to focus on software design and coding issues.



The calculator system consists of
- the calculator SW, represented by the calc_process process unit.
- the calculator HW
This HW is composed of:
- a CPU processor unit
- a ROM memory unit
- a RAM memory unit
- an DATA_BUS bus
I/O is managed by two device units:
- a keyboard device
- a screen device

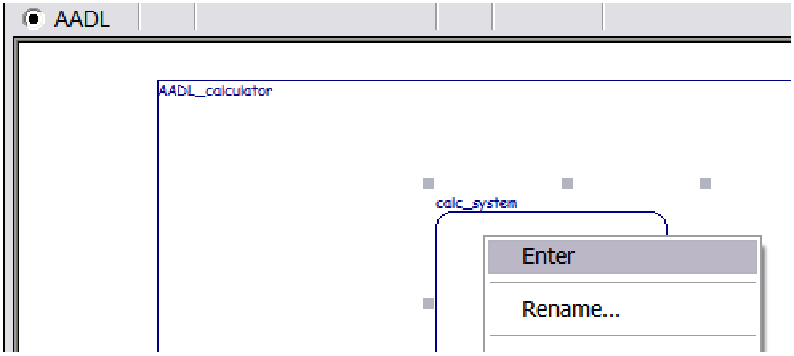
Stood promotes the concept of "incremental documentation" that consists in asking the designer to document each modelling element independently at the time he or she is performing the modelling actions. The final design documentation will compile all these elementary sections to build a complete report.

This modelling process also recommends documenting each component before going deeper in the architecture hierarchy. For instance, the *Identification of Subcomponents* documentation section can be used as a guideline for actually creating the subcomponents (see next chapter).

3.5 Create subcomponents

In the graphical editor, a component can be represented either by its "black box" view that shows the contents of the corresponding component type, or by its "white box" view that shows the contents of the corresponding component implementation.

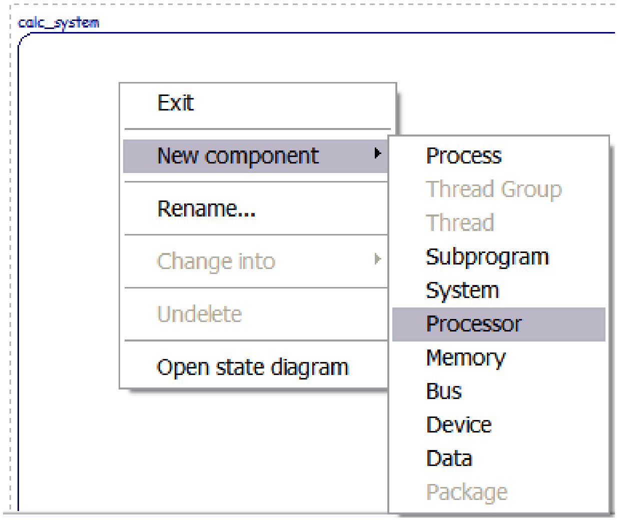
In the picture below, the "black box" view of the **System** component is shown. To show its "white box" view, it is necessary to go one step down the hierarchy. This action can be performed by double-clicking inside the component box or using the *enter* contextual menu.

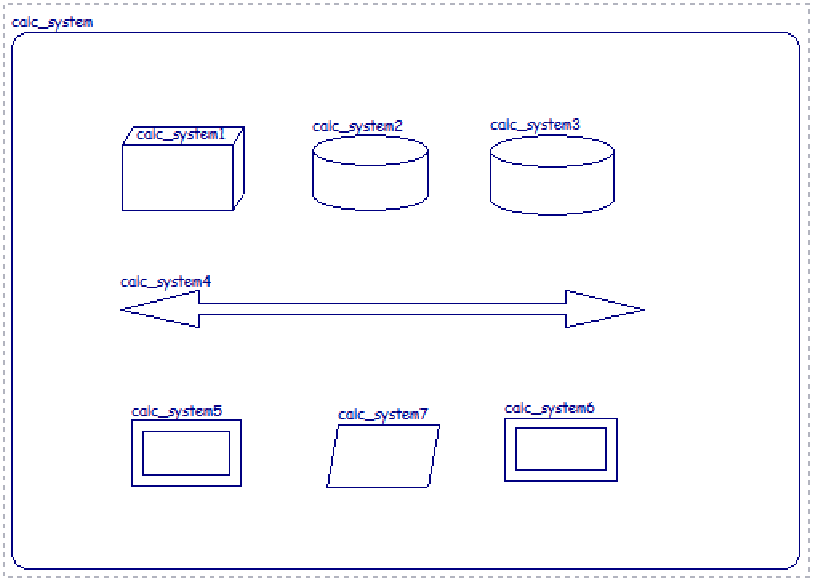


After using the enter menu, the "white box" view of the **System** is shown. It is thus possible to add subcomponents to its implementation. To add a new subcomponent, use the *new AADL component* button, or the *New component* contextual menu. The button will create a component of a pre-defined category, which can be modified later thanks to the *Change into* contextual menu. On the contrary, the *New component* contextual menu offers the full choice of valid categories for creating subcomponents within the current component implementation.

We can for instance create seven subcomponents inside the **System** implementation:

- One component which category is **Processor**
- Two components which category is **Memory**
- One component which category is **Bus**
- Two components which category is **Device**
- One component which category is **Process**



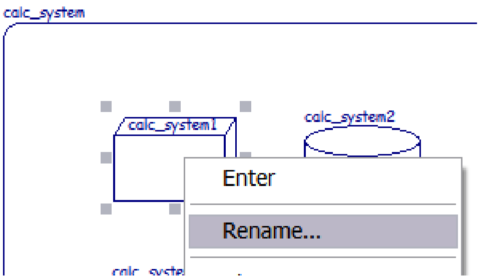


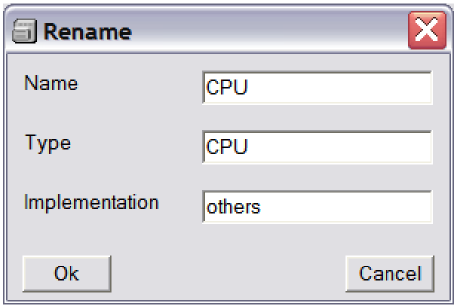
Note that a default name is given to new created components, and that this name is the name of the concrete subcomponent within the enclosing **System**, that may differ from the corresponding component type classifier and component implementation names.

3.6 Rename and give a type to subcomponents

When a component is selected in the graphical editor, the rename contextual menu can be used to perform the following actions:

- Change the name of the selected concrete subcomponent.
- Change the corresponding abstract component type (by default, it will be assumed that subcomponent and component type name are identical)
- Change the corresponding abstract component implementation name (by default, it will be assumed that this name is `others`)



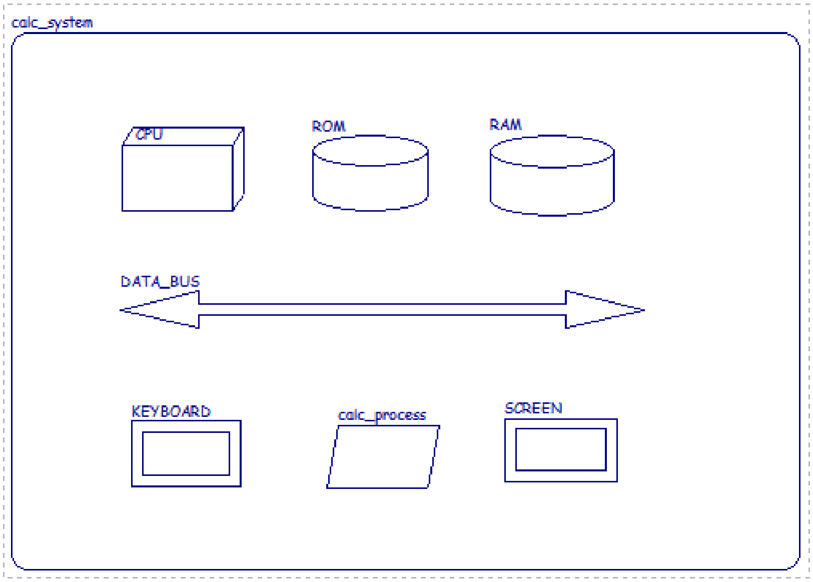

Rename

Name: CPU

Type: CPU

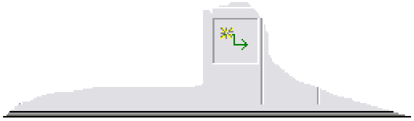
Implementation: others

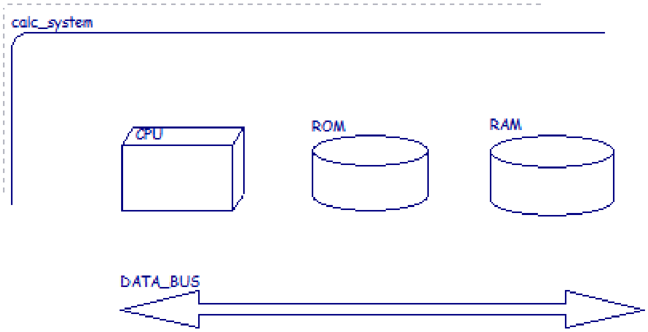
It is thus possible to give the following names to the seven subcomponents of the **System**



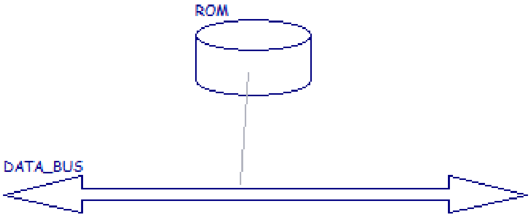
3.7 Create bus access connections

To create bus access connections, use the *new connection* button of the graphical editor.

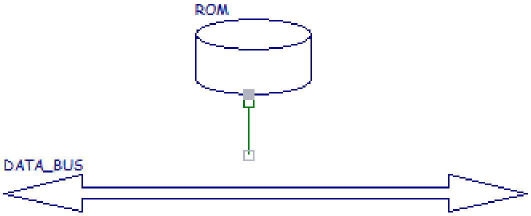




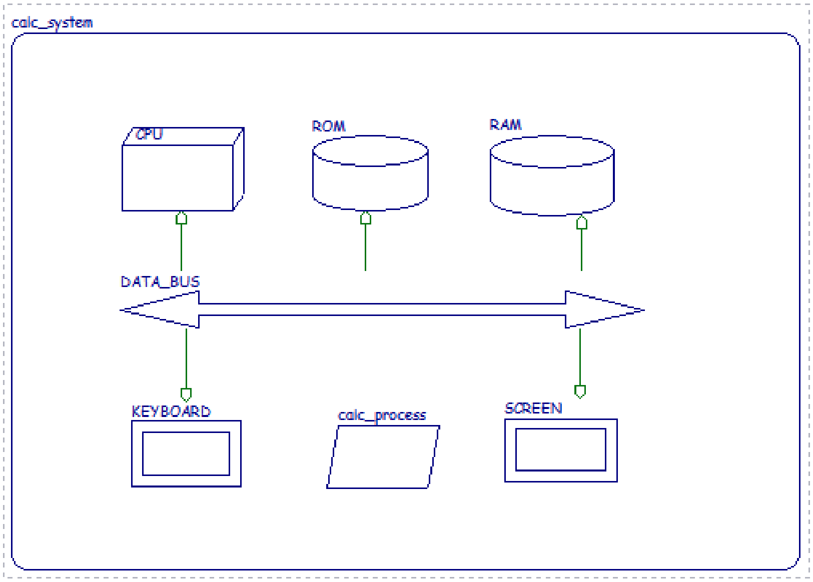
Then click on the accessed bus component before clicking on the accessing component.



This results in a graphical bus access connection between the **Bus** and the **Memory** components.

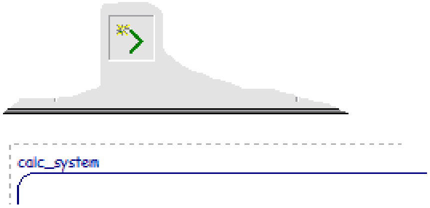


Additional connections may now be added inside our **System** implementation.

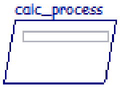


3.8 Create ports

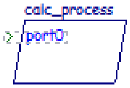
To express for instance that the **Process** can exchange data with the **Device** components it is necessary to add ports. To create a port in a component type, use the *new port* button of the graphical editor. Click on the button (a), drag the mouse on the target component (b) and then click to create the port (c).



(a)

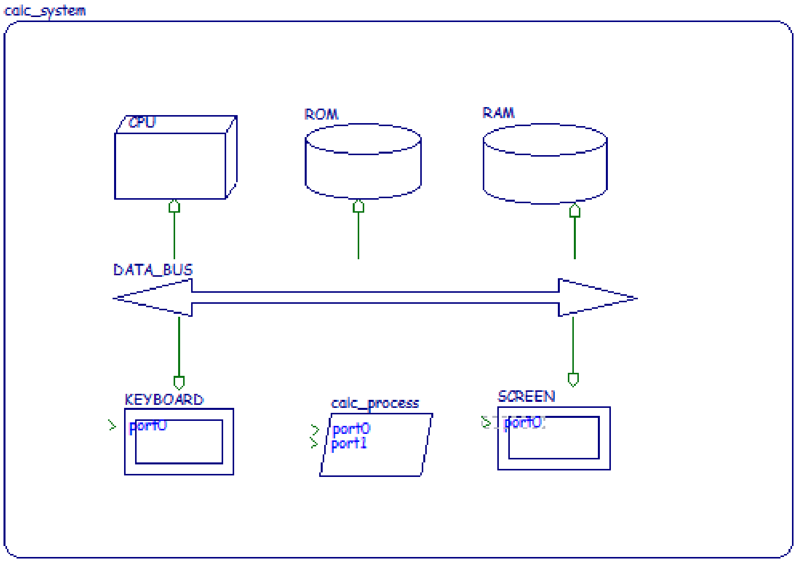


(b)



(c)

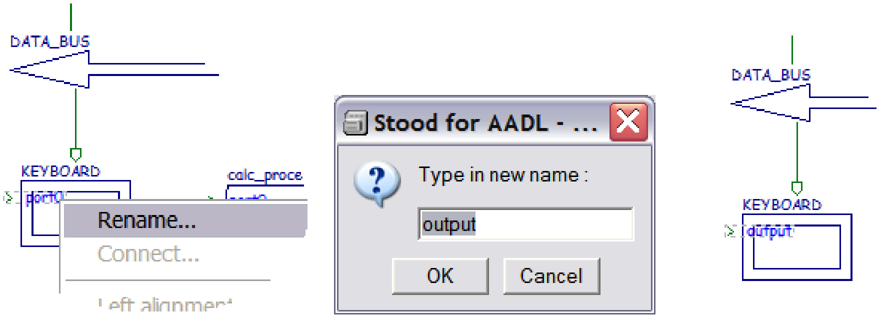
We can thus create four ports as shown in the figure below:



Note that these ports have been created with a default name and as **In Event Ports** by default. Next section explains how to modify the name, the direction and the kind of the ports.

3.9 Rename and customize ports

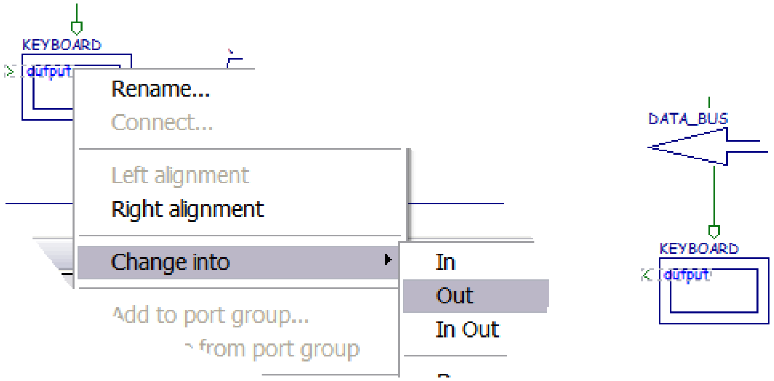
To rename a port, first select it and then use the *Rename* contextual menu.



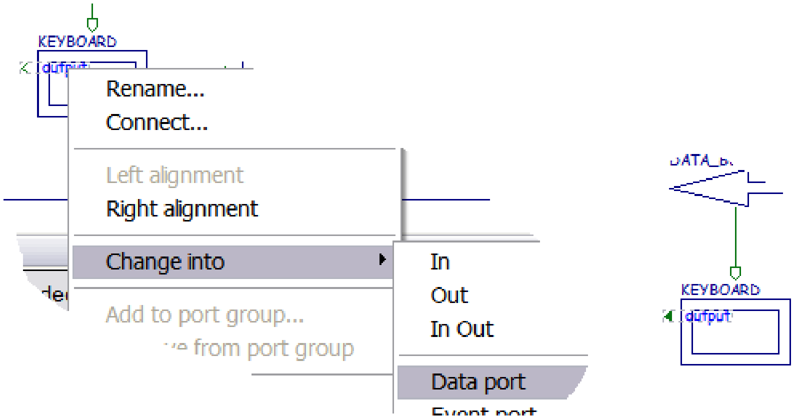
Type in new name :

output

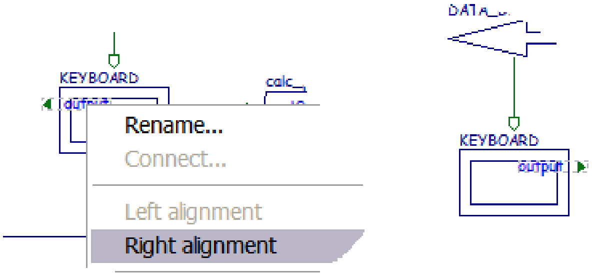
To change the direction of a port, first select it and use the *Change into* contextual menu.



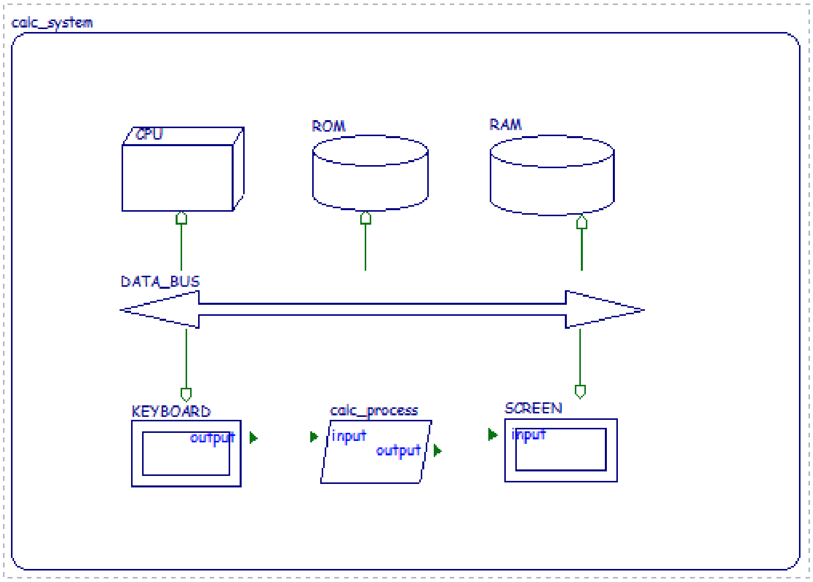
To change the kind of a port, first select it and use again the *Change into* contextual menu.



By default, ports are attached to the left border of the component. It is however possible to move them to the right border, using the *Right alignment* contextual menu. In a similar way, a port attached to the right border can be moved back to the left border thanks to the *Left alignment* contextual menu.



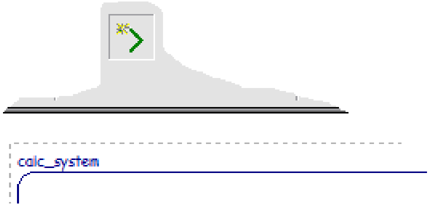
We can now customize the four ports as follow:



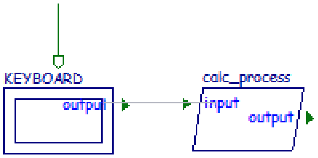
3.10 Create port connections

To create connections between ports, use the new connection button of the graphical editor. First click on the button (a), then click on one of the connected ports (b) and then on the other port (c).

Note that port compatibility is verified before accepting to create the connection. These verifications concern, port kind, port direction and port type for **Data Ports** and **Event Data Ports**.

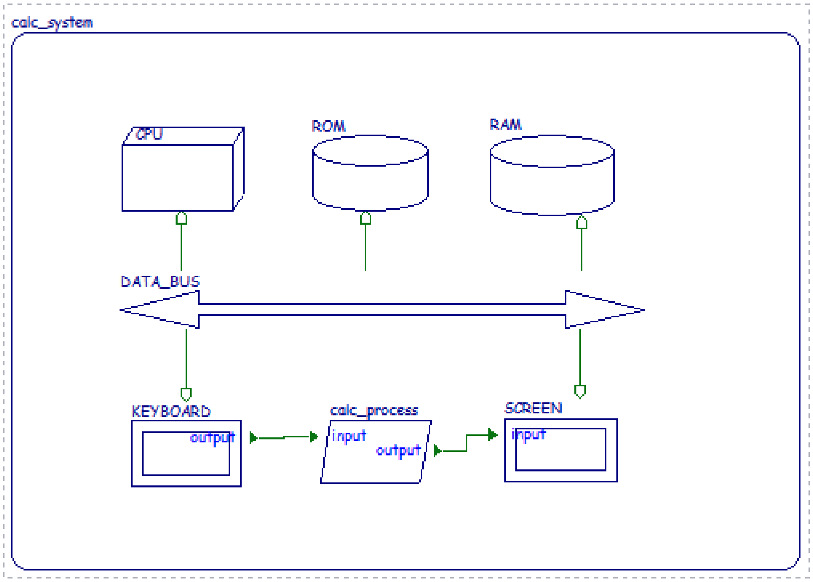


(a)



(b) (c)

We can thus create port connections between the **Process** and each of the two **Devices**.

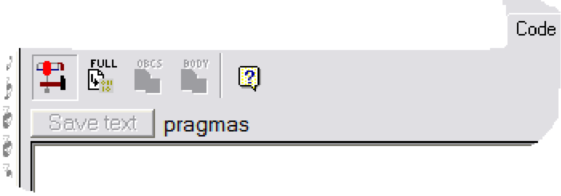


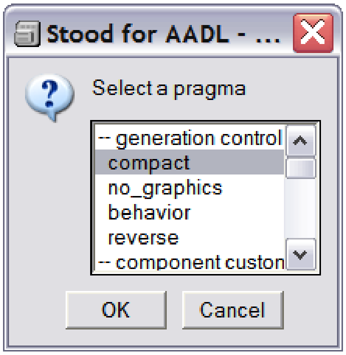
3.11 Generate the AADL code for the system

Our model has been created with just a few mouse clicks in the graphical editor. It is however possible to generate a full **AADL** specification from it.

To generate textual **AADL** code from a graphical model in **Stood**, the *Code* tab must be selected instead of the *Graphic Design* one.

The new button bar shows two buttons. The first button on the left is called *add pragma* and may be used to customize the code generation. Pressing this button opens a dialog box showing the list of the possible options that can be selected.



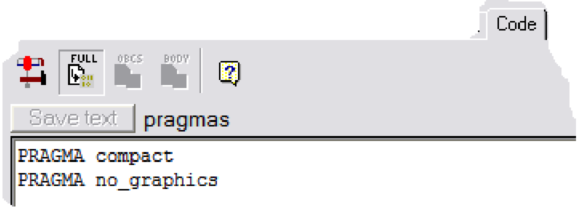

Stood for AADL - ...

Select a pragma

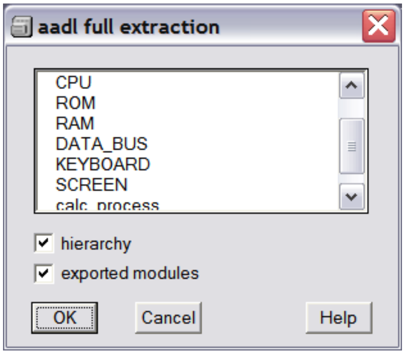
```
-- generation control
compact
no_graphics
behavior
reverse
-- component custon
```

Select pragma *compact* in order to generate all the **AADL** code in only one file (default rule is one file per component) and then pragma *no_graphics* to disable the generation of **Stood** specific properties that are used to propagate the positions of the graphical items in the diagram.

The **AADL** code generation can then be activated by pressing the *full extraction* button. This opens a dialog box that can be used to specify which part of the **Design** has to be generated. Most of the times, we need the whole **Design** to be generated, which is the choice that is proposed by default.



```
PRAGMA compact
PRAGMA no_graphics
```

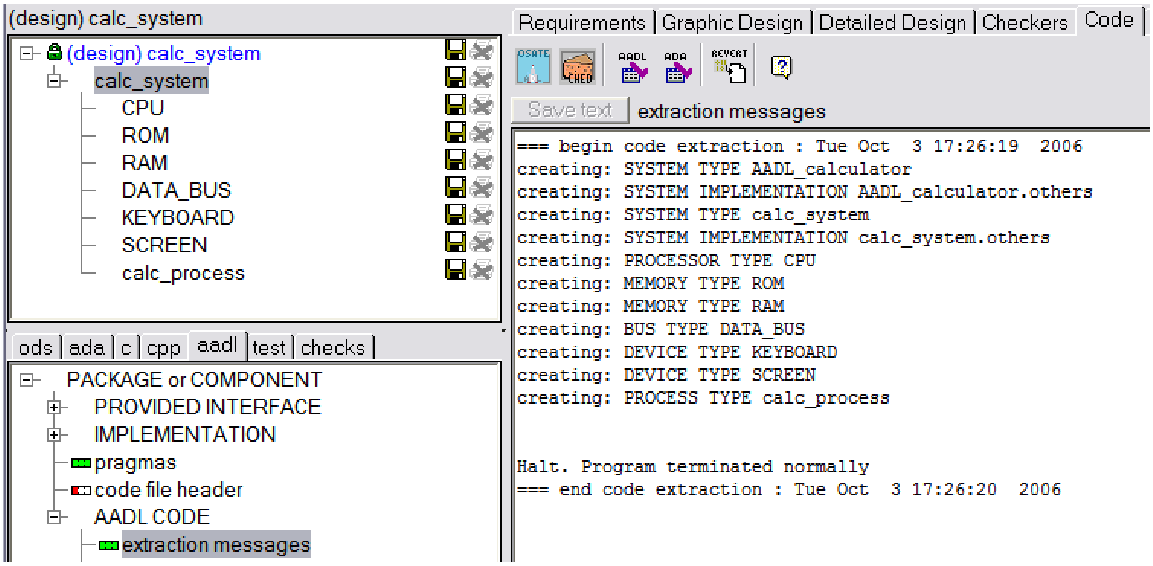

aadl full extraction

```
CPU
ROM
RAM
DATA_BUS
KEYBOARD
SCREEN
calc_process
```

☑ hierarchy

☑ exported modules

After having pressed the *Ok* button and waited a little, the *extraction messages* file is shown.



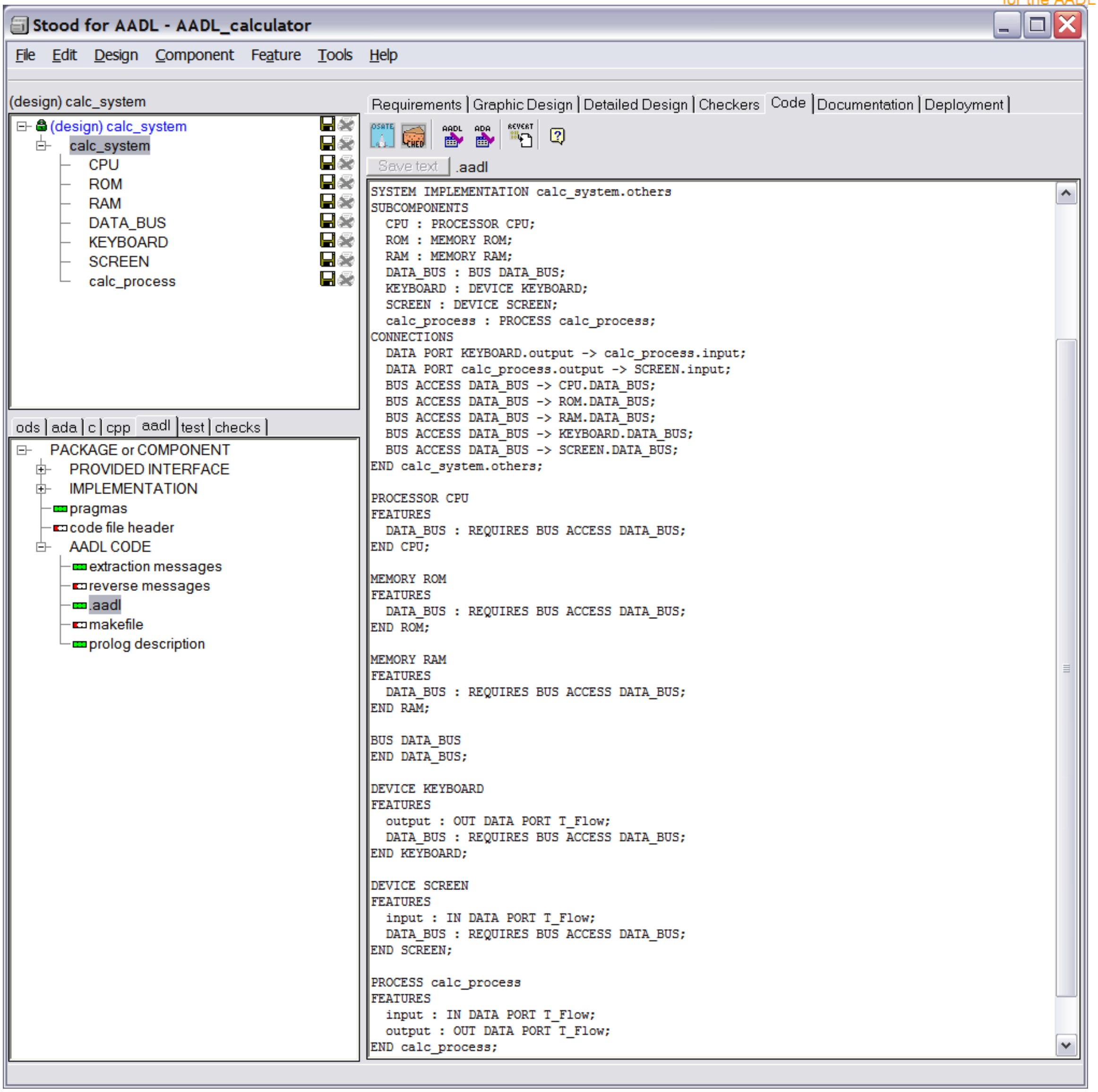
```
=== begin code extraction : Tue Oct  3 17:26:19  2006
creating: SYSTEM TYPE AADL_calculator
creating: SYSTEM IMPLEMENTATION AADL_calculator.others
creating: SYSTEM TYPE calc_system
creating: SYSTEM IMPLEMENTATION calc_system.others
creating: PROCESSOR TYPE CPU
creating: MEMORY TYPE ROM
creating: MEMORY TYPE RAM
creating: BUS TYPE DATA_BUS
creating: DEVICE TYPE KEYBOARD
creating: DEVICE TYPE SCREEN
creating: PROCESS TYPE calc_process


Halt. Program terminated normally
=== end code extraction : Tue Oct  3 17:26:20  2006
```

The messages file lists the abstract component types and implementations that had to be created to fully describe our **System** instance.

3.12 Show generated AADL code

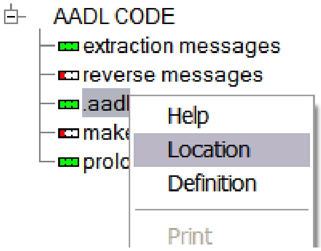
The **AADL** generated code can be shown by changing the selection in the lower left list of the **Stood** window from *extraction messages* to *aadl*.

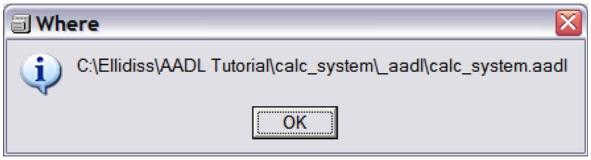
Note that, due to the fact that we put a pragma *compact*, **AADL** code has been associated to the root component in the hierarchy only.



```
SYSTEM IMPLEMENTATION calc_system.others
SUBCOMPONENTS
  CPU : PROCESSOR CPU;
  ROM : MEMORY ROM;
  RAM : MEMORY RAM;
  DATA_BUS : BUS DATA_BUS;
  KEYBOARD : DEVICE KEYBOARD;
  SCREEN : DEVICE SCREEN;
  calc_process : PROCESS calc_process;
CONNECTIONS
  DATA PORT KEYBOARD.output -> calc_process.input;
  DATA PORT calc_process.output -> SCREEN.input;
  BUS ACCESS DATA_BUS -> CPU.DATA_BUS;
  BUS ACCESS DATA_BUS -> ROM.DATA_BUS;
  BUS ACCESS DATA_BUS -> RAM.DATA_BUS;
  BUS ACCESS DATA_BUS -> KEYBOARD.DATA_BUS;
  BUS ACCESS DATA_BUS -> SCREEN.DATA_BUS;
END calc_system.others;

PROCESSOR CPU
FEATURES
  DATA_BUS : REQUIRES BUS ACCESS DATA_BUS;
END CPU;

MEMORY ROM
FEATURES
  DATA_BUS : REQUIRES BUS ACCESS DATA_BUS;
END ROM;

MEMORY RAM
FEATURES
  DATA_BUS : REQUIRES BUS ACCESS DATA_BUS;
END RAM;

BUS DATA_BUS
END DATA_BUS;

DEVICE KEYBOARD
FEATURES
  output : OUT DATA PORT T_Flow;
  DATA_BUS : REQUIRES BUS ACCESS DATA_BUS;
END KEYBOARD;

DEVICE SCREEN
FEATURES
  input : IN DATA PORT T_Flow;
  DATA_BUS : REQUIRES BUS ACCESS DATA_BUS;
END SCREEN;

PROCESS calc_process
FEATURES
  input : IN DATA PORT T_Flow;
  output : OUT DATA PORT T_Flow;
END calc_process;
```

This **AADL** code can be edited with **Stood**, but the corresponding file in the repository may be easily located for a remote access. To locate a particular file, select the corresponding entry in the lower left list and use the *Location* contextual menu.

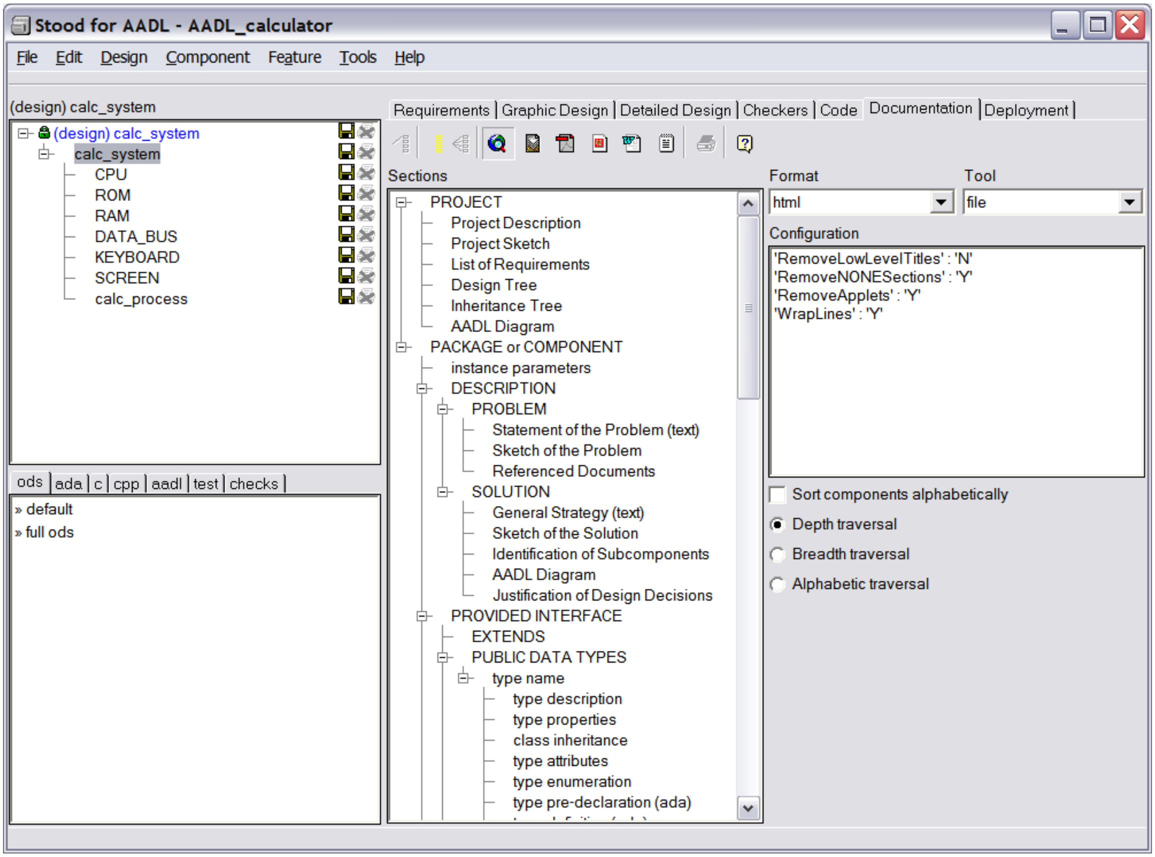




C:\Ellidiss\AADL Tutorial\calc_system_aadl\calc_system.aadl

3.13 Create a design report

Stood also offers a seamless way to create design documentation reports. Such a report compiles all the appropriate information that has been entered while building the model. This includes textual and graphical entries. To switch on the report settings tool, select the *documentation* tab.



Format: html

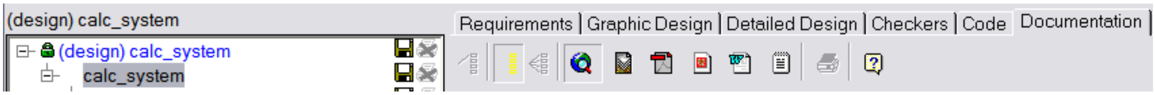
Tool: file

Configuration

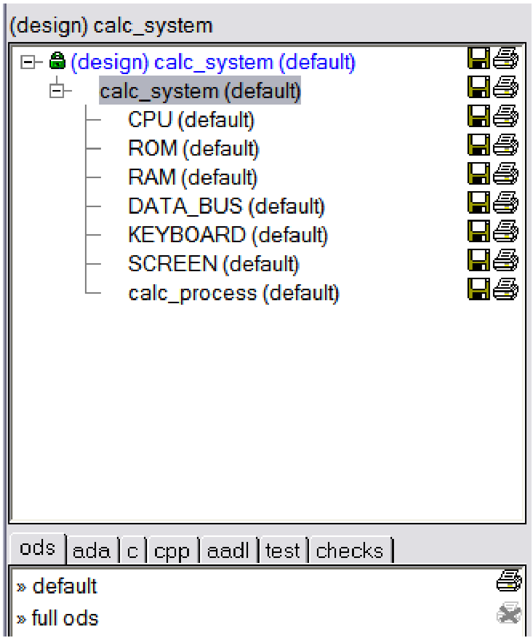
```
'RemoveLowLevelTitles' : 'N'
'RemoveNONESections' : 'Y'
'RemoveApplets' : 'Y'
'WrapLines' : 'Y'
```

☐ Sort components alphabetically
● Depth traversal
○ Breadth traversal
○ Alphabetic traversal

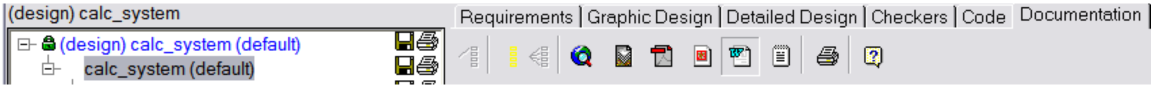
First step consists in defining the components that must be included in the report. To select all the components, use the *select all* button.



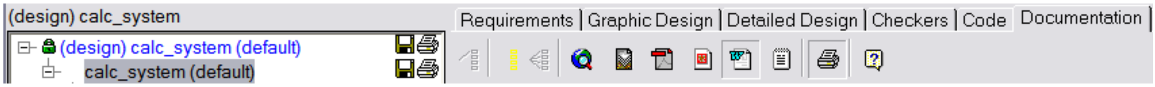
The effect of this action is to display a small printer icon at the left of the component name to mean that it has to be included to the report (the small floppy disk icon means that the component has not been saved yet).



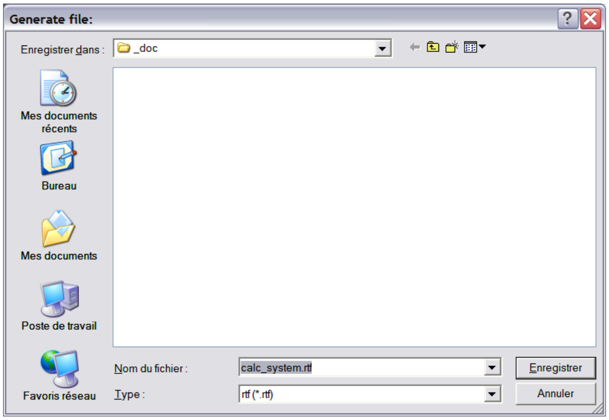
Second step consists in selecting the output format for the report. This can be done by selecting the appropriate button among *html* (default), *mif*, *pdf*, *ps*, *rtf* and *tps*. Select *rtf*.



Last step is the activation of the document generation that will start after the *print* button has been pressed.



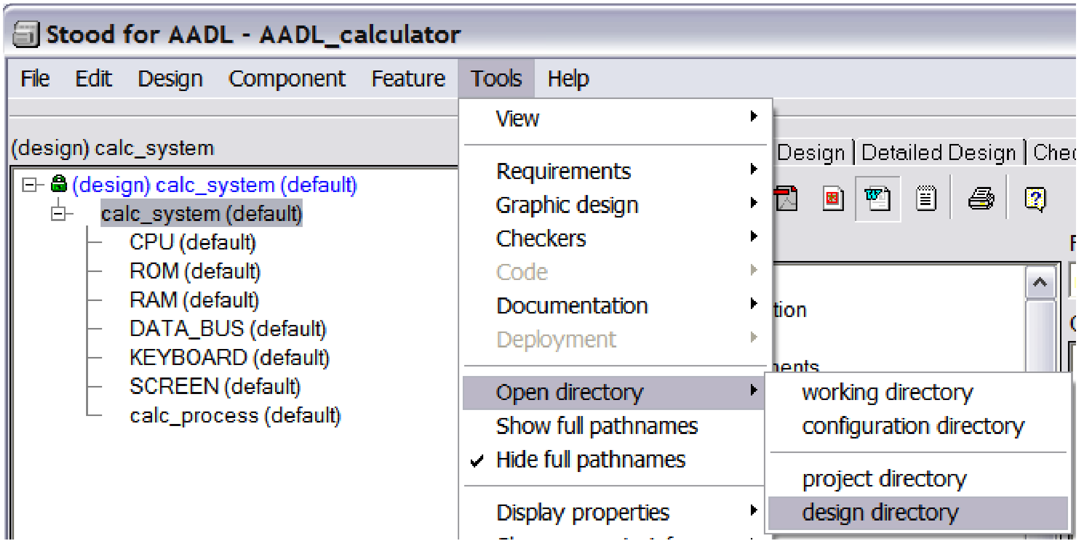
A standard Windows file navigator is then shown to select the output file. A default filename and directory is proposed.



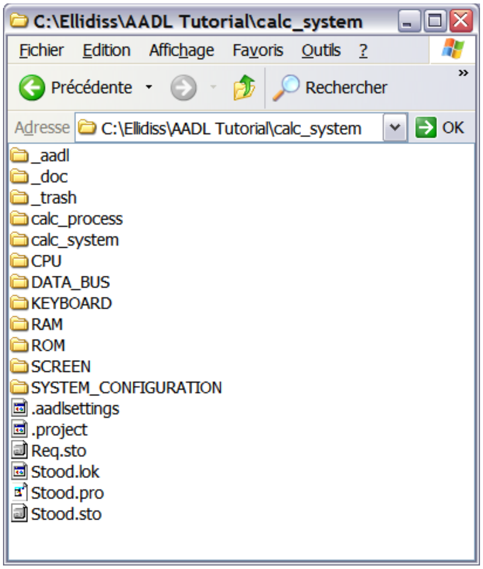
Nom du fichier : calc_system.rtf

Type : rtf (*.rtf)

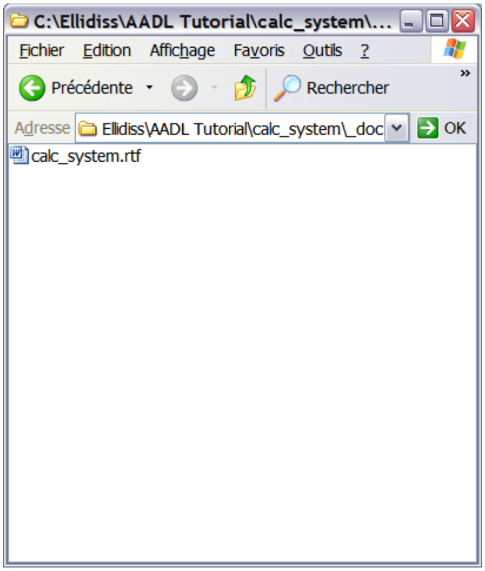
As soon as the document generator has finished to work, it is possible to view the report by opening its containing directory. If the default output file location was not changed, it can be found by using the menu *Tools/Open directory/design directory*.



The design directory contains all the information related to the **Design**. Generated documentation may be found inside the `_doc` subdirectory.


C:\Ellidiss\AADL Tutorial\calc_system
Fichier
Edition
Affichage
Favoris
Outils
?
Précédente
Rechercher
Adresse
C:\Ellidiss\AADL Tutorial\calc_system
OK

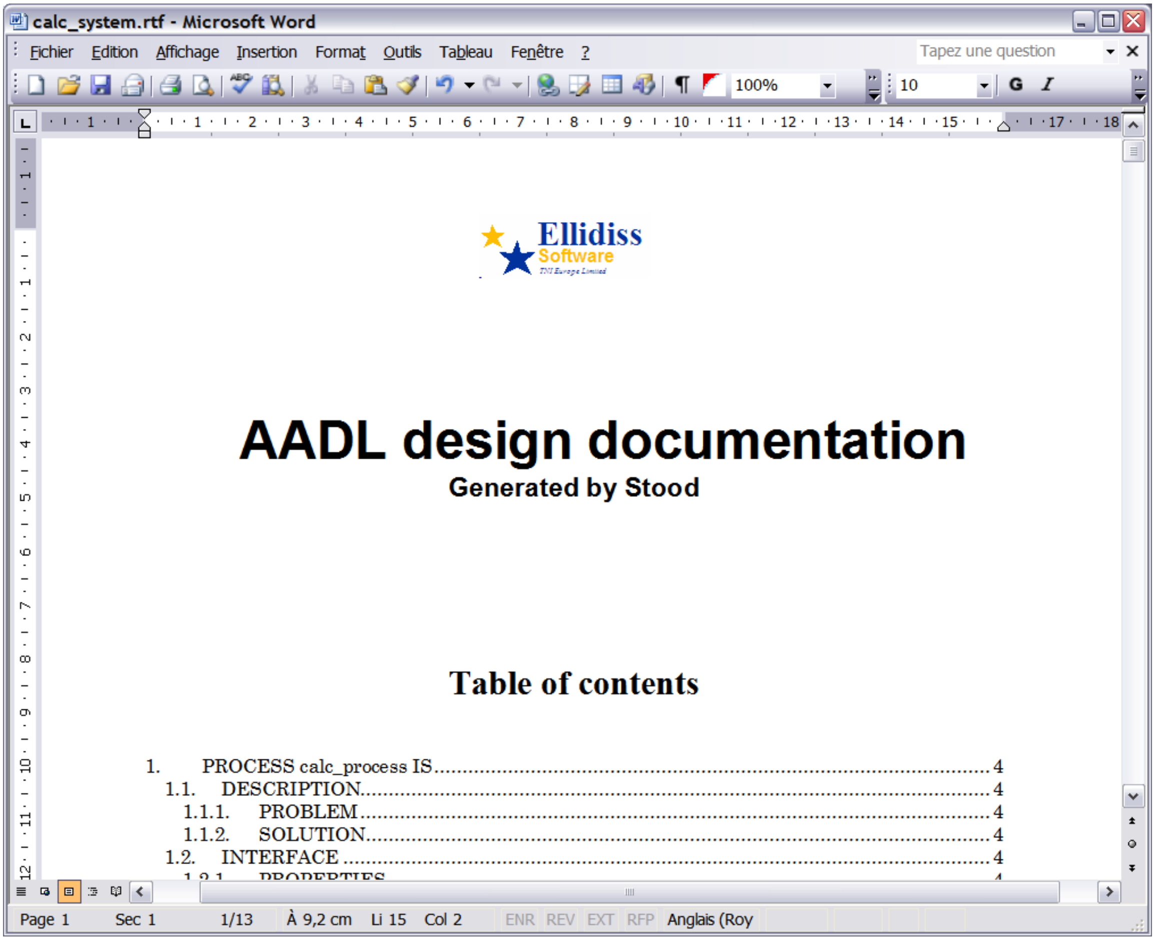
```
_aadl
_doc
_trash
calc_process
calc_system
CPU
DATA_BUS
KEYBOARD
RAM
ROM
SCREEN
SYSTEM_CONFIGURATION
.aadlsettings
.project
Req.sto
Stood.lok
Stood.pro
Stood.sto
```


C:\Ellidiss\AADL Tutorial\calc_system\...
Fichier
Edition
Affichage
Favoris
Outils
?
Précédente
Rechercher
Adresse
Ellidiss\AADL Tutorial\calc_system_doc
OK

```
calc_system.rtf
```

Note that the **AADL** code that was generated previously can be found in the `_aadl` subdirectory.

The figure next page shows the result of the documentation generation with the **RTF** format.


calc_system.rtf - Microsoft Word
Fichier Edition Affichage Insertion Format Outils Tableau Fenêtre ?
Tapez une question
100%
10
G I
Ellidiss
Software
TNI Europe Limited
Page 1 Sec 1 1/13 À 9,2 cm Li 15 Col 2 ENR REV EXT RFP Anglais (Roy

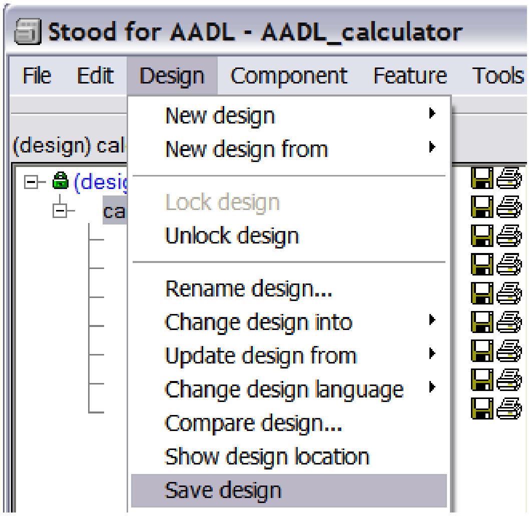
AADL design documentation

Generated by Stood

Table of contents

3.14 Save the design

It is recommended to save the design to the design directory from time to time. To do so, use the menu *Design/Save design*.



Note that the save icons that are shown at the right of the component names will disappear once they are saved.

4 Create an AADL package

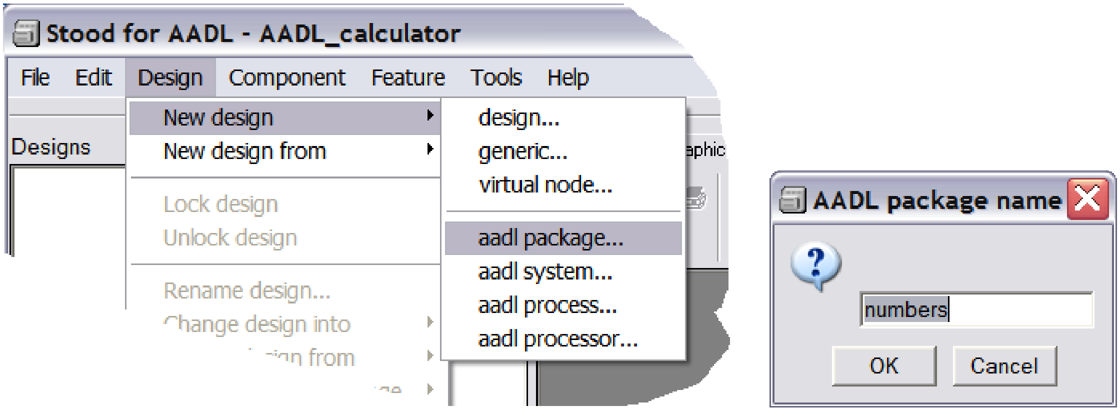
In the previous section, we did not explain (in purpose) how existing component classifiers could be referenced in other **AADL** models. This is however mandatory to enable proper component reuse.

In order to be properly referenced with a **Project** wide scope, it is a good practice to group component classifier definitions within **AADL Packages**. In theory, this should be done for any category of component, however the particular case of **Data** component classifiers is especially important as they are not only instantiated to create subcomponents, but also to specify the actual data type of **Data Ports**, **Event Data Ports** or **Subprogram Parameters**.

This section explains how to create an **AADL Package** that provides a set of **Data** component classifiers.

4.1 Create a new design of kind "aadl package"

To create a new **Package** inside the current **Project** (cf.§2.5), use the menu *Design/New design/aadl package…* and then specify its name in the dialog box.

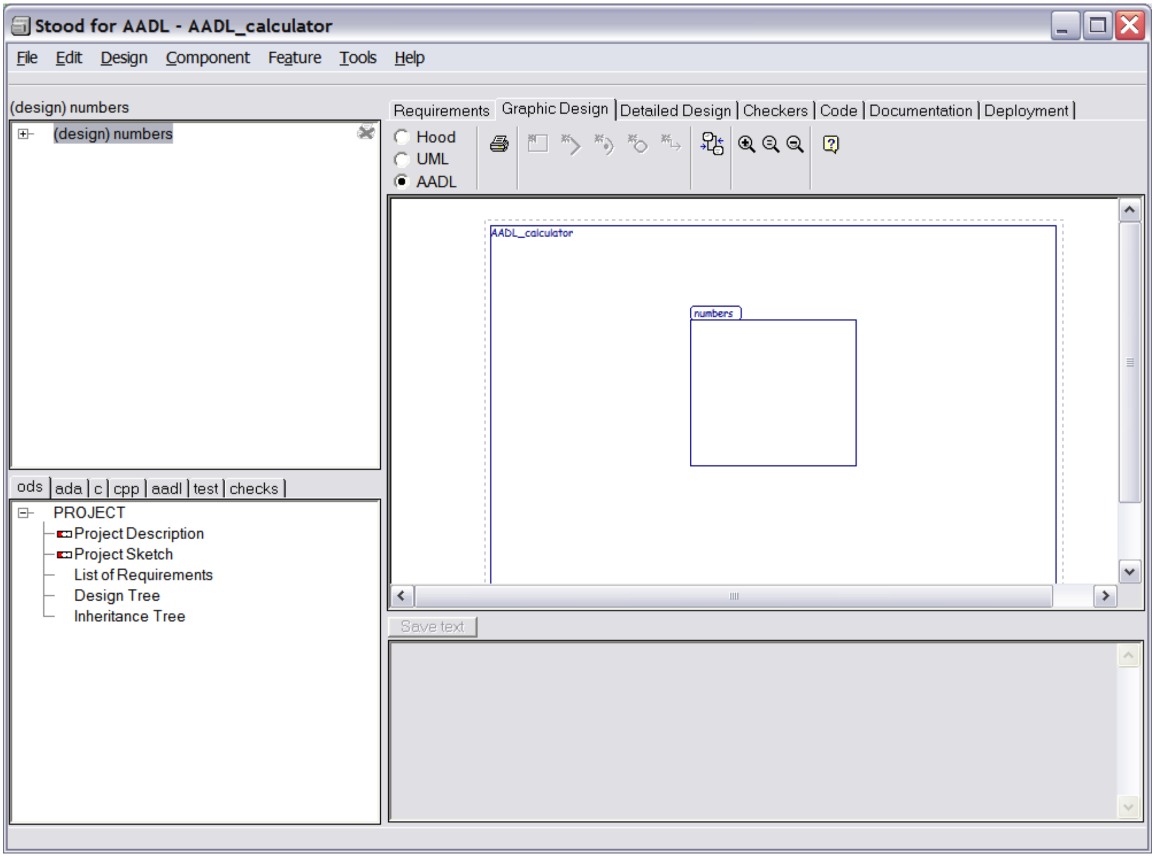


numbers

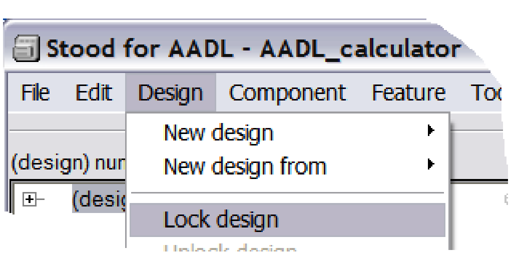
Note that a **Design** name in **Stood** must be alphanumeric (i.e. only contain characters '`a`' to '`z`', '`A`' to '`Z`', '`0`' to '`9`' or the underscore character '`_`').

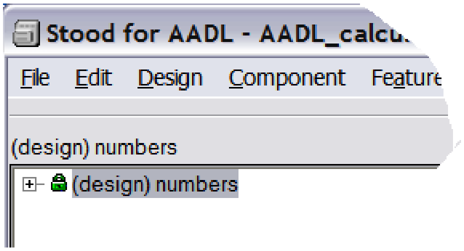
4.2 Lock the package to enter edit mode

When it has just been created, the new **Package** design is automatically loaded and it is shown in the **AADL** graphical editor as an empty box at the middle of a larger one representing the **Project**.



However, this **Package** design is set to read-only mode by default. To enable performing modifications on this **Package**, it is necessary to “lock” it so that no other user will be allowed to get a concurrent write access to the model.

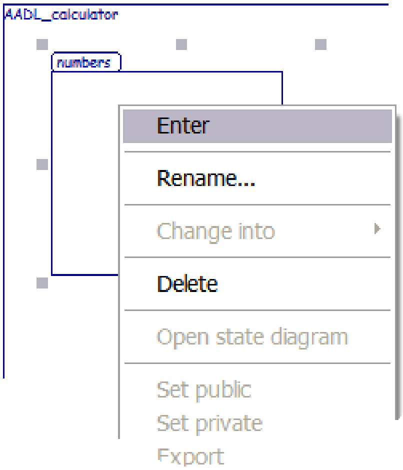

Stood for AADL - AADL_calculator
File Edit Design Component Feature Too
New design
New design from
Lock design
Unlock design
(design) nur
(desig

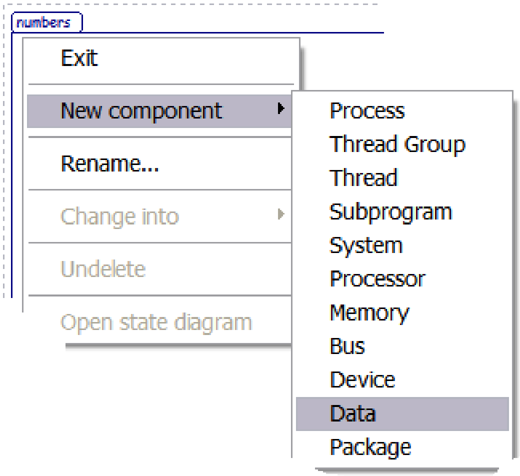

Stood for AADL - AADL_calcu
File Edit Design Component Feature
(design) numbers
(design) numbers

When a **Package** design is locked (may be modified in the current **Session**), a green padlock is shown at the left of its name.

4.3 Create Data component classifiers inside the package

To create components in the **Package**, it must be opened first. To open a **Package**, it must be selected and the contextual menu *enter* must be used. An alternate solution is to perform a mouse double click inside the boundaries of the **Package**.

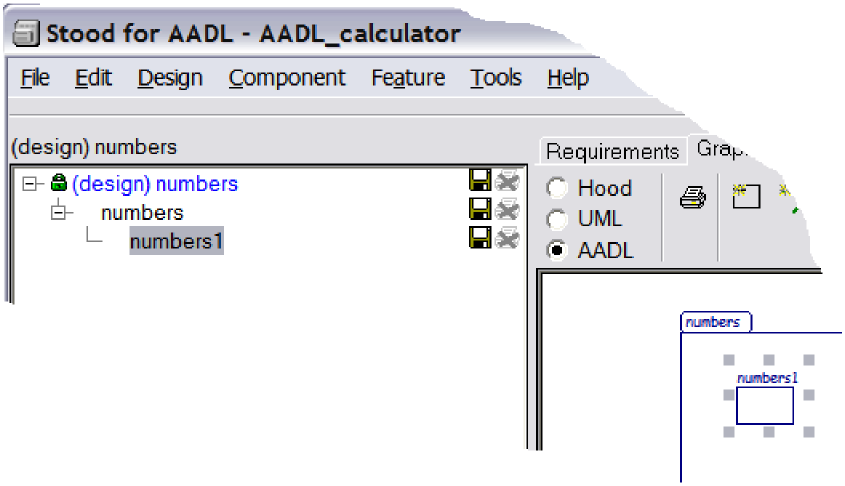


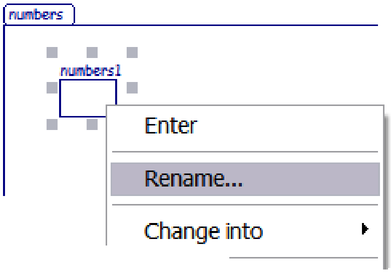


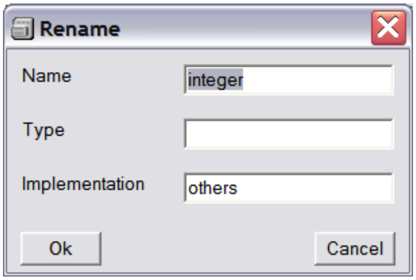
When the **Package** has been opened and is selected, it is possible to create components, either with the *new AADL component* button (in which case a **Data** component classifier will be created by default), or with the *new component* contextual menu. After the button or the menu has been used, a new box is shown on the diagram and a new component is added to the top left list. Default name given to new components is the name of the container box followed by an integer value.

4.4 Rename the Data component

To rename the new component, it must be selected first (on the diagram or in the list), and the contextual menu *rename* must be used. This opens a dialog box where the actual name of the component can be given.






Rename

Name: integer

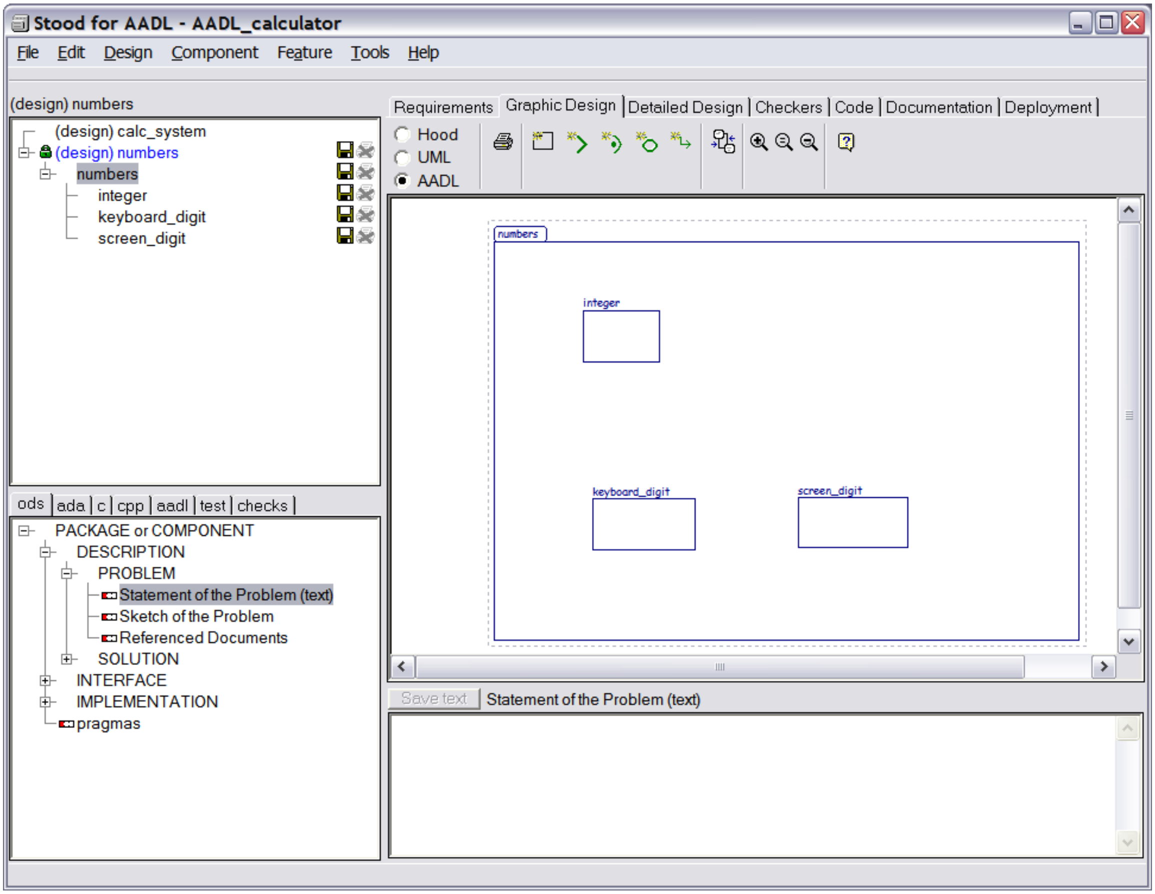
Type:

Implementation: others

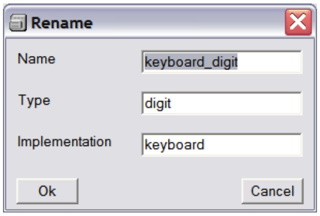
Note that within a **Package**, only component classifiers are described, thus **Stood** component name generally matches the **AADL** component type name. However, in case of several components of the same type, but of different implementation, the box name will be used to distinguish them, as explained in next chapter.

4.5 Specify component type and implementation

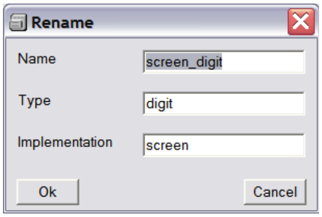
Within a **Package**, a unique **Stood** component is used to represent both **AADL** component type and implementation. If two components have the same type and different implementations, two **Stood** components must be created. The three fields of the *rename* dialog box can then be used to specify the unique **Stood** component name, the **AADL** type name and the **AADL** implementation name.



In the example below, two **Stood** components `keyboard_digit` and `screen_digit` have been created. They have the same **AADL** type name `digit` and different implementation name `keyboard` and `screen`.



Name: keyboard_digit
Type: digit
Implementation: keyboard



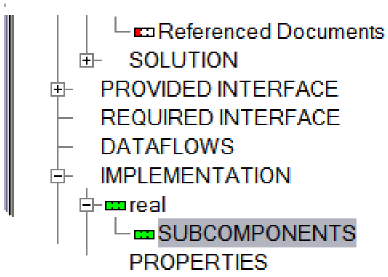
Name: screen_digit
Type: digit
Implementation: screen

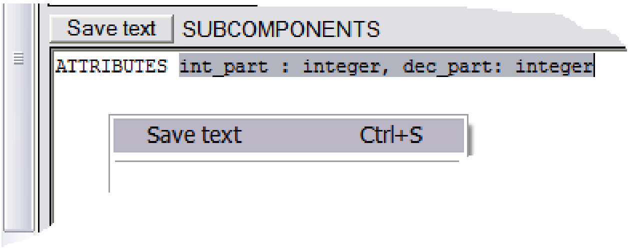
4.6 Define subcomponents of a Data component

According to the **AADL** standard, a **Data** component classifier can accept subcomponents that must also be instances of **Data** components. As a special case, subcomponents of **Data** component classifiers are managed by **Stood** as a list of typed **Attributes**. This is in fact compliant with the way software structured data types (**Ada** record, **C** struct, **C++** class) are handled by the tool.

When a **Data** component classifier is selected on the diagram or in the top-left list, a dedicated *SUBCOMPONENTS* section is available inside the component descriptor in the bottom-left list. This section contains a formal declaration of the list of the **Data** subcomponent names associated with their corresponding classifier reference (name of a **Data** component classifier). Note that keyword ATTRIBUTES must not be removed and that the list separator is a comma.

To illustrate this, we can create a new **Data** component classifier called real and specify that it has two subcomponents int_part and dec_part that are both instances of integer.





```
ATTRIBUTES int_part : integer, dec_part: integer
```

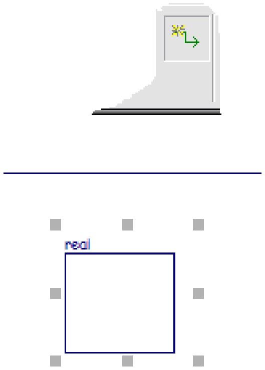
Note: do not forget to use the *save test* button after any change in the text input area.

4.7 Define Data component extension

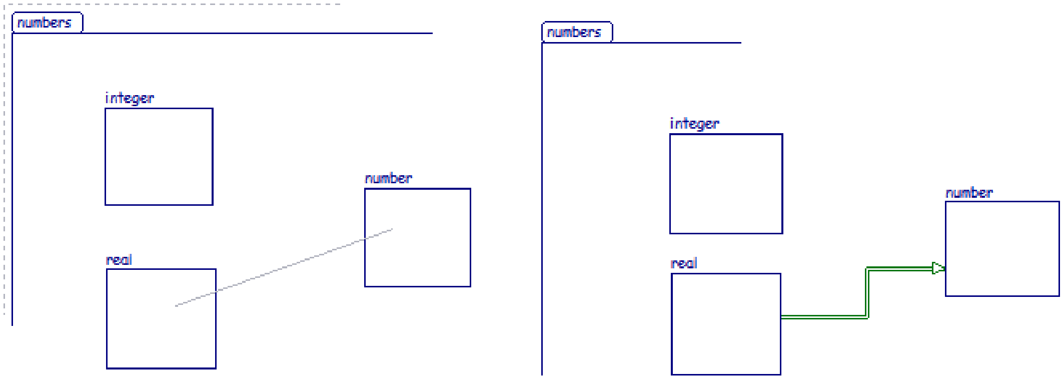
According to the **AADL** standard, a **Data** component classifier may be specified as an extension of another **Data** component classifier. Such an extension mechanism can be compared to software class inheritance in object-oriented languages. The fact that a **Data** component classifier extends another **Data** component classifier can be expressed on the diagram thanks to a graphical connection. To create such a connection, for instance to specify that integers and floats are kind of numbers, please operate as follow:

(a) create a new **Data** component classifier called `number`

(b) click on the new connection button of the **AADL** graphical editor



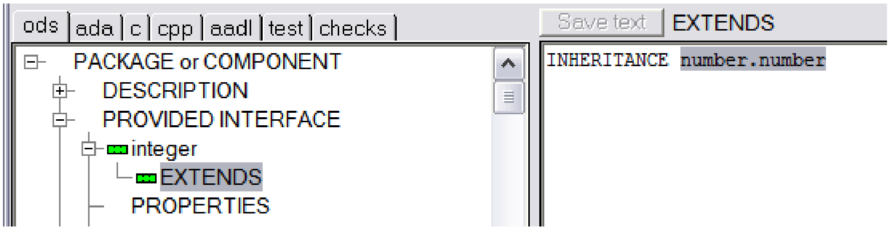
(c) then, select the descendent **Data** component classifier



(d) and finally select the ancestor **Data** component classifier.

Note: the graphical representation of the extend connection does not comply with the recommendation of the annex A of the standard.

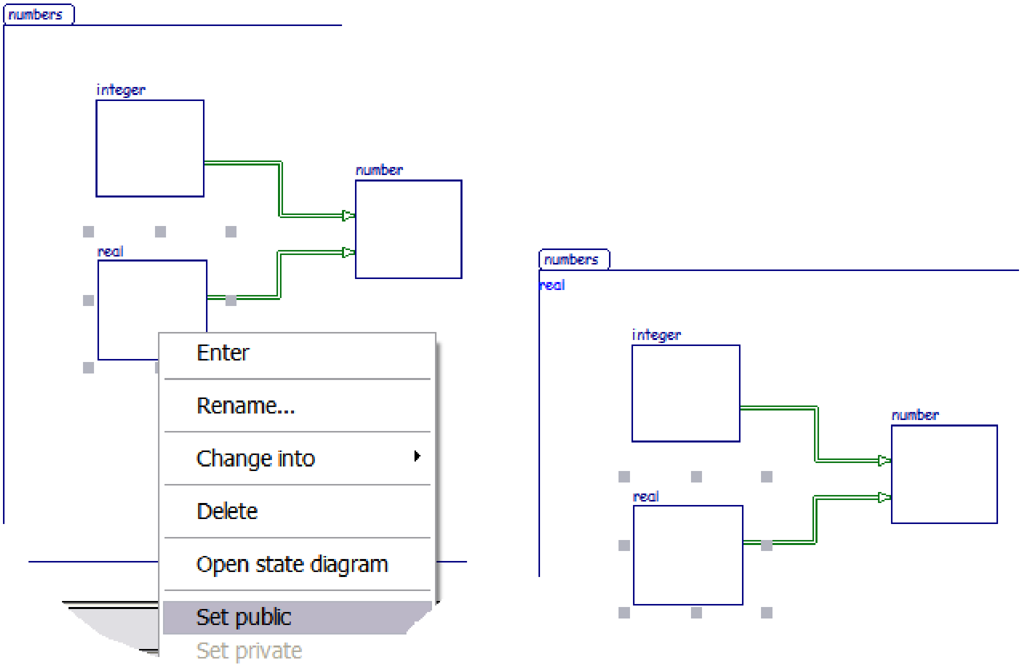
This component extension information can also be edited textually. It can be accessed by selecting the *EXTENDS* section of the component descriptor while the component is selected on the diagram or in the top-left list.



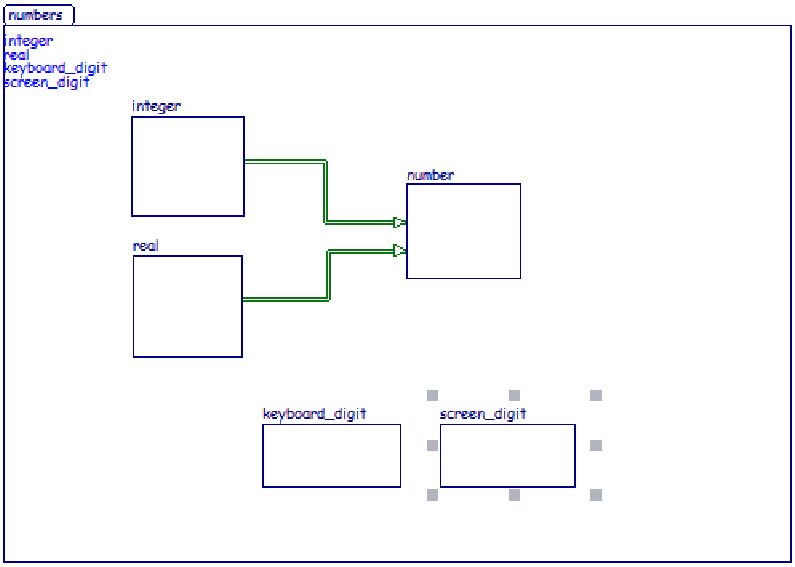
```
INHERITANCE number.number
```

4.8 Define the public section of the package

When adding **Data** component classifiers in a **Package** with **Stood**, they are put in its private section by default. To let a **Data** component classifier become public, it must be selected and the contextual menu *Set public* must be used.



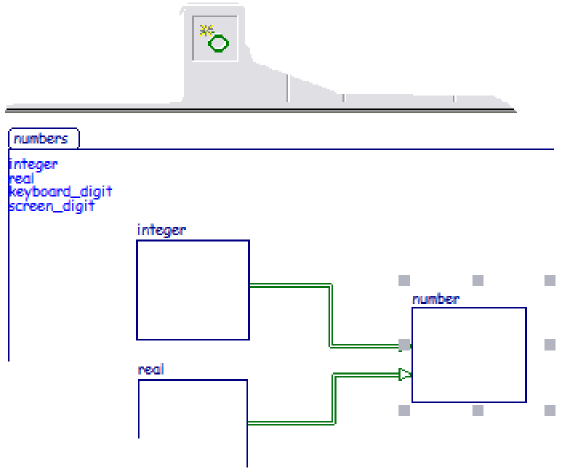
In order to be able to distinguish between public and private **Data** component classifiers, the former are listed in the left border of the **Package** box in the diagram. Note that this graphical notation is specific to **Stood**. For the purpose of our example, we can for instance specify that **Data** component classifiers `integer`, `float`, `keyboard_digit` and `screen_digit` are public, whereas `number` remains private.



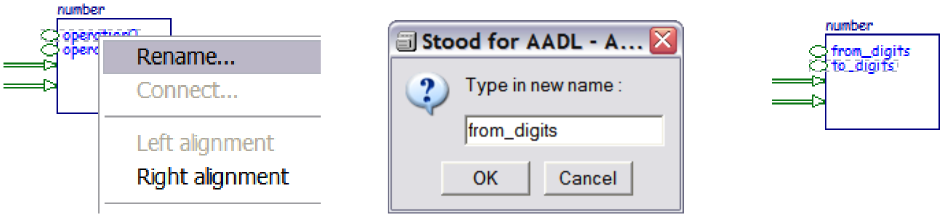
4.9 Define Data Subprograms

Like with other object oriented languages, it is possible to define the methods or member functions that are associated to a **Data** component classifier. In **AADL** they are called data **Subprogram** features.

To create **Subprograms**, click on the *new subprogram* button of the **AADL** graphical editor, then select a Data component classifier.



The new **Subprogram** is given a default name. The rename contextual menu can be used to change it.



Type in new name : from_digits

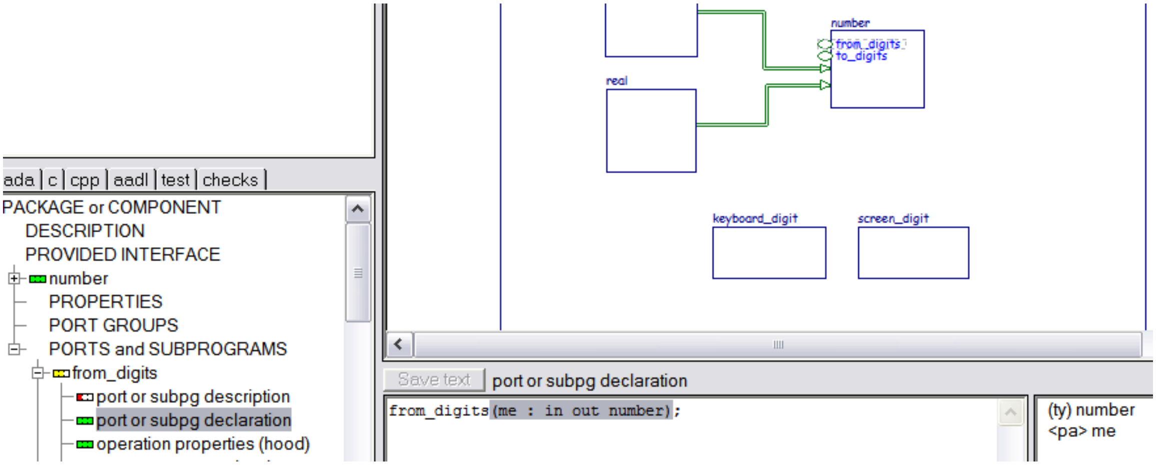
4.10 Specify Subprogram Parameters

Whereas **Ports** can carry a single event or data message, **Subprograms** can express more complex dataflows that are defined by a list of directional typed **Parameters**. In **Stood**, this parameters list must be entered in the *port or subpg declaration* section as shown in the sequence of screenshots below.

The syntax that is used by **Stood** to specify a list of **Parameters** for a **Subprogram** is the one recommended by **HOOD** which is very similar to what is defined by the **Ada** standard. The syntax for a single **Parameter** is (list separator is a semicolon):

```
<parameter_name> : <direction> <parameter_type>
```

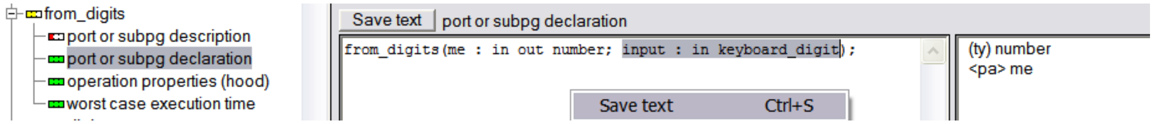
(a) Select the **Subprogram** in the diagram or in the list. The default list of **Parameters** is shown in the text input area. In case of a data **Subprogram** defined in a **Data** component classifier, default **Parameter** is the receiver which default name is me and default type is the **Data** component classifier.



```
from_digits(me : in out number);
```

(ty) number
<pa> me

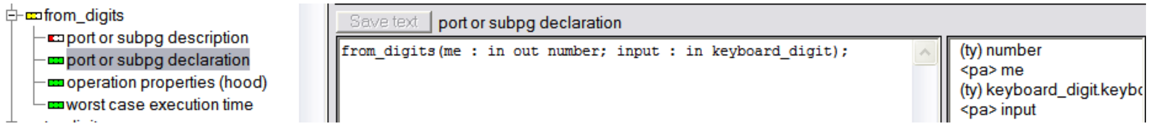
(b) Modify the **Parameters** in the text input area. Do not forget to save the changes with the button, contextual menu or keyboard shortcut.


from_digits
port or subpg description
port or subpg declaration
operation properties (hood)
worst case execution time
Save text
port or subpg declaration
Save text Ctrl+S

```
from_digits(me : in out number; input : in keyboard_digit);
```

(ty) number
<pa> me

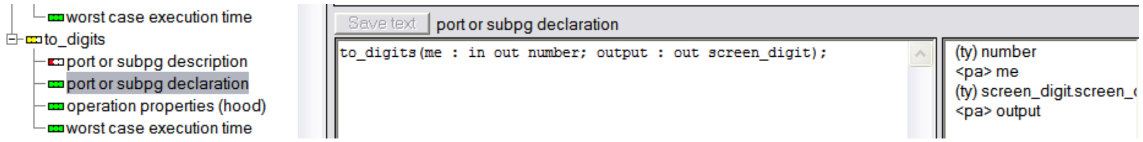
(c) Note that specified **Parameter** type is checked against **Stood** cross reference table and the result of this analysis is shown in the right hand side of the text input area.


from_digits
port or subpg description
port or subpg declaration
operation properties (hood)
worst case execution time
Save text
port or subpg declaration

```
from_digits(me : in out number; input : in keyboard_digit);
```

(ty) number
<pa> me
(ty) keyboard_digit.keybo
<pa> input

By specifying proper **Parameters**, we can express that the two data **Subprogram** features of **Data** component classifier `number` are `from_digits` with an input **Parameter** of type `keyboard_digit`, and `to_digits` with an output **Parameter** of type `screen_digit`.

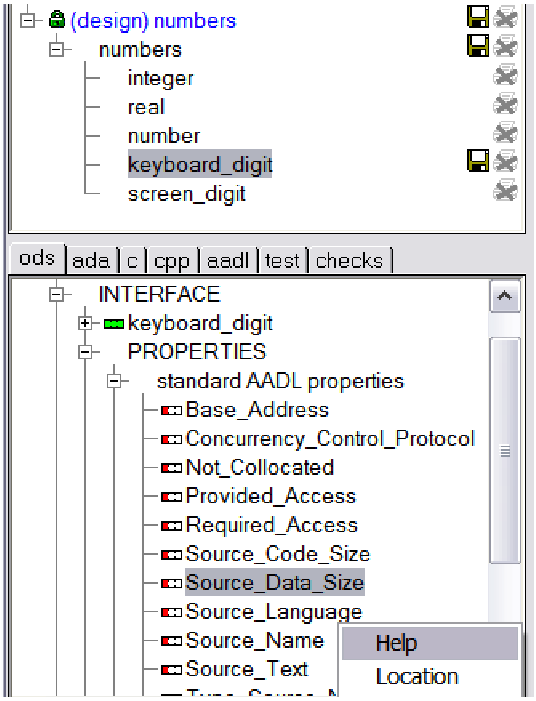

worst case execution time
to_digits
port or subpg description
port or subpg declaration
operation properties (hood)
worst case execution time
Save text
port or subpg declaration
(ty) number
<pa> me
(ty) screen_digit screen_(
<pa> output

```
to_digits(me : in out number; output : out screen_digit);
```

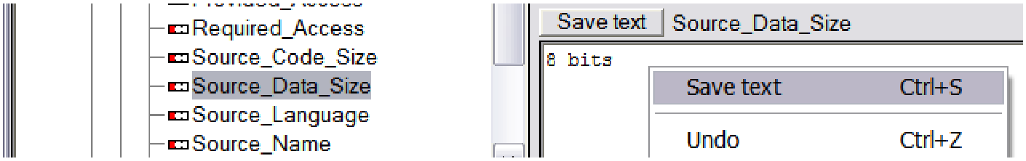
4.11 Add AADL Properties

AADL entities specification can be refined by a set of predefined or project-specific **Properties**. The way to enter predefined **Properties** with **Stood 5.2** differs from what was proposed with **Stood 5.1**. In **Stood 5.2**, all the predefined **Properties** have been included into the default configuration, which simplifies their use. Note that it is possible to customize this list in the tool configuration files, to hide those **Properties** that are not relevant for the current **Project**.

When a component or a feature is selected, the list of possible valid **Properties** can be shown in the *INTERFACE* section. A contextual help is available for each individual **Property**.

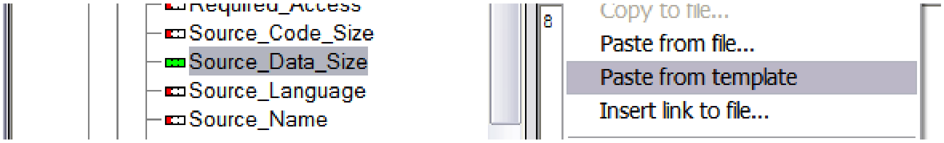


To add a **Property** association, first select the appropriate **AADL** entity (here, `keyboard_digit` **Data** component classifier), and the chosen **Property** in the list (here, `Source_Data_Size`). Then enter the **Property** value in the text input area and save with the button, the contextual menu or the keyboard shortcut.



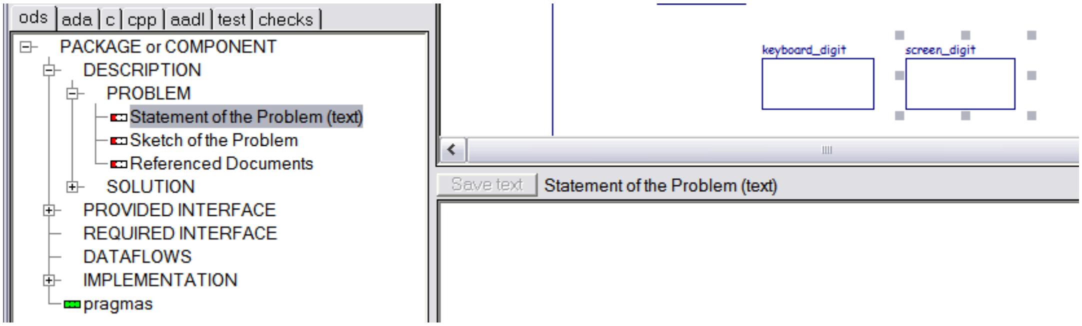
8 bits

Note that a default value is proposed for each **Property**. To display this default value, use *paste from template* contextual menu of the text input area.

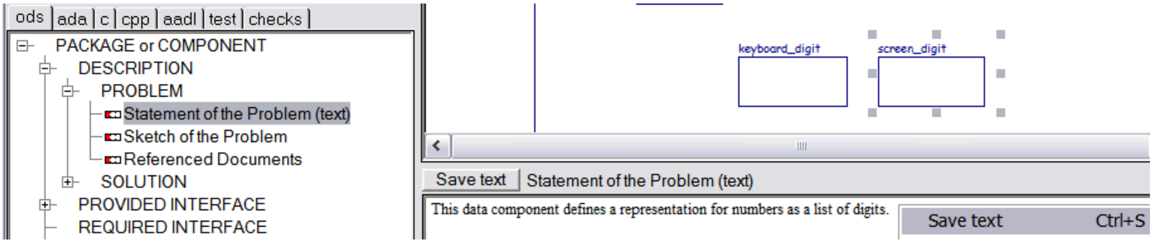


4.12 Add textual comments

It is recommended to insert comments and other textual information inside the design data structure while creating new entities. These comments may be used to provide explanations about the "why", "what" and "how" of each component or feature. The standard configuration of the tool proposes a structured list of comment sections that can however be customized to better fit any other documentation strategy. To fill in one of the proposed documentation section, first select the appropriate entity and one of the proposed (text) sections.



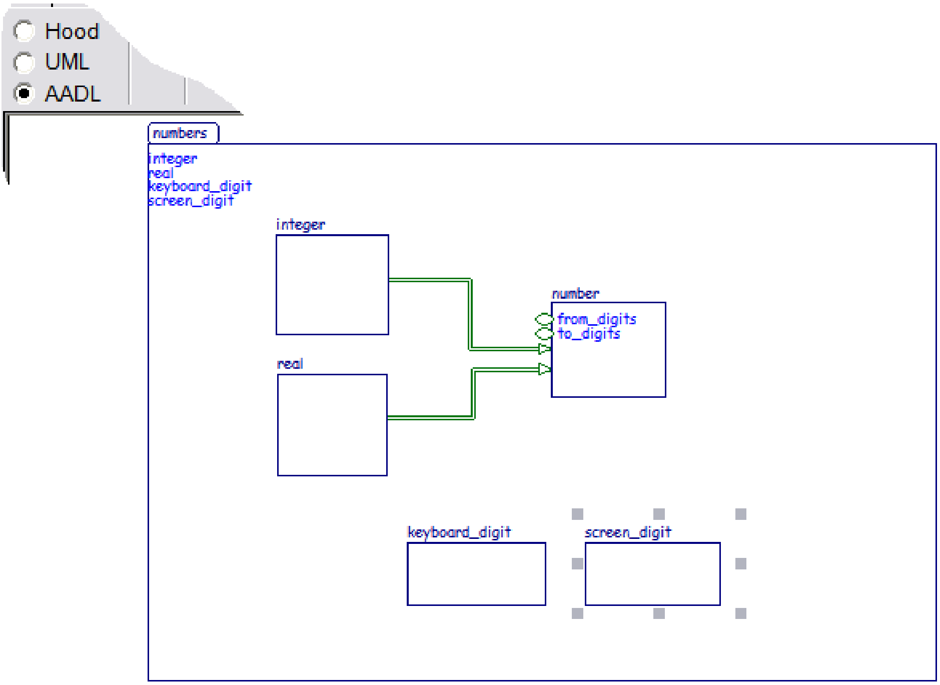
Text can be entered inside the text input area and must be saved with the button, contextual menu or keyboard shortcut.



This data component defines a representation for numbers as a list of digits.

4.13 Show full AADL diagram of the package

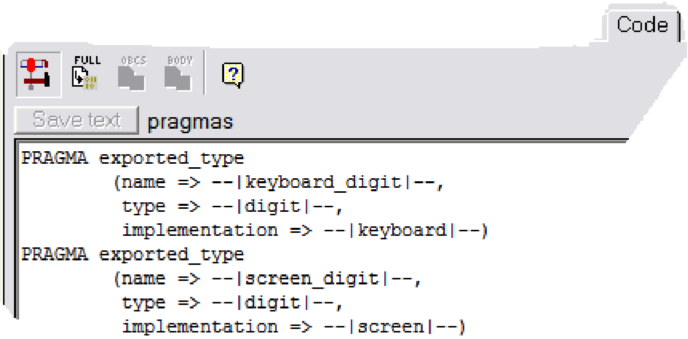
The complete **AADL** diagram for our **Package** is now as shown below:



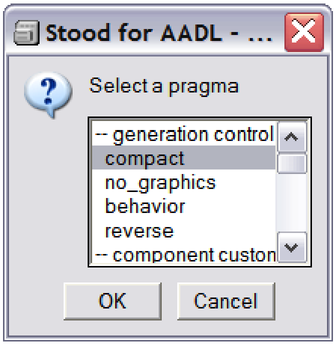
Note that the corresponding graphical representation of the same model in **UML** and **HOOD** is also available, simply by switching the notation selector.

4.14 Generate the AADL code for the package

To generate textual **AADL** code from a graphical model in **Stood**, the *Code* tab must be selected instead of the *Graphic Design* one. The new button bar shows two buttons. The first button on the left is called *add pragma* and may be used to customize the code generation. Pressing this button opens a dialog box showing the list of the possible options that can be selected. Note that some options may have already been automatically inserted by **Stood**, as it is the case here.

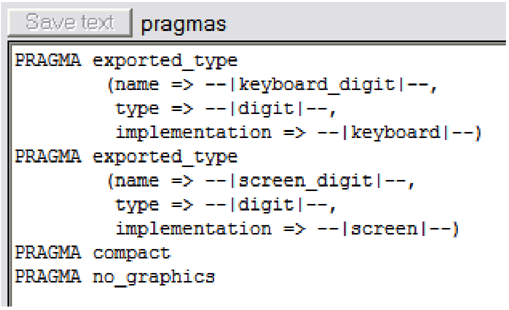


```
PRAGMA exported_type
        (name => --|keyboard_digit|--,
         type => --|digit|--,
         implementation => --|keyboard|--)
PRAGMA exported_type
        (name => --|screen_digit|--,
         type => --|digit|--,
         implementation => --|screen|--)
```

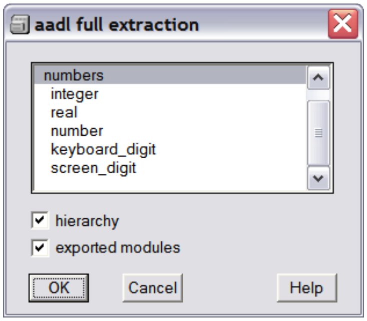


Select pragma *compact* in order to generate all the **AADL** code in only one file (default rule is one file per component) and then pragma *no_graphics* to disable the generation of **Stood** specific properties that are used to propagate the positions of the graphical items in the diagram.

The **AADL** code generation can then be activated by pressing the *full extraction* button. This opens a dialog box that can be used to specify which part of the **Design** has to be generated. Most of the times, we need the whole **Design** to be generated, which is the choice that is proposed by default.

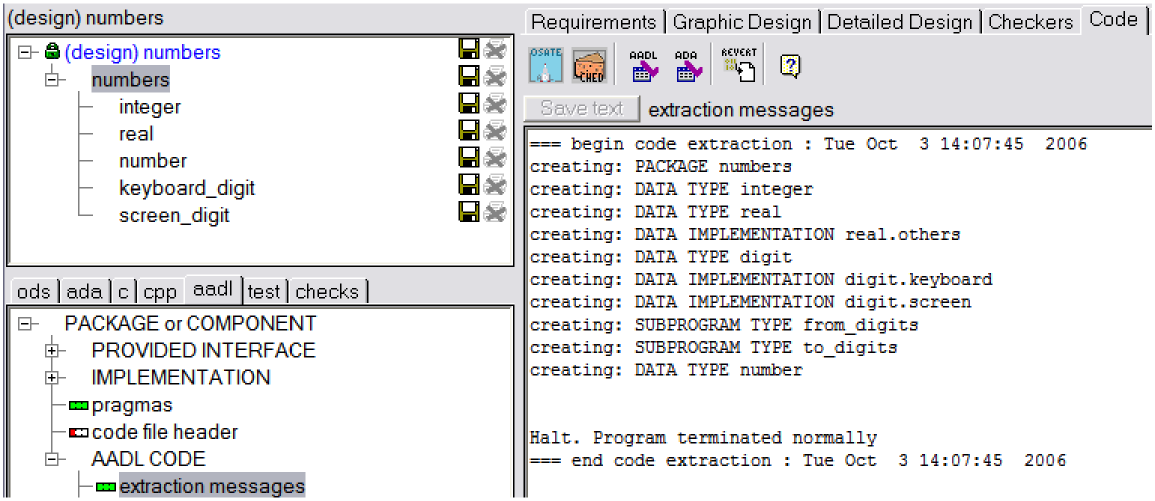


```
PRAGMA exported_type
        (name => --|keyboard_digit|--,
         type => --|digit|--,
         implementation => --|keyboard|--)
PRAGMA exported_type
        (name => --|screen_digit|--,
         type => --|digit|--,
         implementation => --|screen|--)
PRAGMA compact
PRAGMA no_graphics
```



☑ hierarchy
☑ exported modules

After having pressed the *Ok* button and waited a little, the *extraction messages* file is shown. The messages file lists the abstract component types and implementations that had to be created to fully describe our **Package**.

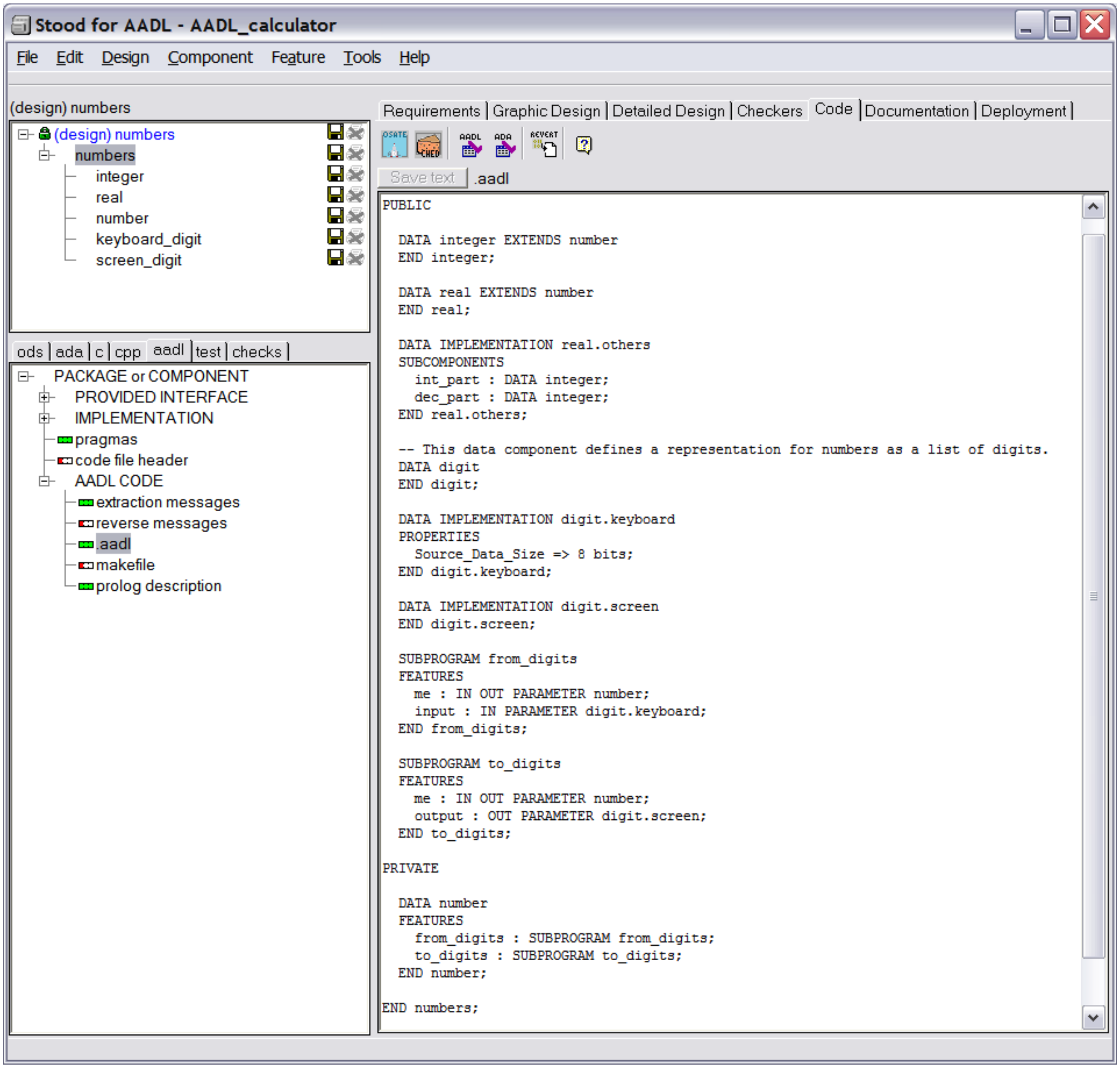


```
=== begin code extraction : Tue Oct  3 14:07:45  2006
creating: PACKAGE numbers
creating: DATA TYPE integer
creating: DATA TYPE real
creating: DATA IMPLEMENTATION real.others
creating: DATA TYPE digit
creating: DATA IMPLEMENTATION digit.keyboard
creating: DATA IMPLEMENTATION digit.screen
creating: SUBPROGRAM TYPE from_digits
creating: SUBPROGRAM TYPE to_digits
creating: DATA TYPE number


Halt. Program terminated normally
=== end code extraction : Tue Oct  3 14:07:45  2006
```

4.15 Show generated AADL code

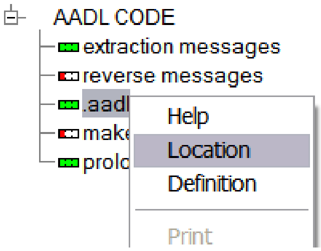
The **AADL** generated code can be shown by changing the selection in the lower left list of the **Stood** window from *extraction messages* to *aadl*.

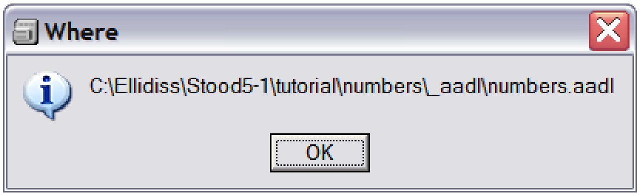
Note that, due to the fact that we put a pragma *compact*, **AADL** code has been associated to the root component in the hierarchy only.



```
PUBLIC

  DATA integer EXTENDS number
  END integer;

  DATA real EXTENDS number
  END real;

  DATA IMPLEMENTATION real.others
  SUBCOMPONENTS
    int_part : DATA integer;
    dec_part : DATA integer;
  END real.others;

  -- This data component defines a representation for numbers as a list of digits.
  DATA digit
  END digit;

  DATA IMPLEMENTATION digit.keyboard
  PROPERTIES
    Source_Data_Size => 8 bits;
  END digit.keyboard;

  DATA IMPLEMENTATION digit.screen
  END digit.screen;

  SUBPROGRAM from_digits
  FEATURES
    me : IN OUT PARAMETER number;
    input : IN PARAMETER digit.keyboard;
  END from_digits;

  SUBPROGRAM to_digits
  FEATURES
    me : IN OUT PARAMETER number;
    output : OUT PARAMETER digit.screen;
  END to_digits;

PRIVATE

  DATA number
  FEATURES
    from_digits : SUBPROGRAM from_digits;
    to_digits : SUBPROGRAM to_digits;
  END number;

END numbers;
```

This **AADL** code can be edited with **Stood**, but the corresponding file in the repository may be easily located for a remote access. To locate a particular file, select the corresponding entry in the lower left list and use the *Location* contextual menu.



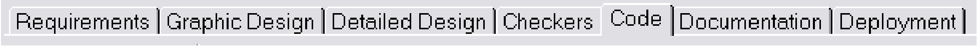


C:\Ellidiss\Stood5-1\tutorial\numbers_aadl\numbers.aadl

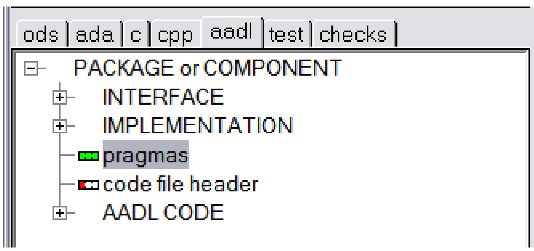
4.16 Generate C++ code

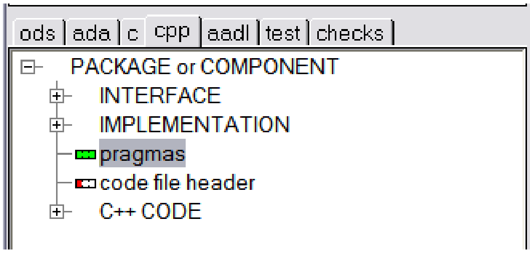
Without changing anything in the design model, it is possible to also generate **Ada**, **C** or **C++** source code. The process for generating **C++** code (for instance) is very similar to the one applied to generate the **AADL** code, i.e.:

(a) Select the *Code* tab again:

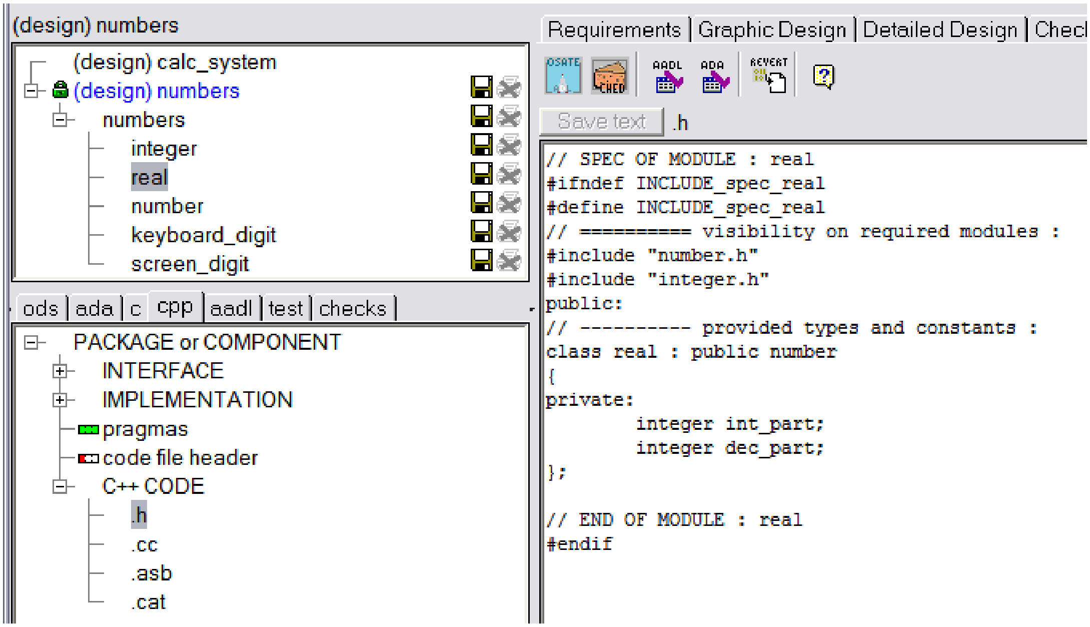


(b) Change the source language tab from *aadl* to *cpp*:





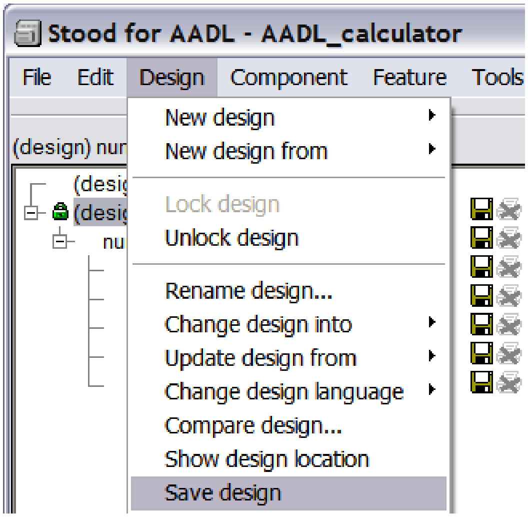
(c) Press the *full extraction* button, then the *OK* button in the dialog box. Generated files can be shown by selecting the appropriate items in the selection lists:



```
// SPEC OF MODULE : real
#ifndef INCLUDE_spec_real
#define INCLUDE_spec_real
// ========== visibility on required modules :
#include "number.h"
#include "integer.h"
public:
// ---------- provided types and constants :
class real : public number
{
private:
        integer int_part;
        integer dec_part;
};

// END OF MODULE : real
#endif
```

4.17 Save the design

It is recommended to save the design to the design directory from time to time. To do so, use the menu *Design/Save design*.



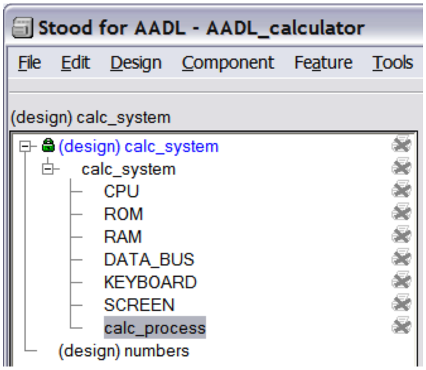
5 Create an AADL process

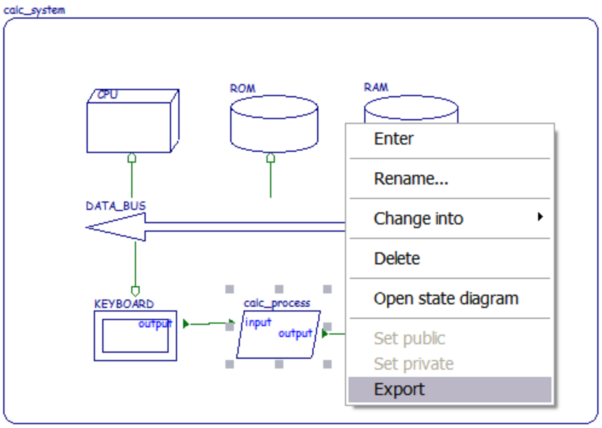
The third kind of **Design** that can be managed with **Stood** is associated to an **AADL Process**. Such a **Design** represents a software program for which it is possible to generate a complete set of target language source files that can be compiled and linked to produce an executable file. It is possible to create a **Design** of kind **AADL** Process thanks to the *Design/New design* menu. Another option consists in creating a new **Design** by exporting a **Process** subcomponent defined in an **AADL System**.

5.1 Create a new design by export

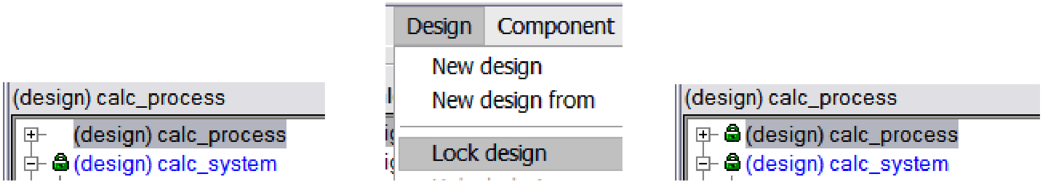
In the **Design** `calc_system`, we defined a **Process** subcomponent called `calc_process`. It would be possible to refine the contents of this **Process** within this **Design**. However, it may be interesting to isolate the pure software part of the **System** in a separate **Design** to complete software design and coding activities until the end.

To do so, after having loaded the `calc_system` Design again, `calc_process` component must be selected and the export contextual menu must be used, as shown below:





A new **Design** is added to the list of the **Project** `AADL_calculator`. This new **Design** now needs to be selected (loaded) and locked (opened in read-write mode) as shown below.

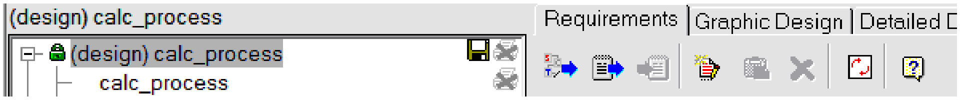


5.2 Import a list of design requirements

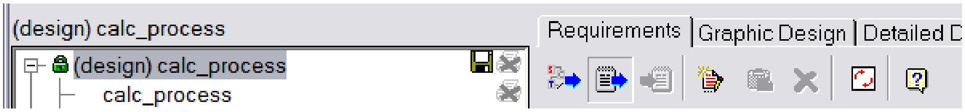
It is possible to import the list of software requirements that must be covered by the current design and coding activities. The simplest way to import such a list of requirements consists in reading a tabulated **ASCII** text file that can be easily produced by any requirements management tool. Such a file must be formatted as follow to be properly imported by **Stood**:

- one requirement per line
- two fields separated by a tab character per requirement: the unique requirement ID and a comment.

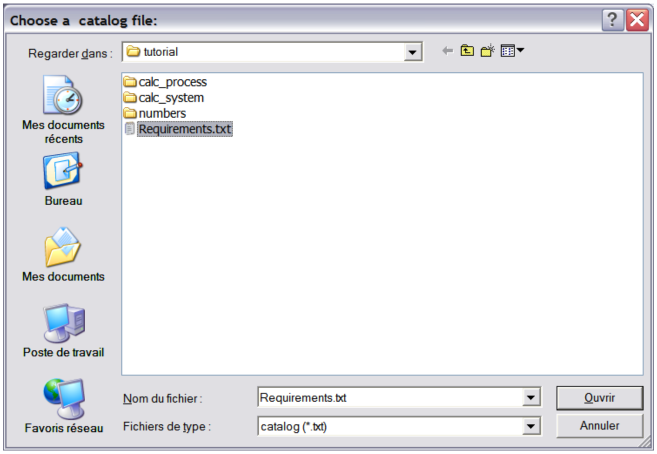
As soon as such a file is available, first switch **Stood** lifecycle tab to *Requirements*:



Then click on the button *load requirements from text*:



A file navigator dialog is shown in which the appropriate file must be selected. Our **Workspace** contains a file called `Requirements.txt` which contents was described in chapter 2.3.



Choose a catalog file:

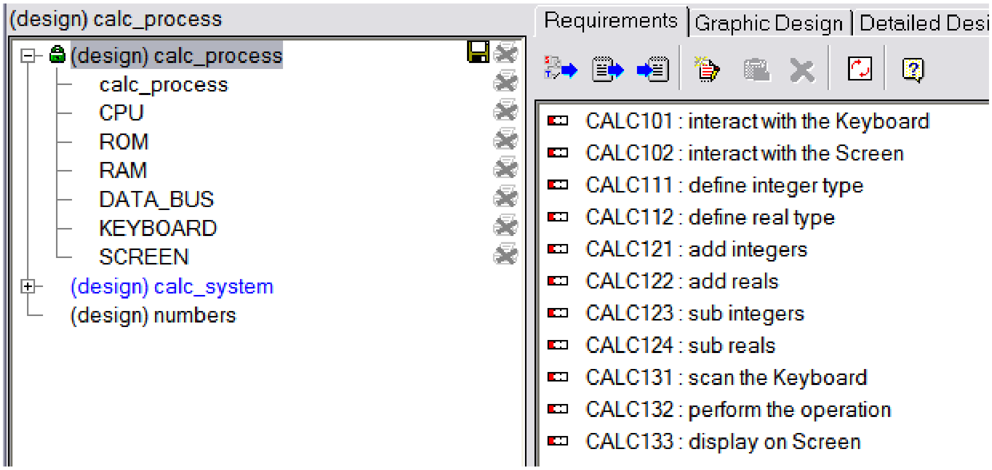
Regarder dans : tutorial

- calc_process
- calc_system
- numbers
- Requirements.txt

Nom du fichier : Requirements.txt

Fichiers de type : catalog (*.txt)

Once the file is loaded, the corresponding list of requirements appears in **Stood**. Note that a small red gauge is shown at the left of each individual item, which means that the requirement is not covered yet by any design entity.



(design) calc_process

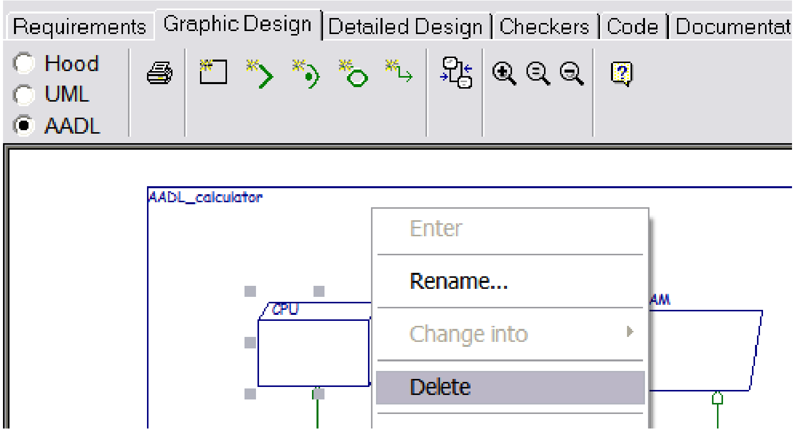
- (design) calc_process
  - calc_process
  - CPU
  - ROM
  - RAM
  - DATA_BUS
  - KEYBOARD
  - SCREEN
- (design) calc_system
- (design) numbers

- CALC101 : interact with the Keyboard
- CALC102 : interact with the Screen
- CALC111 : define integer type
- CALC112 : define real type
- CALC121 : add integers
- CALC122 : add reals
- CALC123 : sub integers
- CALC124 : sub reals
- CALC131 : scan the Keyboard
- CALC132 : perform the operation
- CALC133 : display on Screen

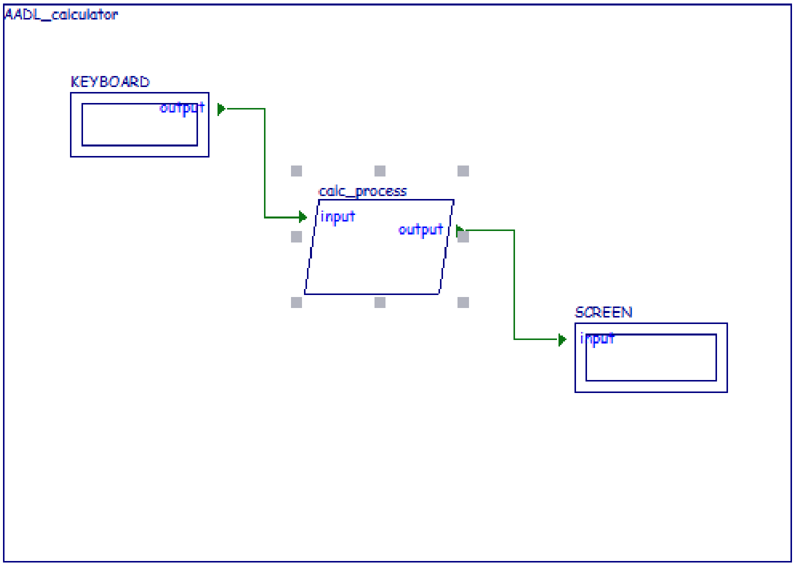
5.3 Clean up the environment

Current **Design** has been created by exporting a **Process** subcomponent of an **AADL System** in another **Design**. This export function also propagates information about the environment of the exported component, and in particular, all the sibling subcomponents. However, they are not all relevant anymore in the context of our new **Design**.

To clean up this environment, switch the lifecycle tab to *Graphic Design* to show the **AADL** diagram, select individually each component to be removed and use the *Delete* contextual menu as shown below:



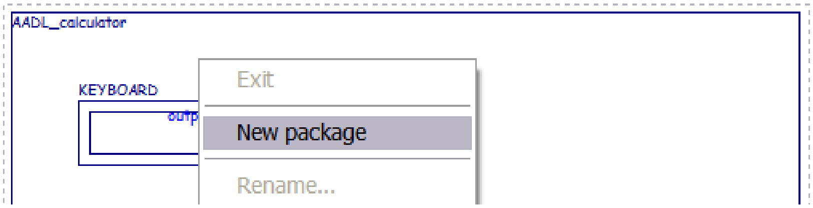
After having deleted all the components that are note directly in interaction with `calc_process`, the cleaned model now looks like the following:



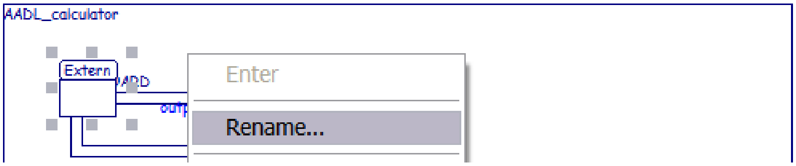
5.4 Import a package

In the model we have imported from `calc_system`, we did not specify precisely the data types associated to the **Data Ports**. We now want to reference the **Data** component classifiers we defined in the `numbers` **Package** to give a type to the **Data Ports**. The most consistent way to do that in **Stood** requires the **Package** to be imported first within the **Design** scope.

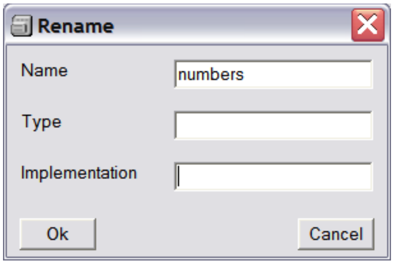
In the **AADL** diagram, the outer box being selected (`aadl_calculator`), use the *New package* contextual menu to create a local representation of a remote **Package**:



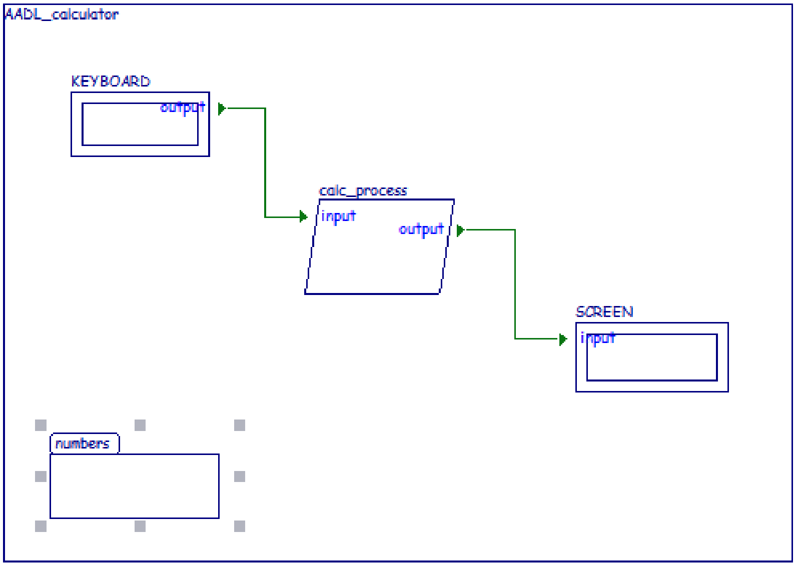
A new box has been added to the diagram, with the default name `Extern`. To change this name, use the *Rename* contextual menu (the `Extern` **Package** must be selected).



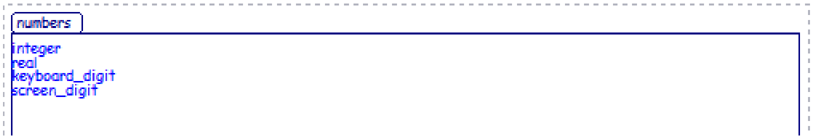
Let us now give to this local **Package** the name of the actual **Package** we created in the **Project**, i.e. `numbers`.



Name: numbers
Type:
Implementation:



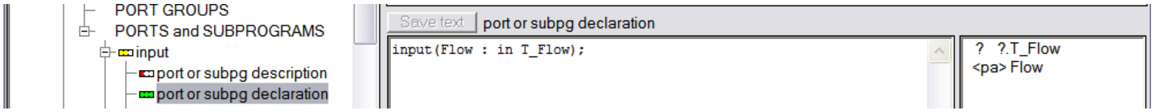
Stood has now made the association between our local **Package** and the actual remote **Design** of the same name. This will allow us to use the various **Data** component classifiers defined in the **Package** numbers in the current **Design**. To check the available **Data** component classifiers, double-click on the local **Package** numbers:



Note that if changes are made to the remote **Package**, they will be propagated to the local copy only during a **Design** load.

5.5 Change data ports type

When we added **Data Ports** to subcomponents in section 3.8, we did not care about the associated data type. A default data type `T_Flow` was used. It is now possible to reference the **Data** component classifiers provided by the imported **Package** to specify the actual type of the **Data Ports**. To illustrate how a port definition can be modified, select section *port or subpg declaration* section for port `input` in component `calc_process`.

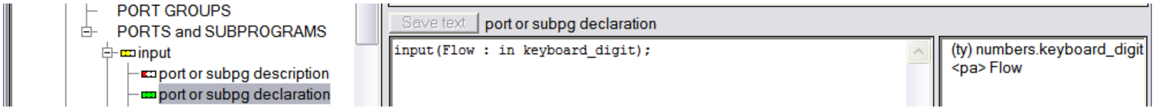


port or subpg declaration

```
input(Flow : in T_Flow);
```

? ?.T_Flow
<pa> Flow

The right hand list, called *symbol table*, shows that type `T_Flow` is unknown. Let us modify the port declaration to use type `keyboard_digit` instead. Please, do not forget to save the changes with the button, the contextual menu or the keyboard shortcut. The new port declaration must look like the following:

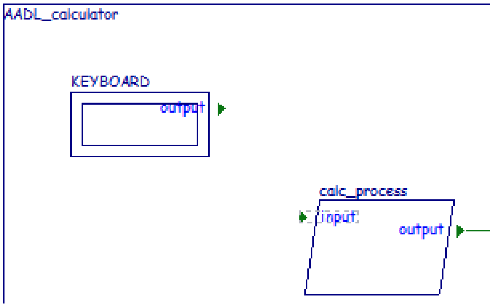


port or subpg declaration

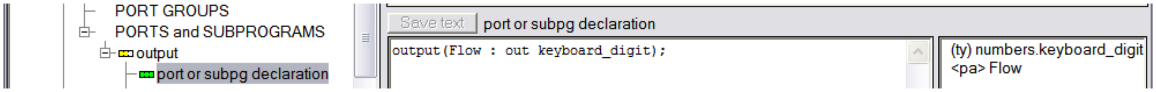
```
input(Flow : in keyboard_digit);
```

(ty) numbers.keyboard_digit
<pa> Flow

Note that the data type is now well recognized in the *symbol table*. However, the **Data Port** connection between **Device** `KEYBOARD` and **Process** `calc_process` has suddently disappeared from the diagram.



The reason is that the two ends of the connection are no more type compatible. The declaration of port `output` in component `KEYBOARD` must also be changed in a consistent way:



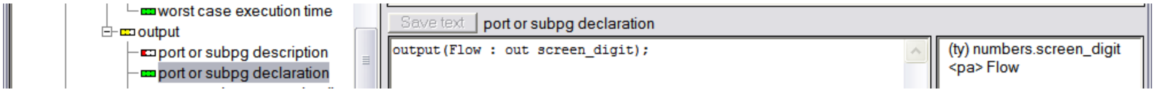
port or subpg declaration

```
output(Flow : out keyboard_digit);
```

(ty) numbers.keyboard_digit
<pa> Flow

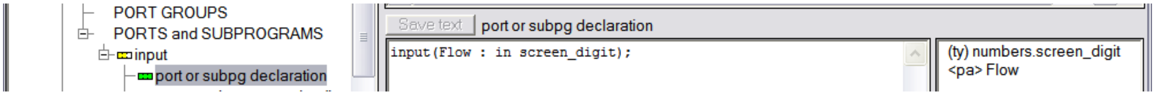
Note that the **Data Port** connection becomes visible again in the diagram as soon as its two ends become type compatible again.

We can now do similar changes to port `output` of component `calc_process` and port `input` of component `SCREEN`. The data type these two ports must reference is screen_digit.


worst case execution time
output
port or subpg description
port or subpg declaration
Save text
port or subpg declaration

```
output (Flow : out screen_digit);
```

(ty) numbers.screen_digit
<pa> Flow

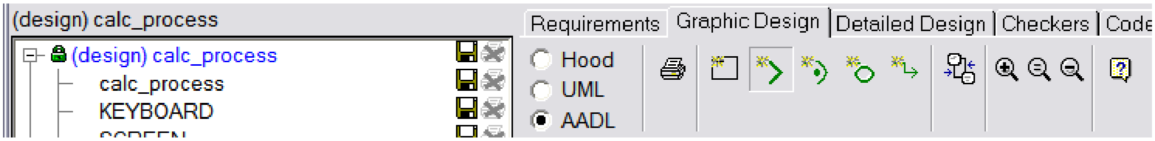


```
input (Flow : in screen_digit);
```

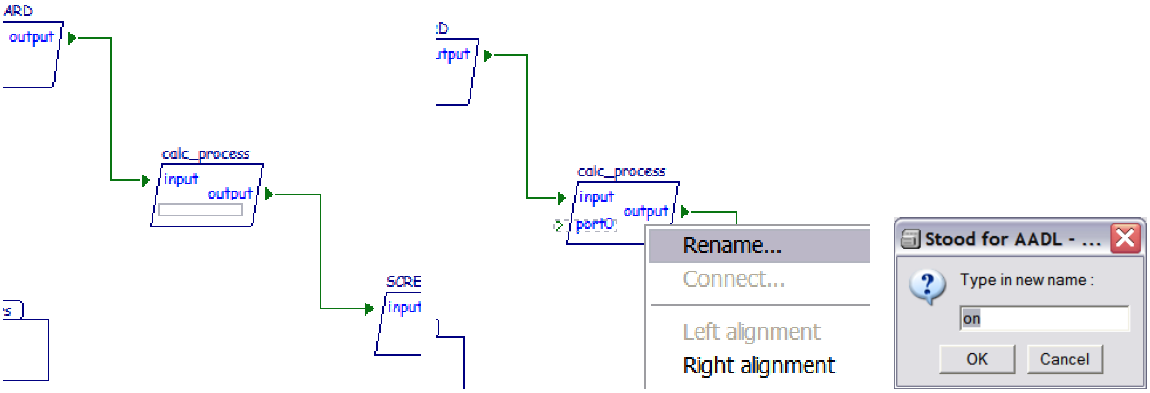
(ty) numbers.screen_digit
<pa> Flow

5.6 *Add ports to the process*

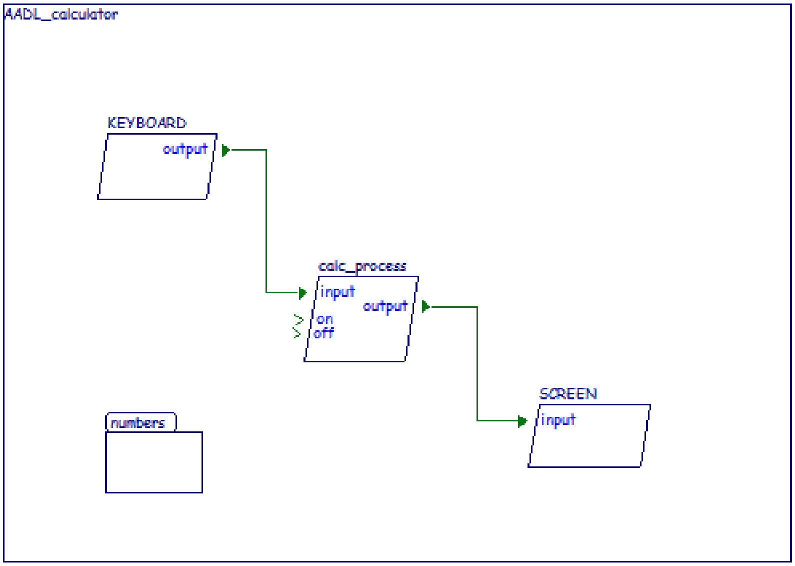
The **Process** currently only shows **Data Ports** in its interface. **Data Ports** can be used to describe data flows between components. We are now going to add **Event Ports** to specify control flow entry points for the **Process**.



To create a new **Event Port**, use the *new port* button of the button bar in the **AADL** diagram editor then click inside the `calc_process` box. Default name `port0` can be changed using the *Rename* contextual menu, as shown below:

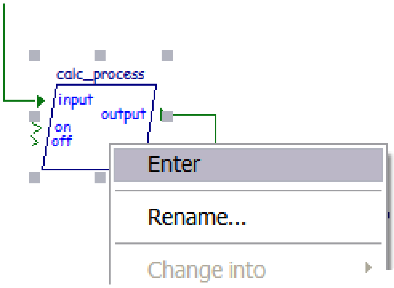


After having done the same for a second **Event Port** called `off`, the diagram must now be as follow:

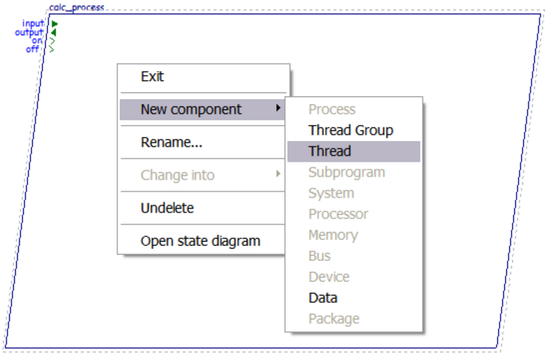


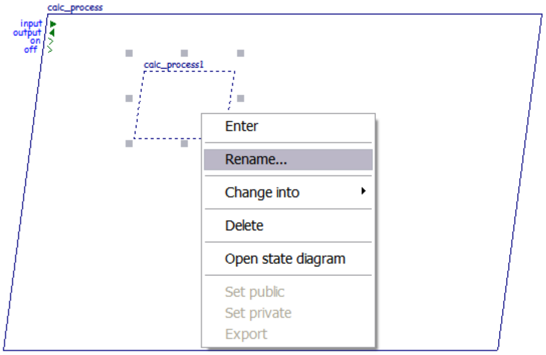
5.7 Add subcomponents to the process

It is now time to provide some details about the internals of our **Process**. The current graphical representation of `calc_process` only shows its interfaces. It is its *black box view*. In order to be able to edit its internal details, we must enter the component first to show its *white box view*. The *Enter* contextual menu, or a double-click, must be used for that purpose:

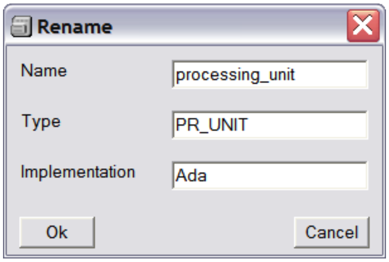


According to the **AADL** rules, a **Process** component implementation can contain **Thread Group**, **Thread** or **Data** subcomponents. To create a subcomponent, it is possible to use the *new AADL component* button of the button bar in the AADL diagram editor, or the *New component* contextual menu. The newly created component can be renamed using the *Rename* contextual menu as shown below:





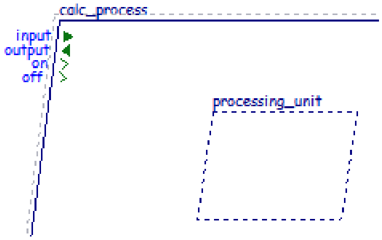
As already explained in section 3.6, the *Rename* dialog box is also used to specify the **AADL** component type and component implementation of the subcomponents.


Rename

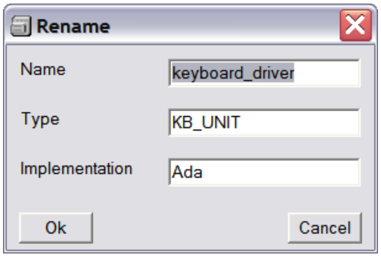
Name processing_unit

Type PR_UNIT

Implementation Ada



Our model can now be enriched by two other **Thread** subcomponents representing local **Device** interface software.

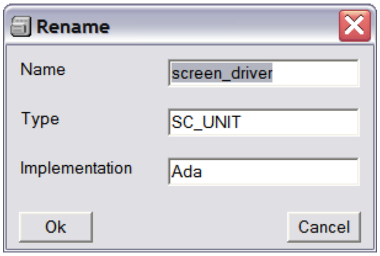


Rename

Name: keyboard_driver

Type: KB_UNIT

Implementation: Ada



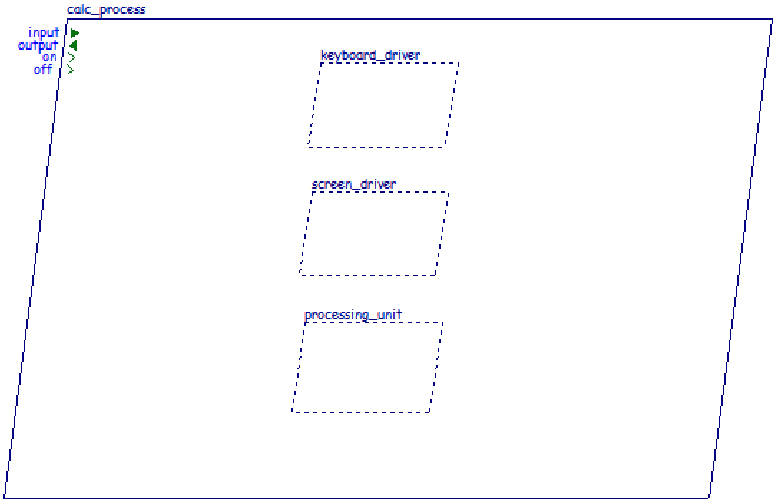
Rename

Name: screen_driver

Type: SC_UNIT

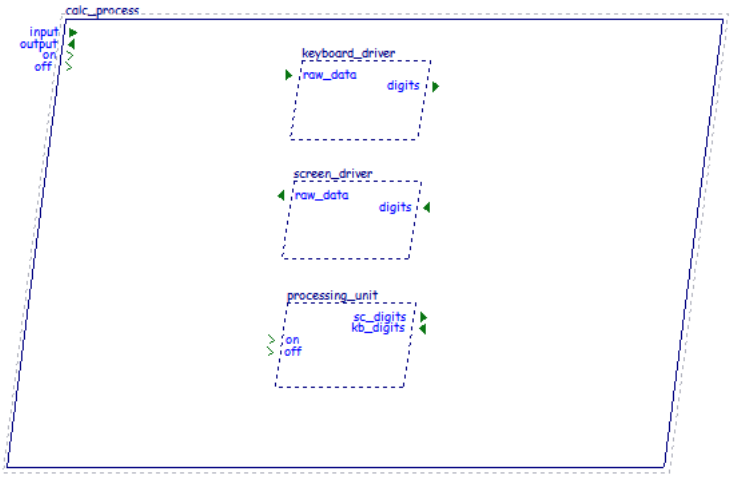
Implementation: Ada

The graphical representation of the internals of our **Process** now looks like the diagram below:

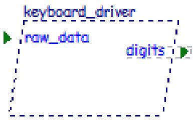


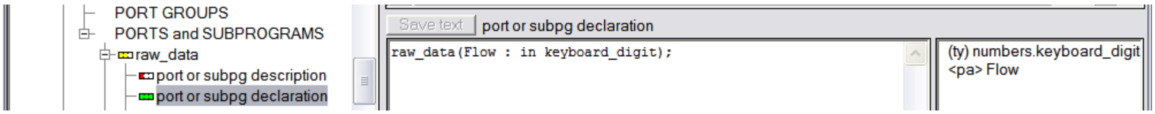
5.8 Create and customize ports in subcomponents

Following a top-down modelling process, we must now specify the interface of each subcomponent. Let us add ports as shown below:



The details for new port declarations are given below for each subcomponent:

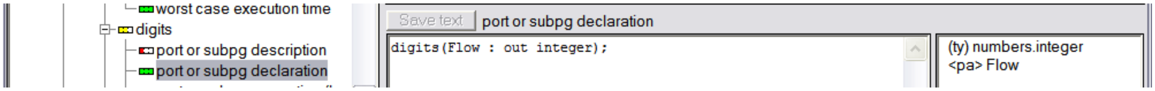




port or subpg declaration

```
raw_data(Flow : in keyboard_digit);
```

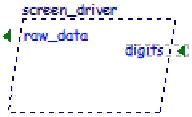
(ty) numbers.keyboard_digit
<pa> Flow

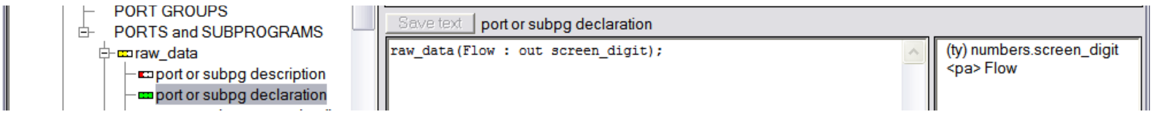

worst case execution time
digits
port or subpg description
port or subpg declaration
Save text

port or subpg declaration

```
digits(Flow : out integer);
```

(ty) numbers.integer
<pa> Flow

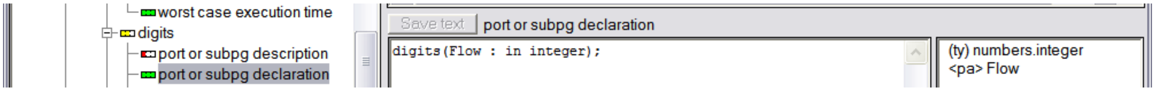




port or subpg declaration

```
raw_data(Flow : out screen_digit);
```

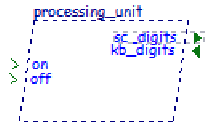
(ty) numbers.screen_digit
<pa> Flow

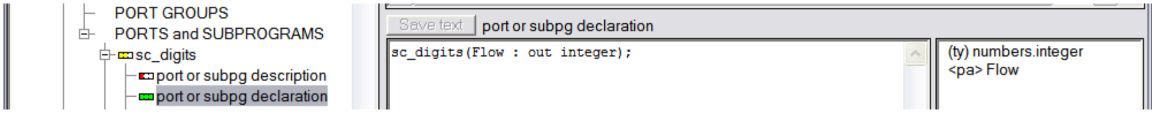

worst case execution time
digits
port or subpg description
port or subpg declaration
Save text

port or subpg declaration

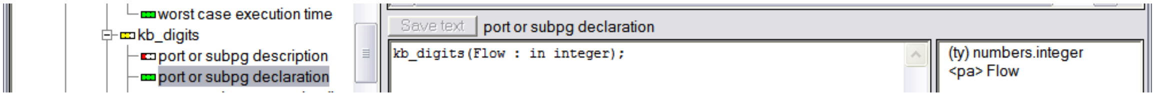
```
digits(Flow : in integer);
```

(ty) numbers.integer
<pa> Flow




PORT GROUPS
PORTS and SUBPROGRAMS
sc_digits
port or subpg description
port or subpg declaration
Save text
port or subpg declaration

```
sc_digits(Flow : out integer);
```

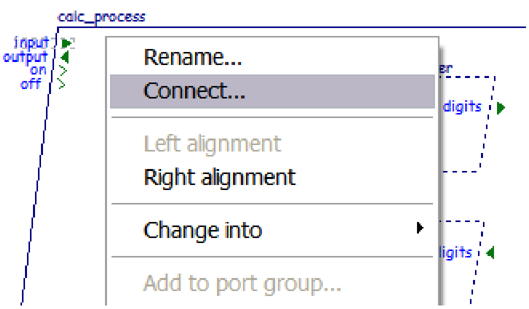

worst case execution time
kb_digits
port or subpg description
port or subpg declaration
Save text
port or subpg declaration

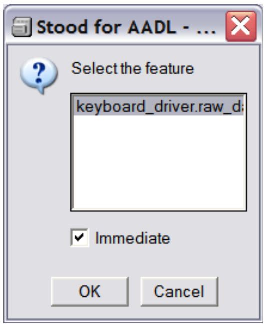
```
kb_digits(Flow : in integer);
```

(ty) numbers.integer
<pa> Flow

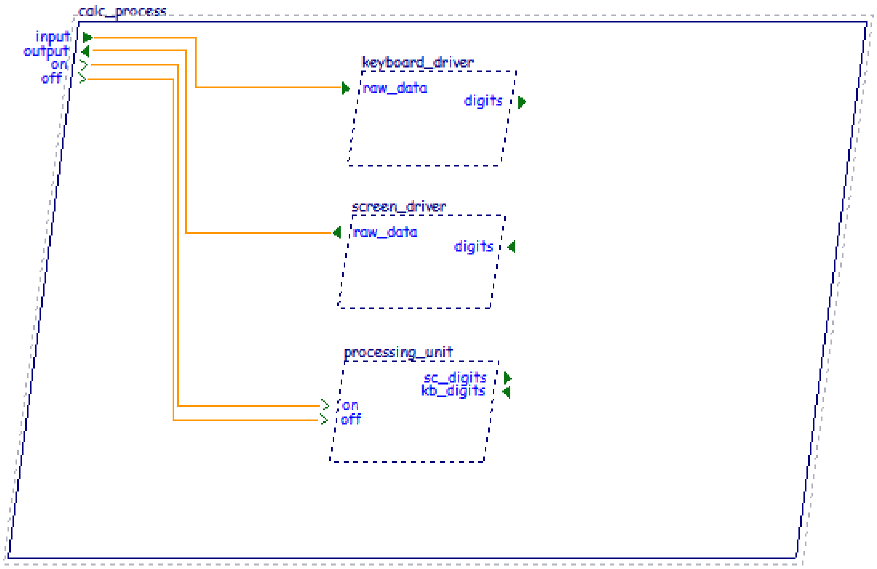
5.9 *Connect ports between a component and its subcomponents*

Connections can now be established between the interface of outer component and the interface of its inner subcomponents. To create such connections, it is possible to use the *new connection* button in the button bar of the **AADL** diagram editor and click in sequence on the two ports to be connected. Another solution consists in selecting a port in the outer component interface and calling the *Connect* contextual menu.



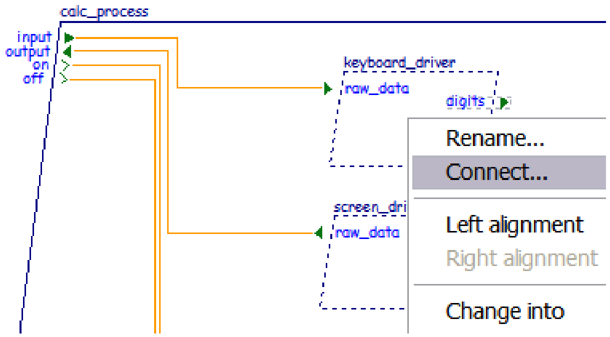


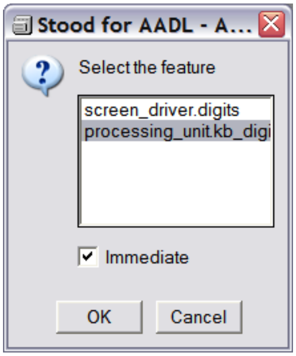
Note that only the direction and type compatible ports are proposed in the dialog box. The new diagram that is obtained after having connected the four ports of **Process** interface is:



5.10 Connect ports between subcomponents

To connect ports between subcomponents of a same component, it is possible to use the *new connection* button in the button bar of the **AADL** diagram editor and click in sequence on the two ports to be connected. Another solution consists in selecting a port in one of the subcomponent interface and calling the *Connect* contextual menu.



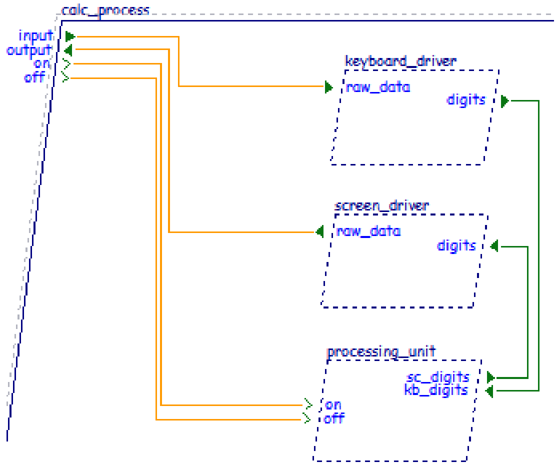


Select the feature

screen_driver.digits
processing_unit.kb_digi

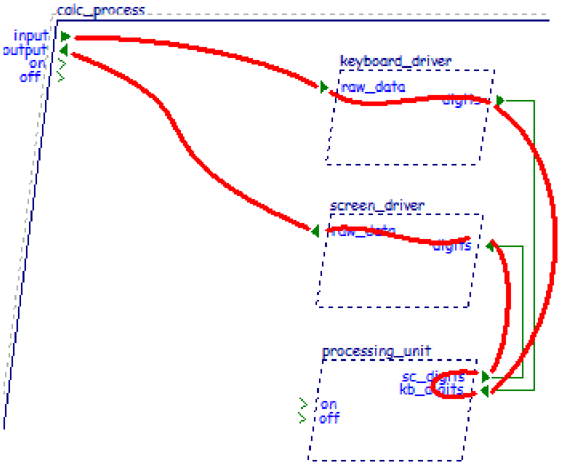
☑ Immediate

Note that only the direction and type compatible ports are proposed in the dialog box. The new diagram that is obtained after having connected all the remaining is as follow:

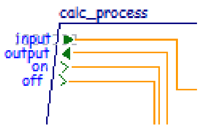


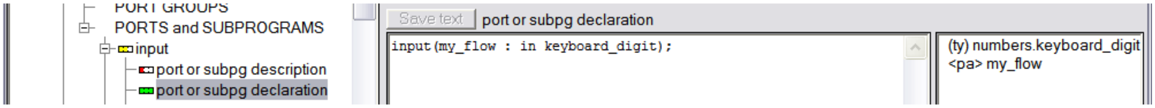
5.11 Specify flows

AADL connections represent point to point interaction between two ports of the same type and having compatible directions. Event if they do not refer to the same data type, several connections may participate to a same more global data flow. Stood has a particular way to express such flow specifications.



For each port involved in a given flow, the flow name must be inserted into the *port or subpg declaration* section in replacement to the default name `Flow`.



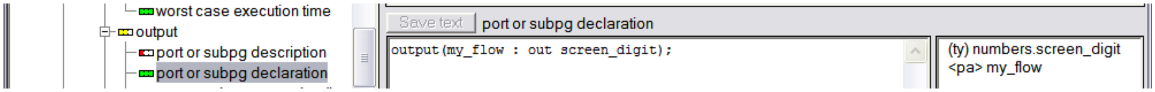


PORT GROUPS
PORTS and SUBPROGRAMS
input
port or subpg description
port or subpg declaration

port or subpg declaration

```
input(my_flow : in keyboard_digit);
```

(ty) numbers.keyboard_digit
<pa> my_flow

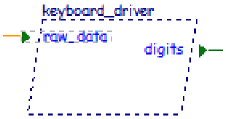


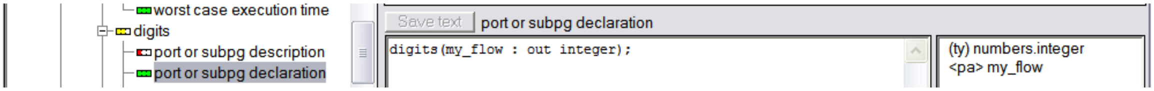
worst case execution time
output
port or subpg description
port or subpg declaration

port or subpg declaration

```
output(my_flow : out screen_digit);
```

(ty) numbers.screen_digit
<pa> my_flow





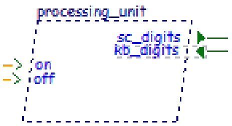
worst case execution time
digits
port or subpg description
port or subpg declaration

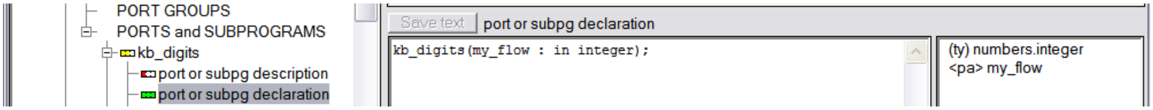
port or subpg declaration

```
digits(my_flow : out integer);
```

(ty) numbers.integer
<pa> my_flow

Note that port raw_data has been automatically updated thanks to the existing connection.



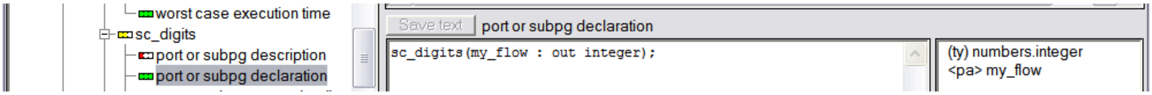


PORT GROUPS
PORTS and SUBPROGRAMS
kb_digits
port or subpg description
port or subpg declaration

port or subpg declaration

```
kb_digits(my_flow : in integer);
```

(ty) numbers.integer
<pa> my_flow

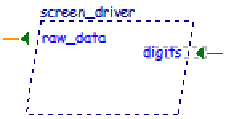


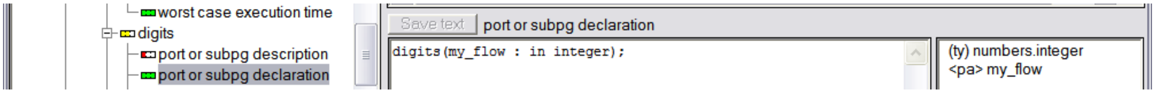
worst case execution time
sc_digits
port or subpg description
port or subpg declaration

port or subpg declaration

```
sc_digits(my_flow : out integer);
```

(ty) numbers.integer
<pa> my_flow



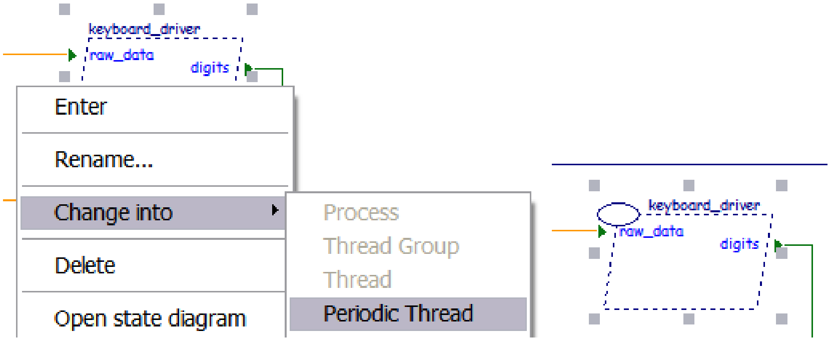

worst case execution time
digits
port or subpg description
port or subpg declaration
Save text
port or subpg declaration
(ty) numbers.integer
<pa> my_flow

```
digits(my_flow : in integer);
```

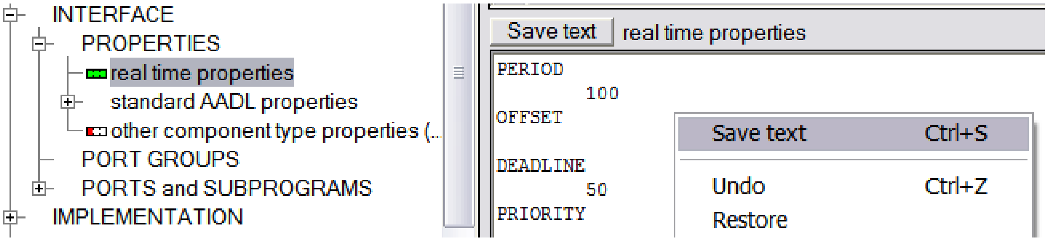
Note that port raw_data has been automatically updated thanks to the existing connection.

5.12 Specify real-time properties

Threads that have been created are *aperiodic*. When **Threads** are *periodic* or *sporadic*, more details about their real time behaviour can be managed by the tool. This subcomponent sub-category can be modified thanks to the contextual menu *Change into*. To illustrate this feature, let us change the two driver *aperiodic* **Threads** into *periodic* **Threads**:

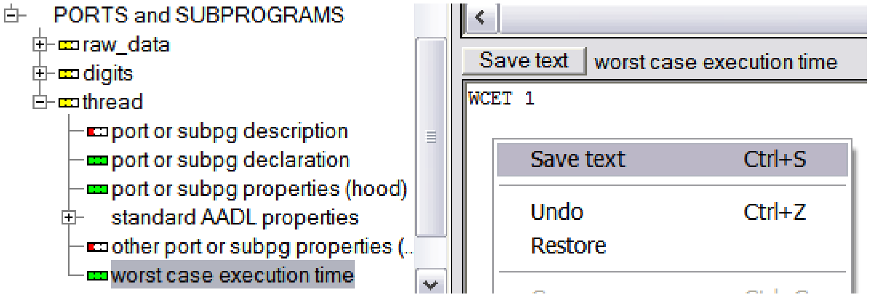


Note that the graphical notation has changed to comply with the **AADL** rules. Real time properties may be entered into the model as standard **AADL** Properties. However, basic schedulability analysis information may also be entered through **Stood** *real time properties* section. We can specify for instance that `keyboard_driver` has a *period* of `100 ms` and a *deadline* of `50 ms`:



```
PERIOD
          100
OFFSET

DEADLINE
          50
PRIORITY
```

In a similar way, Worst Case Execution Time can be specified for each **Subprogram** or **Thread**. Note that a default internal subprogram called `thread` has been automatically created by **Stood** in the model. Its *worst case execution time* section can be used to specify the **Thread** Compute_Execution_Time Property (default unit is ms):

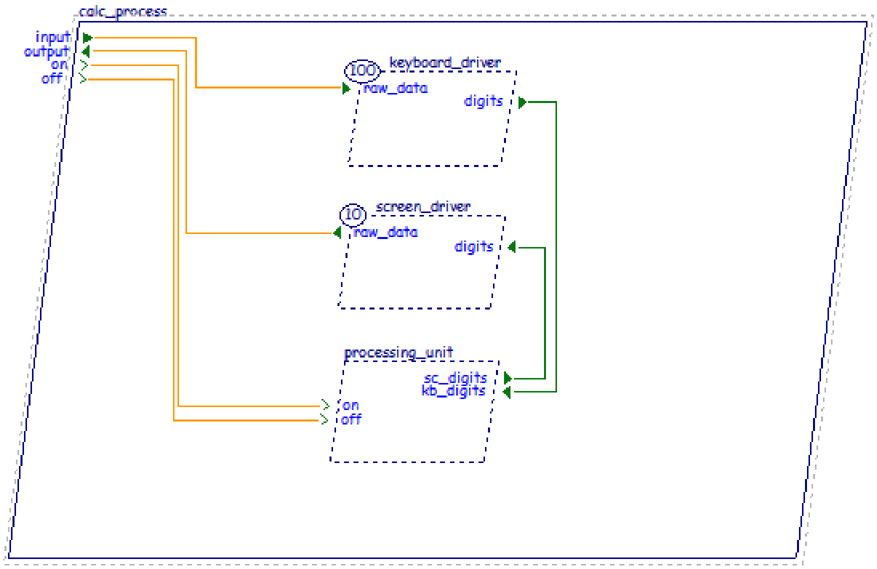


- PORTS and SUBPROGRAMS
  - raw_data
  - digits
  - thread
    - port or subpg description
    - port or subpg declaration
    - port or subpg properties (hood)
    - standard AADL properties
    - other port or subpg properties (..
    - worst case execution time

Save text worst case execution time

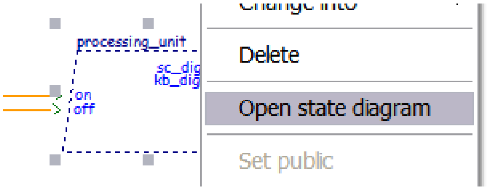
```
WCET 1
```

Similar modifications can now be done for the **Thread** `screen_driver` to change it into a periodic **Thread**, with a *period* of `10 ms`. The graphical model is now as shown below:



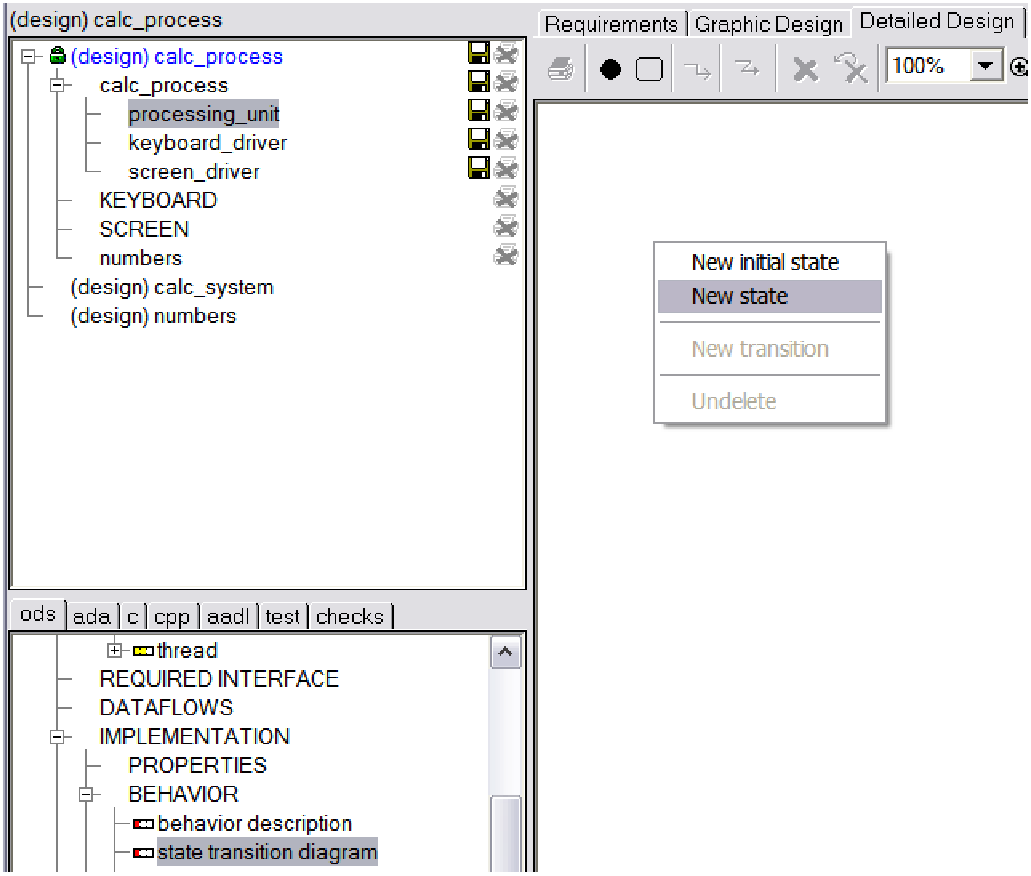
5.13 Specify modes

AADL Modes can be defined to represent operational states of a component. That is why a state diagram editor is used to specify them. We are going to illustrate this on the **Thread** `processing_unit`. The state diagram editor can be launched from the *Open state diagram* contextual menu:

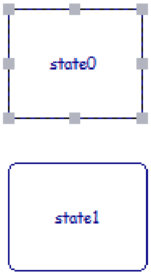


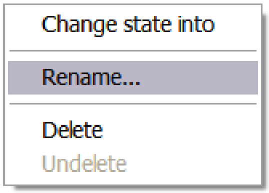
A new graphical editing area is then selected, where it is possible to create states representing **AADL Modes** and transitions representing **AADL Mode Transitions**.

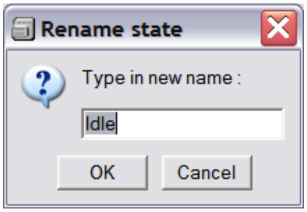
To create a new Mode, use the New state button or contextual menu:



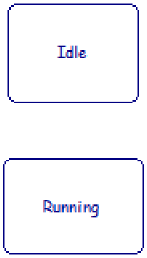
States are given a default name that can be modified thanks to the *Rename* contextual menu. Let us create two **Modes**: `idle` and `running`:



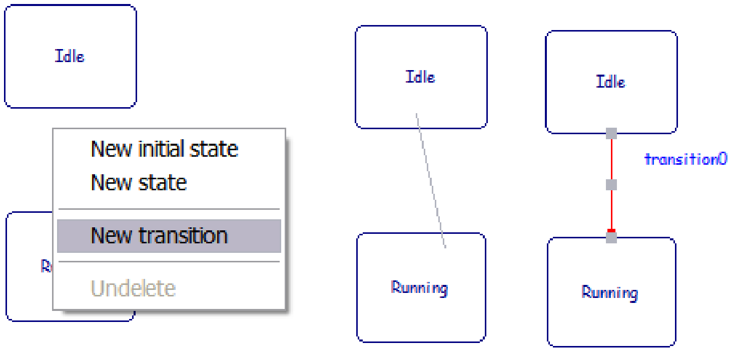




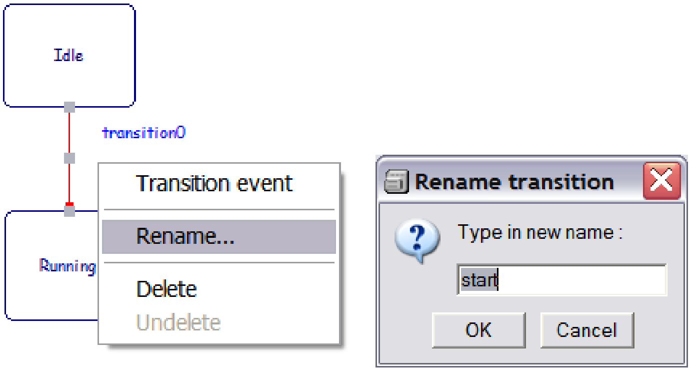
Type in new name : Idle



Transitions can be created with the *new transition* button or contextual menu. First click on the origin **Mode** and then on the destination **Mode**:



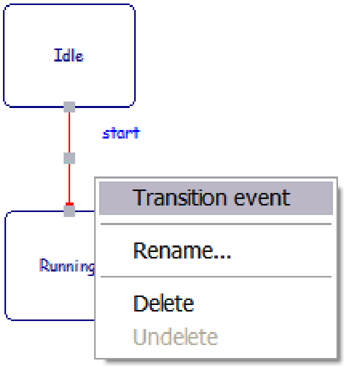
Transitions are also given a default name that can be changed with the *Rename* contextual menu:

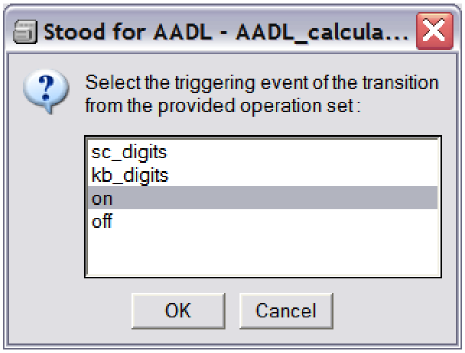


Rename transition

Type in new name : start

Transitions must also be attached to a triggering **Event**. Selection of the **Event** can be done thanks to the *select transition event* button or the *Transition event* contextual menu. This action opens a dialog box showing *all* the **Ports** and **Subprograms** defined in the interface of the current component. Note that only **In** and **In Out Event Ports** can be used to trigger **Mode Transitions**.

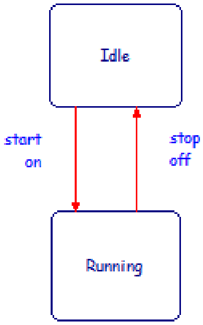



Stood for AADL - AADL_calcula...

Select the triggering event of the transition from the provided operation set :

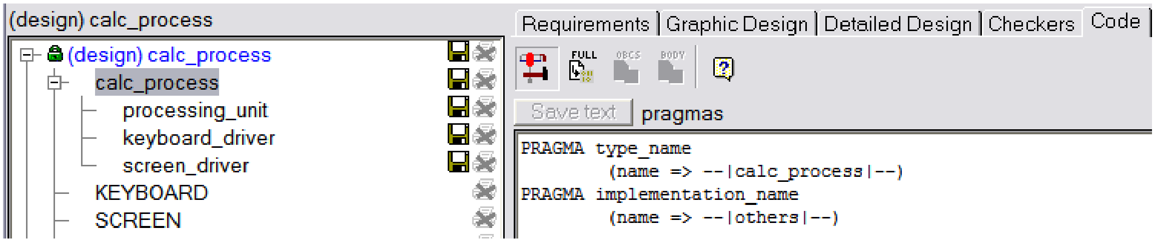
sc_digits
kb_digits
on
off

We can then complete our **Modes** definitions as shown below:



5.14 Generate the AADL code for the process

To generate textual **AADL** code from a graphical model in **Stood**, the *Code* tab must be selected instead of the *Graphic Design* one. The new button bar shows two buttons. The first button on the left is called *add pragma* and may be used to customize the code generation. Pressing this button opens a dialog box showing the list of the possible options that can be selected. Note that some options may have already been automatically inserted by **Stood**, as it is the case here.

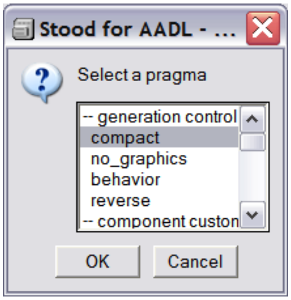

(design) calc_process

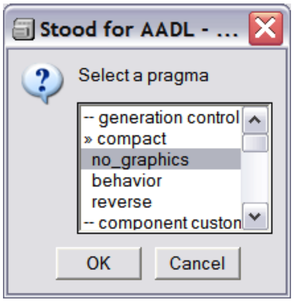
- (design) calc_process
  - calc_process
    - processing_unit
    - keyboard_driver
    - screen_driver
  - KEYBOARD
  - SCREEN

pragmas

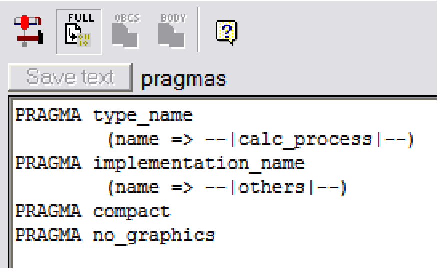
```
PRAGMA type_name
        (name => --|calc_process|--)
PRAGMA implementation_name
        (name => --|others|--)
```

Select pragma *compact* in order to generate all the **AADL** code in only one file (default rule is one file per component) and then pragma *no_graphics* to disable the generation of **Stood** specific properties that are used to propagate the positions of the graphical items in the diagram.

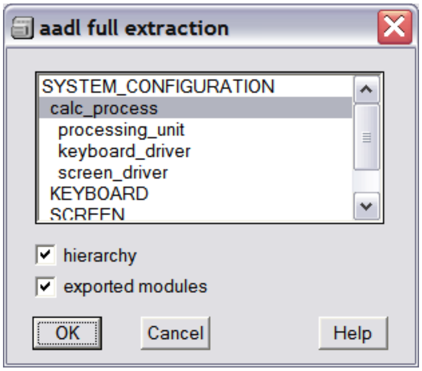




The **AADL** code generation can then be activated by pressing the *full extraction* button. This opens a dialog box that can be used to specify which part of the **Design** has to be generated. Most of the times, we need the whole **Design** to be generated, which is the choice that is proposed by default.



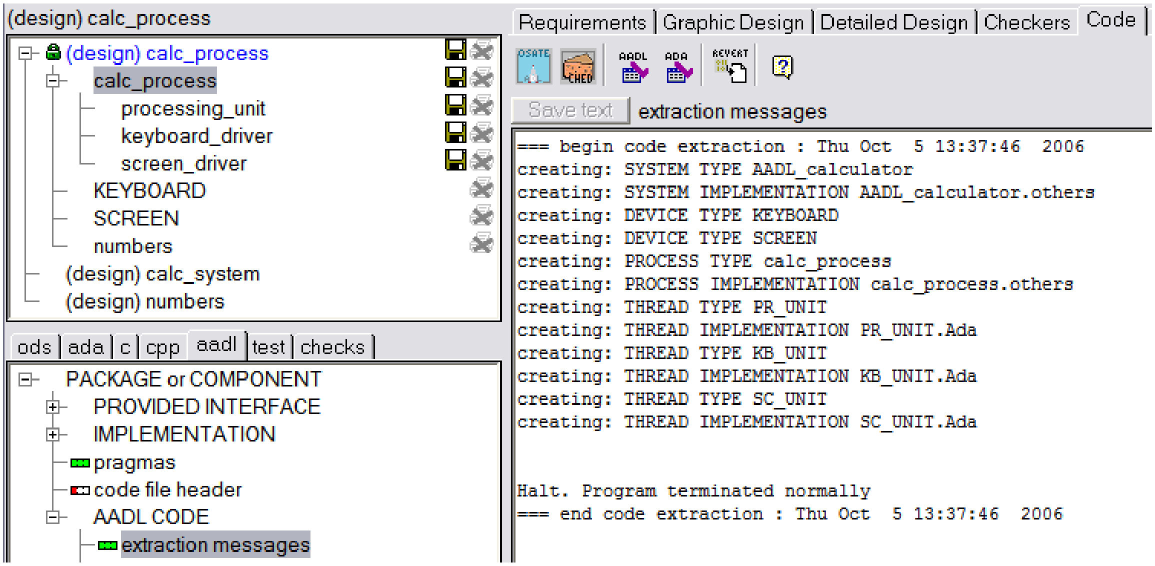
```
PRAGMA type_name
        (name => --|calc_process|--)
PRAGMA implementation_name
        (name => --|others|--)
PRAGMA compact
PRAGMA no_graphics
```



☑ hierarchy

☑ exported modules

After having pressed the *Ok* button and waited a little, the *extraction messages* file is shown. The messages file lists the abstract component types and implementations that had to be created to fully describe our **Process**. Note that the context of the **Process** is also generated as a **System** having the same name as the current **Project** and which also contains the two **Device** components.



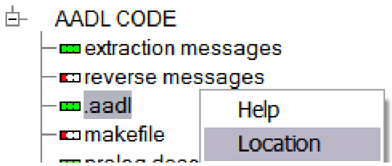
```
=== begin code extraction : Thu Oct  5 13:37:46  2006
creating: SYSTEM TYPE AADL_calculator
creating: SYSTEM IMPLEMENTATION AADL_calculator.others
creating: DEVICE TYPE KEYBOARD
creating: DEVICE TYPE SCREEN
creating: PROCESS TYPE calc_process
creating: PROCESS IMPLEMENTATION calc_process.others
creating: THREAD TYPE PR_UNIT
creating: THREAD IMPLEMENTATION PR_UNIT.Ada
creating: THREAD TYPE KB_UNIT
creating: THREAD IMPLEMENTATION KB_UNIT.Ada
creating: THREAD TYPE SC_UNIT
creating: THREAD IMPLEMENTATION SC_UNIT.Ada


Halt. Program terminated normally
=== end code extraction : Thu Oct  5 13:37:46  2006
```

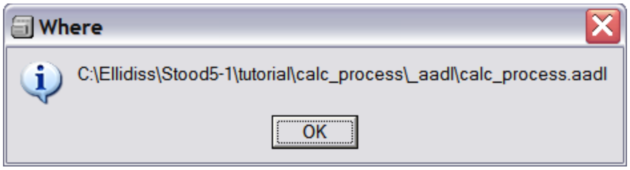
5.15 Show generated AADL code

The **AADL** generated code can be shown by changing the selection in the lower left list of the **Stood** window from *extraction messages* to *aadl*.

Note that, due to the fact that we put a pragma *compact*, **AADL** code has been associated to the root component in the hierarchy only.

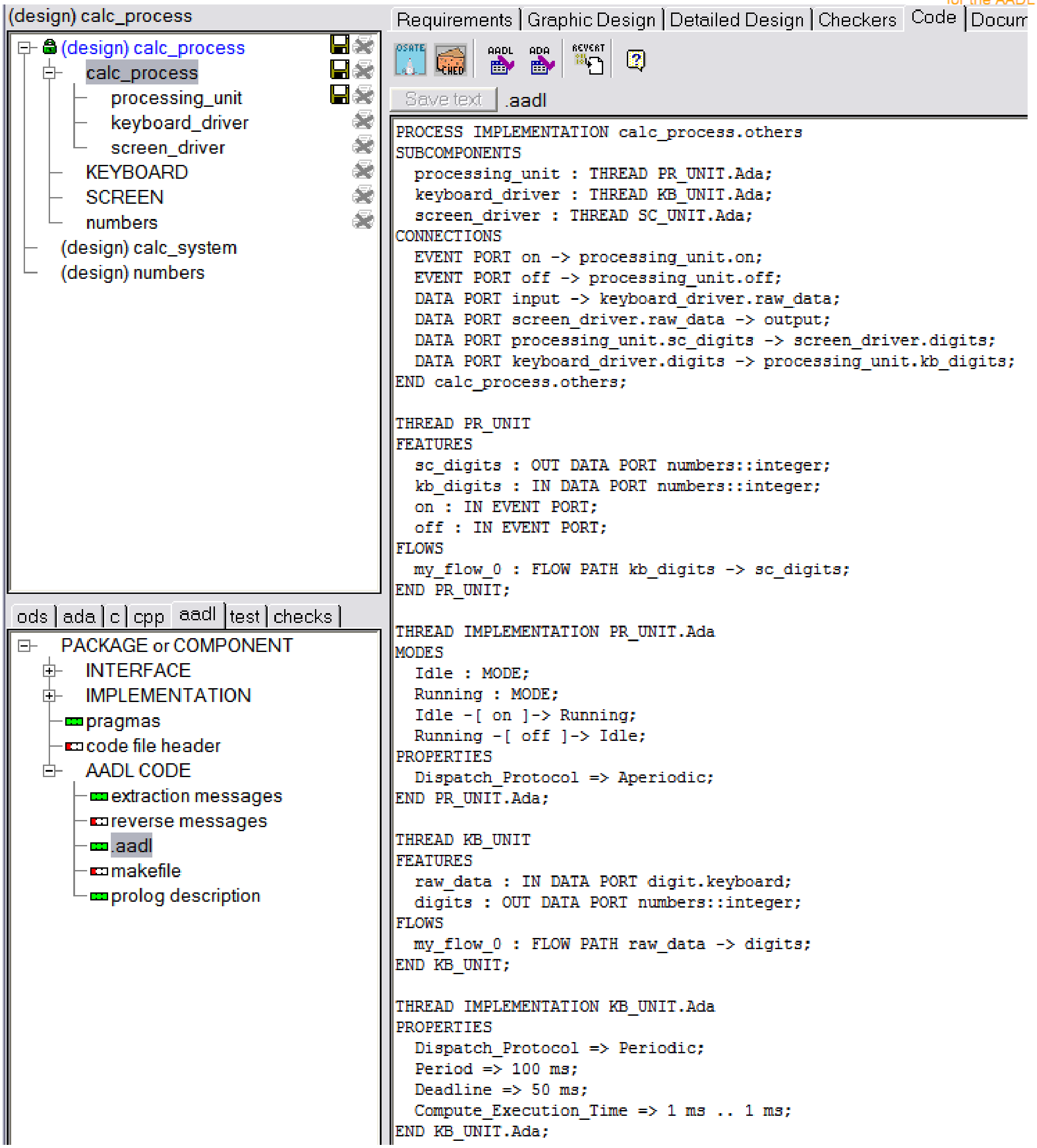
This **AADL** code can be edited with **Stood**, but the corresponding file in the repository may be easily located for a remote access. To locate a particular file, select the corresponding entry in the lower left list and use the *Location* contextual menu.





C:\Ellidiss\Stood5-1\tutorial\calc_process_aadl\calc_process.aadl

The screenshot below shows the result of an **AADL** code generation that only uses the information that has been inserted during the previous modelling steps:



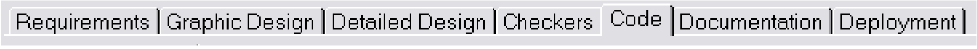
```
PROCESS IMPLEMENTATION calc_process.others
SUBCOMPONENTS
  processing_unit : THREAD PR_UNIT.Ada;
  keyboard_driver : THREAD KB_UNIT.Ada;
  screen_driver : THREAD SC_UNIT.Ada;
CONNECTIONS
  EVENT PORT on -> processing_unit.on;
  EVENT PORT off -> processing_unit.off;
  DATA PORT input -> keyboard_driver.raw_data;
  DATA PORT screen_driver.raw_data -> output;
  DATA PORT processing_unit.sc_digits -> screen_driver.digits;
  DATA PORT keyboard_driver.digits -> processing_unit.kb_digits;
END calc_process.others;

THREAD PR_UNIT
FEATURES
  sc_digits : OUT DATA PORT numbers::integer;
  kb_digits : IN DATA PORT numbers::integer;
  on : IN EVENT PORT;
  off : IN EVENT PORT;
FLOWS
  my_flow_0 : FLOW PATH kb_digits -> sc_digits;
END PR_UNIT;

THREAD IMPLEMENTATION PR_UNIT.Ada
MODES
  Idle : MODE;
  Running : MODE;
  Idle -[ on ]-> Running;
  Running -[ off ]-> Idle;
PROPERTIES
  Dispatch_Protocol => Aperiodic;
END PR_UNIT.Ada;

THREAD KB_UNIT
FEATURES
  raw_data : IN DATA PORT digit.keyboard;
  digits : OUT DATA PORT numbers::integer;
FLOWS
  my_flow_0 : FLOW PATH raw_data -> digits;
END KB_UNIT;

THREAD IMPLEMENTATION KB_UNIT.Ada
PROPERTIES
  Dispatch_Protocol => Periodic;
  Period => 100 ms;
  Deadline => 50 ms;
  Compute_Execution_Time => 1 ms .. 1 ms;
END KB_UNIT.Ada;
```

Note that this view has new buttons that can be used to activate **AADL** compliant tools such as **Osate** or **Cheddar.**

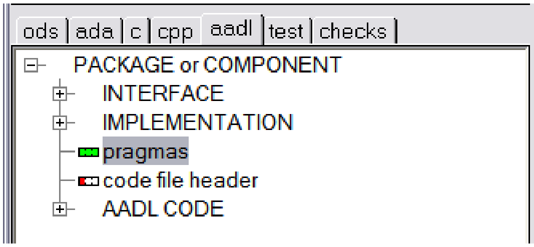
5.16 Generate Ada code

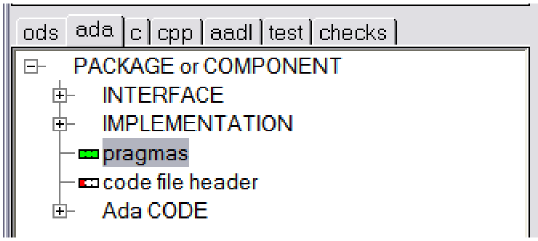
Without changing anything in the design model, it is possible to also generate **Ada**, **C** or **C++** source code. The process for generating **Ada** code (for instance) is very similar to the one applied to generate the **AADL** code, i.e.:

(a) Select the *Code* tab again:



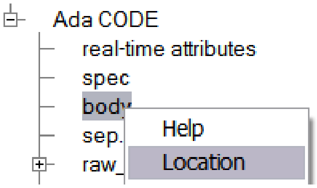
(b) Change the source language tab from *aadl* to *cpp*:

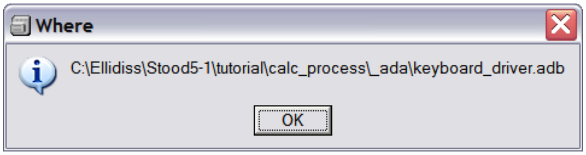




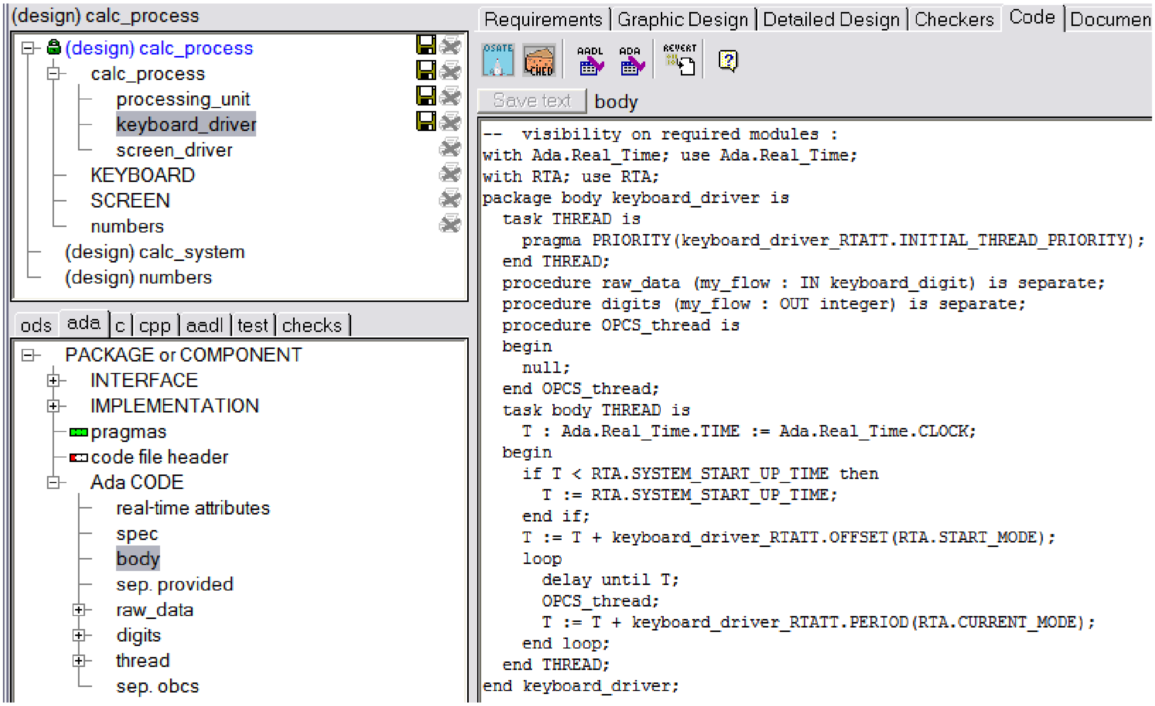
(c) Press the *full extraction* button, then the *OK* button in the dialog box. Generated files can be shown by selecting the appropriate items in the selection lists (see next page).

Note that the generated **Ada** source files are stored in a default location in the **Workspace**. Location of each file can be found easily thanks to the *Location* contextual menu:





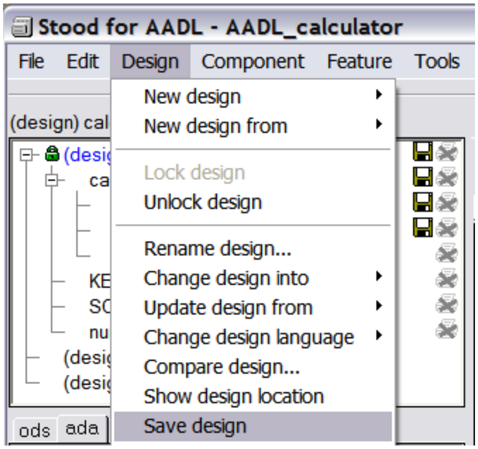
C:\Ellidiss\Stood5-1\tutorial\calc_process_ada\keyboard_driver.adb



```
-- visibility on required modules :
with Ada.Real_Time; use Ada.Real_Time;
with RTA; use RTA;
package body keyboard_driver is
  task THREAD is
    pragma PRIORITY(keyboard_driver_RTATT.INITIAL_THREAD_PRIORITY);
  end THREAD;
  procedure raw_data (my_flow : IN keyboard_digit) is separate;
  procedure digits (my_flow : OUT integer) is separate;
  procedure OPCS_thread is
  begin
    null;
  end OPCS_thread;
  task body THREAD is
    T : Ada.Real_Time.TIME := Ada.Real_Time.CLOCK;
  begin
    if T < RTA.SYSTEM_START_UP_TIME then
      T := RTA.SYSTEM_START_UP_TIME;
    end if;
    T := T + keyboard_driver_RTATT.OFFSET(RTA.START_MODE);
    loop
      delay until T;
      OPCS_thread;
      T := T + keyboard_driver_RTATT.PERIOD(RTA.CURRENT_MODE);
    end loop;
  end THREAD;
end keyboard_driver;
```

5.17 Save the design

It is recommended to save the design to the design directory from time to time. To do so, use the menu *Design/Save design*.



6 Conclusion

This tutorial does not provide information about all the possible modelling and model processing features of **Stood**. In particular, this first version of the document does not give explanations about the following important topics that are nevertheless already supported by **Stood 5.2**:

- Create a new **Design** from a remote **AADL** textual specification.
- Update an existing **Design** from a remote **AADL** textual specification.
- Create an **AADL** model from legacy **Ada** or **C** source files.
- Use the integrated **Design** verification tools.
- Perform software to hardware binding.

Ellidiss
Software
TNI Europe Limited

www.ellidiss.com
stood@ellidiss.com

TNI Europe Limited
Triad House
Mountbatten Court
Worall Street
Congleton
Cheshire
CW12 1AG
UK

+44 1260 291 449

Ellidiss Technologies
Technopôle Brest-Iroise
115 rue Claude Chappe
29280 Plouzané
Brittany
France

+33 298 451 870

www.aadl.info