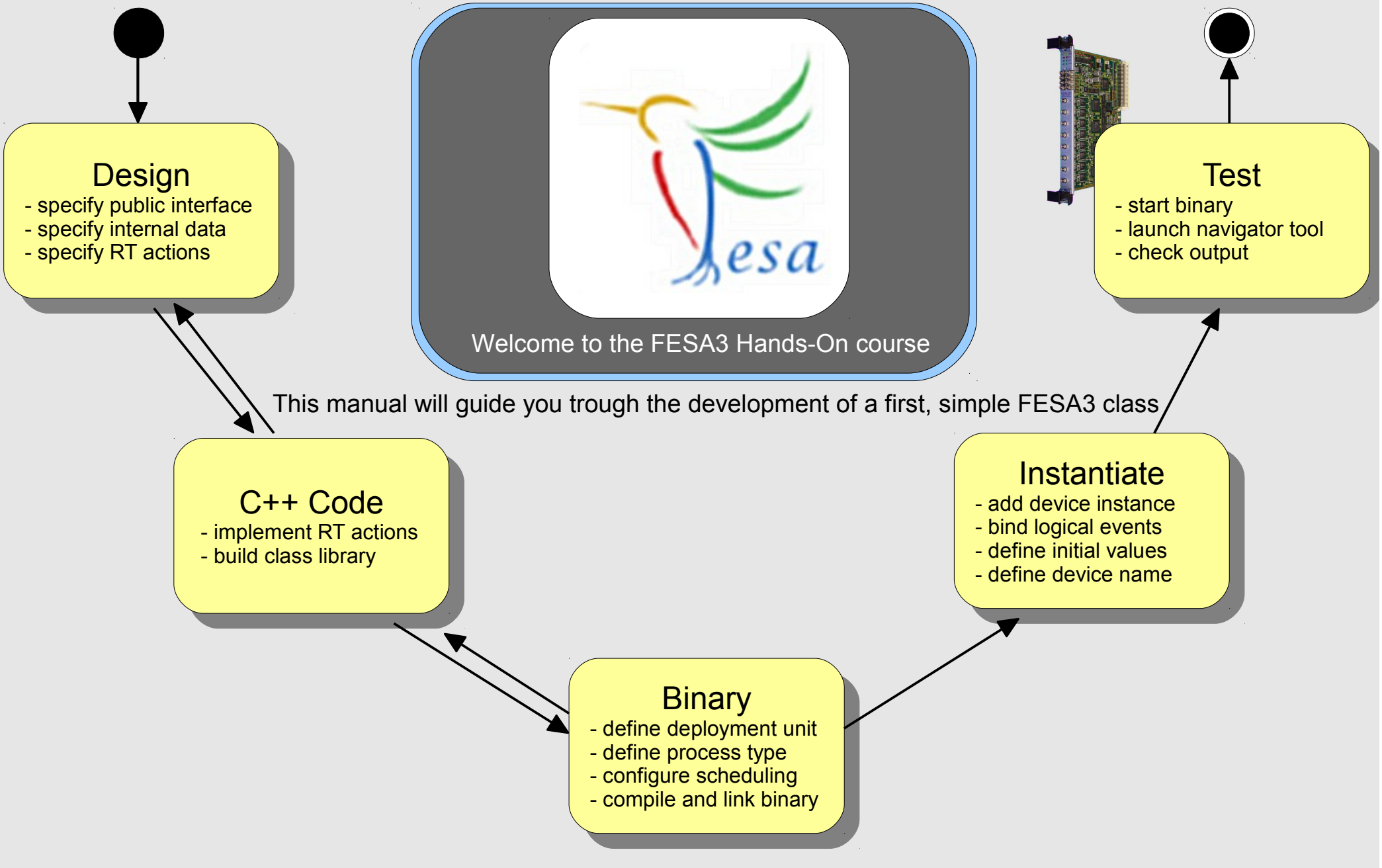

Welcome to the FESA3 Hands-On course
This manual will guide you trough the development of a first, simple FESA3 class
Design
- specify public interface
- specify internal data
- specify RT actions
C++ Code
- implement RT actions
- build class library
Binary
- define deployment unit
- define process type
- configure scheduling
- compile and link binary
Instantiate
- add device instance
- bind logical events
- define initial values
- define device name
Test
- start binary
- launch navigator tool
- check output

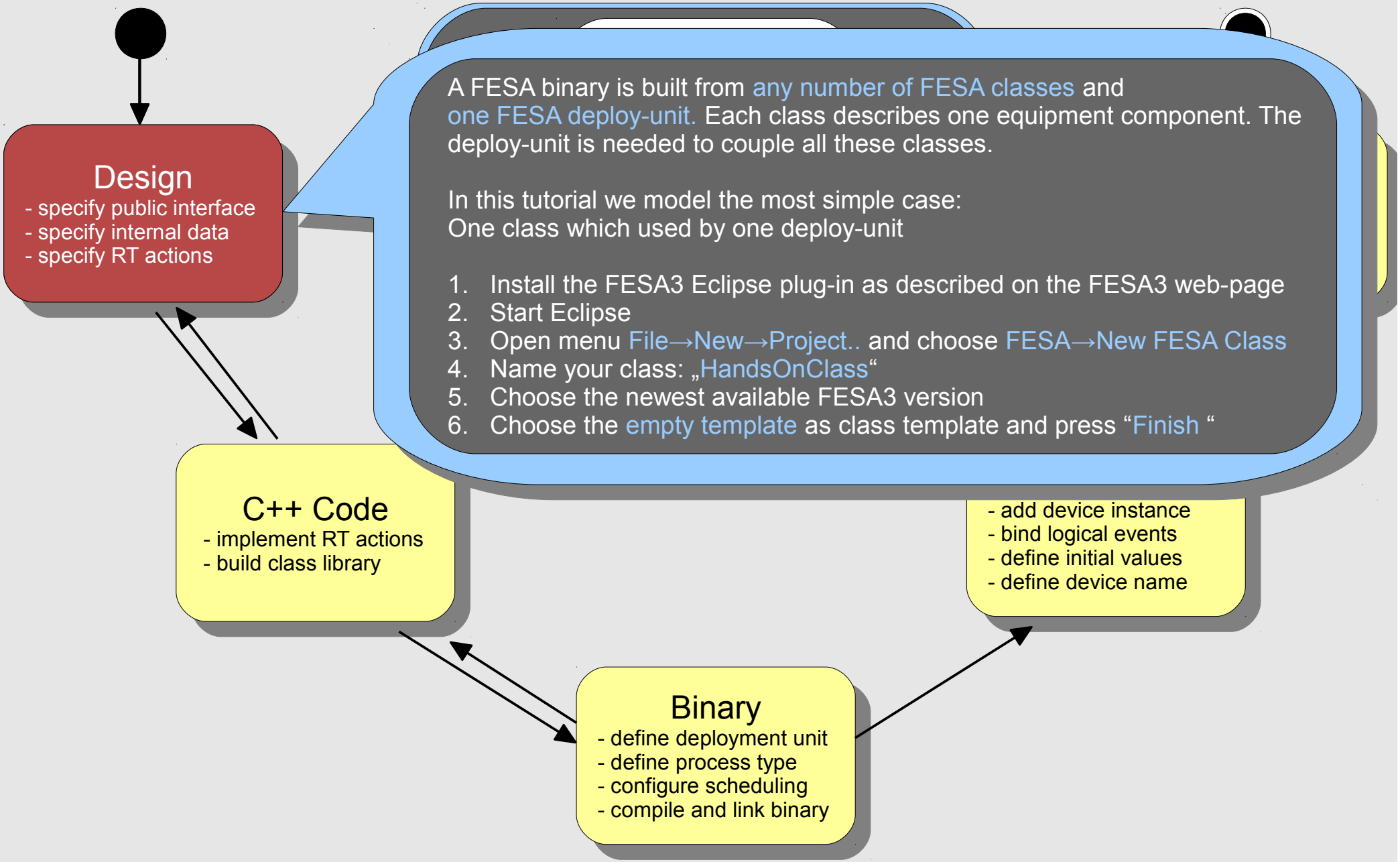
The Mission

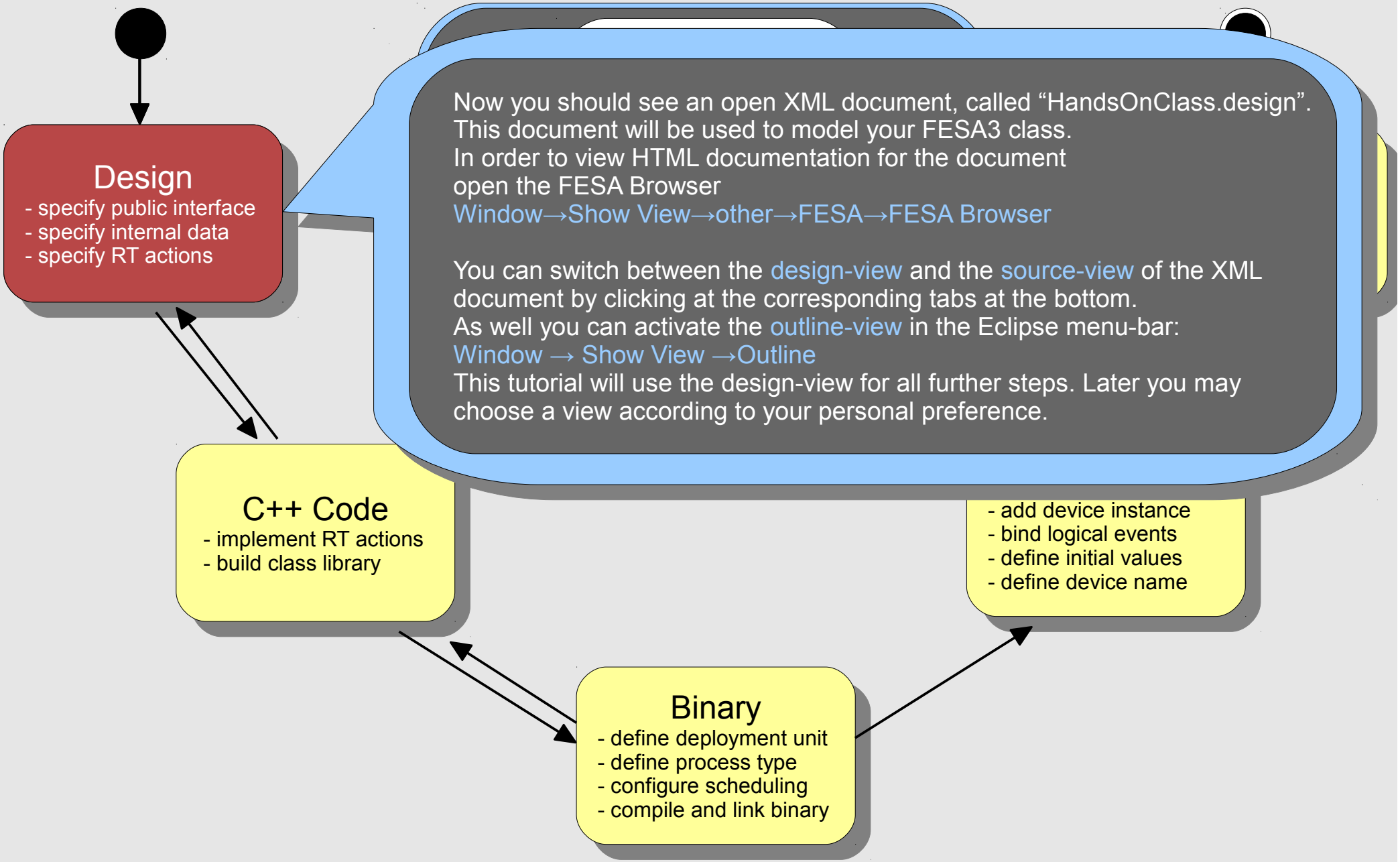
Implement a random number generator using FESA

Requirements (I):

- Generate one random number per second
- Allow clients to subscribe to the generated random numbers
- Allow clients to specify max-limit for the random numbers (greatest number which can be generated)

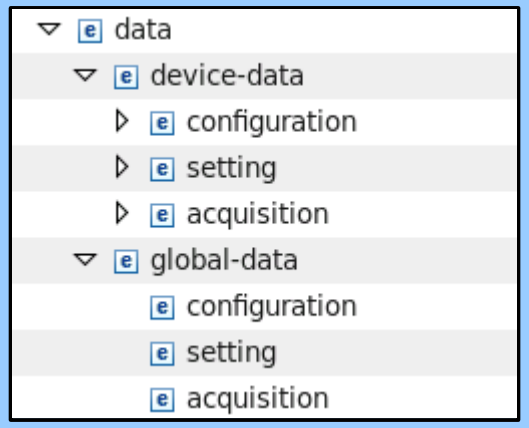
On any problems: fesa-support@gsi.de

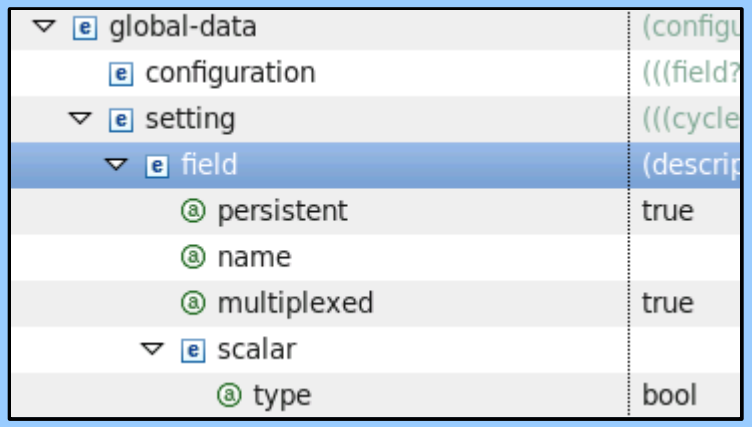

Design
- specify public interface
- specify internal data
- specify RT actions
A FESA binary is built from any number of FESA classes and one FESA deploy-unit. Each class describes one equipment component. The deploy-unit is needed to couple all these classes.
In this tutorial we model the most simple case:
One class which used by one deploy-unit
1. Install the FESA3 Eclipse plug-in as described on the FESA3 web-page
2. Start Eclipse
3. Open menu File→New→Project.. and choose FESA→New FESA Class
4. Name your class: „HandsOnClass“
5. Choose the newest available FESA3 version
6. Choose the empty template as class template and press “Finish “
C++ Code
- implement RT actions
- build class library
- add device instance
- bind logical events
- define initial values
- define device name
Binary
- define deployment unit
- define process type
- configure scheduling
- compile and link binary


Design
- specify public interface
- specify internal data
- specify RT actions
Now you should see an open XML document, called “HandsOnClass.design”.
This document will be used to model your FESA3 class.
In order to view HTML documentation for the document
open the FESA Browser
Window→Show View→other→FESA→FESA Browser
You can switch between the design-view and the source-view of the XML
document by clicking at the corresponding tabs at the bottom.
As well you can activate the outline-view in the Eclipse menu-bar:
Window → Show View →Outline
This tutorial will use the design-view for all further steps. Later you may
choose a view according to your personal preference.
C++ Code
- implement RT actions
- build class library
- add device instance
- bind logical events
- define initial values
- define device name
Binary
- define deployment unit
- define process type
- configure scheduling
- compile and link binary

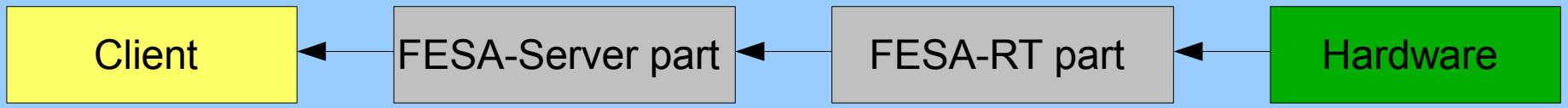
Theoretical background

- spe
- spe
- spe

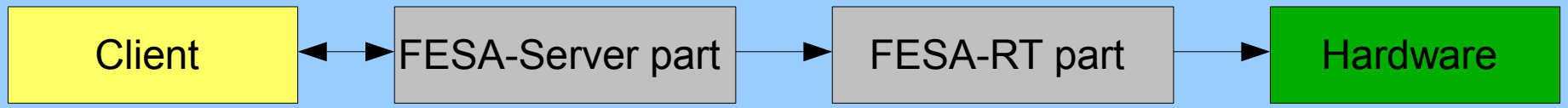




Data-flow – Acquisition



Data-flow – Setting



Design
- specify public interface
- specify internal data
- specify RT actions

C++ Code
- implement RT ac
- build class library

Binary
- define deployment unit
- define process type
- configure scheduling
- compile and link binary

Now we will start to fill our empty class design. The goal is to design a class which generates one random number per second.

data	
device-data	
setting	
field	
persistent	true
name	randomNumberMax
multiplexed	false
scalar	
type	int32_t
acquisition	
field	
name	randomNumber
multiplexed	false
scalar	
type	int32_t

We start with defining the definition of the needed data-containers. Just add all missing elements, like shown in the picture. (right-click-->add-child)

The random number itself is stored as “acquisition” data, since we want to send it to the client.

The maximum number which can be generated shall be configurable by the client. So we choose to store it as “setting”-data.

Click on each element to view the HTML documentation in the FESA Browser!

Theoretical background

- spe
- spe
- spe

interface	(de
device-interface	(se
setting	((c
acquisition	((a
global-interface	(se
setting	((c
acquisition	((a

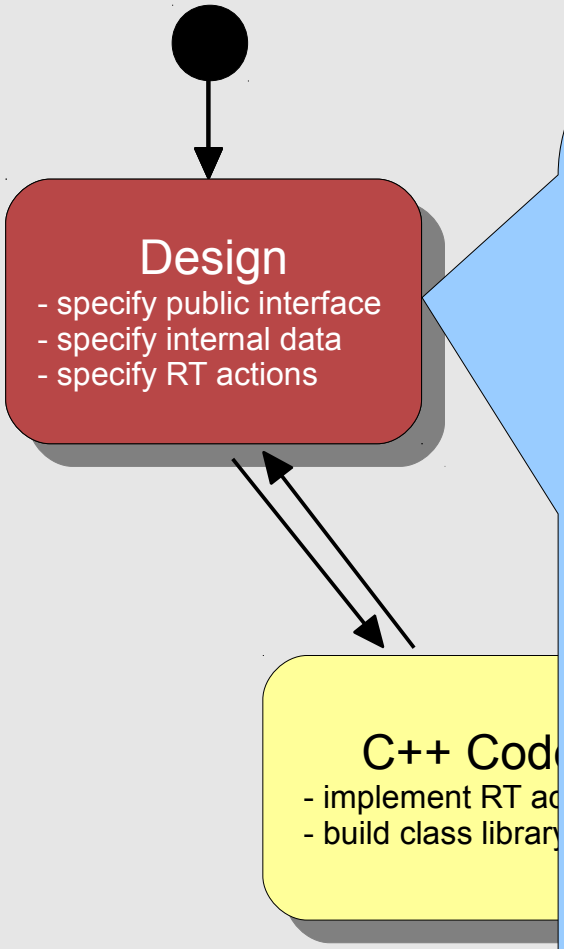
setting-property	((description*), (fi
visibility	operational
name	MyProperty
multiplexed	false
value-item	((description*, (sc
name	myValueItem
direction	INOUT
scalar	
type	bool
data-field-ref	
field-name-ref	mySettingField
update-flag-item	(description*, cus
cycle-name-item	(description*, arra
set-action	(server-action-ref
server-action-ref	
server-action-name-ref	MySetAction
get-action	(server-action-ref

Client-code-examples :

device = rda → getDeviceHandle(devicename, servername);
data = device → get (propertyname, cyclename, context);
device → set (propertyName, cyclename, settingdata, context);
Request = device → monitorOn (propertyName, cyclename, replyhandler, context);
device → monitorOff (request);

- actions
  - get/set-server-action (1..n)
    - @implementation
    - @name
    - ...

get-server-action	((description*),
implementation	default
name	MyGetAction
set-server-action	(((description*
implementation	custom
name	MySetAction



In order to provide client-read-access to the defined internal data, we need to add properties in the “interface”-part of our class.

interface	
device-interface	(setting?, acquisition
setting	
acquisition	((acquisition-propert
acquisition-property	
visibility	operational
name	RandomNumber
multiplexed	false
value-item	
name	randomNumber
direction	OUT
scalar	
type	int32_t
data-field-ref	
field-name-ref	randomNumber
get-action	(server-action-ref | al
server-action-ref	
server-action-name-	GetRandomNumber

We define an acquisition-property, which can be read by the client via “Get” or “Subscribe”.

Value-Items are used to outline which data is transferred by a property. Here we connect the value-item to our field, in order to transfer our internal data.

Only the elements which need to be modified are shown here !!

The get-action models the C++ implementation of the data-transfer. Note that the XML file will show an error as long as the action does not exist:

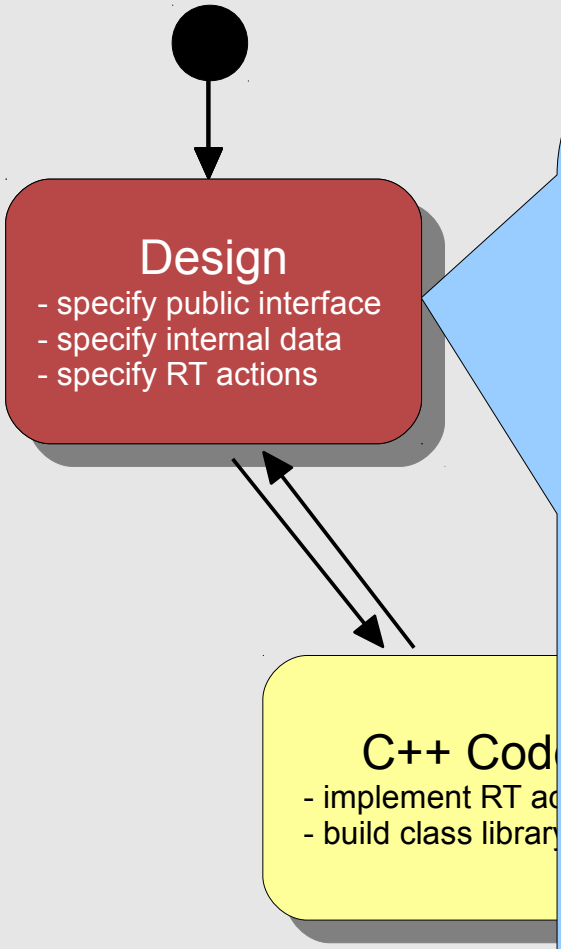
actions	
get-server-action	
implementation	default
name	GetRandomNumber

get-action	
server-action-ref	
server-action-name-	GetRandomNumber

You can check the concrete error message in the “source”-view. (click on red dot)

```
69        </cycle-stamp-item>
70        <get-action>
71            <server-action-ref server-action-name-ref="GetRandomNumber" />
72        </get-action>
73    </acquisition-property></acquisition></device-interface>
```

Validate your FESA class design with the validate button !



Now we proceed in the same way for our setting-field "randomNumberMax", in order to give the client write-access to it..

set-server-action	(((description*), (disabling-
implementation	default
name	SetRandomNumberLimits
get-server-action	((description*), (disabling-
implementation	default
name	GetRandomNumberLimits

This time we start with the actions, in order to use the auto-completion feature.
Again we choose implementation = "default". So we don't need to provide own C++ code for this action.

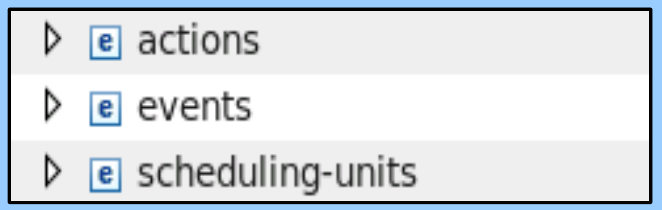
interface	(device-interface?, global-i
device-interface	(setting?, acquisition?)
setting	((command-property*, sett
setting-property	((description*), (filter-item*
multiplexed	false
name	RandomNumberLimits
visibility	operational
value-item	((description*, (scalar | arra
direction	INOUT
name	randomNumberMax
scalar	
type	int32_t
data-field-ref	
field-name-ref	randomNumberMax
set-action	(server-action-ref | abstract
server-action-ref	
server-action-name-ref	SetRandomNumberLimits
get-action	(server-action-ref | abstract
server-action-ref	
server-action-name-ref	GetRandomNumberLimits

A setting-property can be written by a client with "Set" or re-read via "Get".

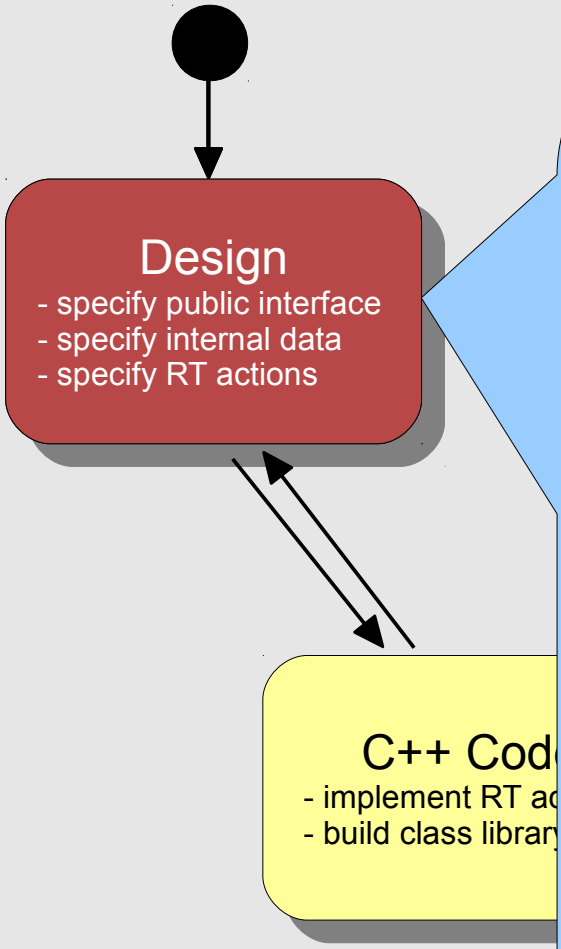
Note that now you can choose the get- and set-actions from a list, because we defined the actions in advance.

Theoretical background

- events
  - sources
    - timer
    - timing
    - on-demand
    - on-subscription
    - custom
  - logical-events (1 .. n)
    - @use
    - @name
    - @type
- actions
  - rt-action (1..n)
    - @name
      - notified-property (1..n)
        - @property-name-ref
        - @automatic



- scheduling-units
  - scheduling-unit (1..n)
    - @name
    - rt-action-ref
    - logical-event-ref



Finally we will design the random number generation itself. For this purpose we use a timer-event-source which periodically triggers an action.

events	
sources	
timing-event-source	
timer-event-source	
logical-events	
logical-event	
use	required
name	timerEvent
type	timer

First we define the event-source and the logical-event which is used by this source.
Right-click on the root-element “equipment-model” in order to add the element “events”.

actions	
rt-action	
name	GenerateRandomNumber
notified-property	
property-name-ref	RandomNumber
automatic	true

All actions which do not interact with the client are called “rt-action”. This is what we need for the number generation. We as well choose to automatically notify all clients which subscribed to our property “GetRandomNumber”.

scheduling-units	
scheduling-unit	
name	TimerSchedulingUnit
rt-action-ref	
rt-action-name-ref	GenerateRandomNumber
logical-event-ref	
logical-event-name-ref	timerEvent

In order to connect our rt-action with the logical-event, we need to add a “scheduling-unit”.
Again right-click on the root-element in order to add the element “scheduling-units”.

Finally you finished the design-phase! Now re-check if your design is valid by pressing and fix all remaining bugs.
After that, trigger the code generation by pressing the button. This will generate the C++ source code skeleton of your class.

Theoretical background

- **C++ coding**
  - Use the Wiki !!!
    - “FESA3 C++ Code Snippets”
    - “Quick overview on how to develop, run and test a simple FESA3 binary”
    - All slides of the fesa-courses are available in the Wiki !
  - First compile the class to enable the eclipse-auto-completion.
  - Than start coding
- Disable the Eclipse-Code Analysis, if it does not work reliably
  - Window → Preferences → C++ → Code Analysis
    - Uncheck all boxes !

As next step we will add some C++ code in order to generate the random-numbers itself. To do so, open the file “HandsOnClass/src/HandsOnClass/RealTime/GenerateRandomNumber.cpp” from the Eclipse-Project-Explorer and modify it, according to the source-code below.

After you finished the implementation you can compile your FESA class library. Go to the project folder and execute the make target „all x86_64“. This can be done in Eclipse using the „Make Targets“ view in the FESA or C++ perspective.

By executing the target „clean“ you can remove all object files and libraries from previous builds.

- all i686
- all x86_64
- clean

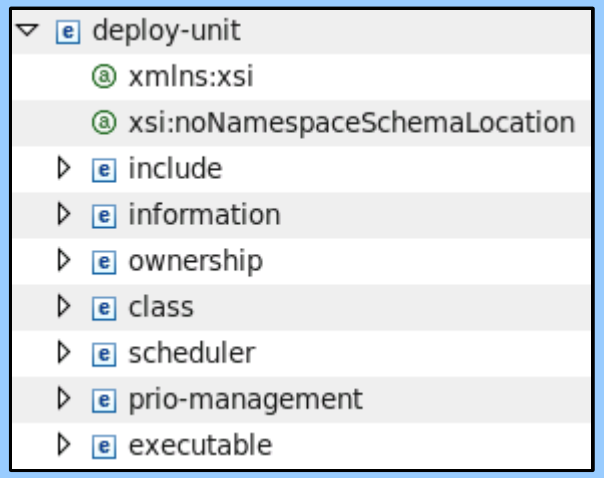
C++ Code
- implement RT actions
- build class library

```
void GenerateRandomNumber::execute(fesa::RTEvent* pEvt)
{
        std::vector<Device*>::iterator device;
        for(device=deviceCol_.begin();device!=deviceCol_.end();++device)
        {
                // get upper limit for random-numbers from internal field
                int32_t rand_max = (*device)->randomNumberMax.get(pEvt->getMultiplexingContext());

                // generate random-number between 0 and rand_max
                int32_t rand_number = rand() % ( rand_max + 1 );

                // produce some output
                std::ostringstream message;
                message << " Produced random number: " << rand_number << " for device: " << (*device)->getName();
                LOG_TRACE_IF(logger, message.str());
                std::cout << message.str() << std::endl;

                // save produced random-number in internal field
                (*device)->randomNumber.set(rand_number,pEvt->getMultiplexingContext());
        }
}
```

You may want to copy + paste this source code!

Theoretical background

- deployment-unit
  - class (1..n)
  - executable
    - mixed
    - rt
    - server
  - scheduler
    - concurrency-layer (1..n)
      - @name
      - @prio
      - @event-queue-size
      - scheduling-unit (1..n)
        - @per-device-group
        - @scheduling-unit-name-ref
  - prio-management



A FESA binary is built from any number of FESA classes and one FESA deploy-unit. Each class describes one equipment component. The deploy-unit is needed to couple all these classes.
To create a deploy-unit project, choose: File→New→Project..→FESA→New FESA Deploy Unit.
According to the class we name it “HandsOnDeployUnit”.

class	
class-name	HandsOnClass
class-major-version	0
class-minor-version	1
class-tiny-version	0
device-instance	required
executable	
mixed	
extension	_M

Only the items that you need to add or change are listed here. When you finished editing the deployment document, validate it and generate the C++ source code.

To generate the executable FESA binary execute the make target „all x86_64“ as well for the deploy-unit.

scheduler	(concurrency-layer)+
concurrency-layer	(scheduling-unit)+
name	TimerLayer
prio	7
scheduling-unit	
per-device-group	no
scheduling-unit-name-ref	HandsOnClass::TimerSchedulingUnit

Note: After adding the class name, save the document. The plug-in will automatically add the elements “path” and “include”. Now you will be able to pick the desired scheduling-unit from a list.

Binary

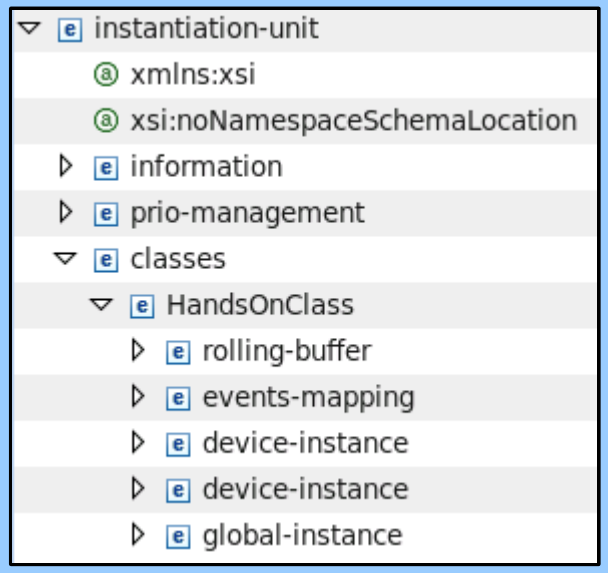
- define deployment unit
- define process type
- configure scheduling
- compile and link binary

Theoretical background

- spe
- spe
- spe

- device-instance (1..n)
  - @name
  - configuration
  - setting
    - myField
      - value
    - events-mapping
      - LogicalEventName (1..n)
  - global instance (1)
    - ...
- prio-management

- classes
  - rolling-buffer
  - events-mapping
    - logicalEventName (1..n)
      - eventConfiguration (1..n)
        - @name
        - concrete-event (source-specific design)



For the next step you need to configure on which front-end (FEC) your binary should run. To do so, open the deploy-unit document and push the „Add FEC“ button. Put in the hostname of the front-end on which you currently work.

classes	
HandsOnClass	
multiplexing	
events-mapping	
timerEvent	
event-configuration	
name	OncePerSecond
Timer	
timer-event	
period	1000
unused-event-configuratio	

Configure the devices of your class as shown on the screenshots.

Note that we use the event-configuration “OncePerSecond” which we defined at our own in the section “events-mapping”.

Validate your instantiation document by pressing .

HandsOnClass	
device-instance	
name	TestDevice1
configuration	
events-mapping	
timerEvent	
event-configuration-ref	
name	OncePerSecond
global-instance	
name	HandsOnGlobalInstance

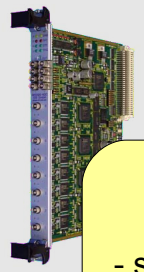
Later you can find this file in: HandsOnDeployUnit/src/test/[FEC]

rse

- compile and link binary

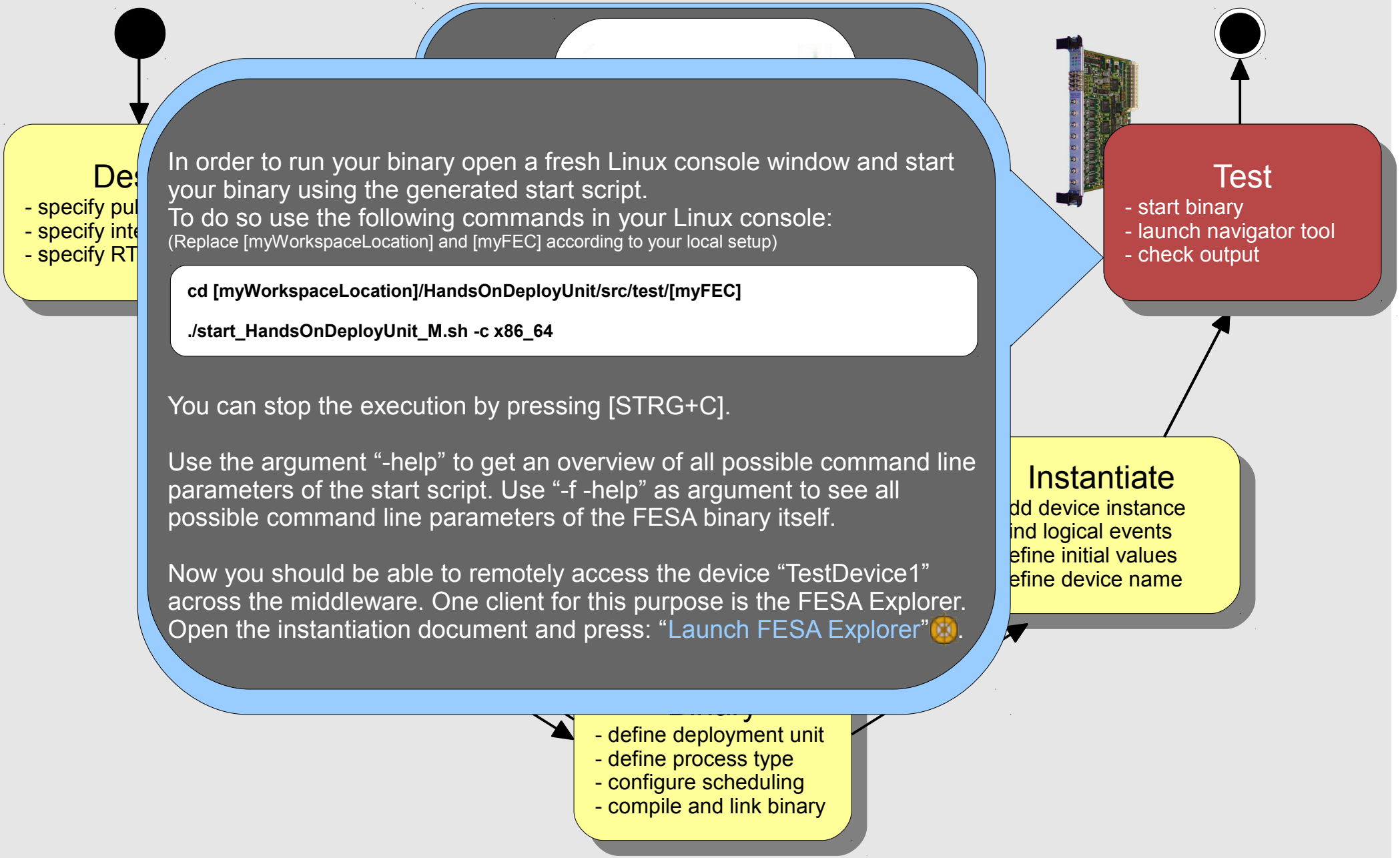
Instantiate

- add device instances
- bind logical events
- define init values
- define device names



Test

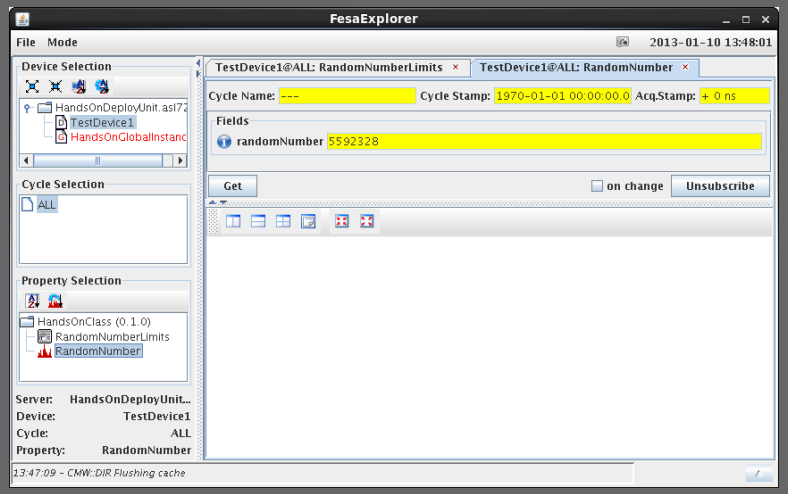
- start binary
- launch navigator tool
- check output


Des
- specify pul
- specify inte
- specify RT
In order to run your binary open a fresh Linux console window and start your binary using the generated start script.
To do so use the following commands in your Linux console:
(Replace [myWorkspaceLocation] and [myFEC] according to your local setup)
cd [myWorkspaceLocation]/HandsOnDeployUnit/src/test/[myFEC]
./start_HandsOnDeployUnit_M.sh -c x86_64
You can stop the execution by pressing [STRG+C].
Use the argument “-help” to get an overview of all possible command line parameters of the start script. Use “-f -help” as argument to see all possible command line parameters of the FESA binary itself.
Now you should be able to remotely access the device “TestDevice1” across the middleware. One client for this purpose is the FESA Explorer. Open the instantiation document and press: “Launch FESA Explorer”.
Test
- start binary
- launch navigator tool
- check output
Instantiate
dd device instance
ind logical events
efine initial values
efine device name
- define deployment unit
- define process type
- configure scheduling
- compile and link binary

D
- specify p
- specify i
- specify F

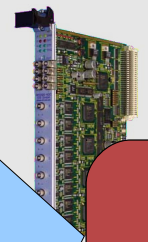
Once the FESA Explorer is open select the “TestDevice1” and double-click on the property “RandomNumberLimits”.
Put a value into the field “randomNumber_max” and press “Set” in order to send the data via the middleware to your class.

Now double-click on the property “RandomNumber” and press “Subscribe”. If you implemented everything in the right way, you should receive one random number per second.



Congratulations!
If you arrived here you finished the FESA3 HandsOn tutorial. On any problems please do not hesitate to check the FESA Wiki or to contact the FESA support team.

For further training you may want to add a field “randomNumber_min” to your class and write a custom-server-action which produces additional output. Feel free to extend your class to whatever you want! As well check the HTML documentation in the FESA Browser if you face any unknown FESA XML elements.



Test
- start binary
- launch navigator tool
- check output

Instantiate
l device instance
d logical events
ine initial values
ine device name

The Mission (II)

Implement a random number generator using FESA

Requirements (I):

- Generate one random number per second
- Allow clients to subscribe to the generated random numbers
- Allow clients to specify max-limit for the random numbers (greatest number which can be generated)

Requirements (II):

- Allow clients to specify min-limit for the random numbers (smallest number which can be generated)
- Generate some console-output for the class, whenever a client got data. (custom get-server-action)

No guideline-support here! On any problems, feel free to ask!

On any problems: fesa-support@gsi.de