TALOS+CIRCUS

How to work with CIRCUS?

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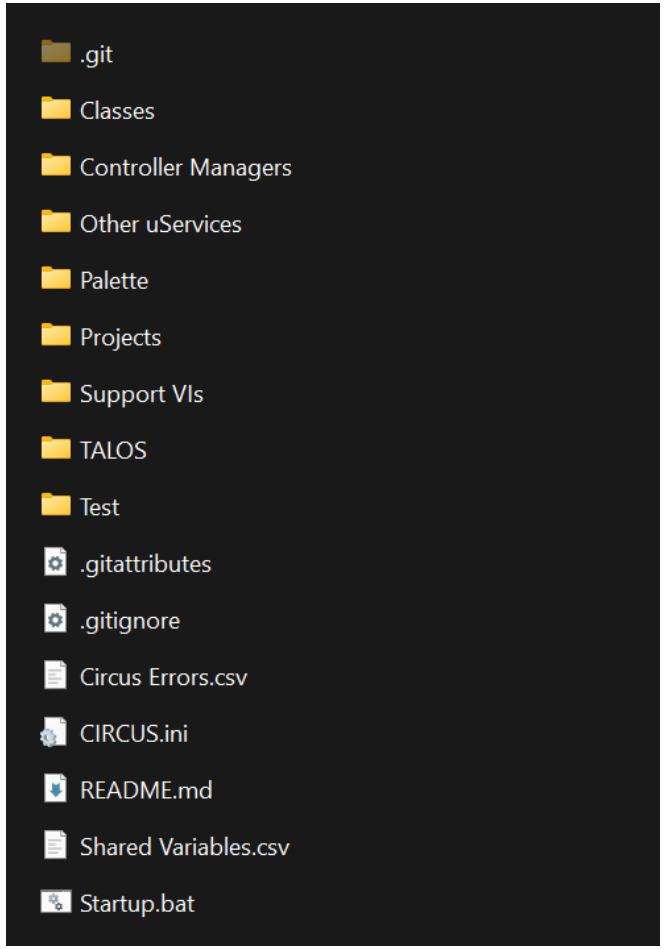
CIRCUS - Computer Interface for Reliably Controlling, in an Unsupervised manner, Scientific experiments

Project based on TALOS that allows for introducing new uServices to perform specific tasks

It provides the skeleton for the Guardian with uServices system



Built in TALOS

CIRCUS – built in TALOS

This is the folder that holds the compiled TALOS library

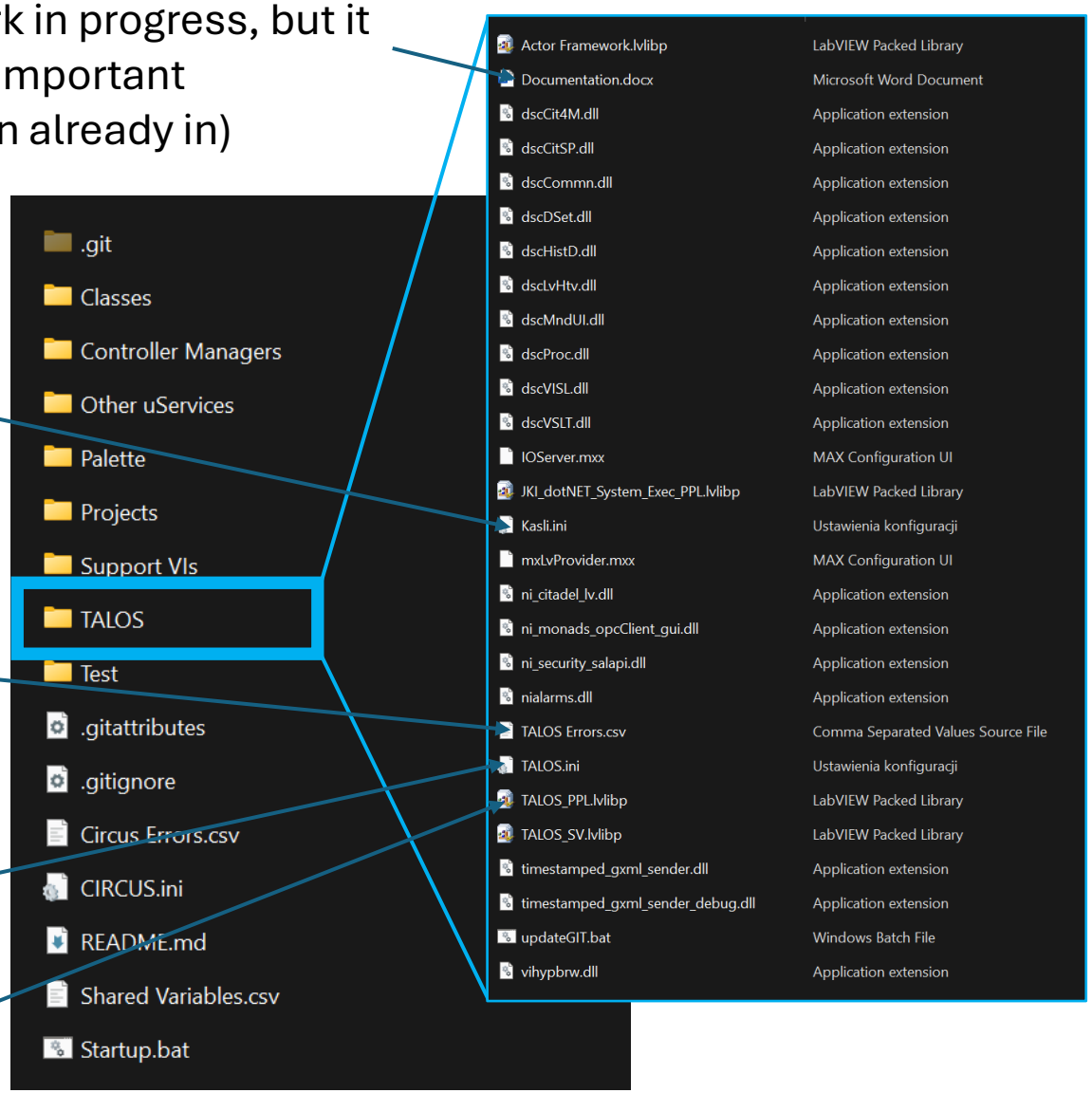
Documentation of TALOS (this is work in progress, but it has some important information already in)

Configuration file for the Kasli controllers (allowing TALOS to be integrated with Sinara control-ecosystem)

Pre-defined custom TALOS errors

Configuration file for TALOS

TALOS library file



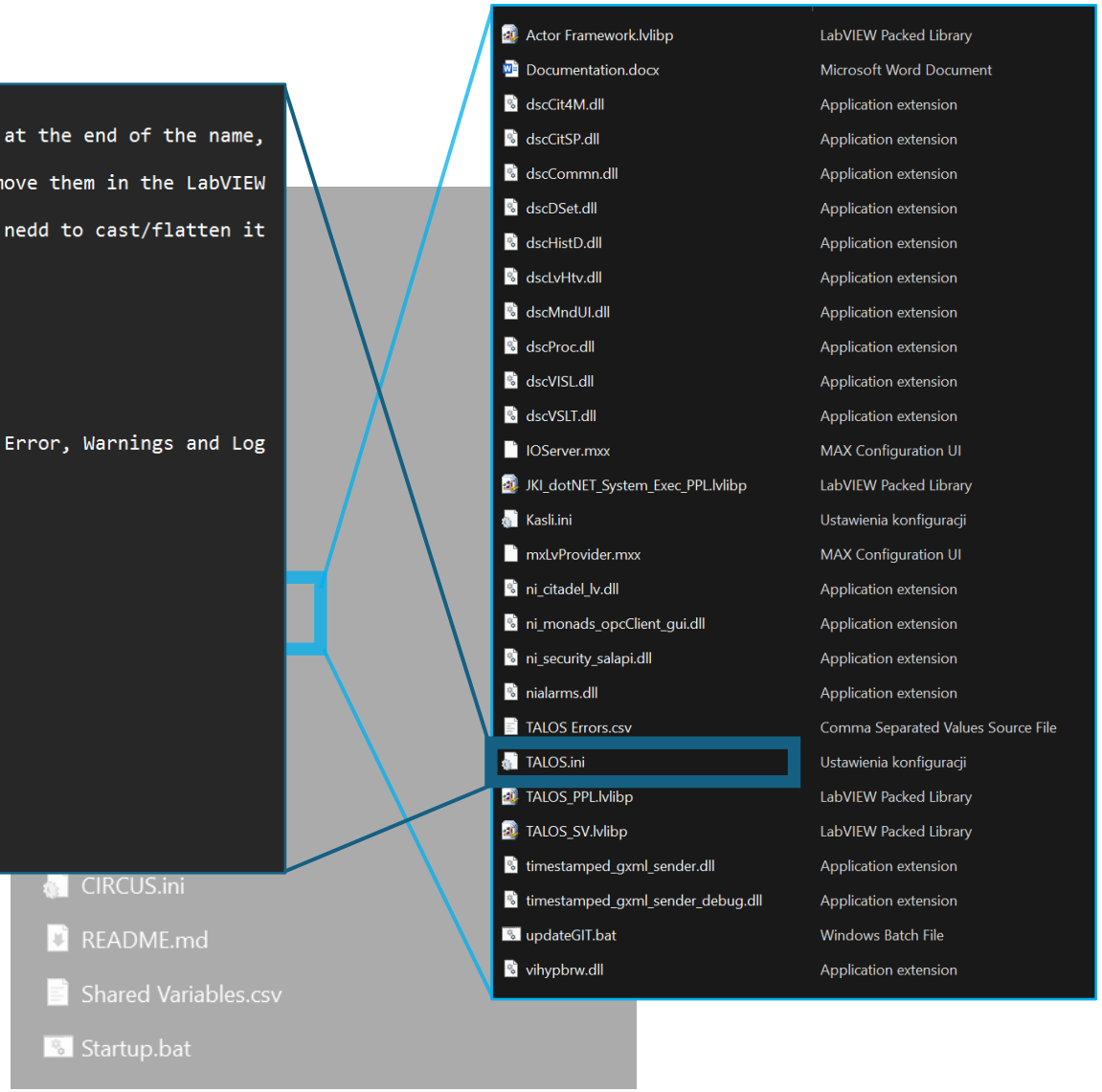
CIRCUS – built in TALOS

TALOS configuration file

```
;This is the Configuration Parameters File.
;Please, if the parameter has a unit (like seconds), append it at the end of the name,
with an underscore (like name_s).
;Please, for the paths, wrap them around double quotes, and remove them in the LabVIEW
code.
;Internally, all the parameters are handled as strings, so you nedd to cast/flatten it
into the appropriate data type.

[TALOS]
uServices_watchdog_triggering_time_s = 60.0
Guardian_watchdog_triggering_time_s = 30.0
Guardian_check_tau_s = 5.0
uServices_check_tau_s = 5.0
ABORT_check_tau_s = 30.0
; Verbosity level: 1 = Error only, 2 = Error and Warnings, 3 = Error, Warnings and Log
Verbosity = 3
; Relative path to Root path
Log_File_Path = "C:\TALOS Log Files"
SV_Timeout_ms = 1000
Timeout_of_RUN_s = 30
uServices_replies_check_tau_s = 1
TCP_Writer_Connection_Check_s = 2
Rotate_files_days = 7
Rotate_files_MB = 50
Highlanders_List = Error Manager
Personal_Log =
GUI_Skins =
Project_INI = CIRCUS.ini


[ERRORS]
Errors_to_ignore = 5359,5362
```



These parameters can be used to change configure behaviour of TALOS for your needs.

CIRCUS – built in TALOS

TALOS configuration file

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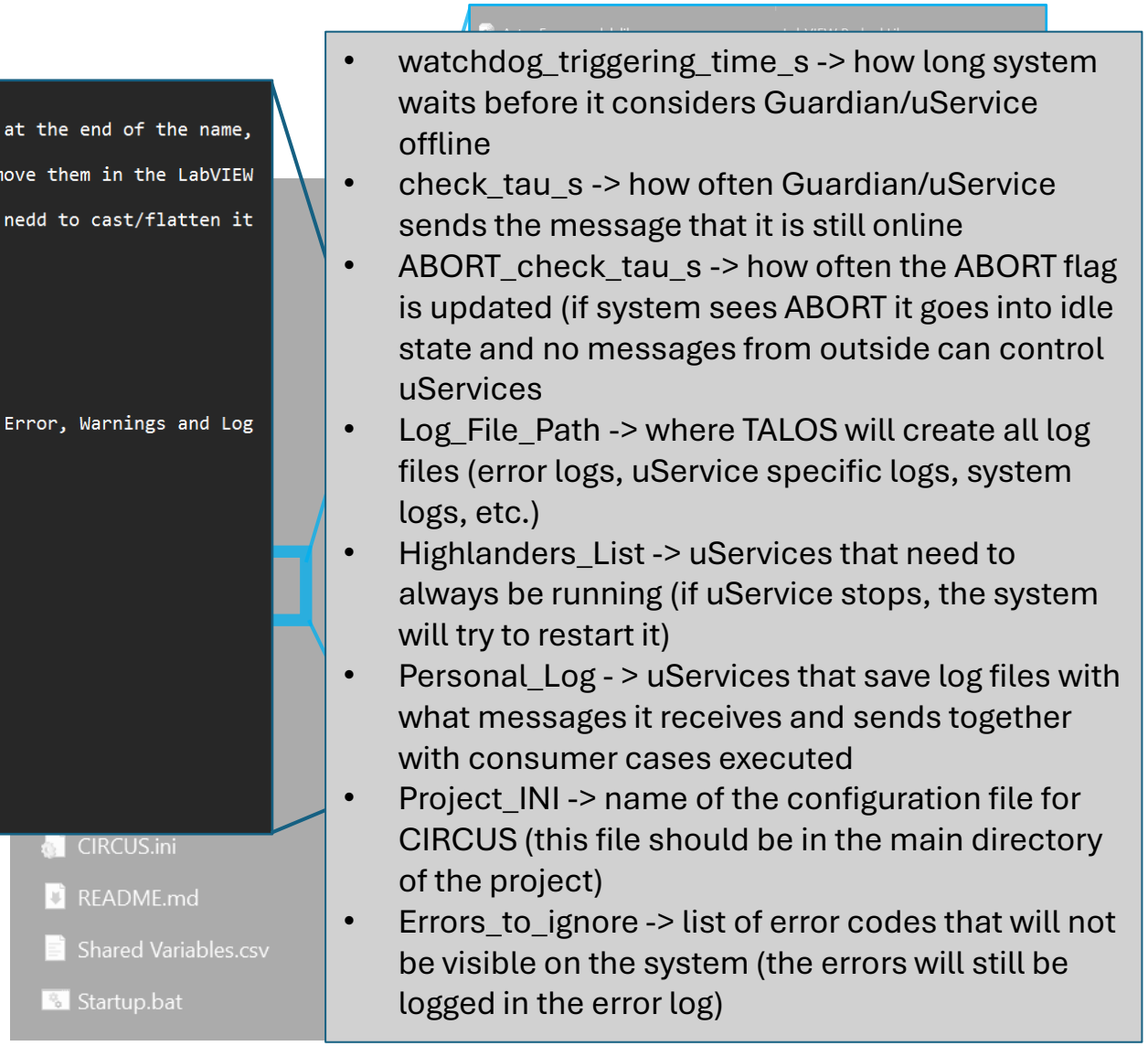


- watchdog_triggering_time_s -> how long system waits before it considers Guardian/uService offline
- check_tau_s -> how often Guardian/uService sends the message that it is still online
- ABORT_check_tau_s -> how often the ABORT flag is updated (if system sees ABORT it goes into idle state and no messages from outside can control uServices
- Log_File_Path -> where TALOS will create all log files (error logs, uService specific logs, system logs, etc.)
- Highlanders_List -> uServices that need to always be running (if uService stops, the system will try to restart it)
- Personal_Log - > uServices that save log files with what messages it receives and sends together with consumer cases executed
- Project_INI -> name of the configuration file for CIRCUS (this file should be in the main directory of the project)
- Errors_to_ignore -> list of error codes that will not be visible on the system (the errors will still be logged in the error log)

These parameters can be used to change configure behaviour of TALOS for your needs.

Arranging LabView Code

CIRCUS – PC specific projects

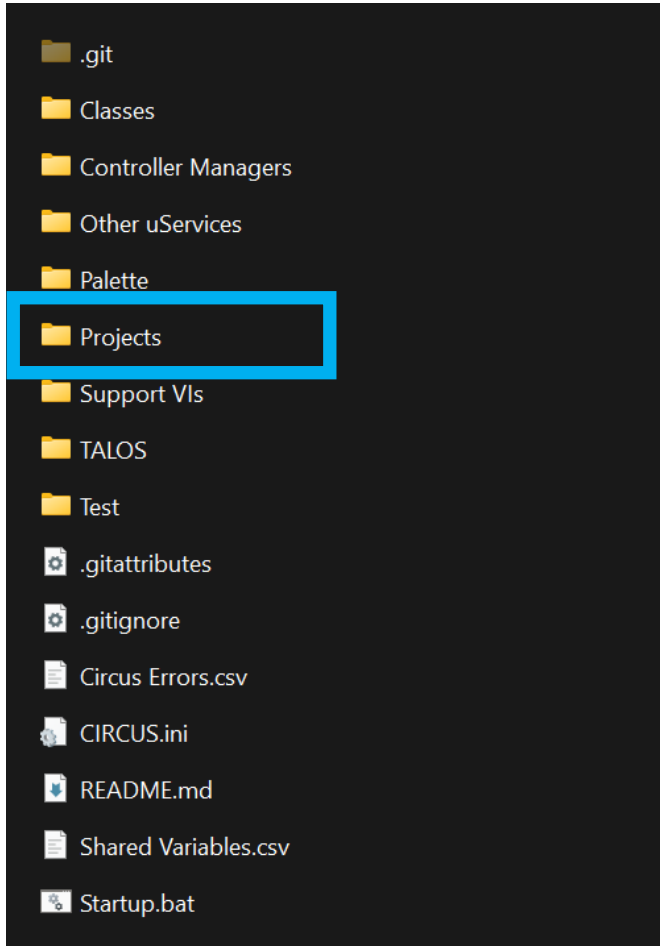
This is the folder that LabView projects for each PC in your system

CIRCUS based on TALOS is a distributed system that can be run on multiple PCs connected via a network with TCP protocol.

Each PC should have it's own project with all uServices that run on that PC inside the project.

This allows PCs to have different software on it (special device drivers).

It also allows for parallel development of uServices for different PCs. Projects are independent of each-other (unless you need to use the same uService).



The project name should reflect the name of the PC (as set up in Windows settings). This is used to start specific project whenever starting CIRCUS in the full system mode.

For the system to start on the machine it needs to have the PC's project opened and there cannot be any errors in that project.

CIRCUS – uServices

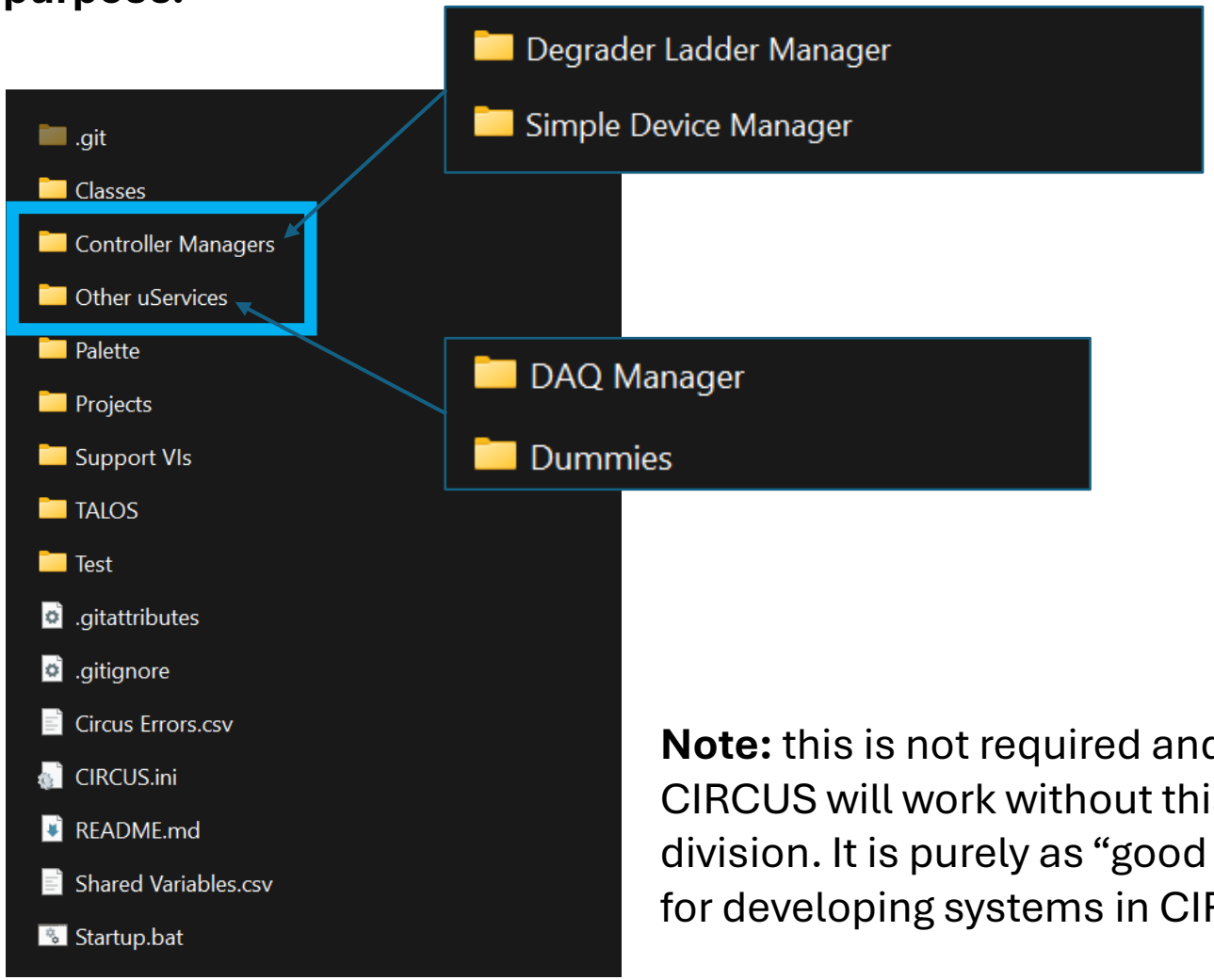
To keep the CIRCUS folder clean it is recommended to put uServices in subfolders based on their purpose.

uServices usually are called Managers.

uService that controls a controller, for example a piston that moves up and down, should be saved in the **Controller Managers** folder.

uService that controls a detector, for example an oscilloscope, should be saved in the **Detector Managers** folder (this folder not shown on this configuration as it doesn't implement any detectors).

uService that isn't controlling a hardware device can be put in the **Other uServices** folder



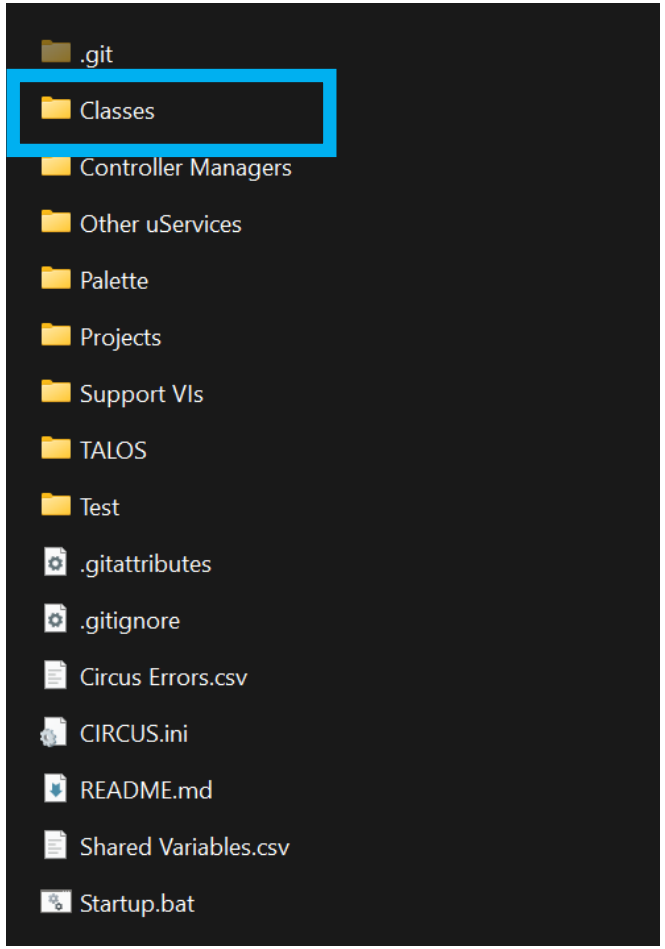
Note: this is not required and the CIRCUS will work without this division. It is purely as "good practice" for developing systems in CIRCUS.

CIRCUS – user specific custom classes

This folder is intended for custom classes that are used to implement specific interfaces from TALOS or just custom classes used in your system.

TALOS provides couple of interfaces like Analysis Framework, DAQ Communicator, FPGA Interface, etc. This allows to define custom behaviour.

For example, each system will be using a specific DAQ infrastructure. This allows the developer to define functions for communicating with the DAQ (sending data or checking the status) which will be automatically used by TALOS.



Note: this is not required and the CIRCUS will work without this division. It is purely as “good practice” for developing systems in CIRCUS.

Error codes in CIRCUS

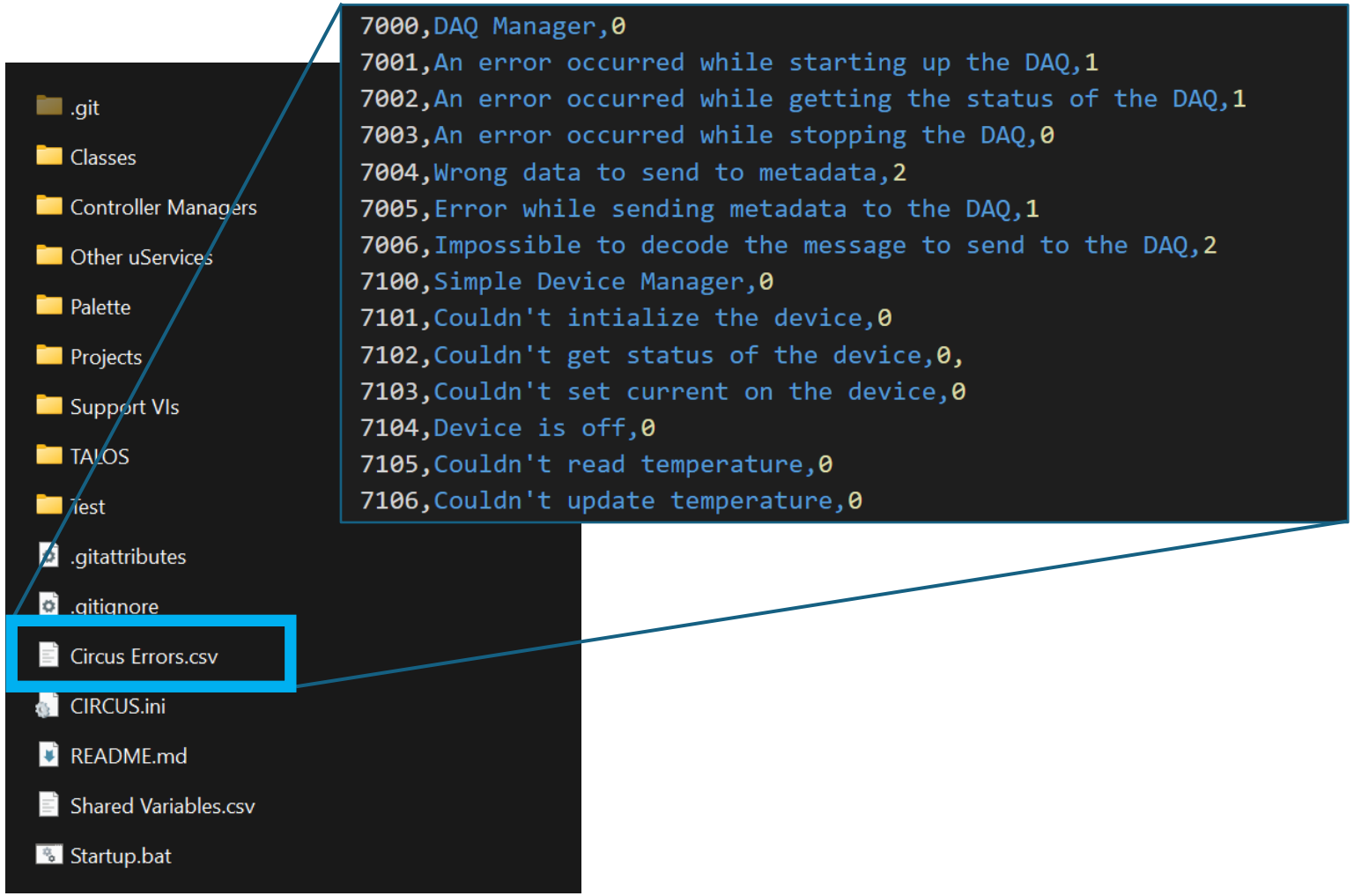
CIRCUS – defining custom errors

Proper error handling is one of the main requirements of the control system. This is done by TALOS (to some extent).

Errors that are generated by a uService:

- Are translated into understandable error messages
- Don’t create an error loop (if something creates an error make sure it isn’t also called infinitely)

Circus Errors.csv is a file that holds definitions of custom errors inside Circus



CIRCUS – defining custom errors

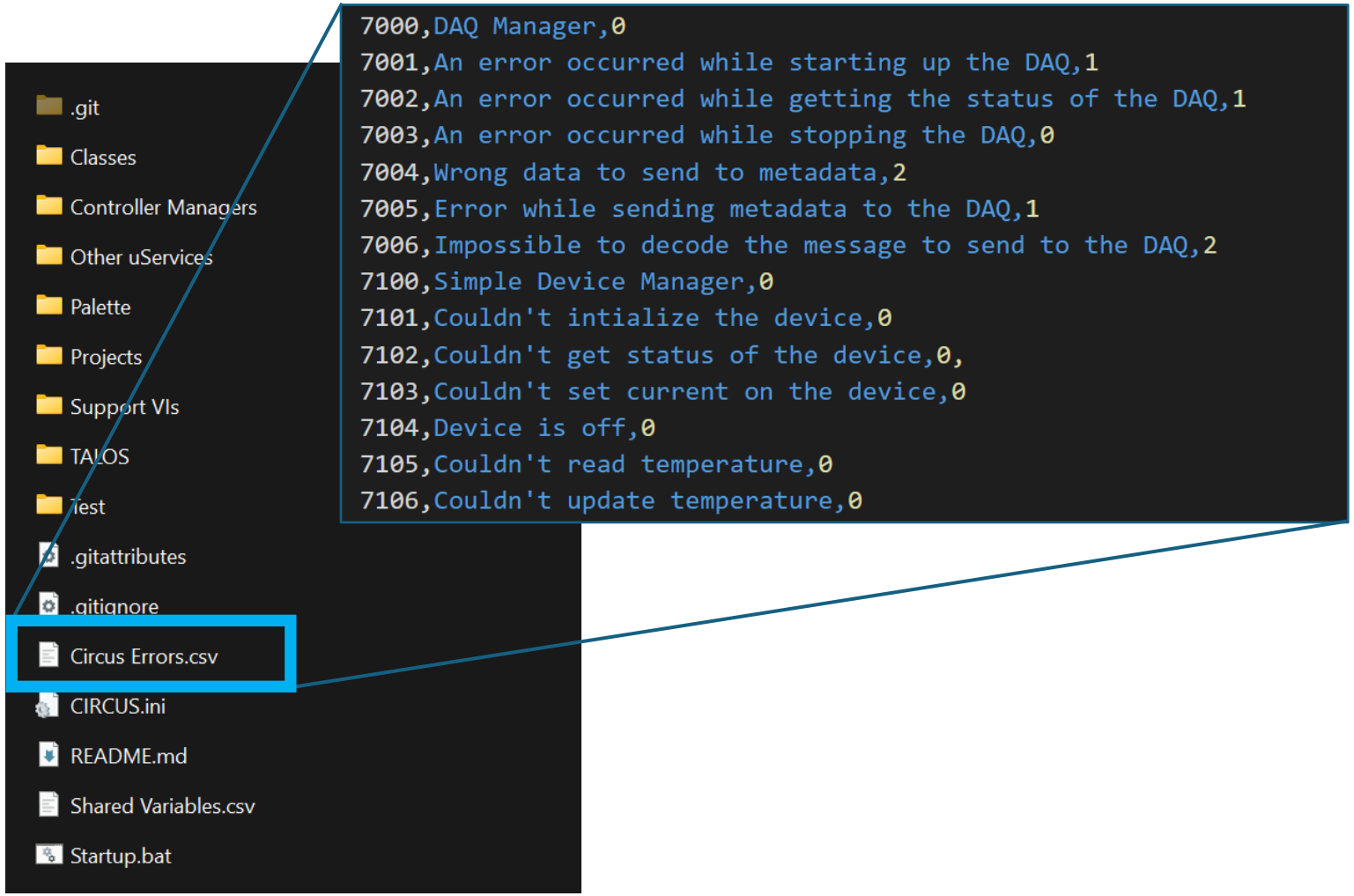
Proper error handling is one of the main requirements of the control system. This is done by TALOS (to some extent).

Errors are arranged in increasing order starting from 7000 for uServices.

Assumed convention is to dedicate 50 error codes for each uService where the starting error is not used and defines the name of the uService (7000, 7050, 7100, etc.).

Errors are saved in three columns:
Error code | Description | Error criticality

Error criticality is used by the system when using Tamer and Monkey for running series of experiments (Schedules) and defines the response of the system to each error (skip, stop, etc.)



CIRCUS config file

CIRCUS – configuring the system

Configuration file with parameters used inside CIRCUS. This is where you can declare the configuration of PCs in your system and parameters used by defined uServices

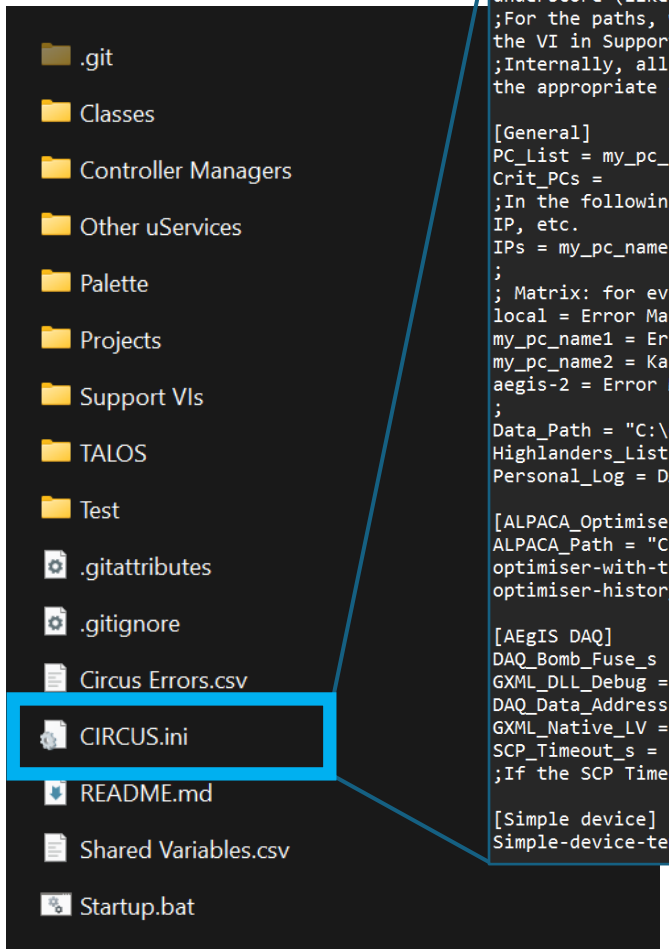
File uses the same format as the TALOS config file

All parameters are stored as strings and can be later converted into specified types

Parameters from this file can be accessed in the LabView code via the CIRCUS parameters.vi

Parameters are divided into sections, usually based on the uService that uses the parameters.

Parameter names should be unique (no duplication, even between sections). If parameter has a unit, append it at the end of the name.




```
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;If the parameter has a unit (like seconds), append it at the end of the name, with an
underscore (like name_s).
;For the paths, wrap them around double quotes, and remove them in the LabVIEW code (use
the VI in Support VIs).
;Internally, all the parameters are handled as strings, so you need to cast/flatten it into
the appropriate data type.

[General]
PC_List = my_pc_name1, my_pc_name2
Crit_PCs =
;In the following the IPs of the PCs can be specified, in the format PC_Name, IP, PC_Name,
IP, etc.
IPs = my_pc_name1, 127.0.0.1, my_pc_name2, 127.0.0.1
;
; Matrix: for every pc, the uServices to launch at startup
local = Error Manager, Tamer, Scheduler
my_pc_name1 = Error Manager, Tamer, Scheduler, DAQ Manager
my_pc_name2 = Kasli Server
aegis-2 = Error Manager, Tamer, Scheduler
;
Data_Path = "C:\CIRCUS Data"
Highlanders_List = Scheduler, Tamer
Personal_Log = DAQ Manager, Tamer

[ALPACA_Optimiser]
ALPACA_Path = "C:\ALPACA\python-analyses"
optimiser-with-training-beta = True
optimiser-history-file-path = "C:\TALOS Log Files\OPTIMISER\training-history.csv"

[AEgIS DAQ]
DAQ_Bomb_Fuse_s = 45
GXML_DLL_Debug = False
DAQ_Data_Address =
GXML_Native_LV = False
SCP_Timeout_s = -1
;If the SCP Timeout is set to -1, the timeout is not set at all

[Simple device]
Simple-device-temp-check_s = 0.1
```
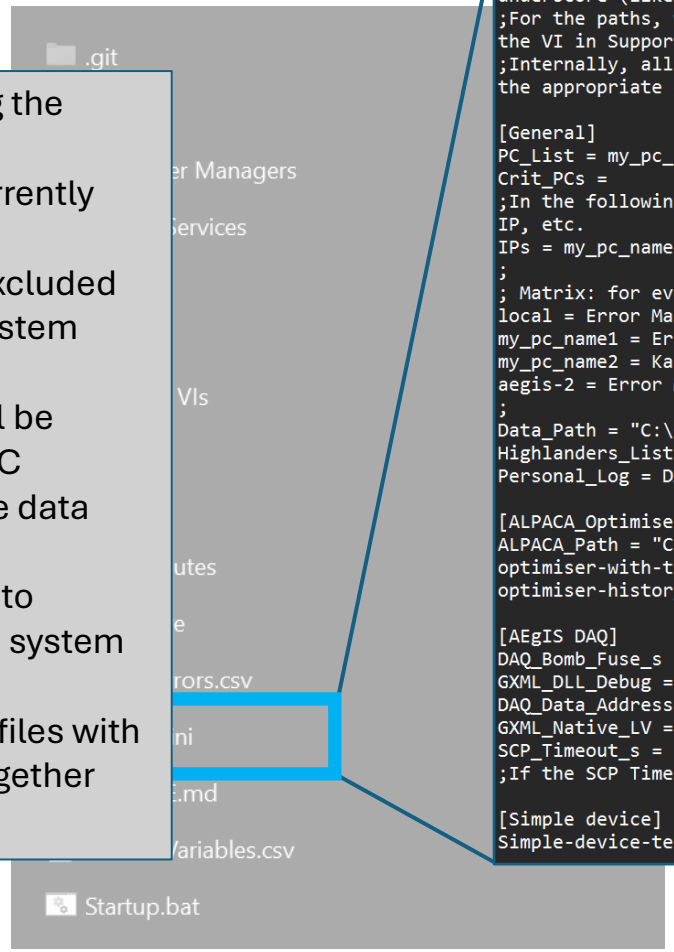

CIRCUS – configuring the system

Configuration file with parameters used inside CIRCUS. This is where you can declare the configuration of PCs in your system and parameters used by defined uServices

General parameters are used for configuring the CIRCUS system:

- PC_List -> names of the PCs that are currently used as the distributed system
- Crit_PCs -> names of the PCs that are excluded from standard updates from git of the system
- IPs-> map of the IPs for all available PCs
- <PC_NAME> - > list of uServices that will be started automatically on the specified PC
- Data_Path -> path where TALOS will save data from detectors as a backup
- Highlanders_List -> uServices that need to always be running (if uService stops, the system will try to restart it)
- Personal_Log -> uServices that save log files with what messages it receives and sends together with consumer cases executed

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II. Using CIRCUS

1. Launching CIRCUS
   a. As distributed system
   b. As stand-alone Guardian
2. Guardian overview
3. TALOS palette and useful functions

Launching CIRCUS (Guardian)

There are two options for starting the CIRCUS:

- **As a distributed system**
- **As a standalone Guardian (usually used for testing)**

Launching CIRCUS (Guardian)

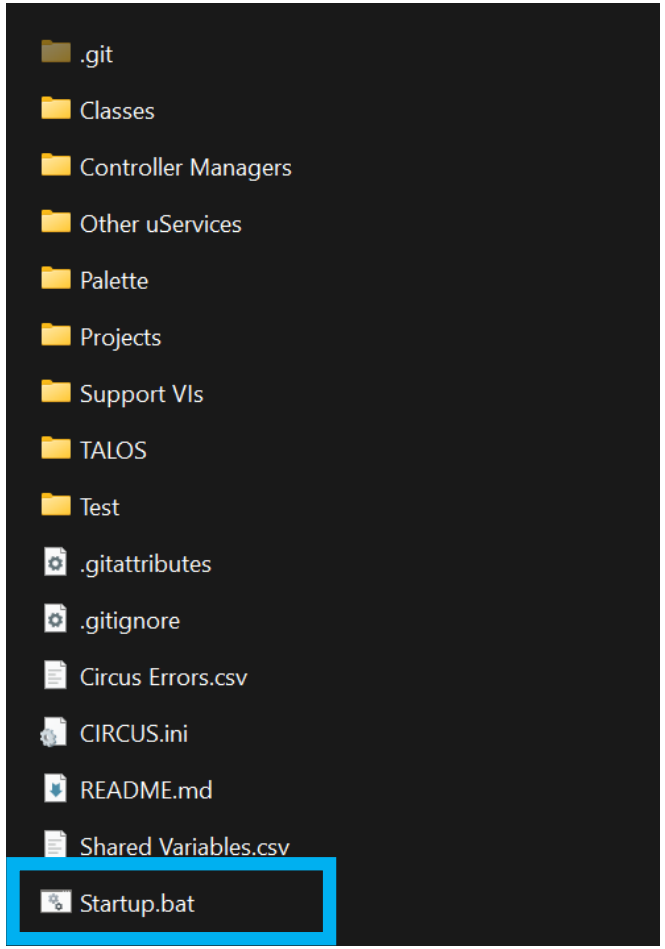
As a distributed system

Starting CIRCUS as a distributed system requires:

- Project with this PC's name (without errors)
- This PC's name in the PC_List of the config file

To start simple double-click the Startup.bat file

It is recommended to open the LabView project of the PC beforehand, however, Startup.bat can take care of it



Note: system started as part of the distributed system expects all PCs from the PC_List to be online. If one of the PCs won't start before Watchdog time, the system will go into Safe Mode (via the ABORT).

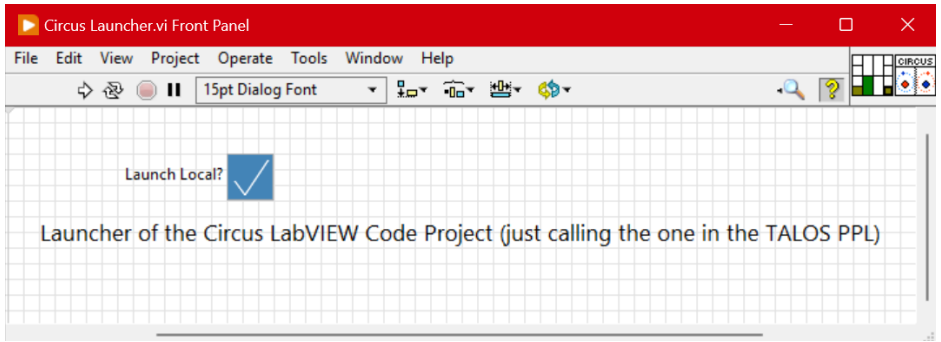
Launching CIRCUS (Guardian)

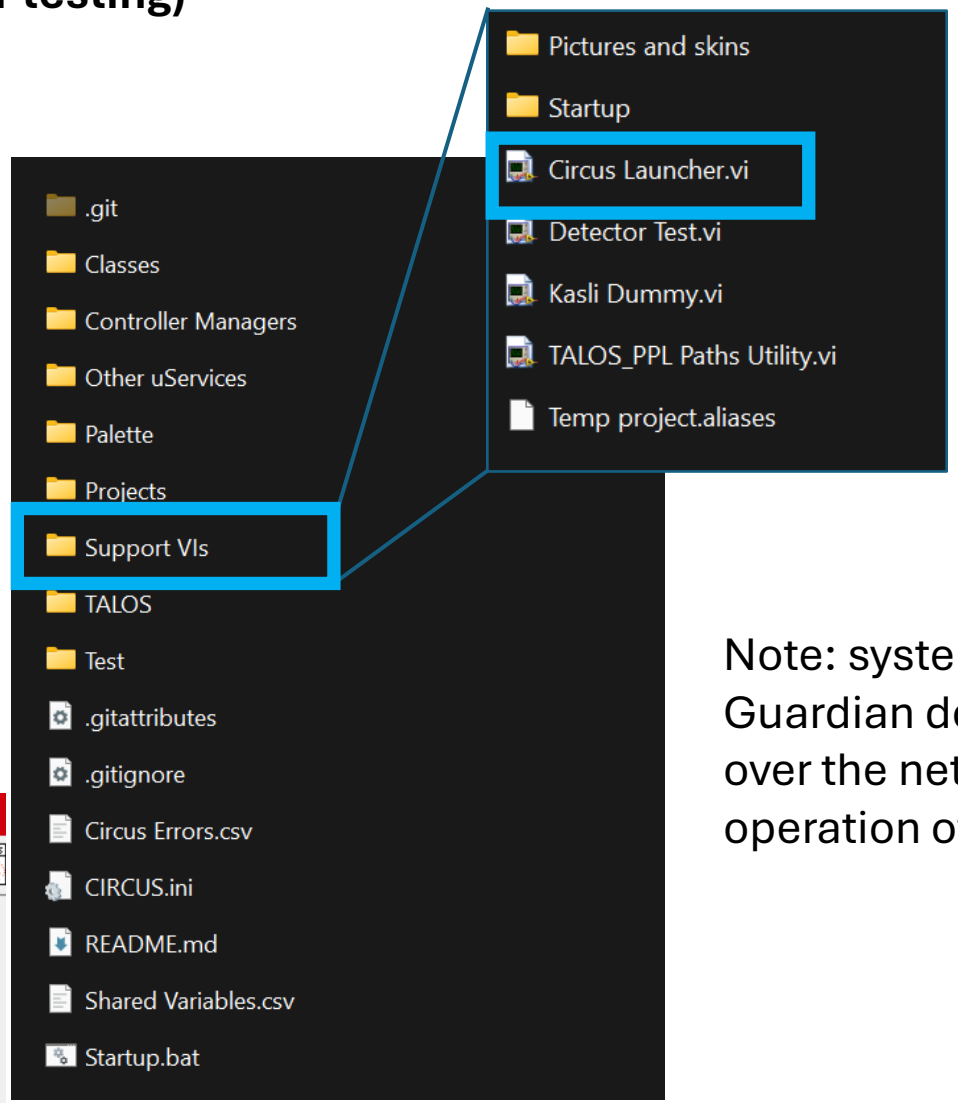
As a standalone Guardian (usually used for testing)

Starting CIRCUS as a standalone Guardian requires:

- A LabView project opened (the name doesn't matter in this case, however, there cannot be errors in the project)

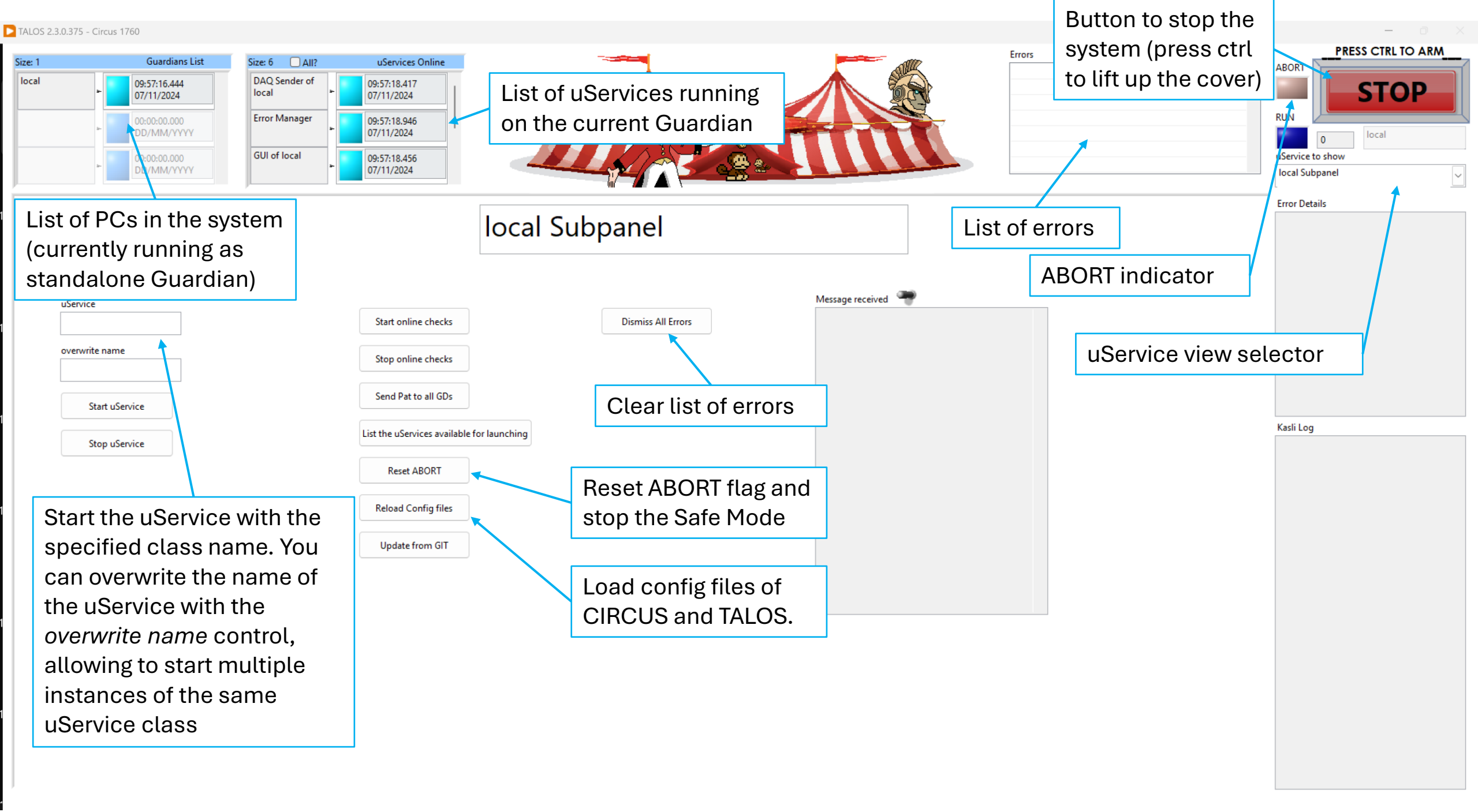
To start navigate to the *Support Vis* directory and open the *Circus Launcher.vi*. Run the VI with the *Launch Local?* ticked on.





Note: system started as a standalone Guardian doesn't support messages over the network. You can still test operation of different uServices

Guardian Overview


TALOS 2.3.0.375 - Circus 1760
Size: 1
Guardians List
local
09:57:16.444
07/11/2024
00:00:00.000
DD/MM/YYYY
Size: 6
All?
uServices Online
DAQ Sender of local
09:57:18.417
07/11/2024
Error Manager
09:57:18.946
07/11/2024
GUI of local
09:57:18.456
07/11/2024
Errors
PRESS CTRL TO ARM
ABORT
STOP
RUN
0
local
uService to show
local Subpanel
Error Details
Kasli Log
uService
overwrite name
Start uService
Stop uService
Start online checks
Stop online checks
Send Pat to all GDs
List the uServices available for launching
Reset ABORT
Reload Config files
Update from GIT
Dismiss All Errors
Message received
Button to stop the system (press ctrl to lift up the cover)
List of uServices running on the current Guardian
List of PCs in the system (currently running as standalone Guardian)
local Subpanel
List of errors
ABORT indicator
uService view selector
Clear list of errors
Reset ABORT flag and stop the Safe Mode
Load config files of CIRCUS and TALOS.
Start the uService with the specified class name. You can overwrite the name of the uService with the *overwrite name* control, allowing to start multiple instances of the same uService class

TALOS palette and useful functions

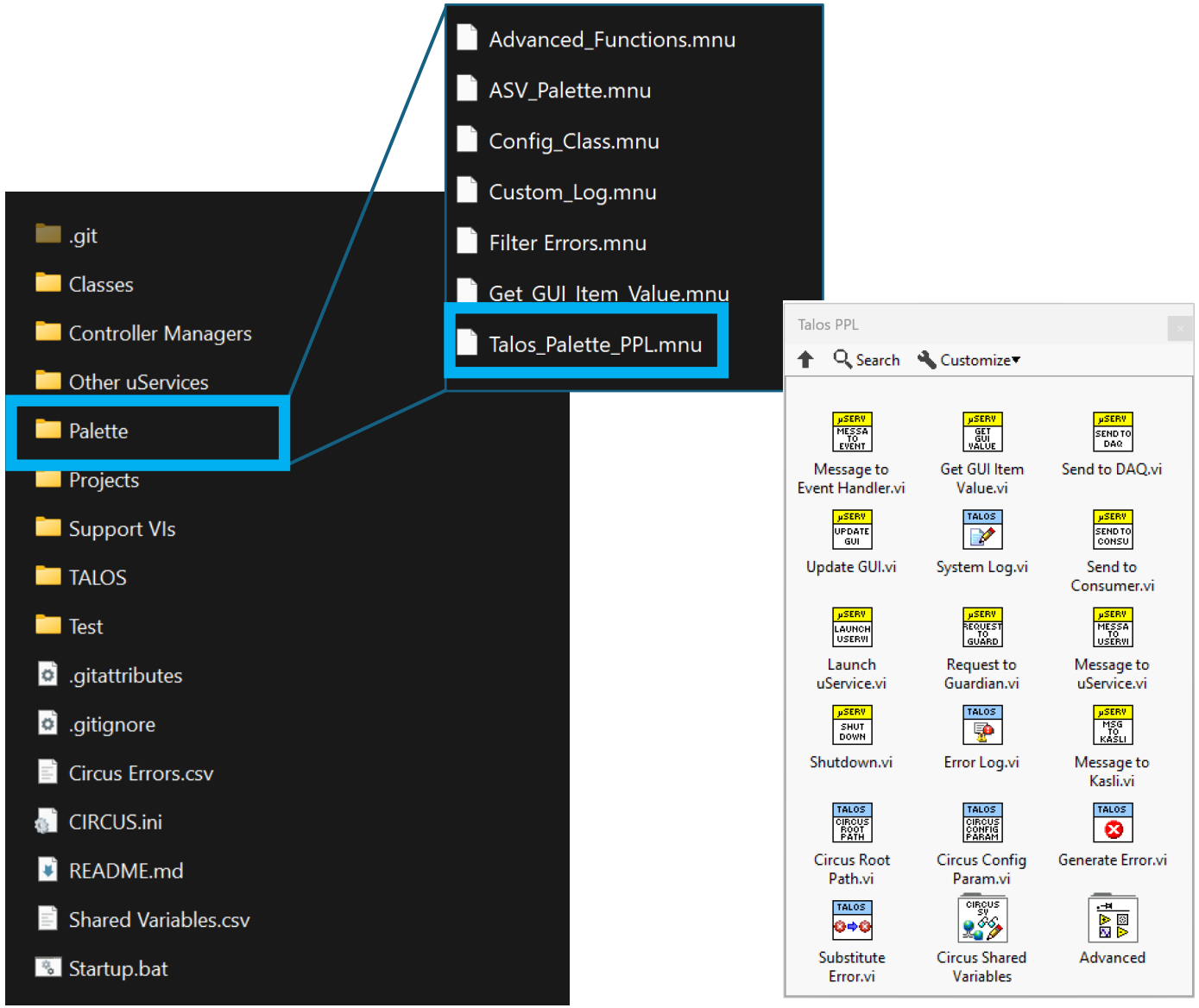
TALOS palette

TALOS comes in with a set of functions as a palette that can be added to the installation of LabView

TALOS comes in with a set of functions as a palette that can be added to the installation of LabView

To add palette to LabView:

1. Open LabView
2. Tools > Advanced > Edit Palette Set...
3. Right click on the *Functions* palette
4. Insert > Subpalette
5. Link to an existing palette file (.mnu)
6. Select the Talos_Palette_PPL.mnu file



TALOS palette

Some functions that are available

Send to Consumer.vi	Add the case to the consumer loop.	Father of all uServices\Father of all uServices\Children Methods\Send to Consumer.vi
Message to uService.vi	Send a message to the uS (any uS that is online in the system).	Father of all uServices\Father of all uServices\Children Methods\Message to uService.vi
Infinite Message Manager.vi	Infinite Message is a continuous case enqueued in the consumer ever specified period (from the CIRCUS parameters.	Father of all uServices\Father of all uServices\Children Methods\Infinite Message Manager.vi
Update GUI.vi	Send data to the control on the uS GUI element (type of the data must much the type of the control).	Father of all uServices\Father of all uServices\Children Methods\Update GUI.vi
Get GUI Item Ref.vi	Get Reference of the control from the current uS GUI.	Father of all uServices\Father of all uServices\Children Methods\Get GUI Item Ref.vi
Get GUI Item Value.vi	Get data from the control of the uS GUI (can return standard types like double, string, integer, or variants).	Father of all uServices\Father of all uServices\Children Methods\Get GUI Item Value.vi
Update GUI - Append ...	Update string control on the uS GUI by appending data to the current value.	Father of all uServices\Father of all uServices\Children Methods\Update GUI - Append String.vi
Update GUI - Waveform ...	Update data by adding a next point to the Waveform Graph on the uS GUI.	Father of all uServices\Father of all uServices\Children Methods\Update GUI - Waveform Chart.vi

Circus Config Param.vi	Get parameter from the CIRCUS config file.	Support VI\Params\Circus Config Param.vi
Substitute Error.vi	Replace the error with the specified error from the CIRCUS error file.	Support VI\Error Generation\Substitute Error.vi
Generate Error.vi	Create error with the specified error code from the CIRCUS error file.	Support VI\Error Generation\Generate Error.vi
String to Bool.vi	Convert string to Boolean.	Support VI\Misc\String to Bool.vi
Temporised Pop-up ...	Open a window with a message for a specified duration.	Support VI\Misc\Temporised Pop-up Window.vi

If the palette doesn't work, you can access all the VIs from the palette directly from the library (open the library and navigate to the specified paths in the library).

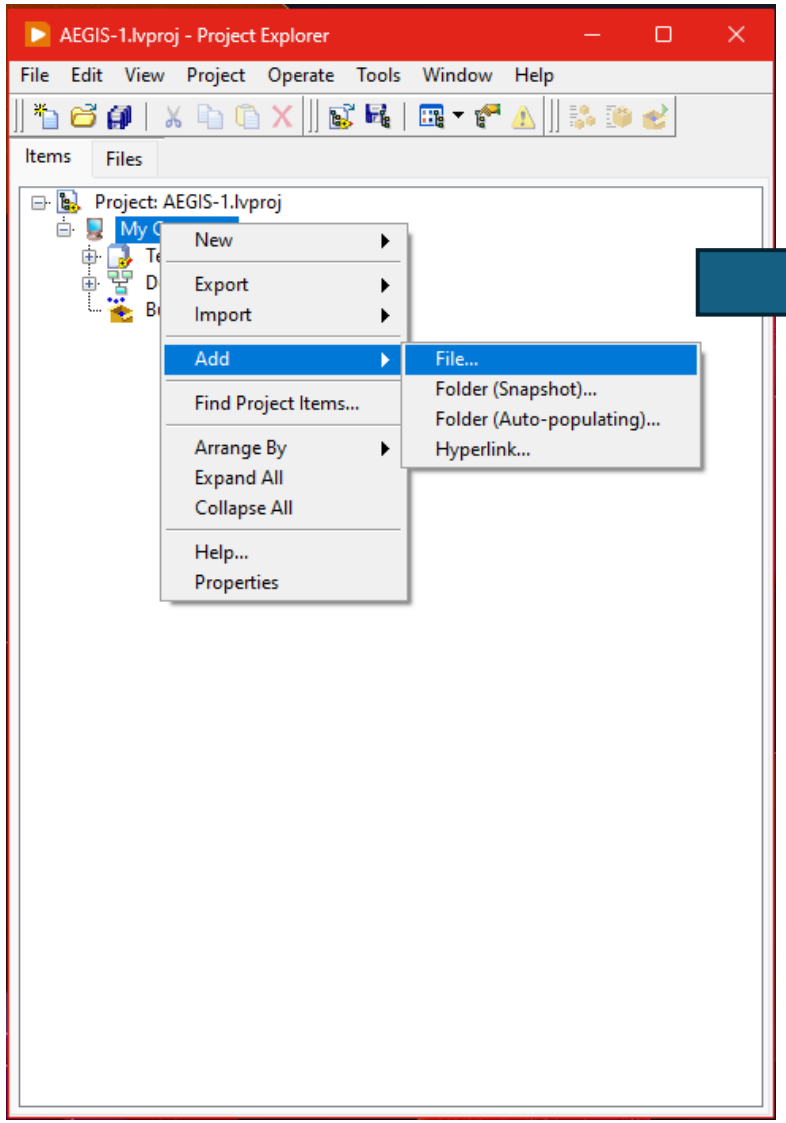
III. Making a new uService

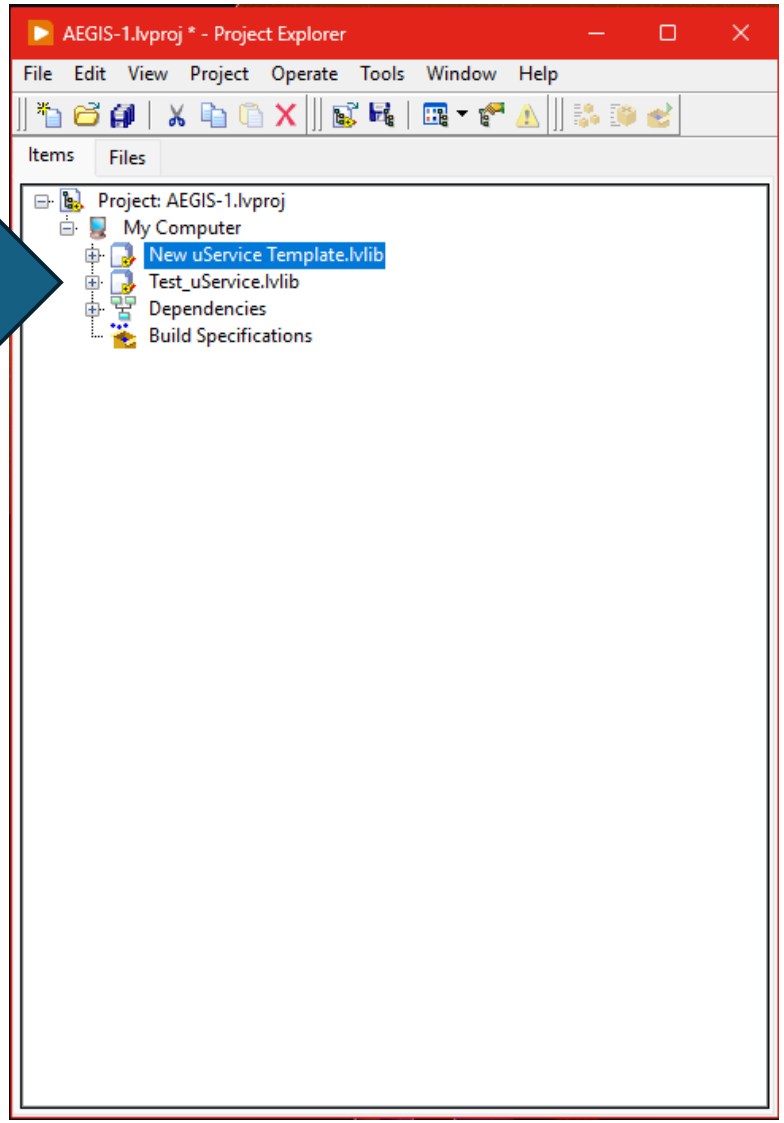
1. Creating from the template
    a. Hardware class
    b. Detector class
2. Example
    a. Step by step simple chat uService
    b. Starting uService
    c. Using uService

Making a uService

Based on the template provided

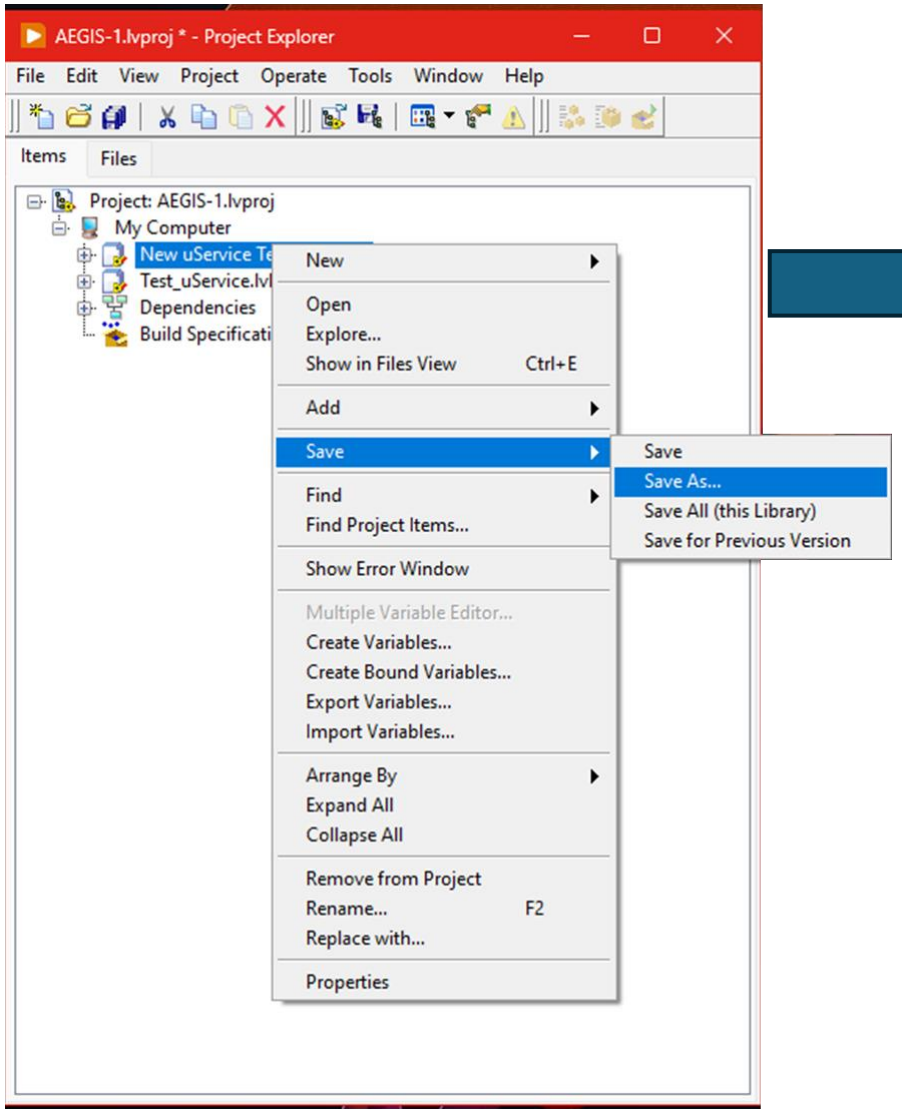
Add the New uService Template to the project

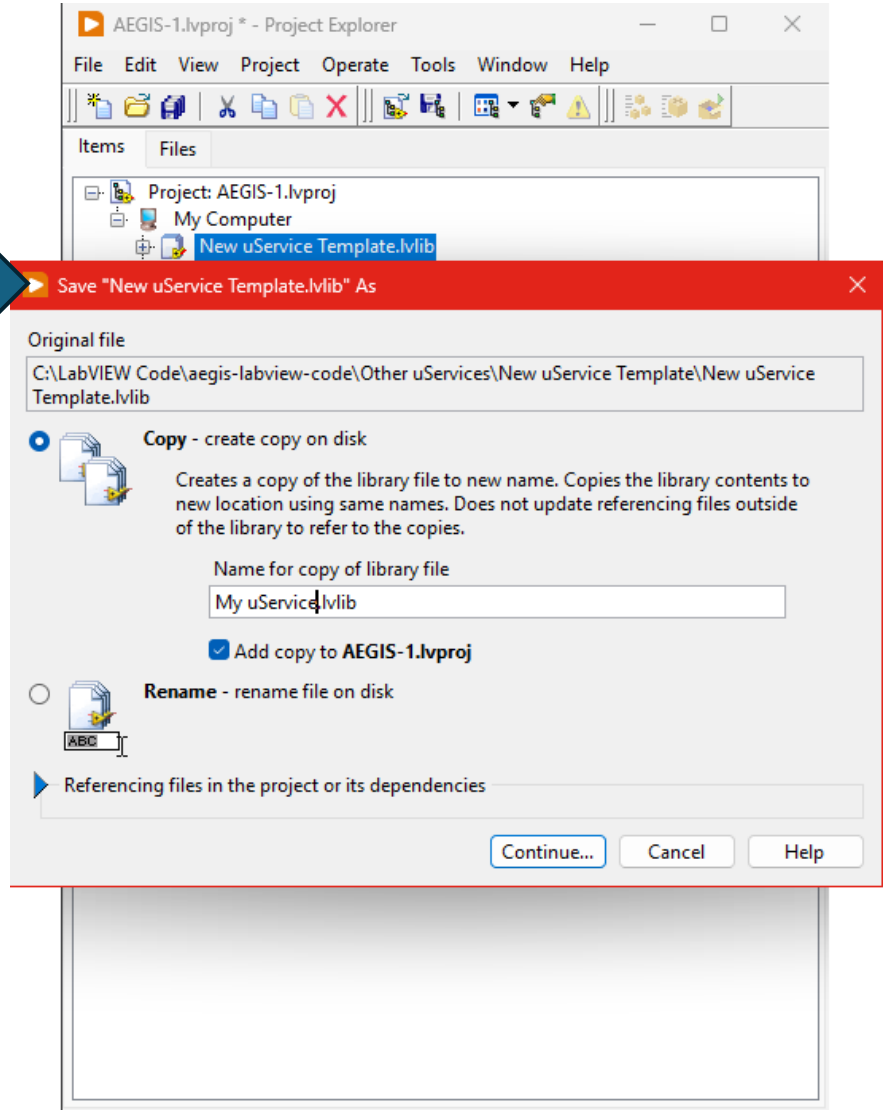




1. Right-click on the *My Computer* in the LV's Project Explorer and select *Add->File…*
2. Inside the directory of the repository (aegis-labview-code) select *Other uServices>New uService Template>New uService Template.lvlib*
   - You want to add the entire library, not only the class

Create a copy of the template

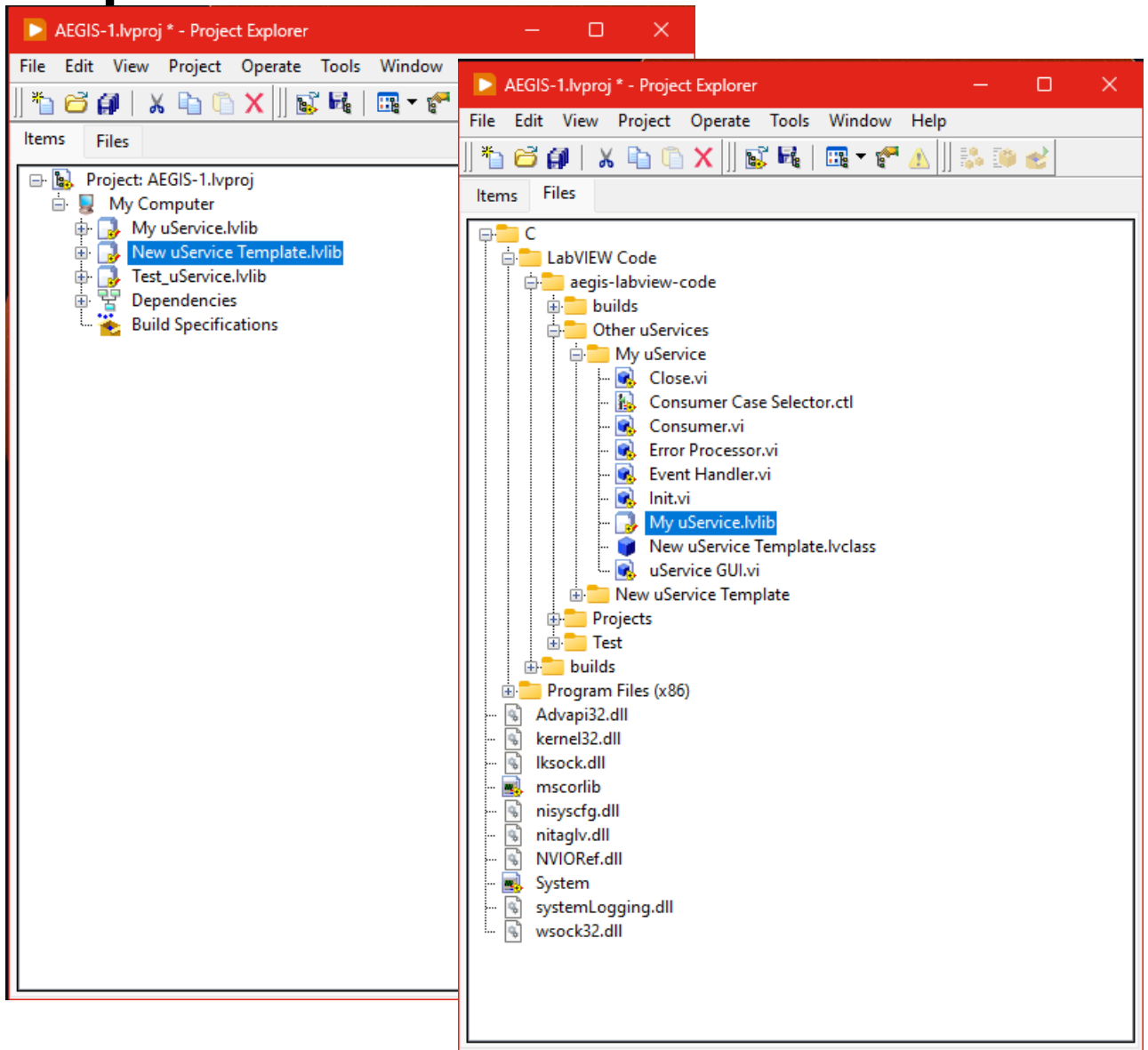




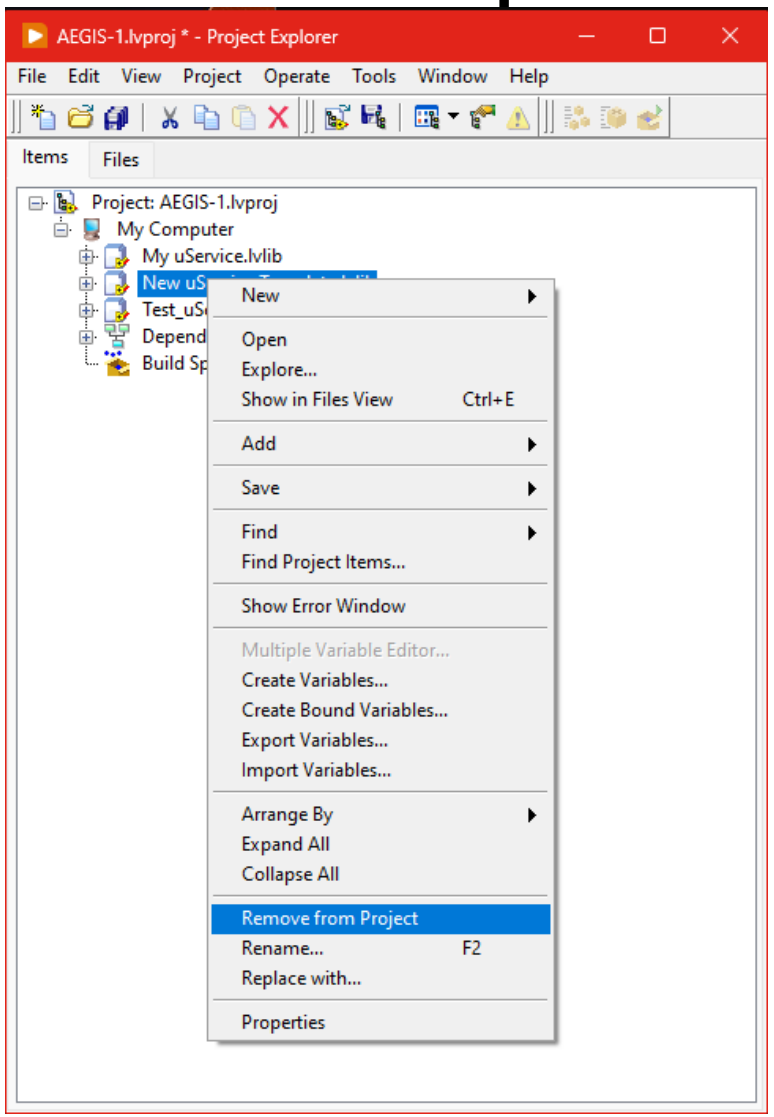
3. Right-click on *New uService Template.lvlib -> Save -> Save as...*
4. Baptise it as you wish (*My uService.lvlib* in the example on the slide)
   - Leave the flag *Add copy to <project name>.lvproj* ticked. This will add the new library to the project you are working in.
5. Press continue

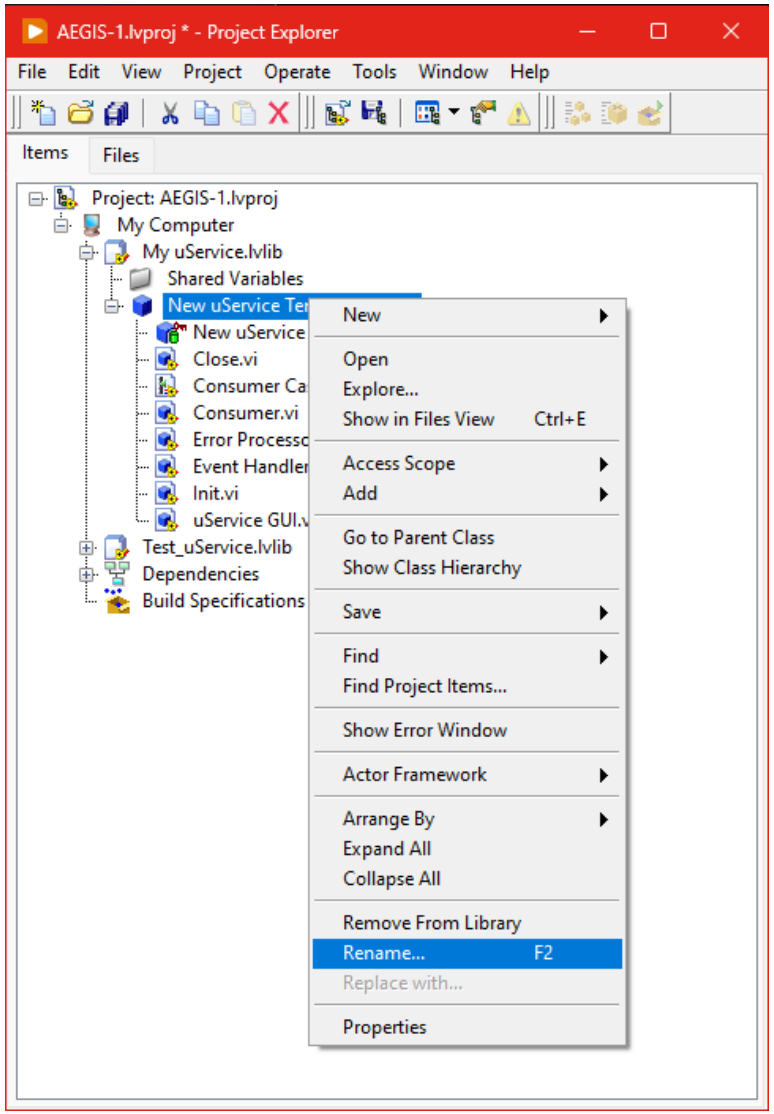
Create a copy of the template

6. Browse for the folder where you want to save your new uService. Some general rules:
   - *Controller Managers* folder -> uServices that control controllers (actuators, electro gun, Rotators, Temperature, etc.)
   - *Detector Managers* folder -> uServices that control detectors (oscilloscopes, cameras etc.)
   - *Other uServices* -> anything else (logging, messaging system, etc.)
   - The name of the folder for your library should be the same as the library (LabView will add *Folder* at the end; you can remove it to make it clean)
7. Press *Save*, it will create a new folder with the specified name and copy all the VIs inside



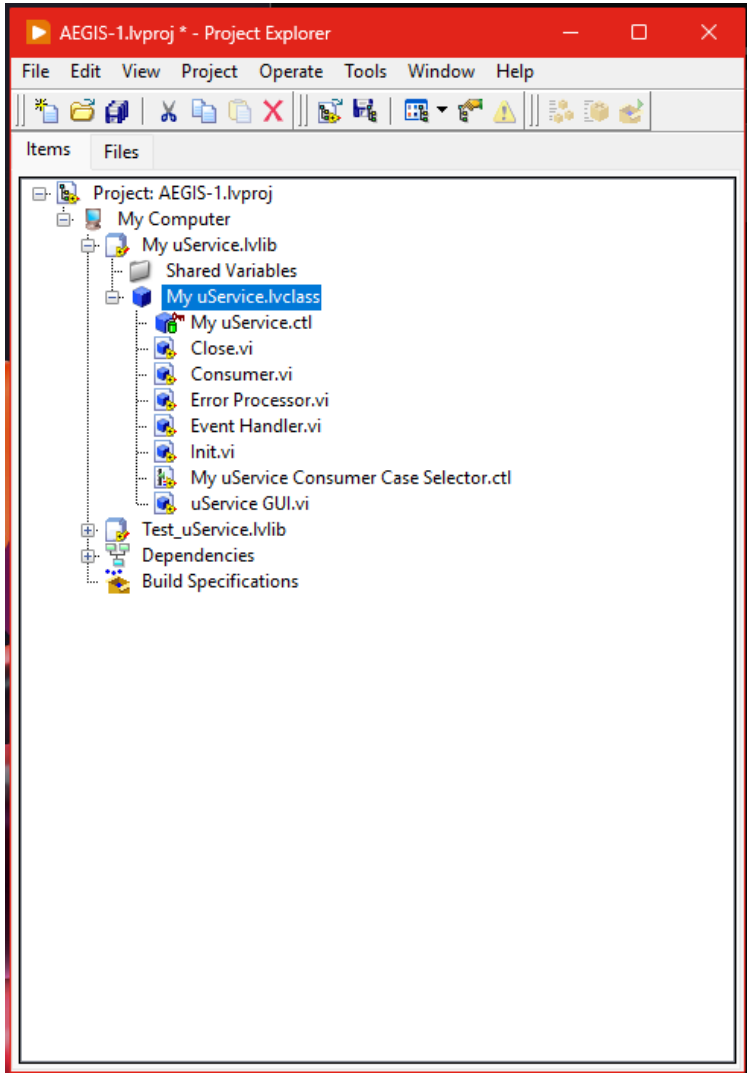
Clean up

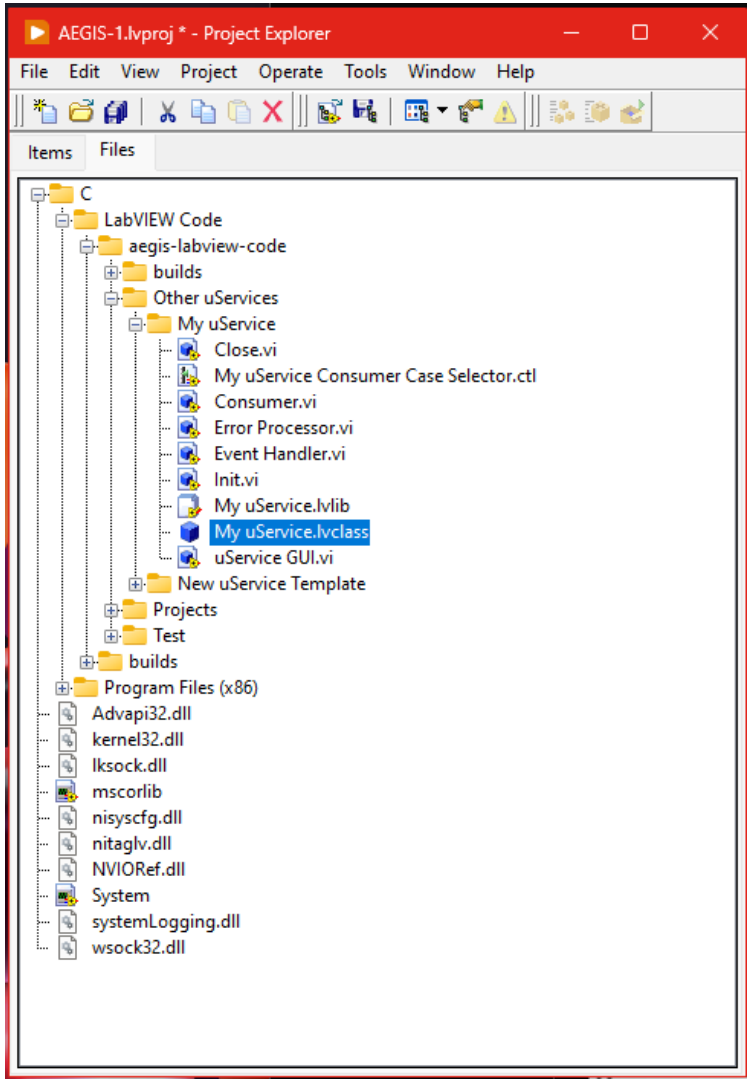




8. Remove the template
    1. Right-click on the *New uService Template.lvlip*
    2. Select *Remove from Project*
    3. Press *OK*
9. Rename the uService class
    1. Open the freshly created library
    2. Right-click on the *New uService Template.lvclass*
    3. Select *Rename*
    4. Give it the same name as the library
    5. Rename also the *Consumer Case Selector* by appending uService name in the front
    6. You can also edit the class's icon. It is recommended to at least set the *Text icon* (This can be accessed by right-clicking the class and selecting *Properties*)

Finish



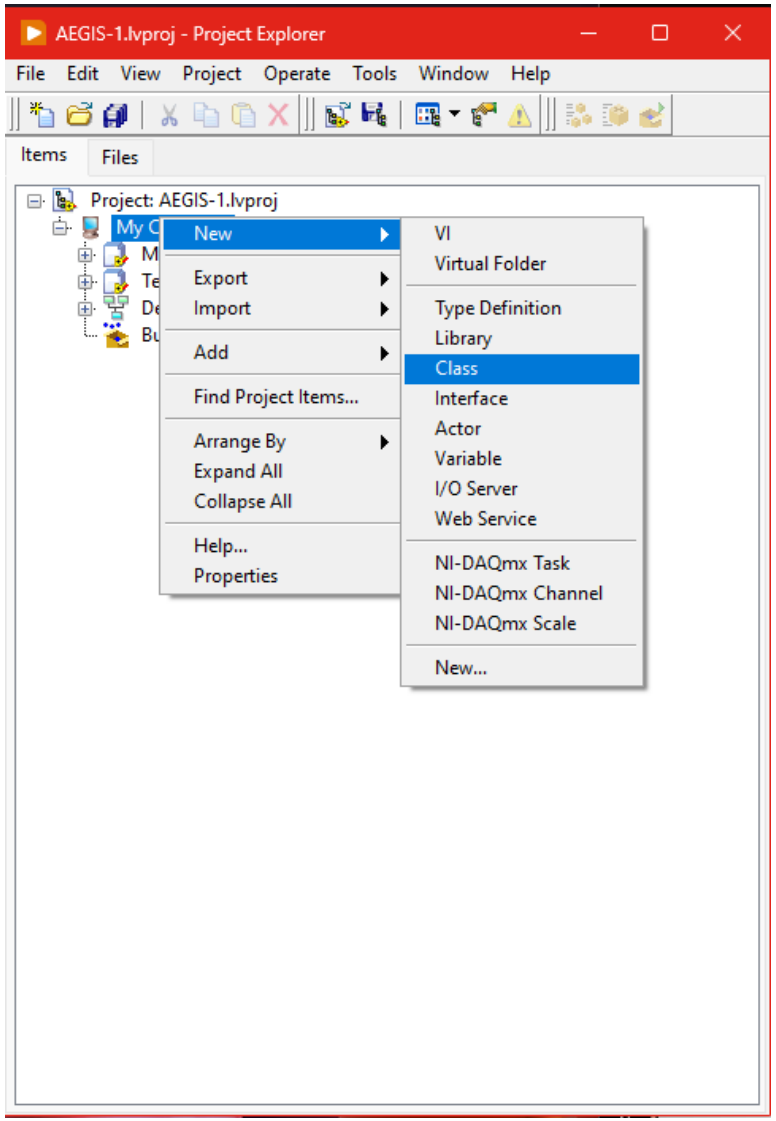


Your project should look like this.

Hardware and Detector class

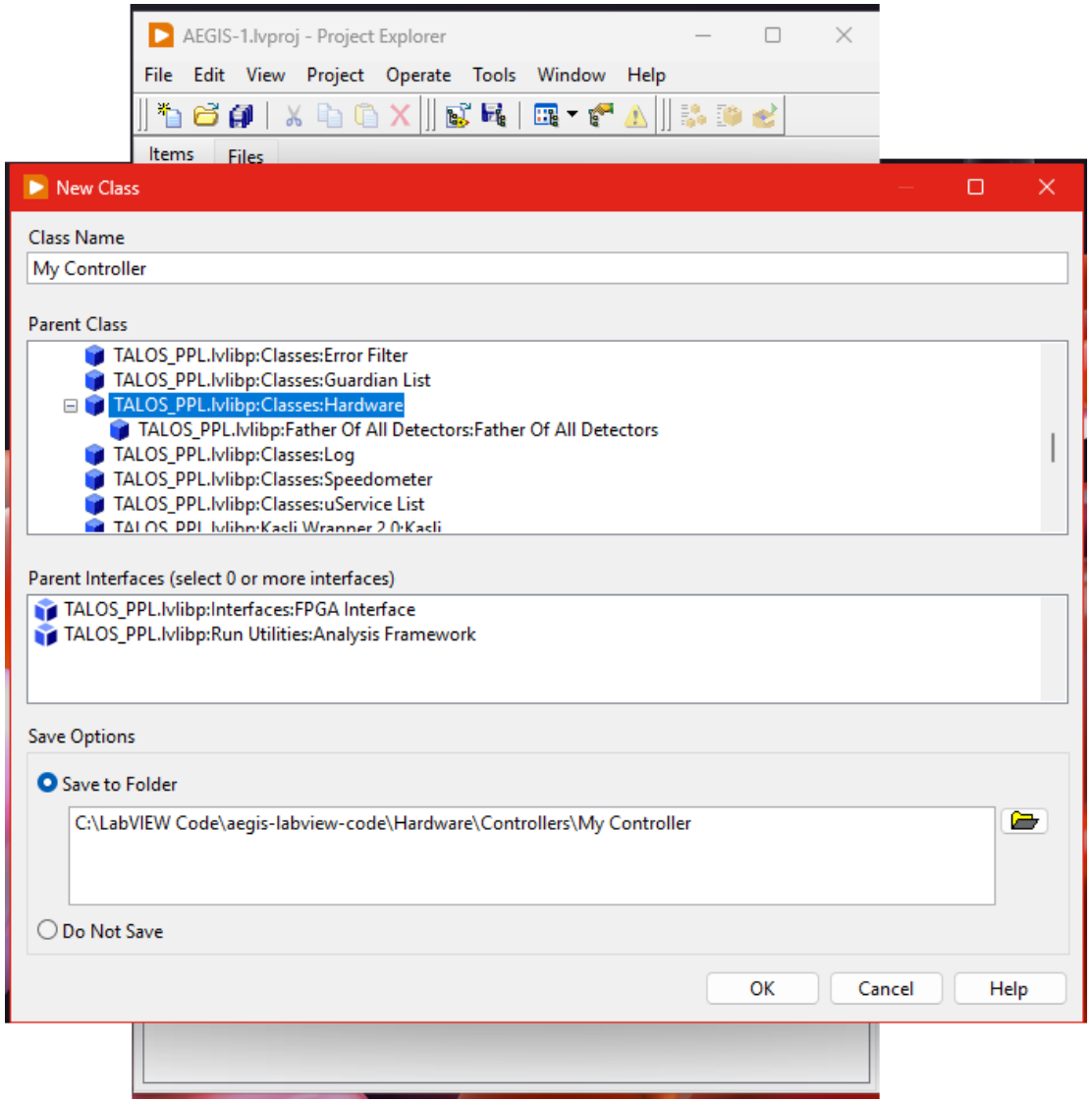
If you want to create a uService for a controller or detector with some new hardware, you will need to create a hardware class (Detector class is a child of the Hardware class)

Hardware/Detector class



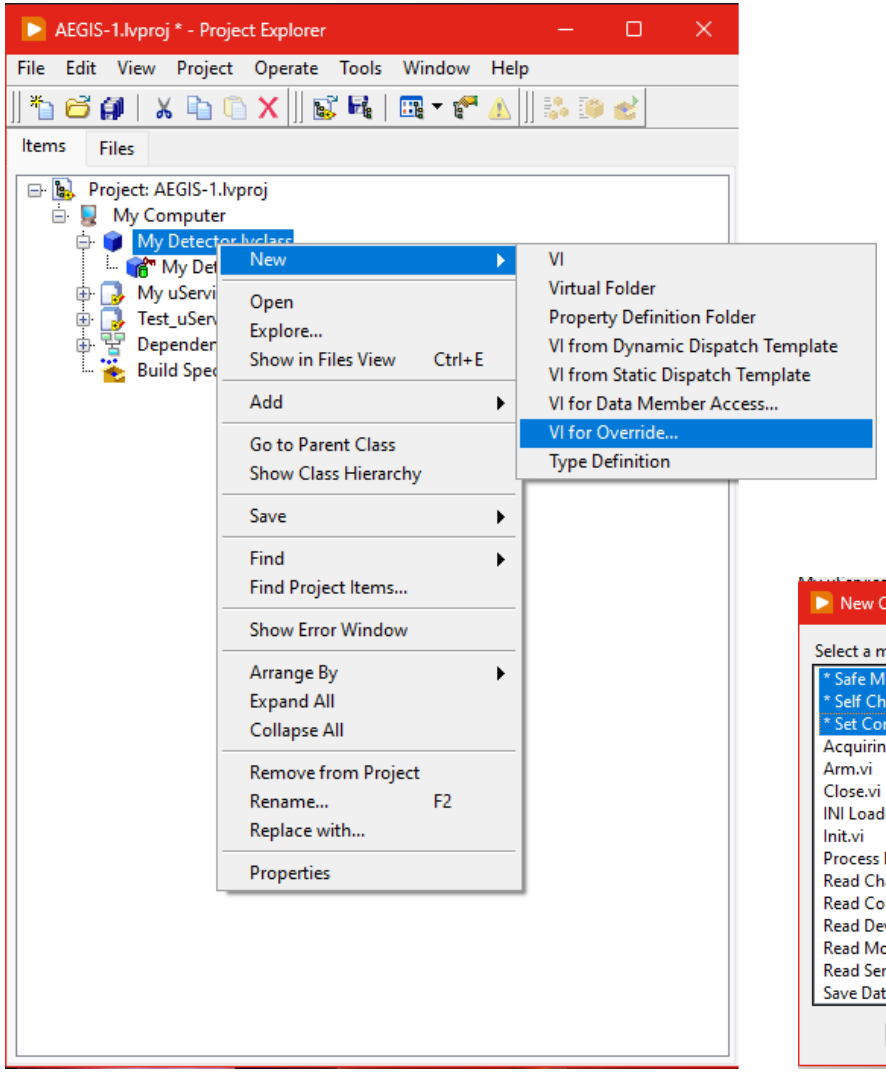
1. Right-click on the *My Computer* in the LV's Project Explorer and select *Add->Class*

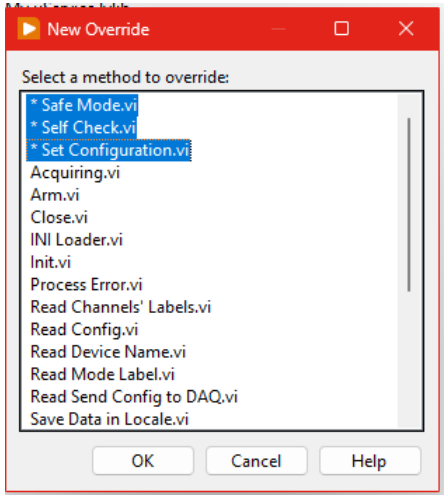
Hardware class



2. Give a new name to the class, usually it will be the name of the controller
   - This class is a general class for operating a specific controller. The same controller can be used by different uServices
3. From the *Parent Class* scroll down and selectr *TALOS_PPL.lvlibp:Classes:Hardware* (if you are implementing a hardware class for a detector, select the entry below *TALOS_PPL.lvlibp:Father of All Detectors:Father of All Detectors*)
4. Tick the *Save to Folder* and then press the browse button to the right. Navigate to the *Harware>Controllers* (or *Detectors*) folder in the project, type the name of your class and press save
5. Press Ok and your new class is created
6. Fill in the methods for the class by creating new VI's (preferably from the *Dynamic Dispatch Templace*)
   - This methods should be general ones for the device: init, close, set parameter, move (depending on the device of course)

Detector class





7. Detector class is used inside Detector Manager and it needs some methods to be overwritten
   1. Rick-click on the detector class created
   2. Select *New->VI for Override*...
   3. Select all Vis with the * and press OK
   4. Implement the functionality according to your desires

Detector Manager uService

Detector Manager is a special uService class that can be used to define new uService for a detector quickly.

You can create it with the same scheme as a new class, but selecting *TALOS_PPL.lvlibp:Detector Manager:Detector Manager* as the parent instead.

Then there are 2 Vis that should be overwritten:

- **Init.vi** – here a new instance of the detector class should be created and saved inside the private data cluster of the class
- **SubPanel.vi** – this will be the GUI inserted into the main the uService

Example uService development

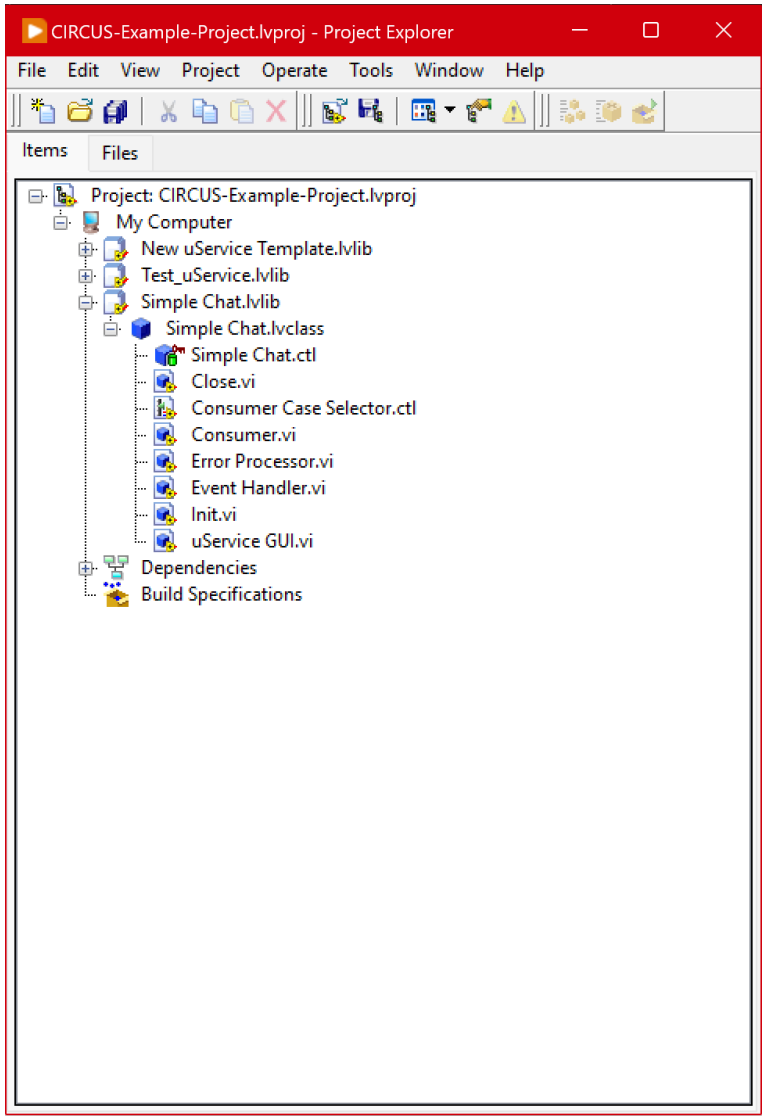
Making a simple chat uService

Simple chat

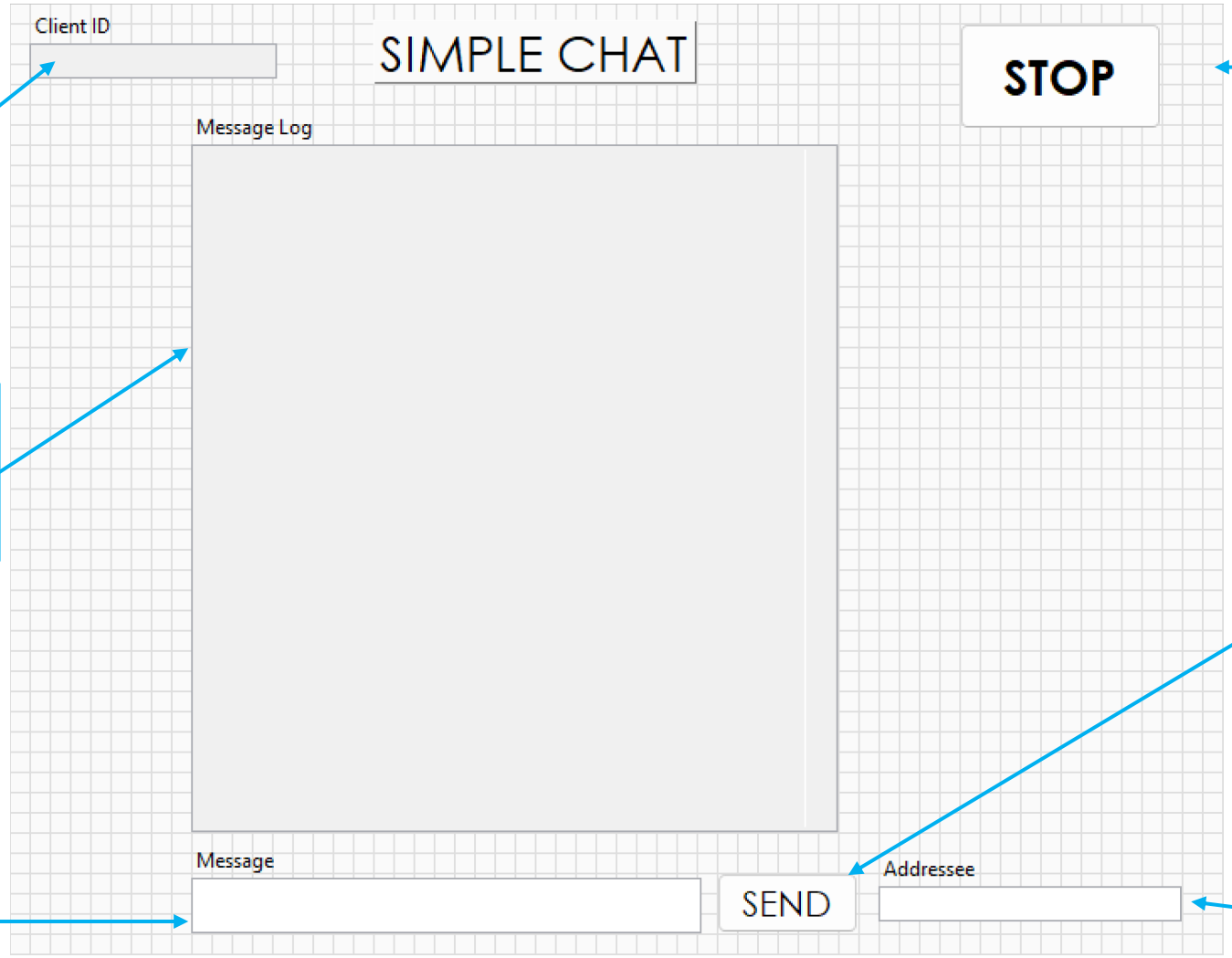
The idea is to create a simple uService that can be used as a chat.

The uService should support sending and receiving a message between other chat participants.

We are going to start with a uService from the template and we will call it “Simple Chat”



Simple chat – GUI (from panel)



String indicator to show what's the name of the client

Button for stopping the uService

String indicator to show sent and received messages

Button for sending the message

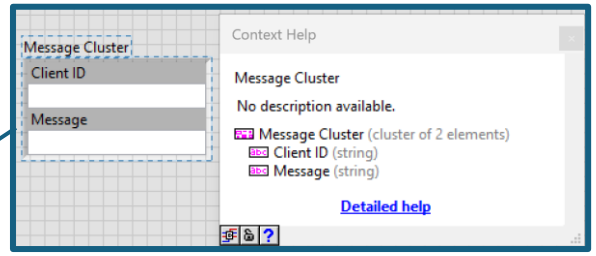
String control for typing out the message to send

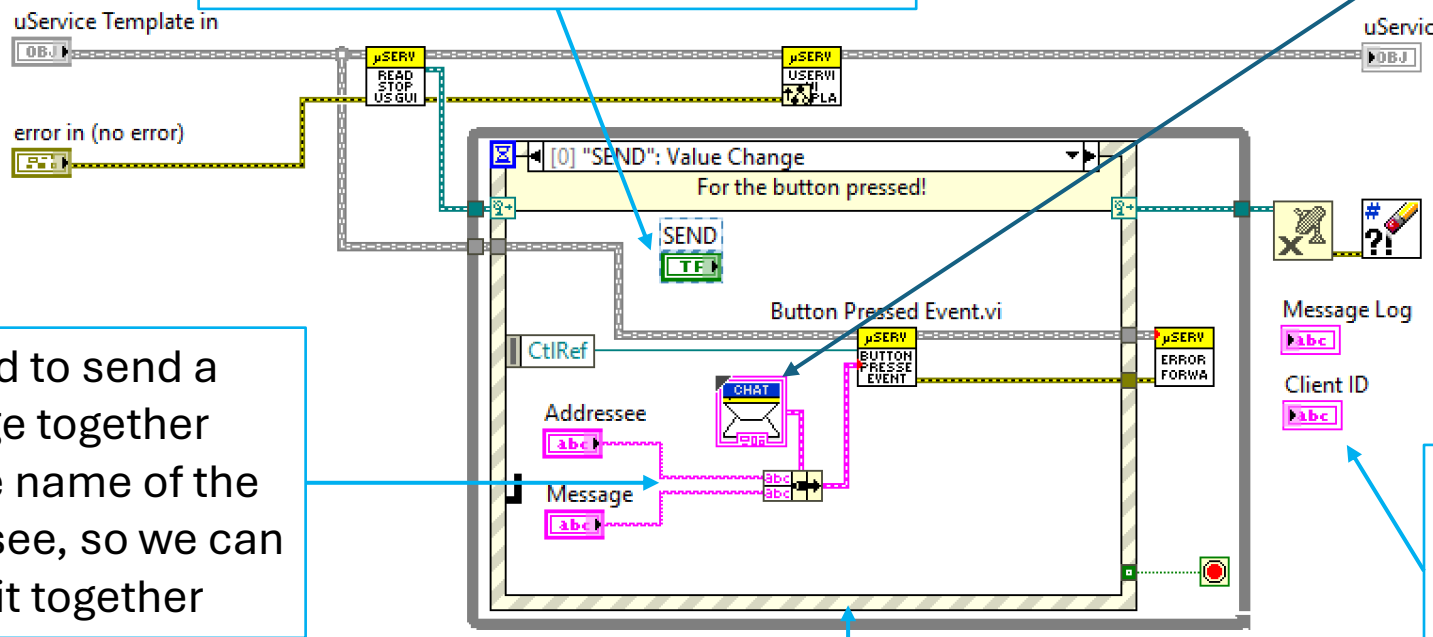
String control for specifying receiver of the message

Simple chat – GUI (block diagram)

Create a custom type definition that we can use throughout the uService (save it inside the class)

Button for sending the message. Having the button inside the case always to use latching mechanism





We need to send a message together with the name of the addressee, so we can bundle it together

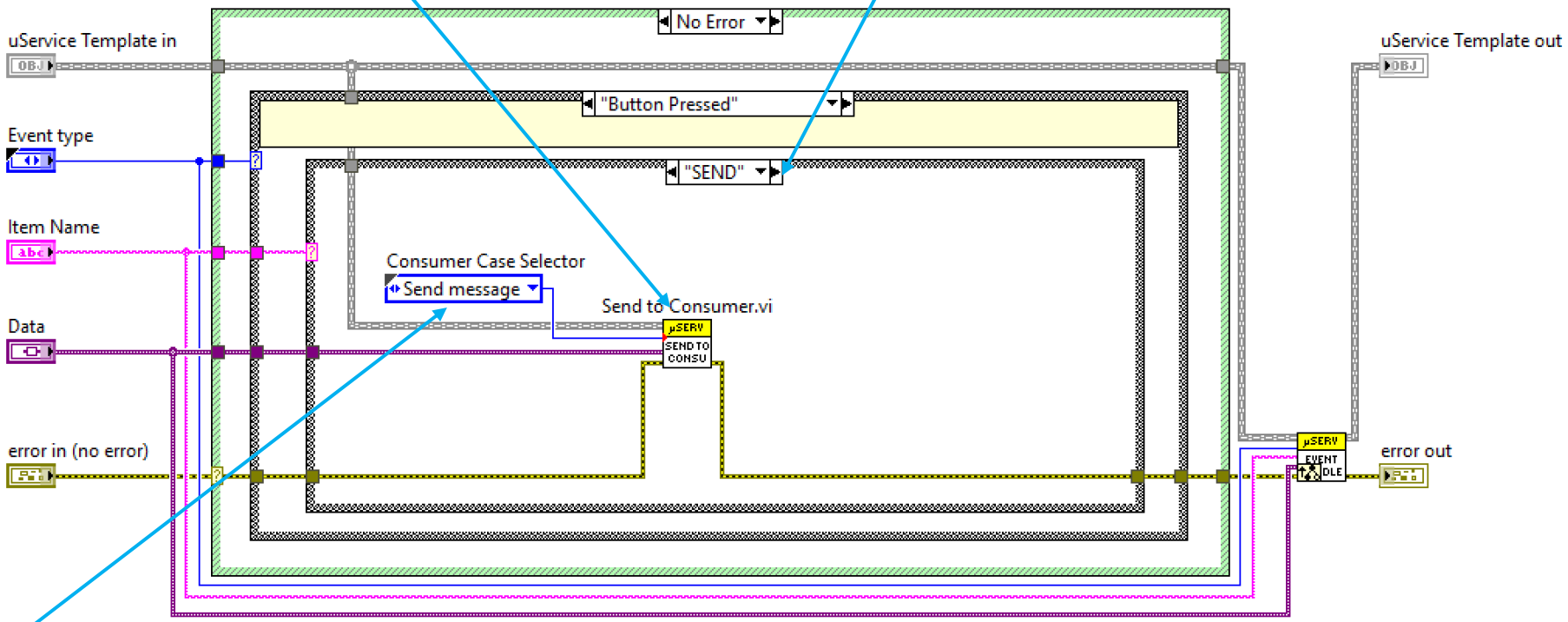
The indicators don't need to be connected. They will be updated throughout the uService running

In this uService we only have one simple button, so only one custom case needed

Simple chat – Add button case in the Event Handler.vi

We have a single button calling the *Button Pressed Event* in the GUI.vi. This means we need to create a case for that button with the case name the same as the button label

In this event we want to call a specific case in the consumer



Options for the Consumer Cases are declared with the Consumer Case Selector Enumerator

We add a new consumer case by editing the items in the type definition

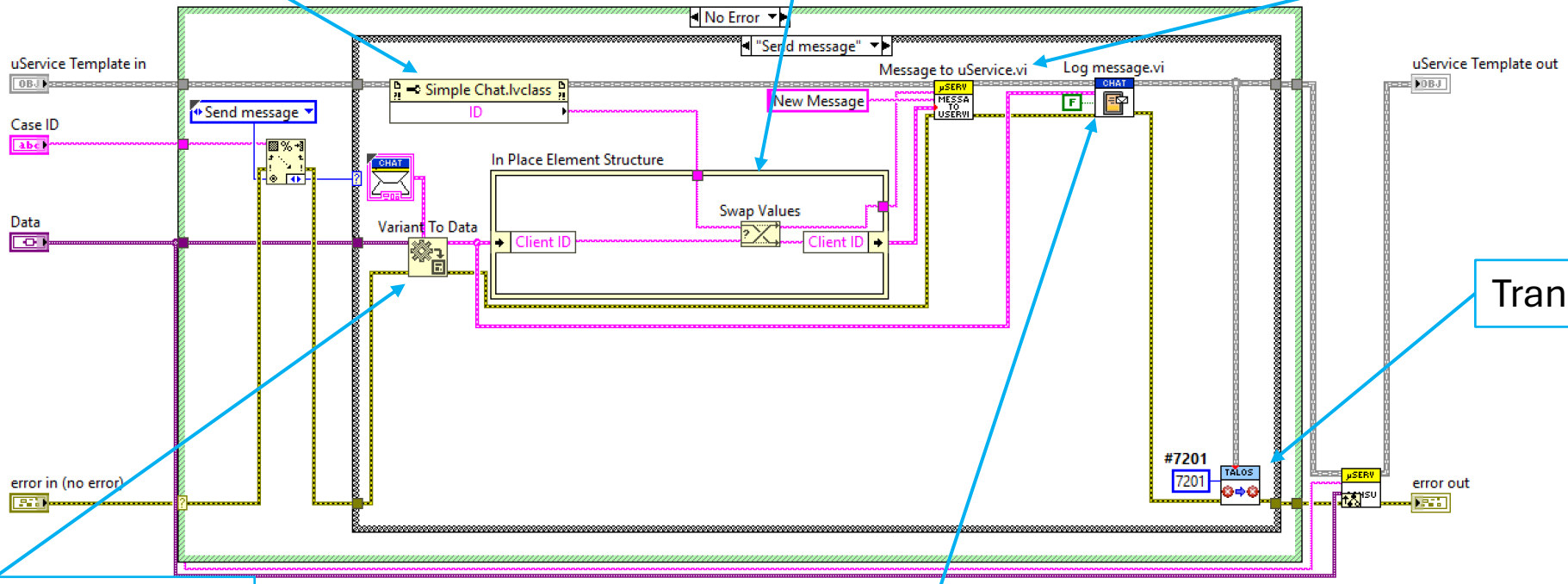
Simple chat – Define the case in the Consumer.vi

We add a new case for sending the message

We are going to use the uService ID as the Client ID

We need to convert the message so we send information about who sent the message

Send a message “New Message” to the uService specified from the message cluster



Translate error

We need to convert variant to the message type (by using the type def)

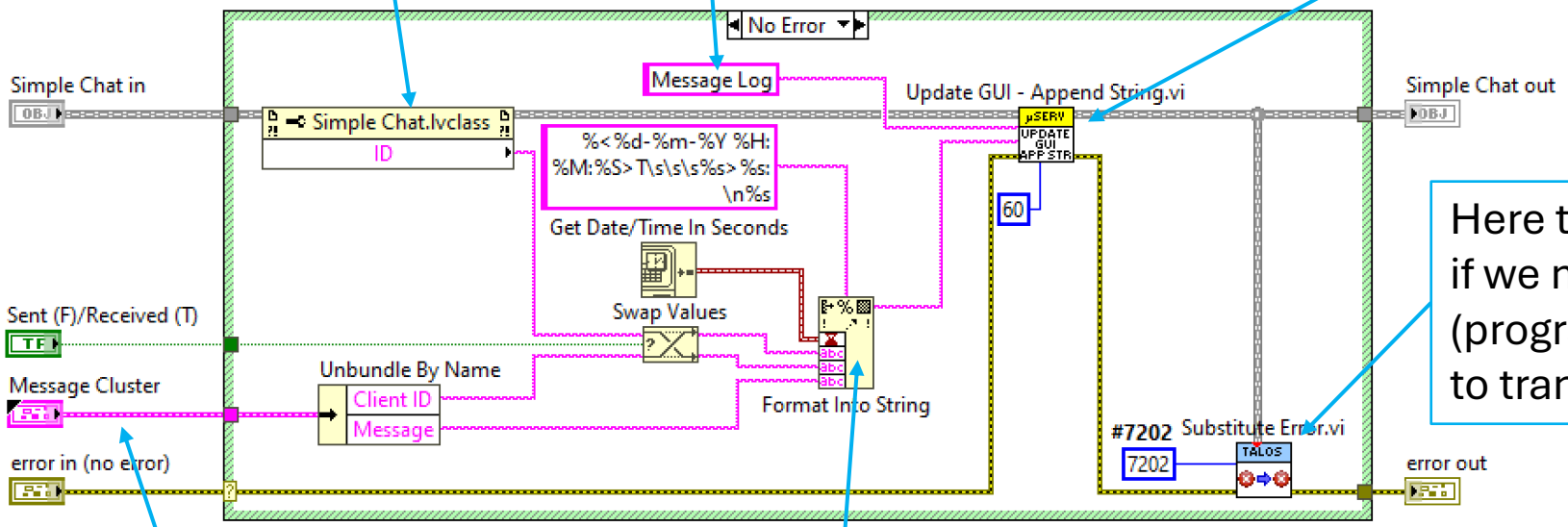
Print message on the GUI. For this we can create a SubVI as we will use it also in received message. This can also be done as a consumer case

Simple chat – SubVI for printing message on the GUI

We are using the uService ID as the Client ID of this uService

Name of the indicator that is used for printing the messages

Update the GUI with the Append String VI to save the previous meesages



Here the error can happen only if we made a mistake (programmer's error). It is safer to translate it anyway

We are going to use the same message type def as the input for the VI

Format message for printing

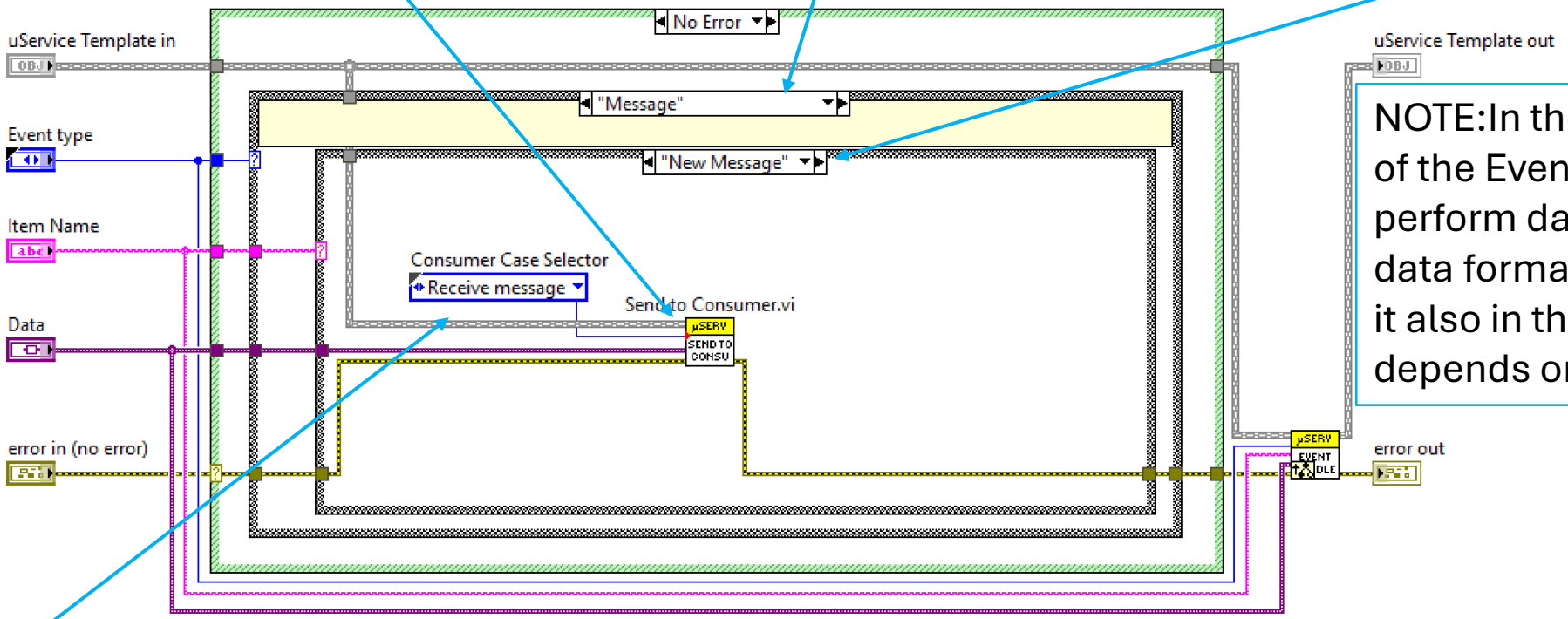
We add a new case by editing the items in the type definition

Simple chat – Add message case in the Event Handler.vi

In the message case of the Event Handler we can add cases for all messages that we expect the uService to receive.

The case name should be the same as the message sent to the uService

In this event we want to call a specific case in the consumer



NOTE:In the message cases of the Event Handler we can perform data checking or data formatting. We can do it also in the Consumer. It depends on our needs.

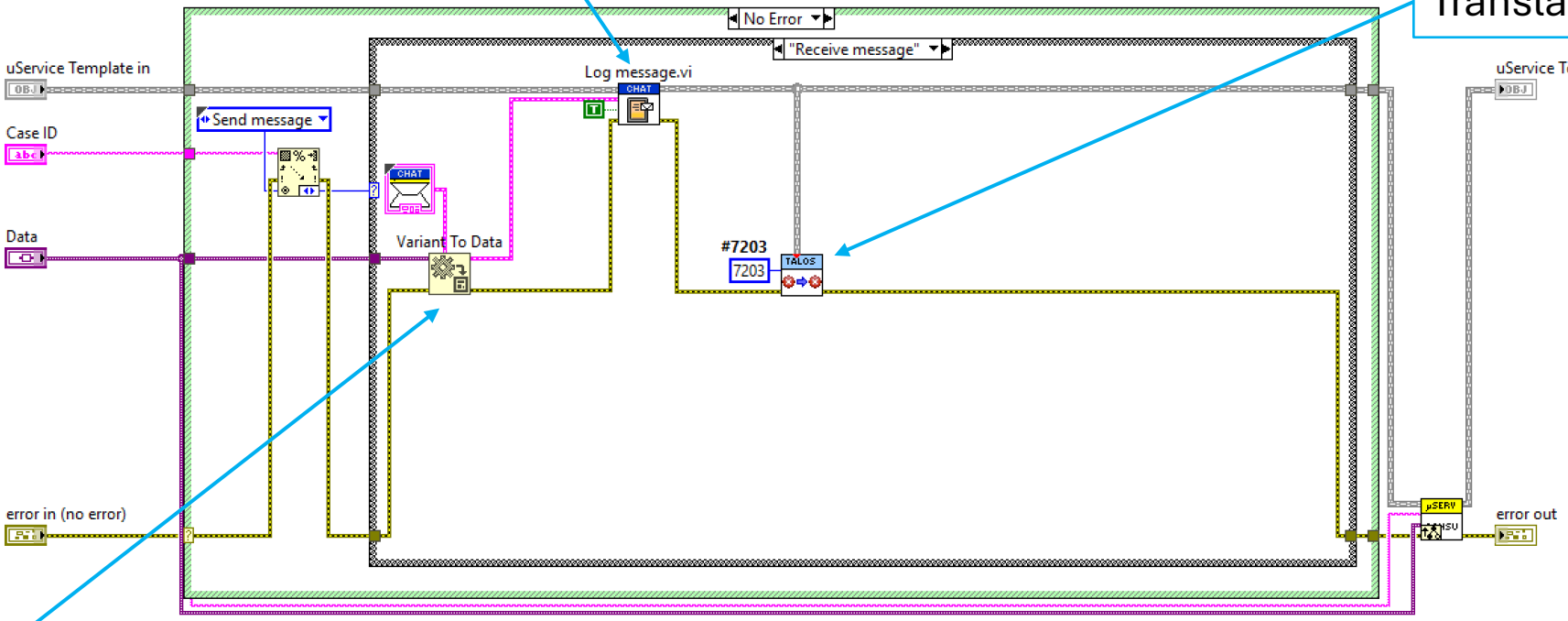
Options for the Consumer Cases are declared with the Consumer Case Selector Enumerator

We add a new consumer case by editing the items in the type definition

Simple chat – Define the case in the Consumer.vi

Receive message case has only to print message on the GUI. Here we can use our SubVI again

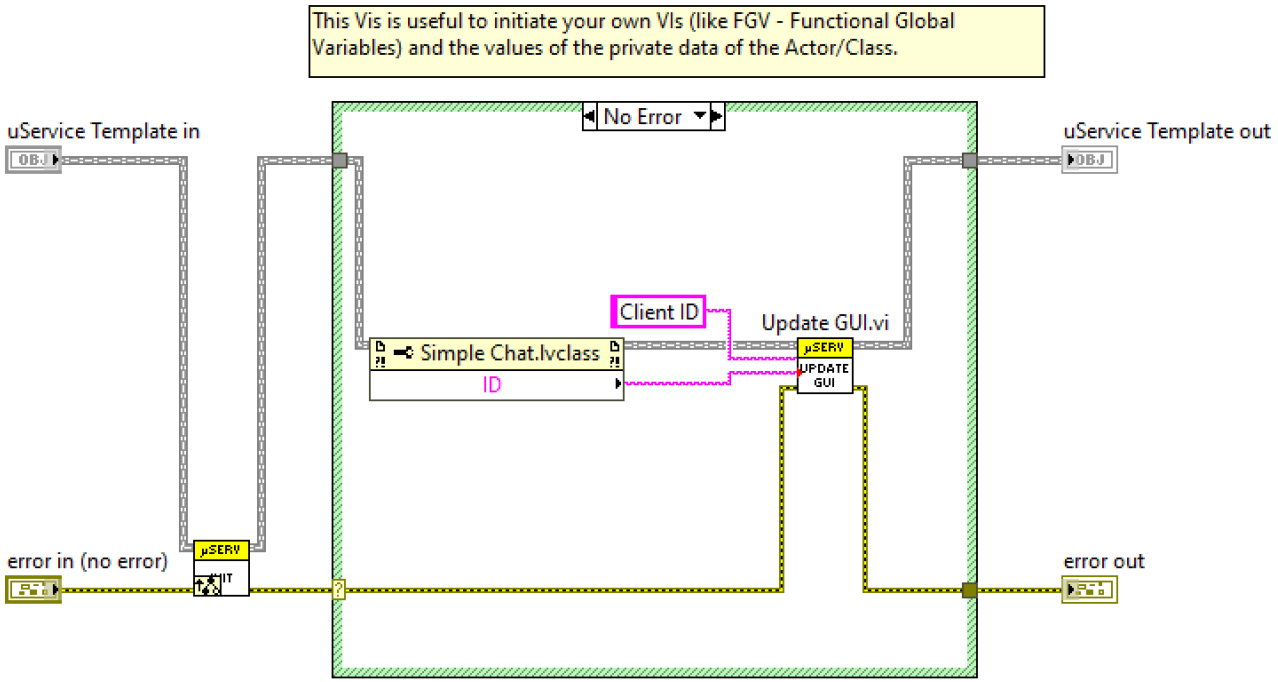
Translate error



We need to convert variant to the message type (by using the type def)

Simple chat – Init.vi

In the Init.vi we only want to upda the indicator with the client ID



Simple chat – update error list

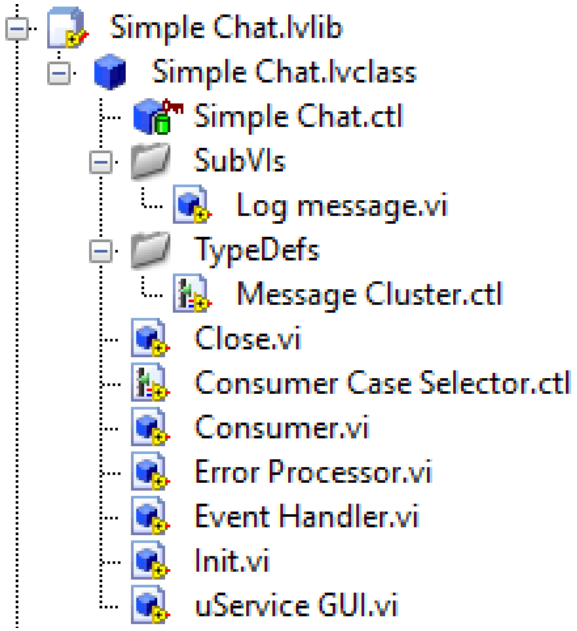
Error list should be updated throughout the development of the code

We decided to start the Simple chat at the error code 7200

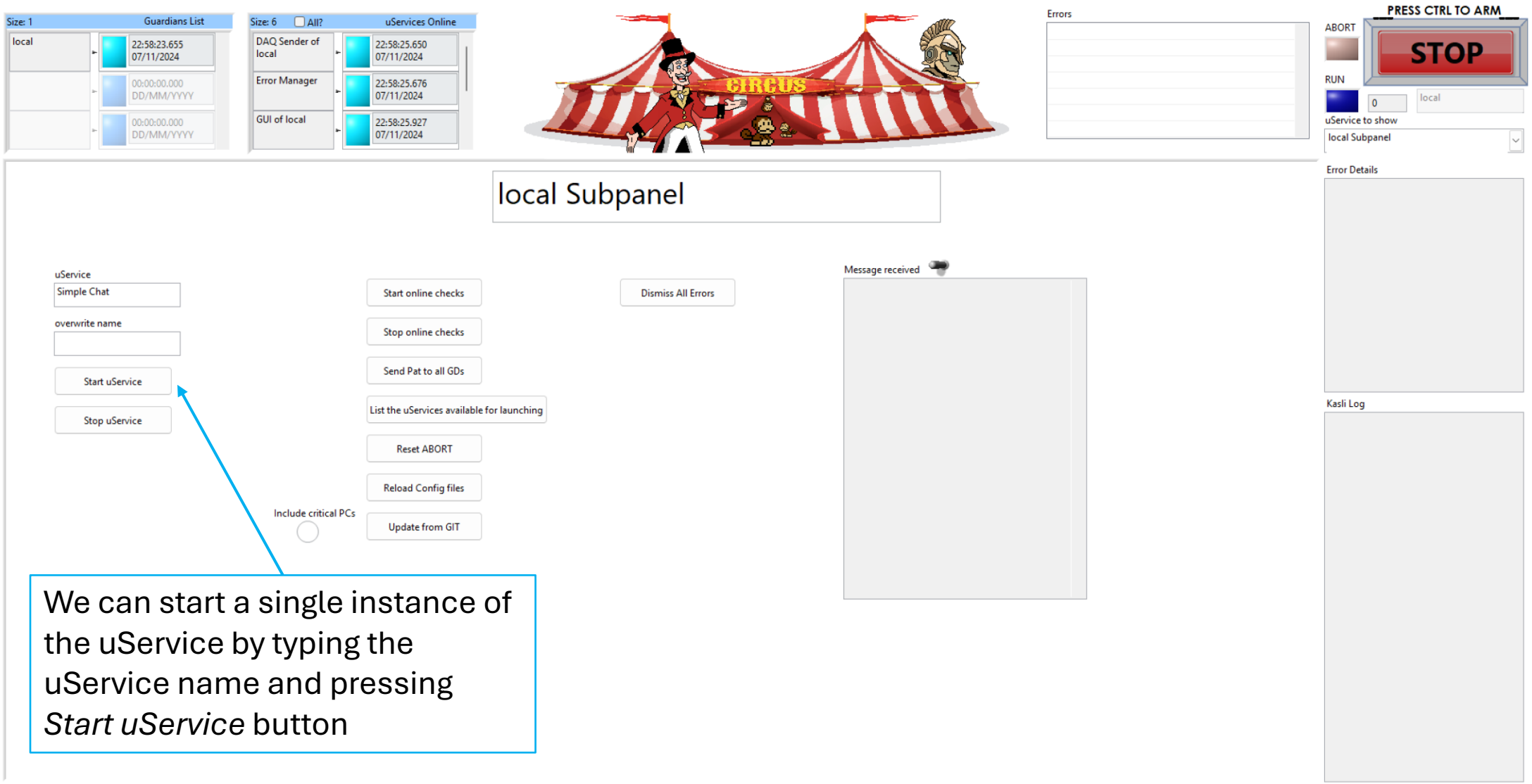
We defined three custom error codes for this uService. These codes are saved in the CIRCUS error file.

```
7200,Simple Chat,0
7201,Error sending a message,0
7202,Error printing the message,0
7203,Error decoding the message,0
```

Simple chat – uService library

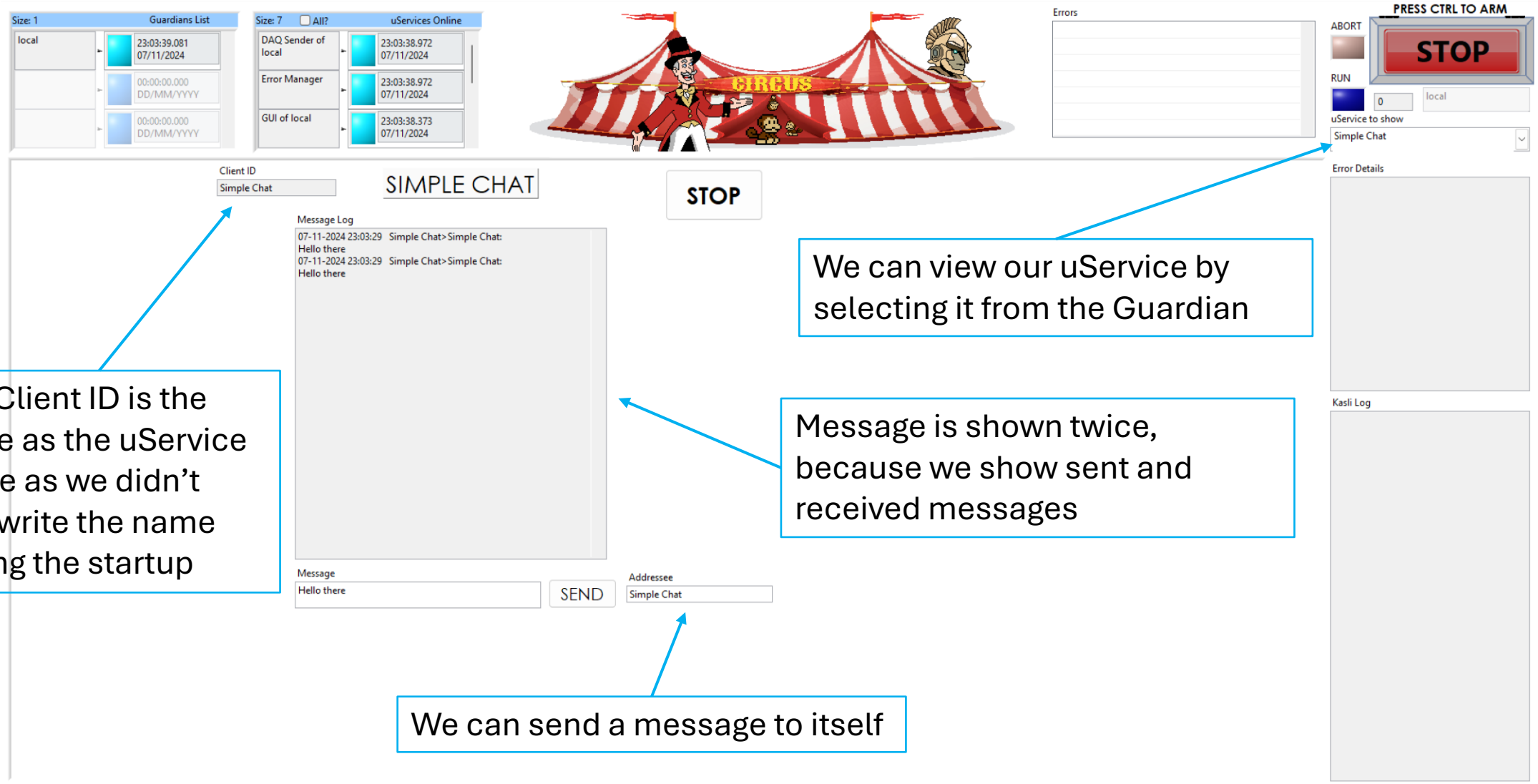


Simple chat – start the uService



We can start a single instance of the uService by typing the uService name and pressing *Start uService* button

Simple chat – send message to itself



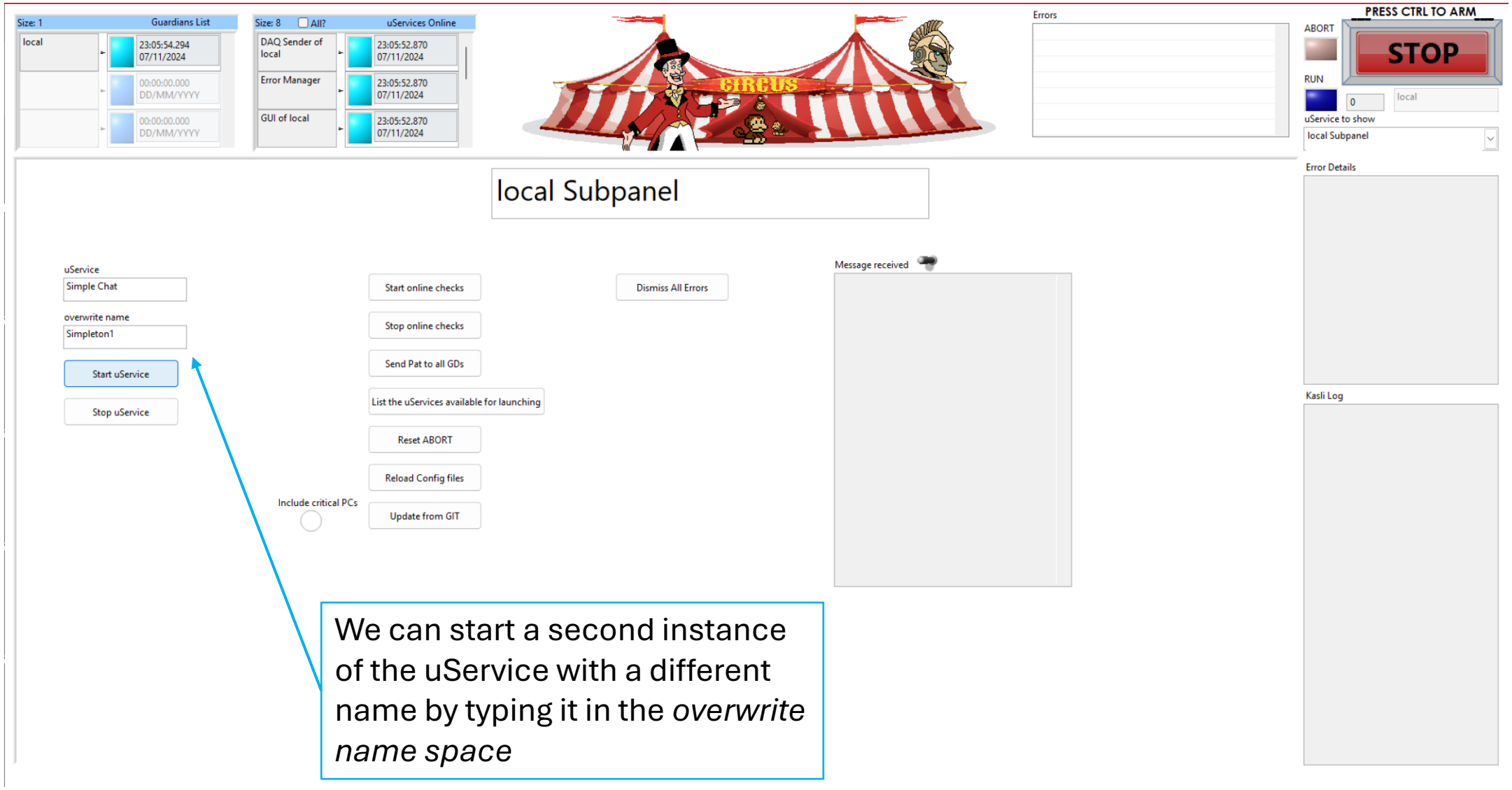
We can view our uService by selecting it from the Guardian

The Client ID is the same as the uService name as we didn't overwrite the name during the startup

Message is shown twice, because we show sent and received messages

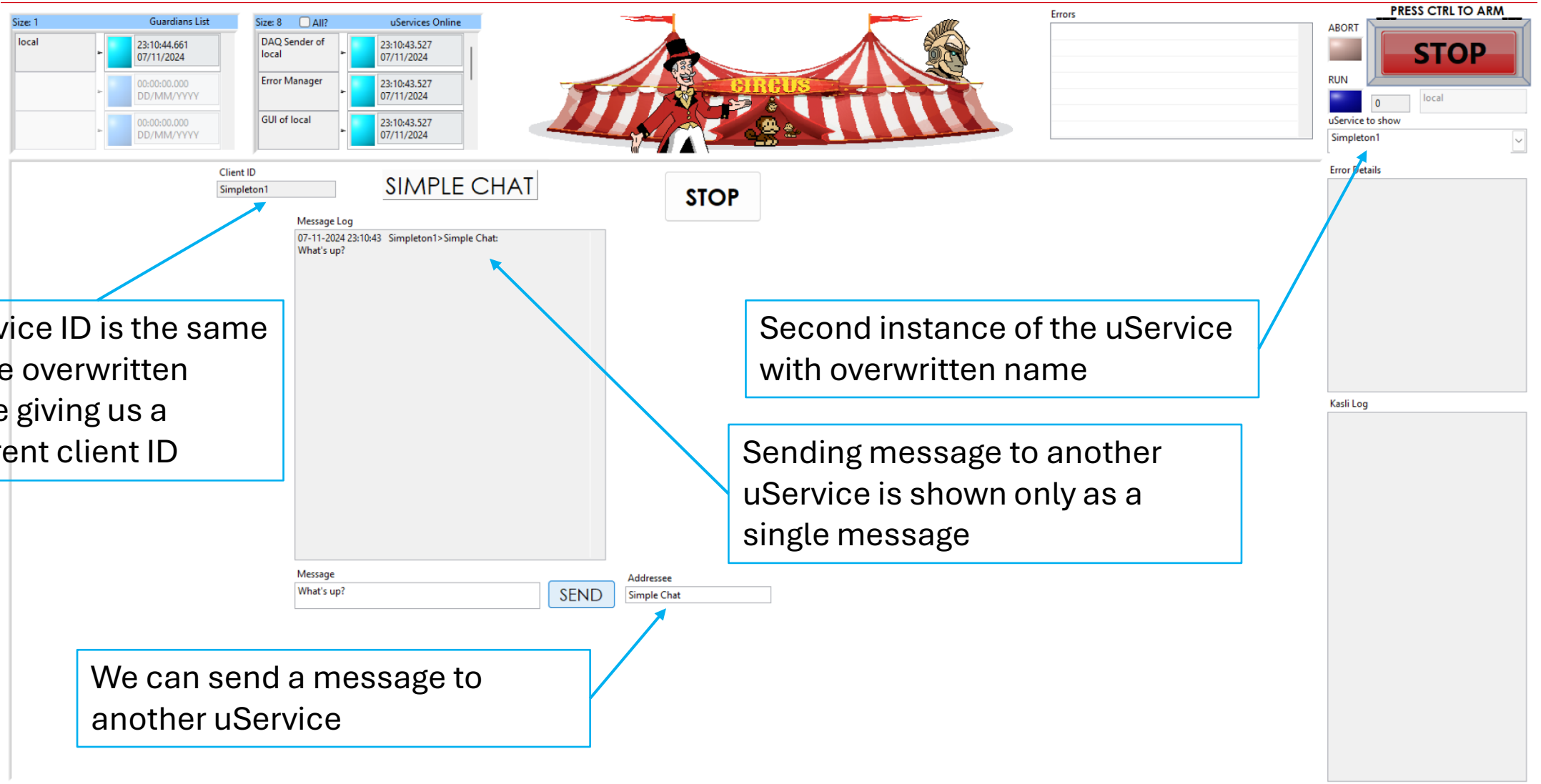
We can send a message to itself

Simple chat – start another instance of the uService



We can start a second instance of the uService with a different name by typing it in the *overwrite name space*

Simple chat – send message between uServices



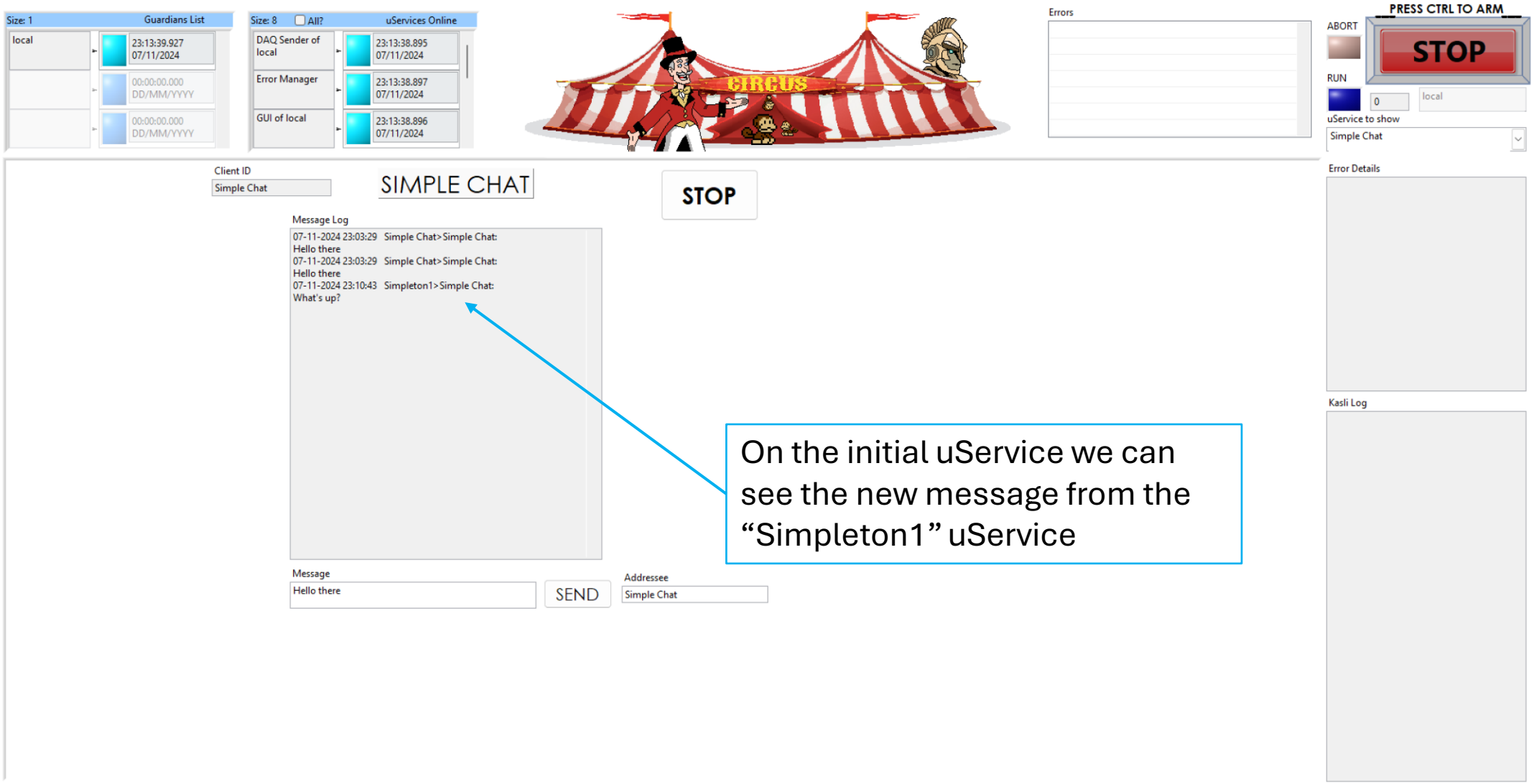
uService ID is the same as the overwritten name giving us a different client ID

Second instance of the uService with overwritten name

Sending message to another uService is shown only as a single message

We can send a message to another uService

Simple chat – received message by the uService



On the initial uService we can see the new message from the "Simpleton1" uService