STM32 Ecosystem workshop

T.O.M.A.S Team

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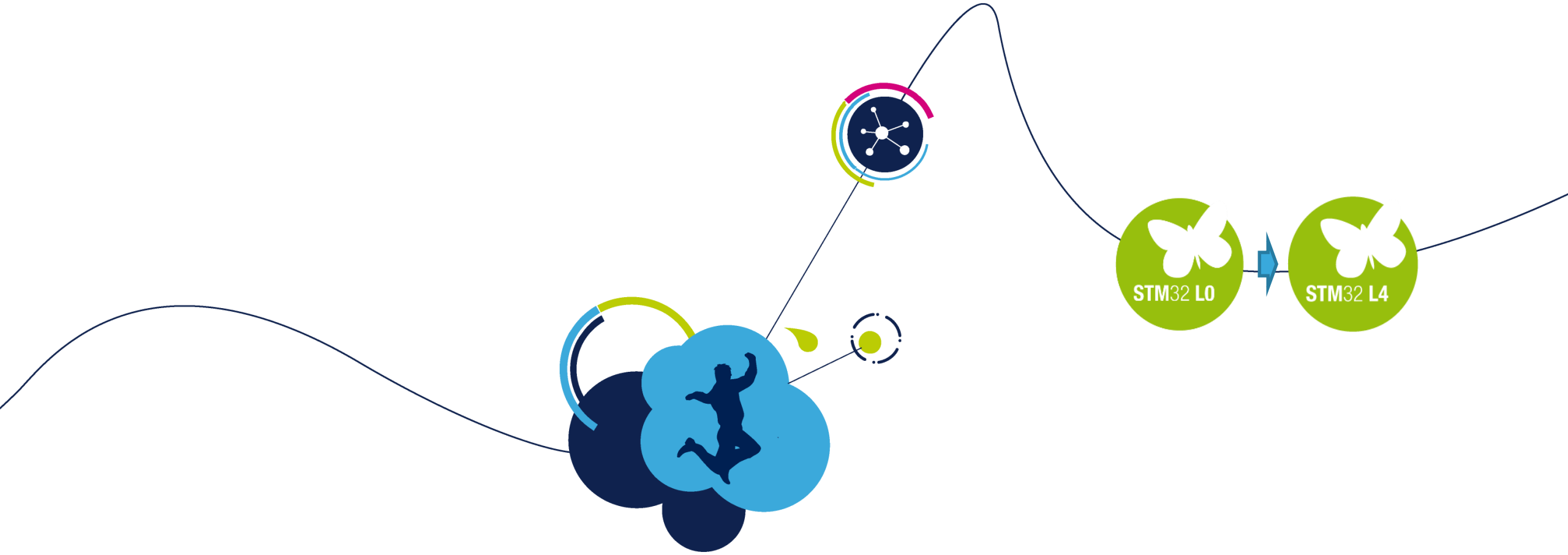
- Now it is time for some activities with STM32CubeMX again ☺
- Our current goal is to port provided ready project done for
  - NUCLEO-L053R8 board (STM32L053R8T6 microcontroller)

  to
  - NUCLEO-L476RG board (STM32L476RGT6 microcontroller)

Our goals for this session:

- Original concept description (for STM32L053R8T6 MCU)
- Project migration in STM32CubeMX step-by-step:
  - Import STM32CubeMX project
  - Run migration to new platform (STM32L476RGT6 MCU)
  - Tune project in STM32CubeMX:
    - Update clocks
    - Re-configure peripherals
    - Generate project for new MCU
  - Tune project in SW4STM32:
    - Import modified project to the same workspace
    - Apply necessary modifications to generated sources
    - Compile and run project on the new platform



Project migration in STM32CubeMX

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Concept of the system

original project for NUCLEO-L053

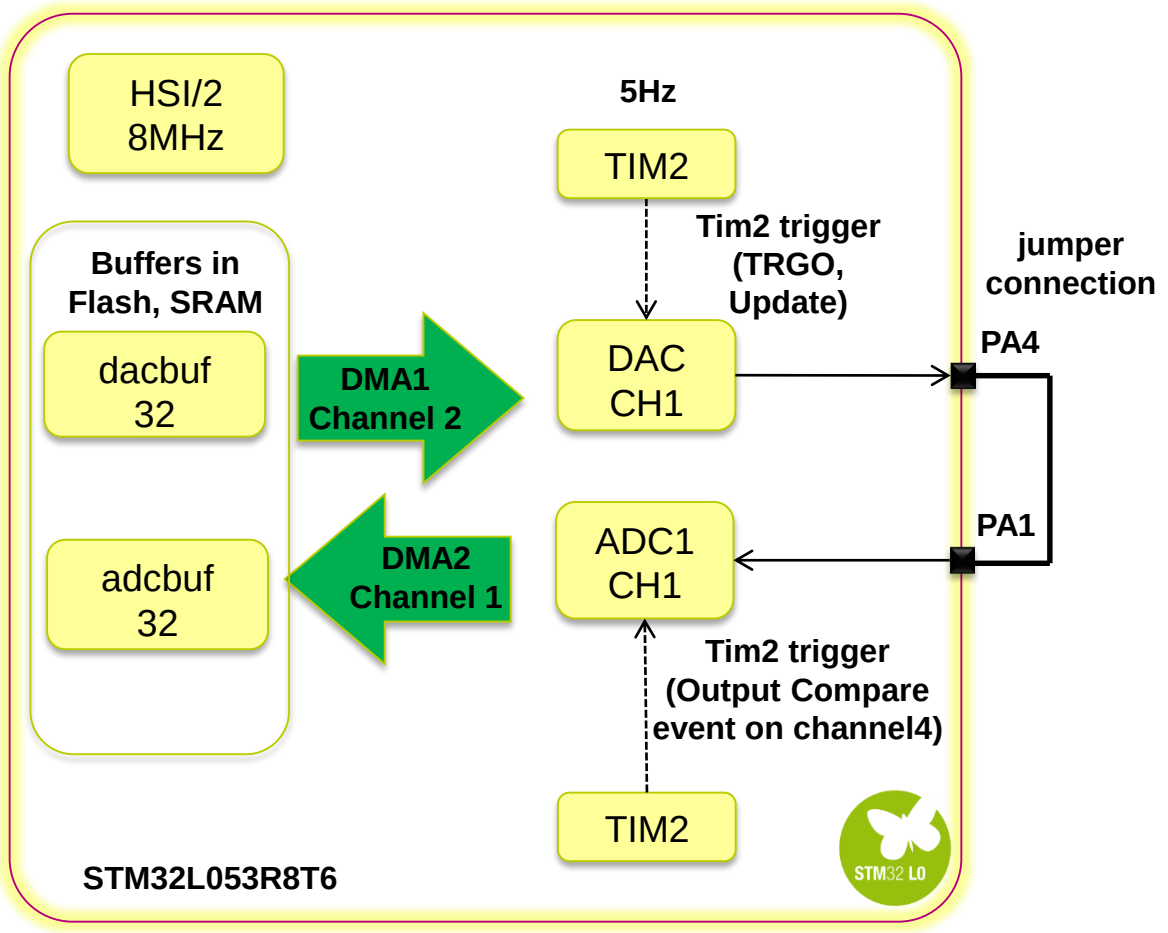
Concept description

Hardware

- **DAC1 Channel1** and **ADC1 Channel1** were selected as **PA4 and PA1** are neighboring pins on the connector; no rework, just need a jumper.

Software

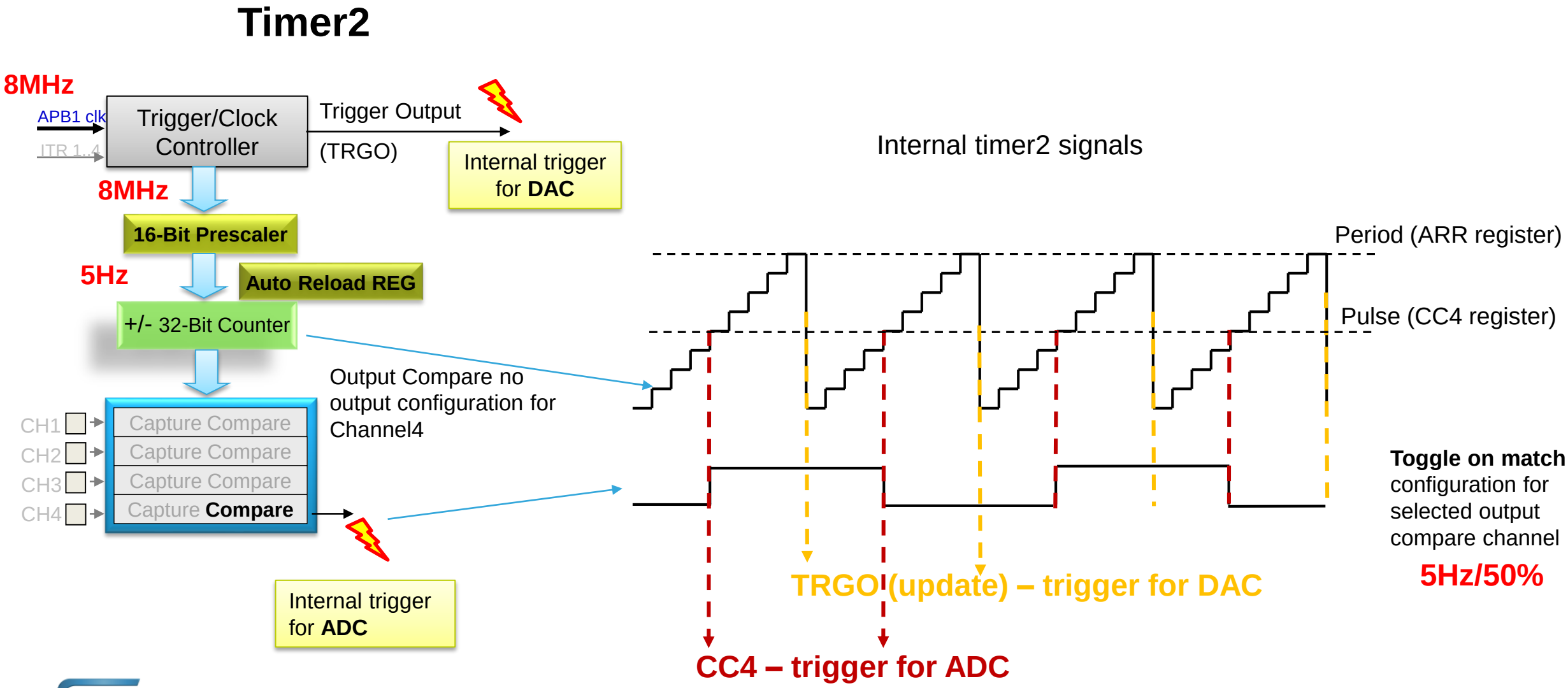
- **Timer2** is configured to work with **5Hz** (200msec period) and to **trigger**:
  - **DAC** (on TRGO Update event)
  - **ADC** (on Channel4 Output Compare event)
- **DAC1 Channel1** is configured to generate on **PA4** signal based on the data sent by **DMA** from internal **dacbuf[]** buffer (sine wave in this example).
- **ADC1 Channel1** is configured to measure signal on **PA1**. Measured data are copied by **DMA** to internal **adcbuf[]** buffer.



Hardware overview

Concept of the system

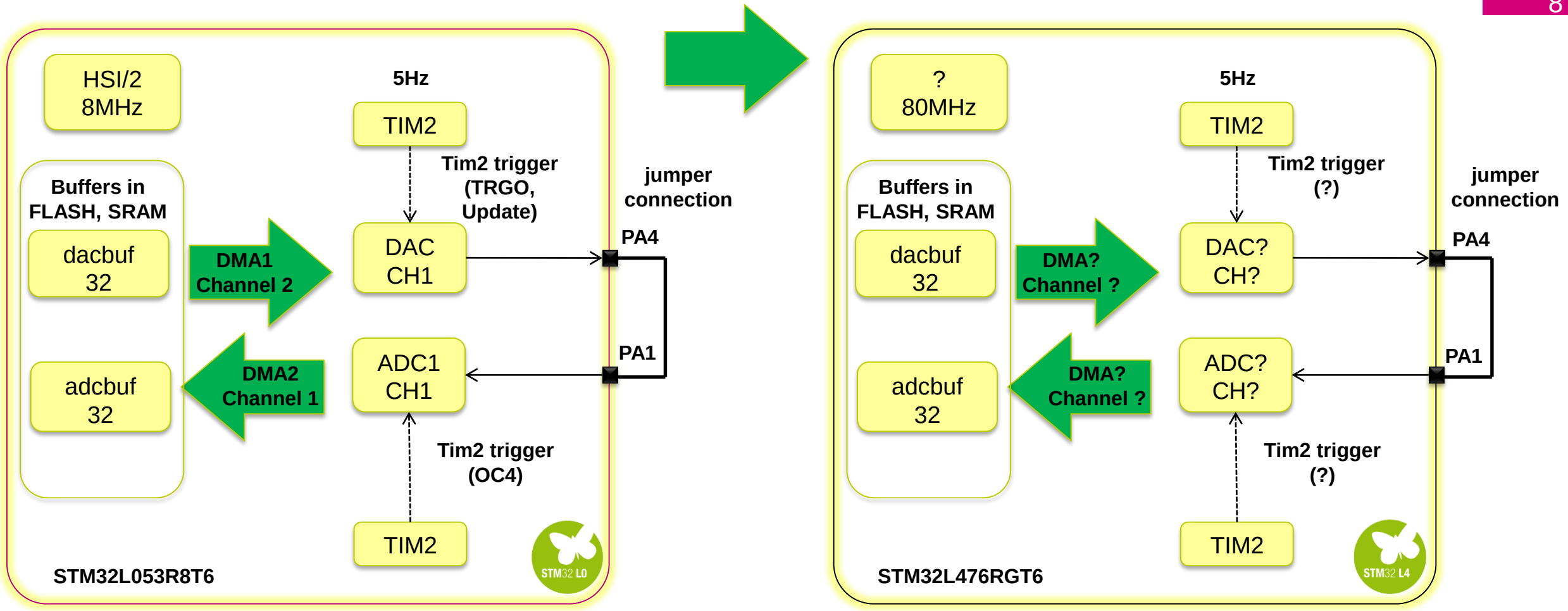
triggering of ADC and DAC by TIM2



This is why we should **trigger ADC on both edges** with the configuration for selected timer output compare set to **toggle on match**

Concept of the system

migration to NUCLEO-L476RG



Hardware overview

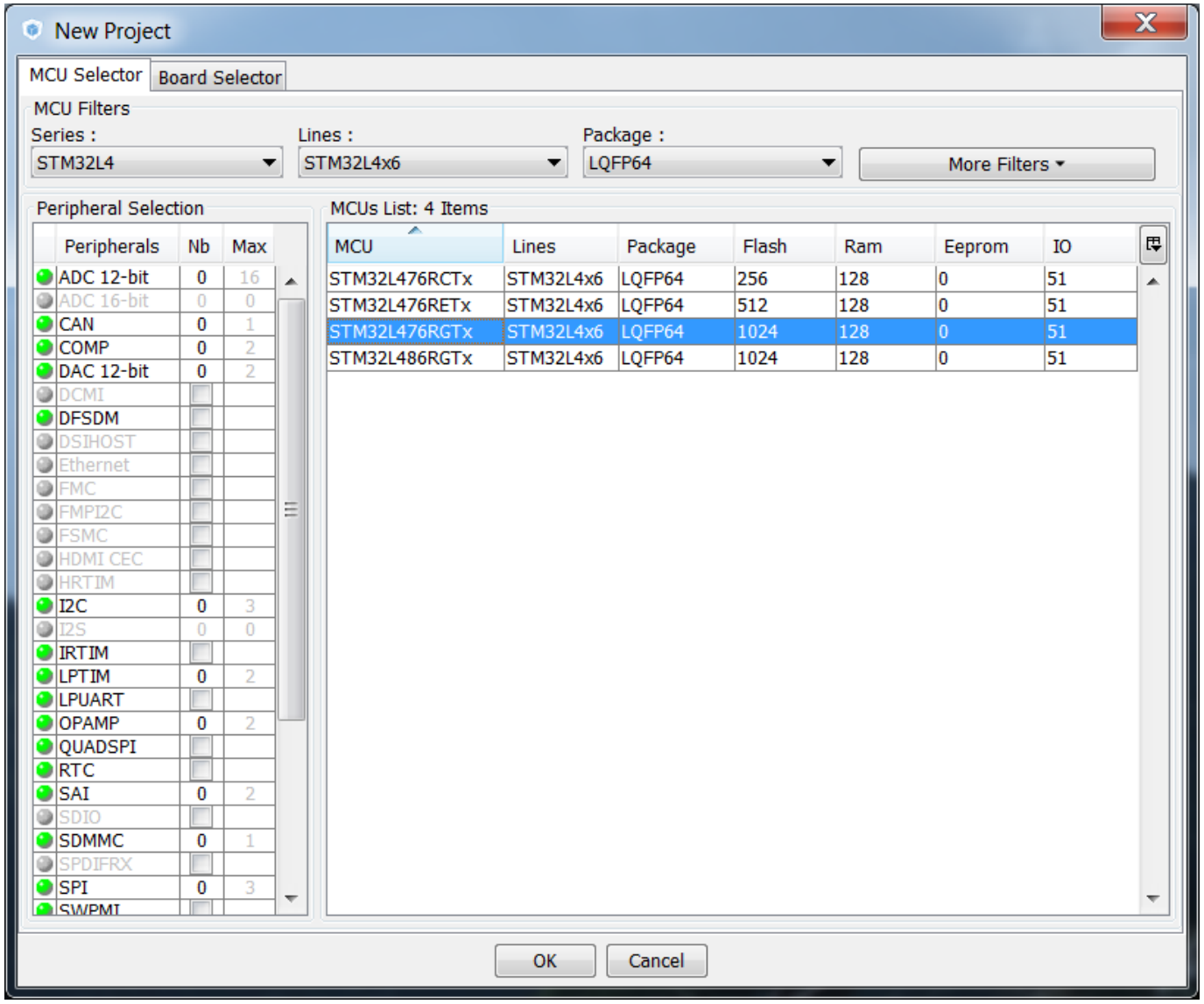
Hardware overview

Project migration from L0 to L4 platform

When creating new project in STM32CubeMX, after selection of the MCU it is possible to import project settings from other project that could be based on different MCU.

Task:

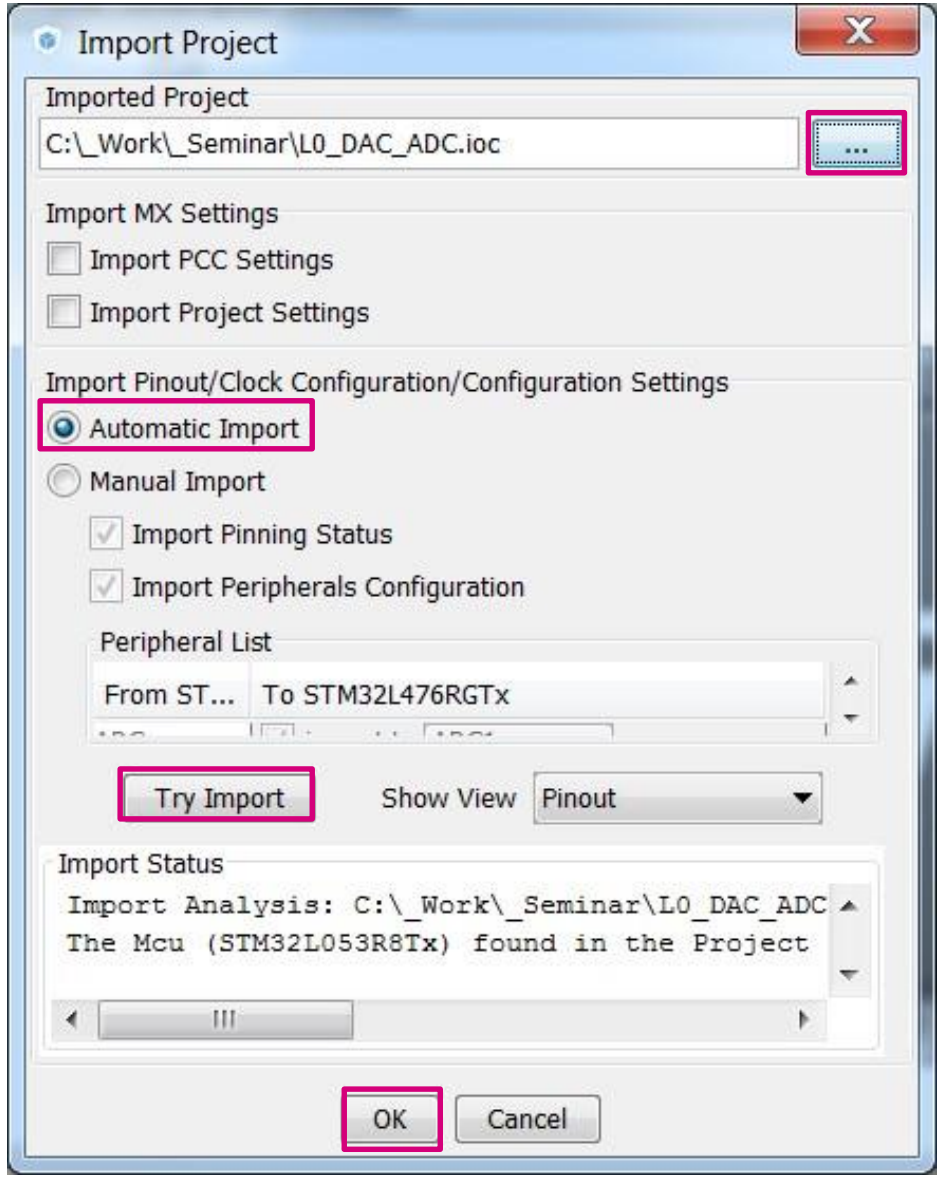
Import the **L0_DAC_ADC** project (generated for **STM32L053R8T6** based Nucleo-L053R8 board) into a new STM32CubeMX project for **STM32L476RGT6** MCU and run it on Nucleo-L476RG board.
New project can be named **L4_DAC_ADC**



Importing the project within STM32CubeMX

automatic import

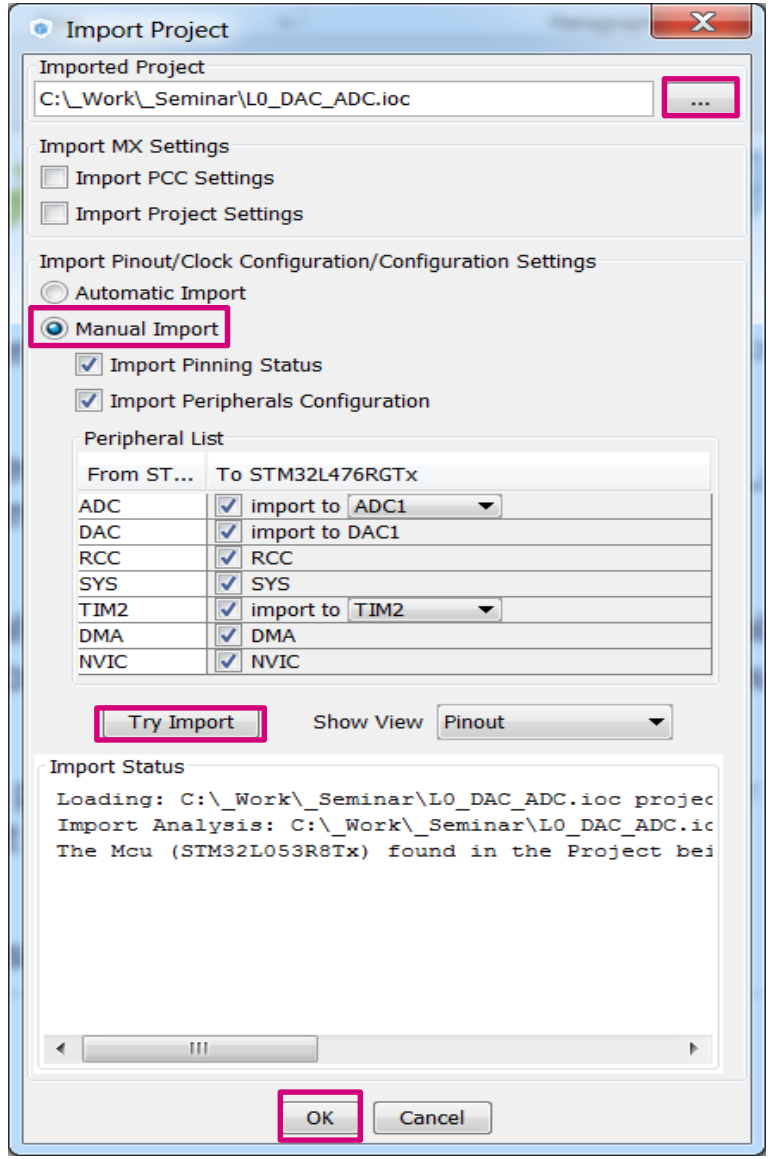
- Run STM32CubeMX and start **New Project**
- Complete MCU selection, then select **File→Import Project**
- Select reference STM32CubeMX project file to be imported (L0_DAC_ADC.ioc in our example)
- Select **Automatic Import** and then click **Try Import** button to analyze possible issues and incompatibilities
  - If **Automatic Import** fails, this is possible to adjust import process flow selecting **Manual Import** option (**see next slide for reference**) – we will not follow this step during workshop
- Click OK



Importing the project within STM32CubeMX

manual import

- Complete MCU selection then select **File→Import Project**
- Select reference STM32CubeMX project file to be imported (L0_DAC_ADC.ioc in our example)
- In order to adapt import settings select **Manual Import**
- In Manual Import mode it is possible to:
  - Select peripherals which would be imported into new project
  - Change destination peripheral after import (like different timer or ADC) if possible
  - Enable/disable import of peripherals configuration
  - Enable/disable import of pinning status
- When completed click **Try Import** button to verify new configuration.
- Click **OK** if import is possible, otherwise try to review setup again



Importing the project within STM32CubeMX

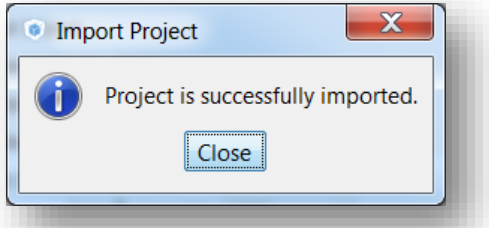
- After completion of import process
  - An information window will be displayed
  - Import Status window will show all issues found (like in an example below)

Import Status

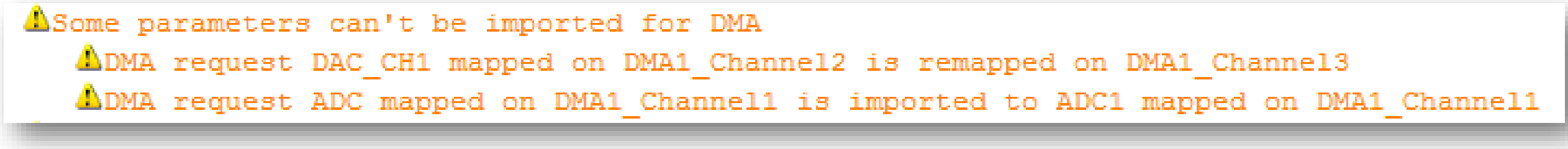
```
Import Analysis: C:\_Work\_L0_DAC_ADC\L0_DAC_ADC.ioc project
The Mcu (STM32L053R8Tx) found in the Project being imported is not the same as the Mcu (STM32L476RGTx) currently edited

Import Try :
Importing Pinout ...
Importing IP configurations ...
⚠Some parameters can't be imported for DMA
   ⚠DMA request DAC_CH1 mapped on DMA1_Channel2 is remapped on DMA1_Channel3
   ⚠DMA request ADC mapped on DMA1_Channel1 is imported to ADC1 mapped on DMA1_Channel1
⚠Some parameters can't be imported for NVIC
   ⚠Interrupt SVC_IRQn is replaced by interrupt SVCall_IRQn
⚠Some parameters can't be imported from ADC to ADC1
   ⚠Can't import parameter:Scan Conversion Mode = ADC_SCAN_DIRECTION_FORWARD, it isn't a possible value in STM32L476RGTx, it's set to default value.
   ⚠Can't import parameter:Low Frequency Mode, it doesn't exist in STM32L476RGTx
   ⚠Can't import parameter:Auto Off, it doesn't exist in STM32L476RGTx
   ⚠Can't import parameter:Sampling Time = ADC_SAMPLETIME_7CYCLES_5, it isn't a possible value in STM32L476RGTx, it's set to default value.
   ⚠Can't import parameter:External Trigger Conversion Source = ADC_EXTERNALTRIGCONV_T2_CC4, it isn't a possible value in STM32L476RGTx, it's set to default value.
   ⚠Can't import parameter:Enable Analog WatchDog Mode, it doesn't exist in STM32L476RGTx
Importing project completed
```

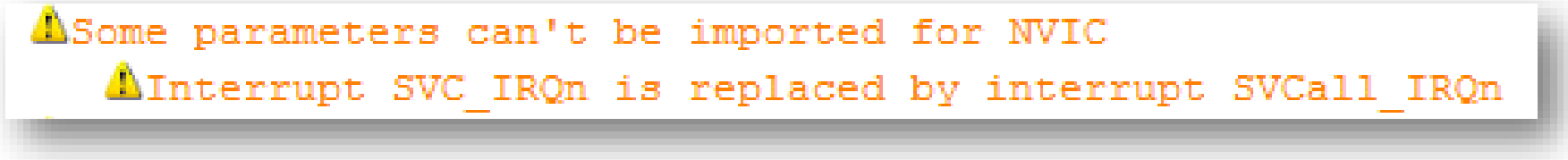
- After clicking Close and OK buttons, new MCU pinout for imported project will be displayed.



Importing the project within STM32CubeMX
warnings overview



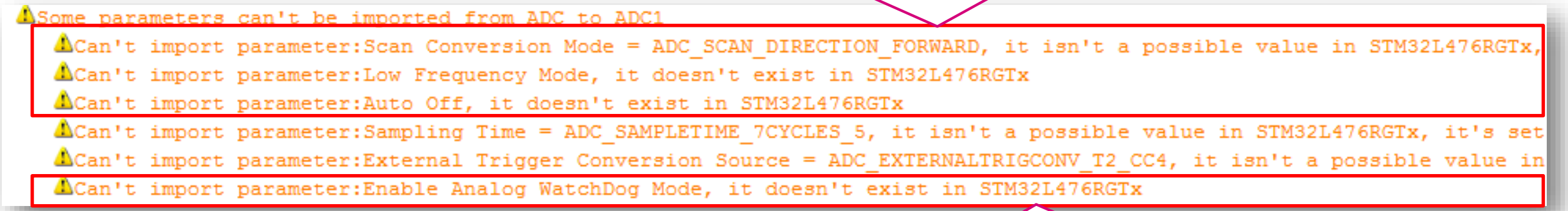
Proper DMA channels will be assigned automatically – no action on programmer side



There is no SVC usage in our application (it is mainly used in RTOS based systems)

Importing the project within STM32CubeMX
warnings overview

We are not using below modes in our application



We are not using analog watchdogs in our application

We should focus on 2 warnings only:

- **Sampling time** -> we should select different value as a default one 2.5 ADC clk is too small for 40MHz ADC clock
- **External Trigger Conversion Source** -> as in STM32L4 there is no trigger of ADC on TIM2_CC2 signal. -> **What we should select ?**

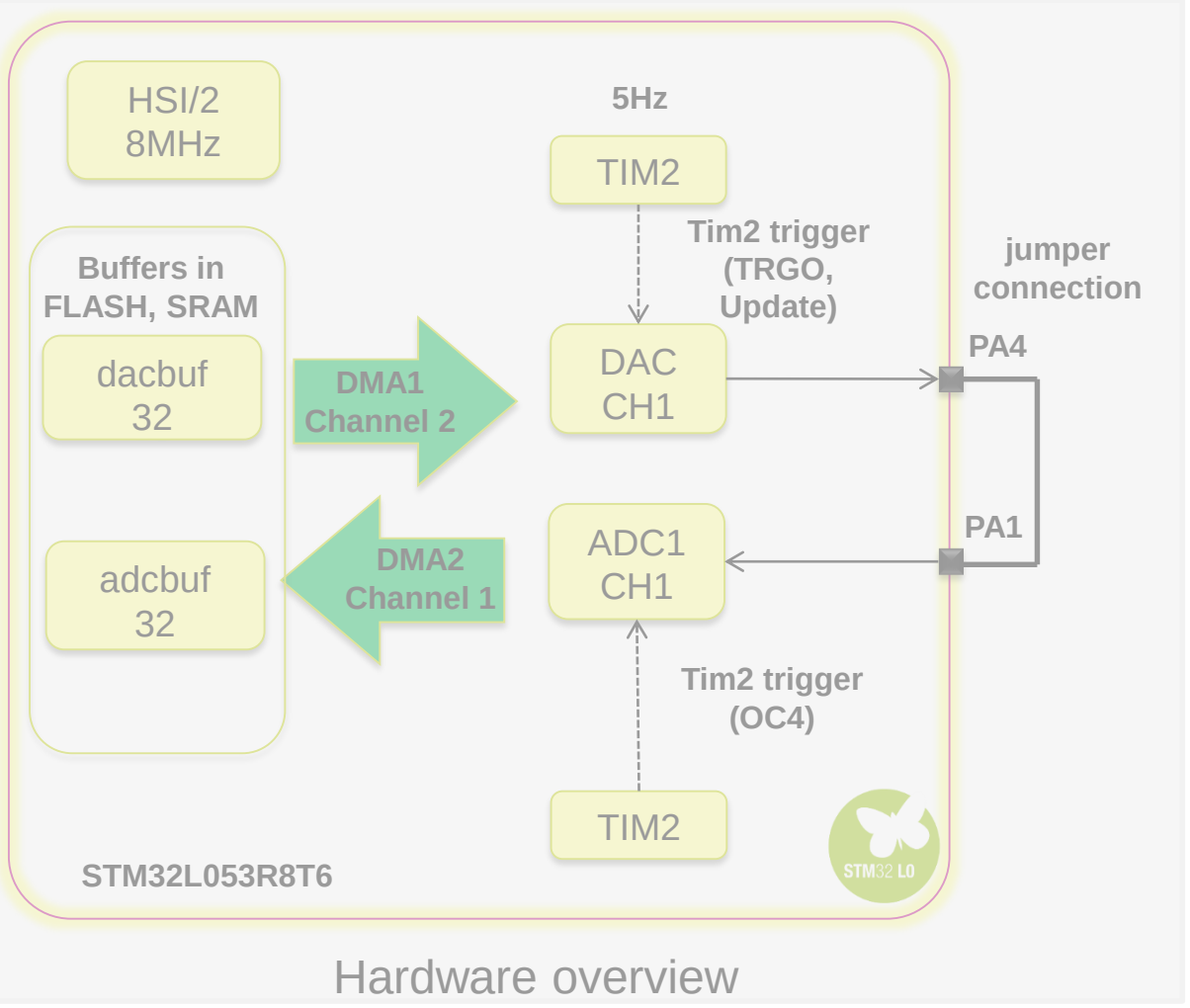
Both parameters can be checked and tuned within **configuration tab**, under **ADC1 button**

STM32L476 is more complex MCU, therefore it might be necessary to adjust the settings for new platform, i.e.

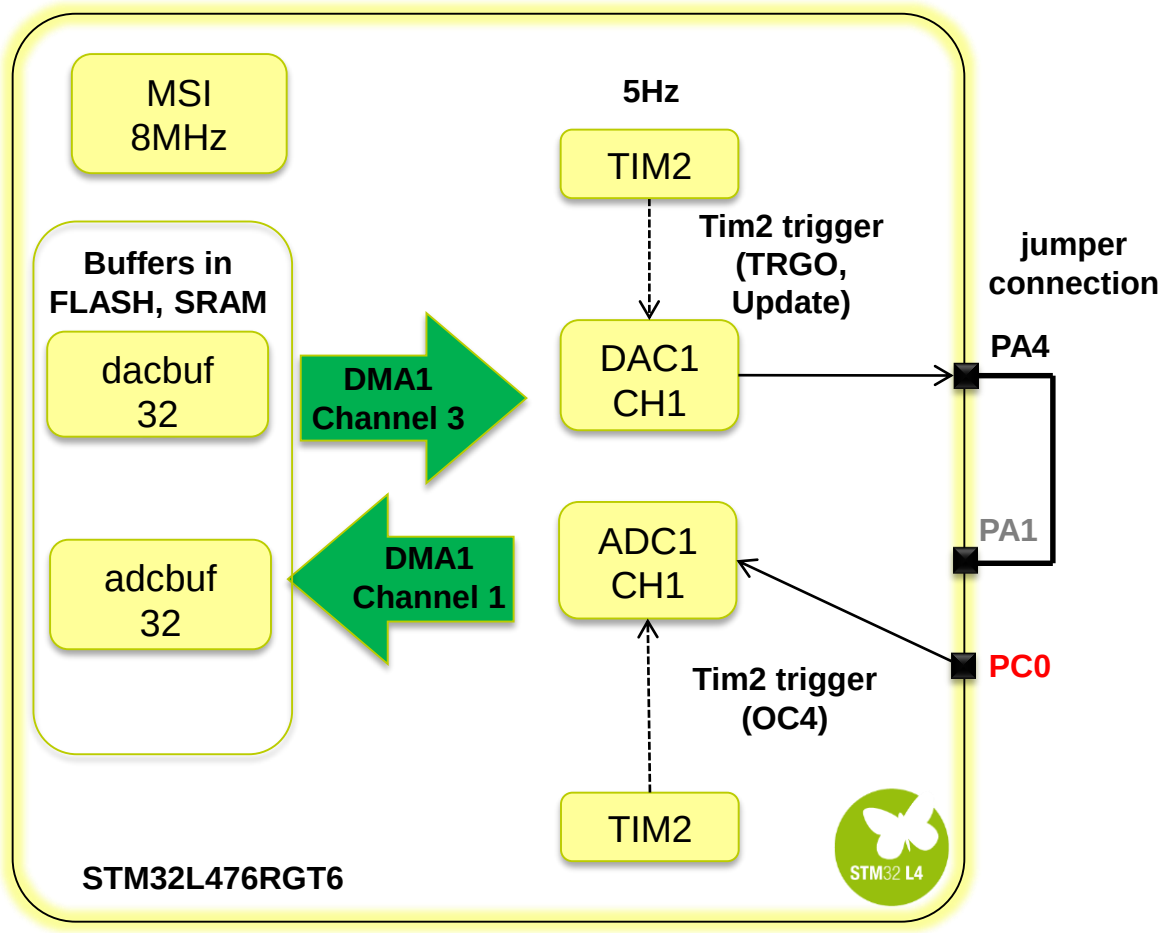
- Pinout
- Clock configuration
- Peripherals configuration

Concept of the system

after migration to NUCLEO-L476RG



Hardware overview

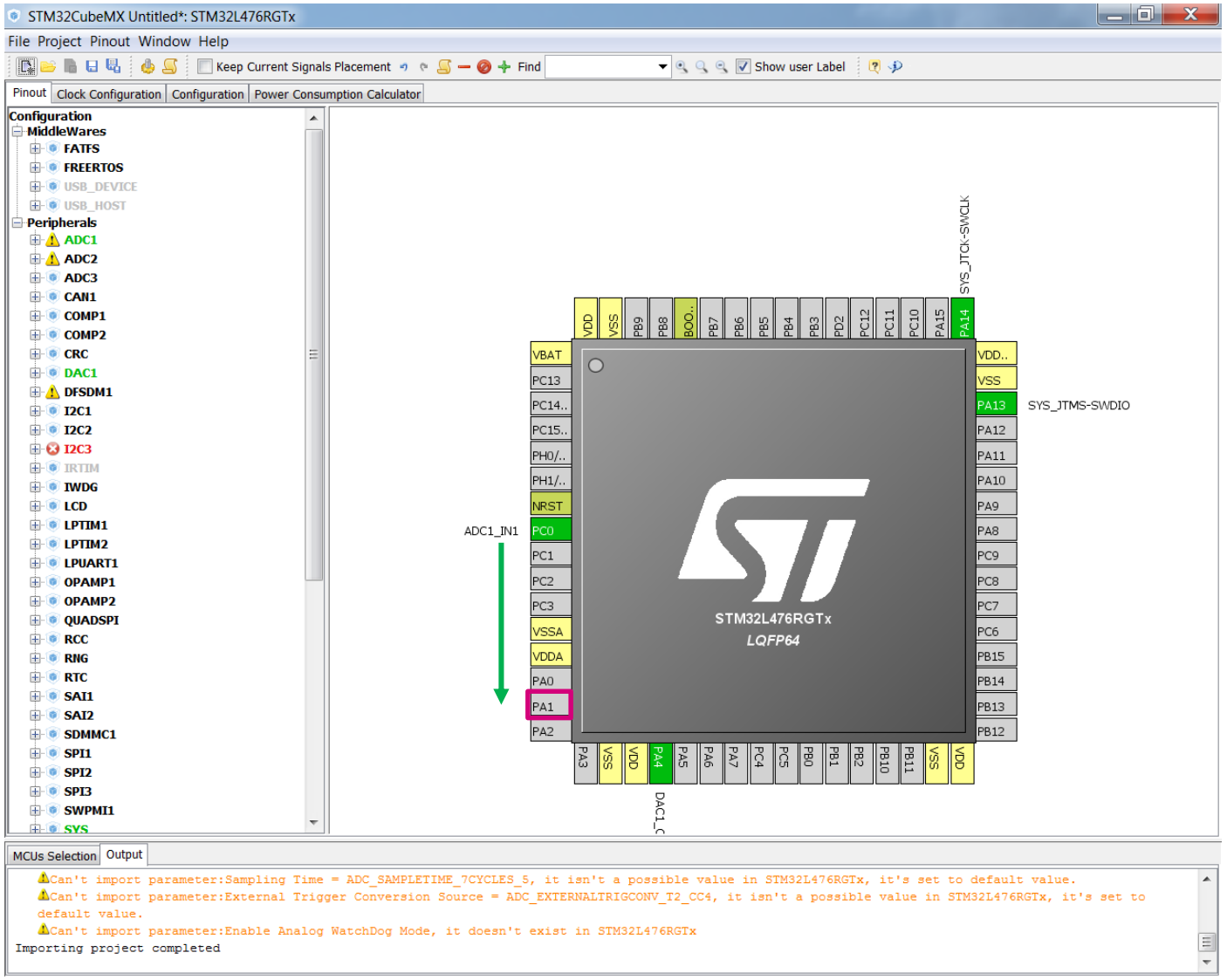


Hardware overview

Project tuning after migration

pinout - task

- After project migration there might be necessity to re-route some pins.
- During migration selected **ADC channels** were left **unchanged**. But
  - **ADC Channel1** in both MCUs is assigned to **different pins** (**PA1** and **PC0** respectively).
- In case of our application we **have to keep** ADC-DAC connection to the **same pins** (**PA1**-**PA4**) to avoid HW changes. Thus
  - We have to select **different ADC channel** to meet the condition of **PA1-PA4** connection.



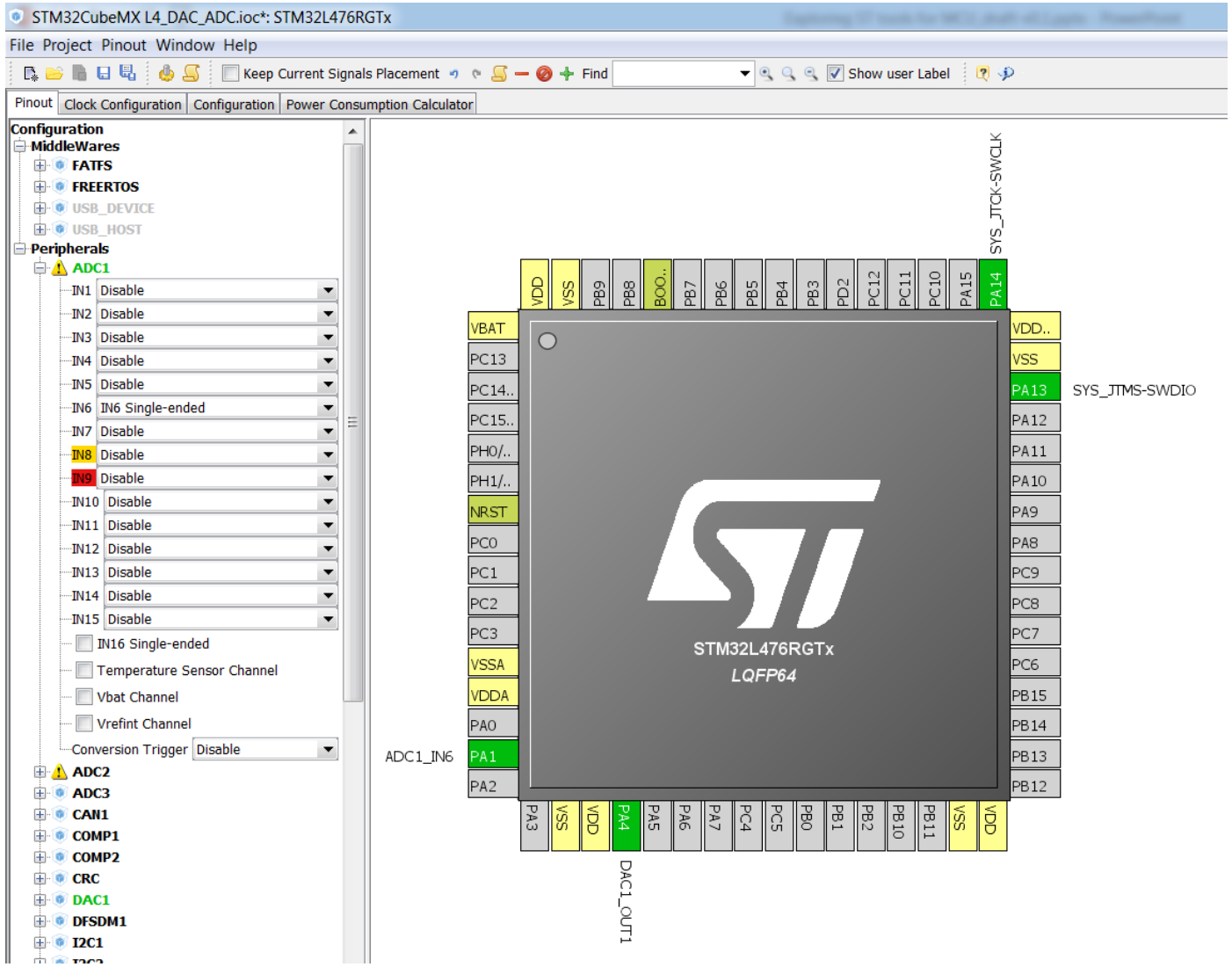
Project tuning after migration

pinout - solution

- To keep **PA1-PA4** connection in place, it is necessary to change ADC channel to **ADC1 Channel6**

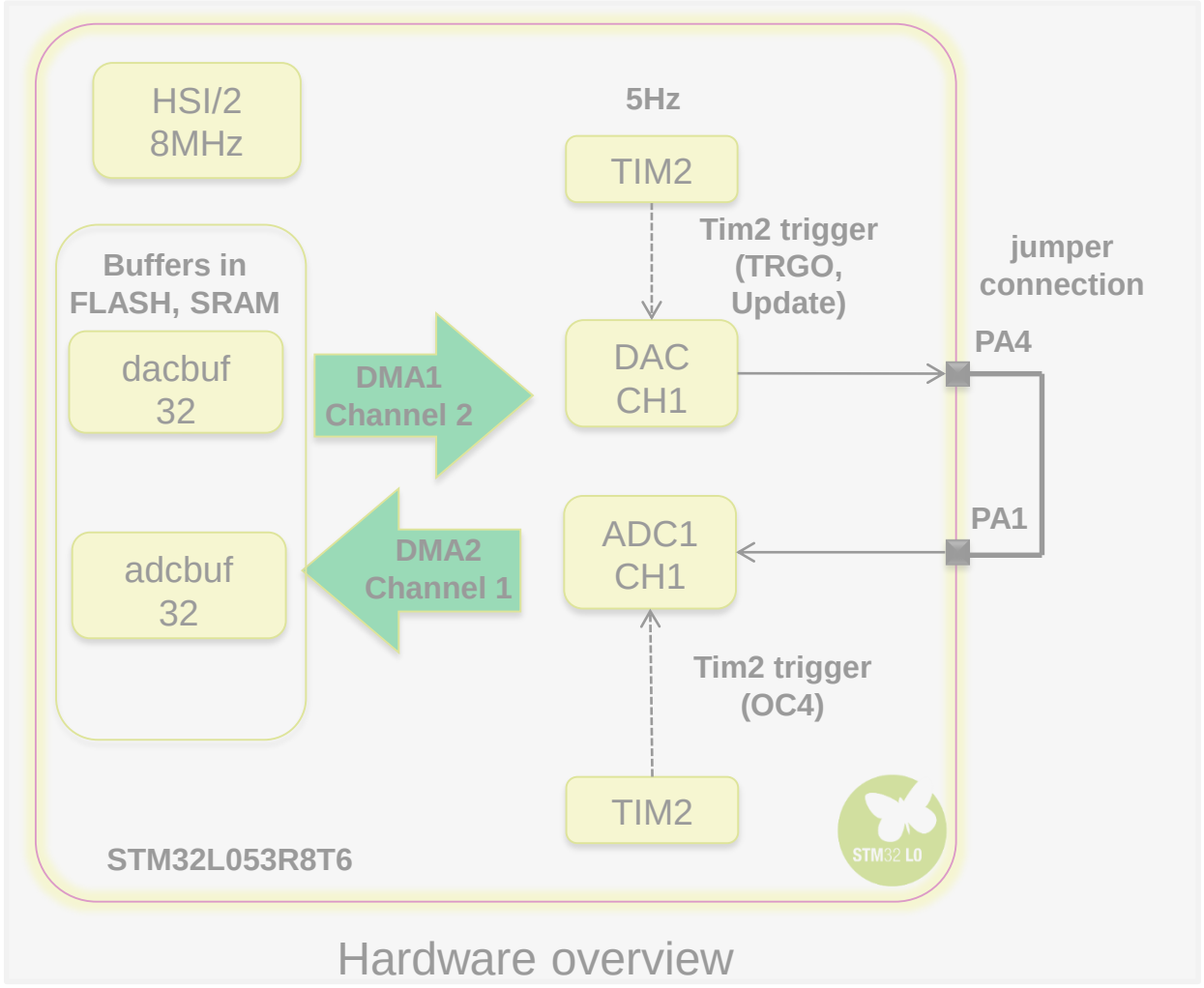
- The procedure should be the following:
  1. **Add** ADC1 Channel6 in single ended mode
  2. **Disable** ADC1 Channel1

Warning: removing the last ADC channel means removing ADC from the application and set its configuration to default values.

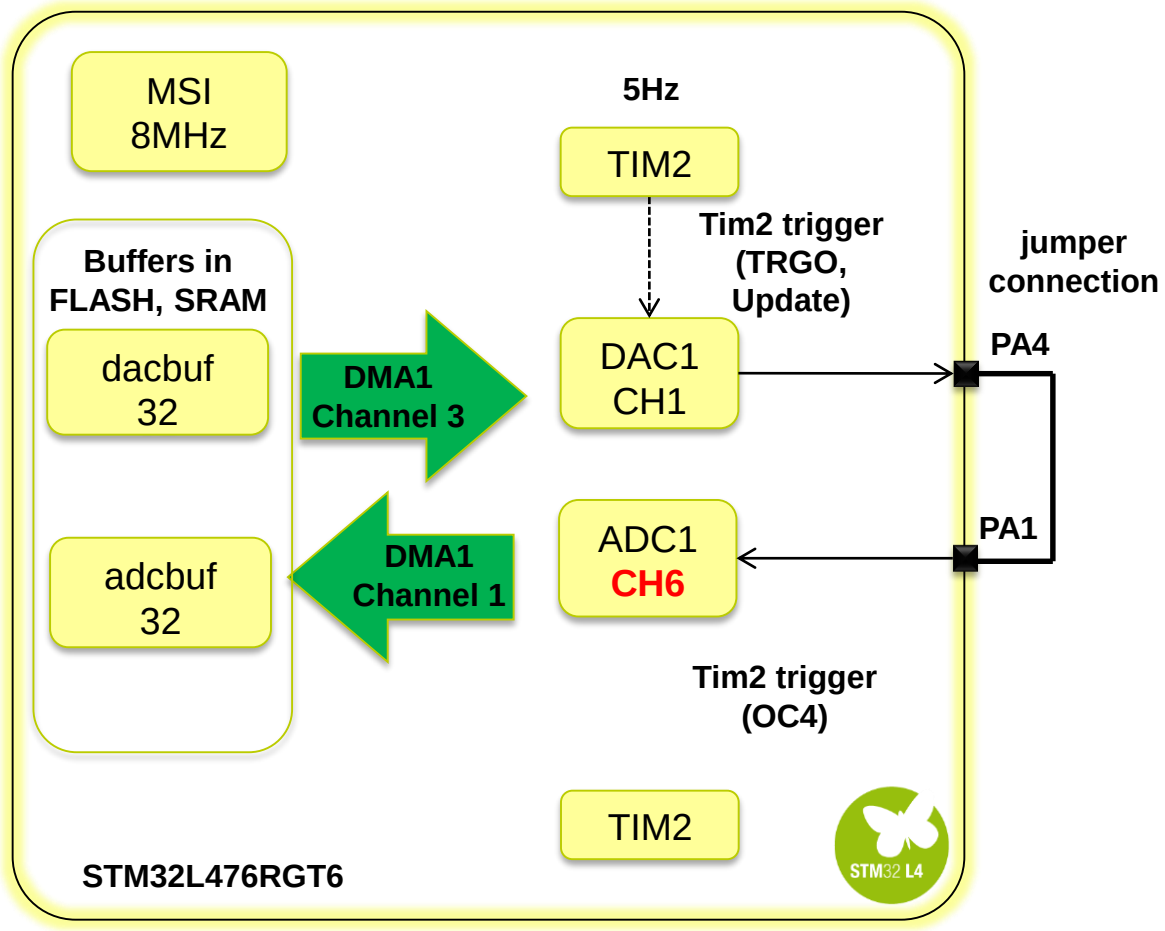


Concept of the system

after migration to NUCLEO-L476RG – ADC input fixed



Hardware overview

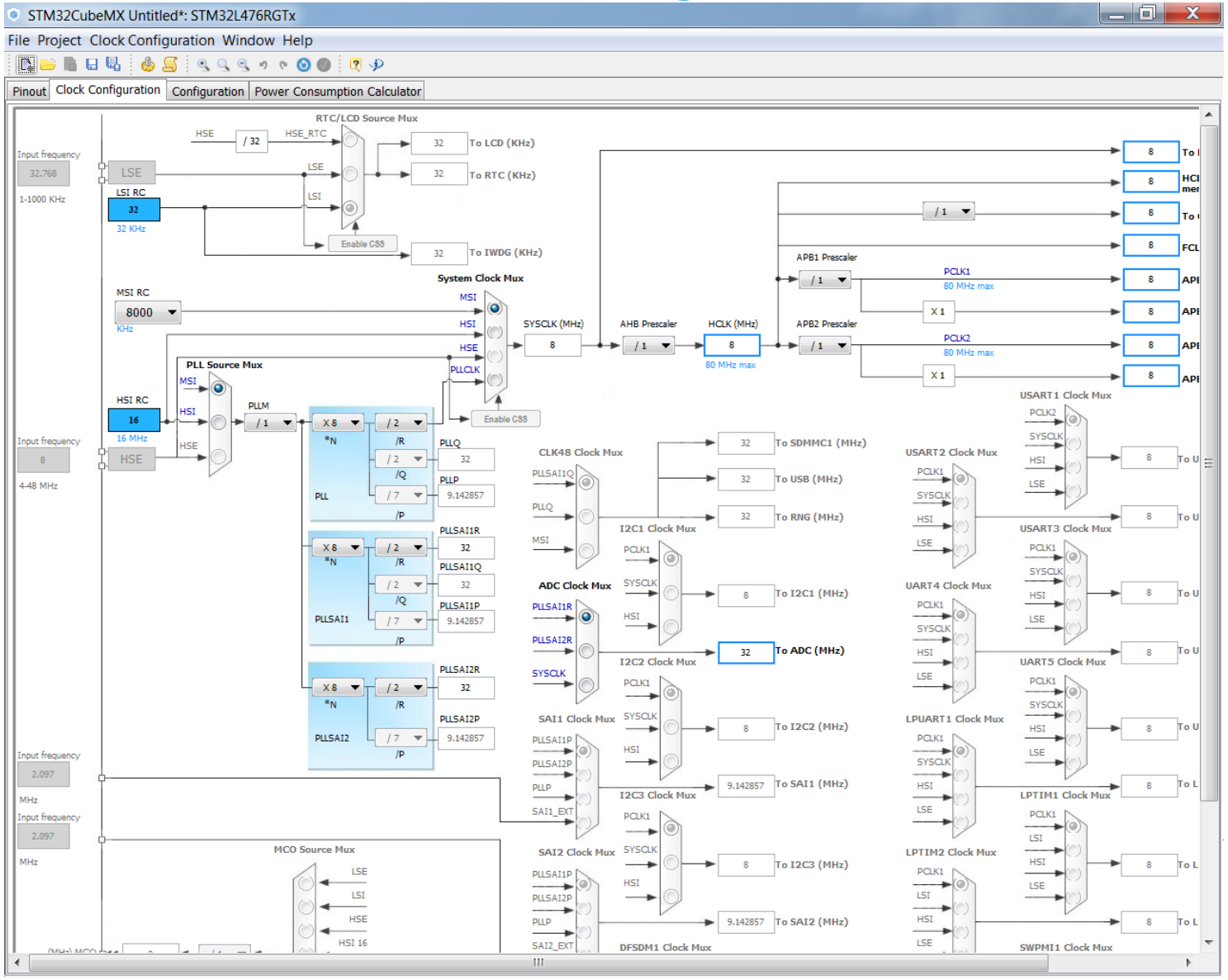


Hardware overview

Project tuning after migration

clock configuration - task

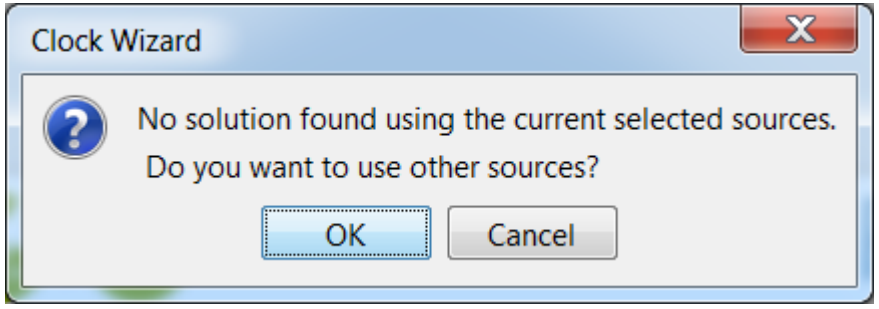
- After project migration it is necessary to adapt clock scheme of new MCU.
- It is possible to insert all values manually or let the application calculate them based on given conditions.
- Application (HCLK, PCLK1, PCLK2) will use **80MHz** clock coming from High Speed Internal (**HSI**) RC oscillator (16MHz).



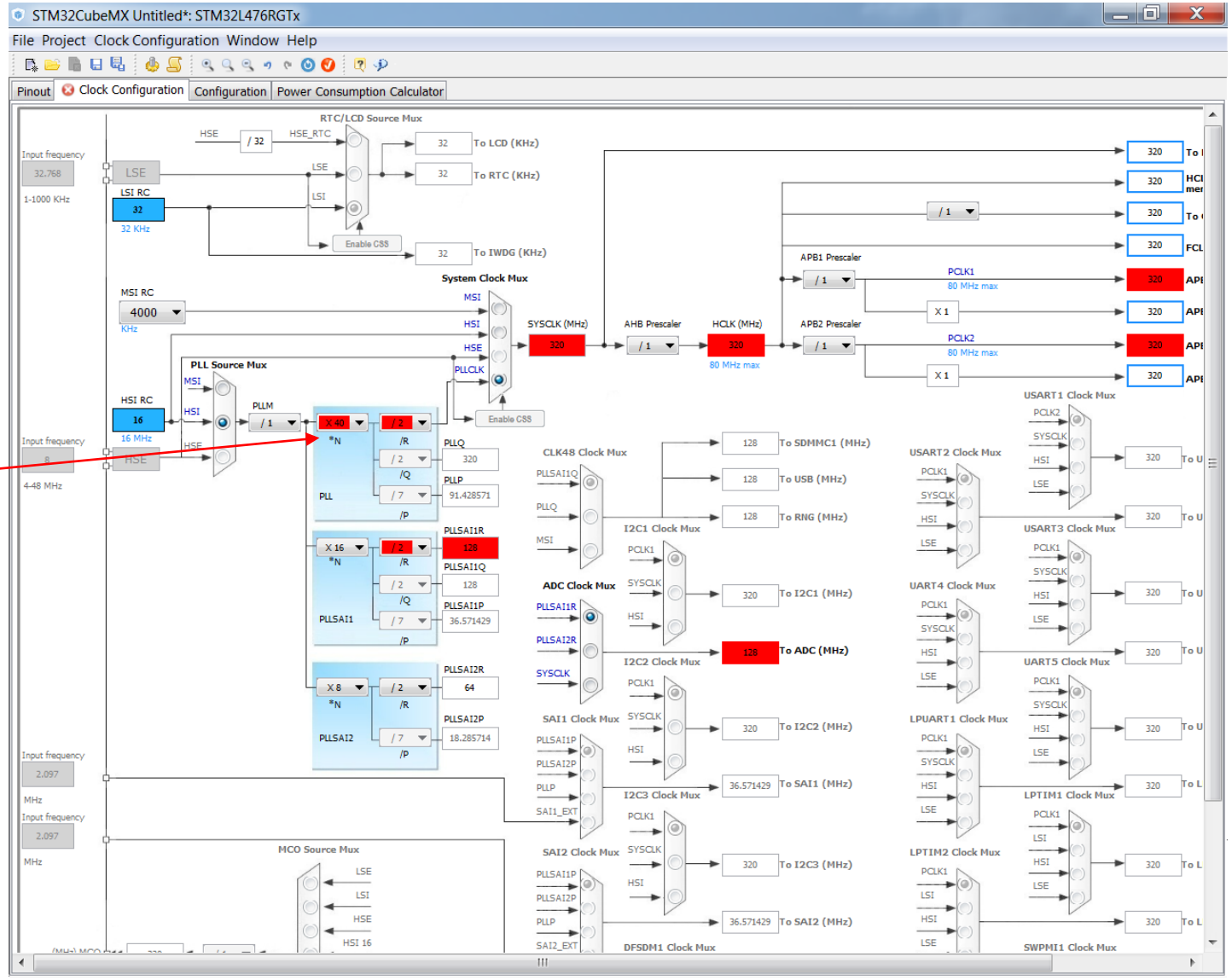
Project tuning after migration

clock configuration - task

- In case it is not possible to reach set target using selected input clocks, information window is generated:



- All errors/issues will be automatically detected and can be solved either automatically or manually



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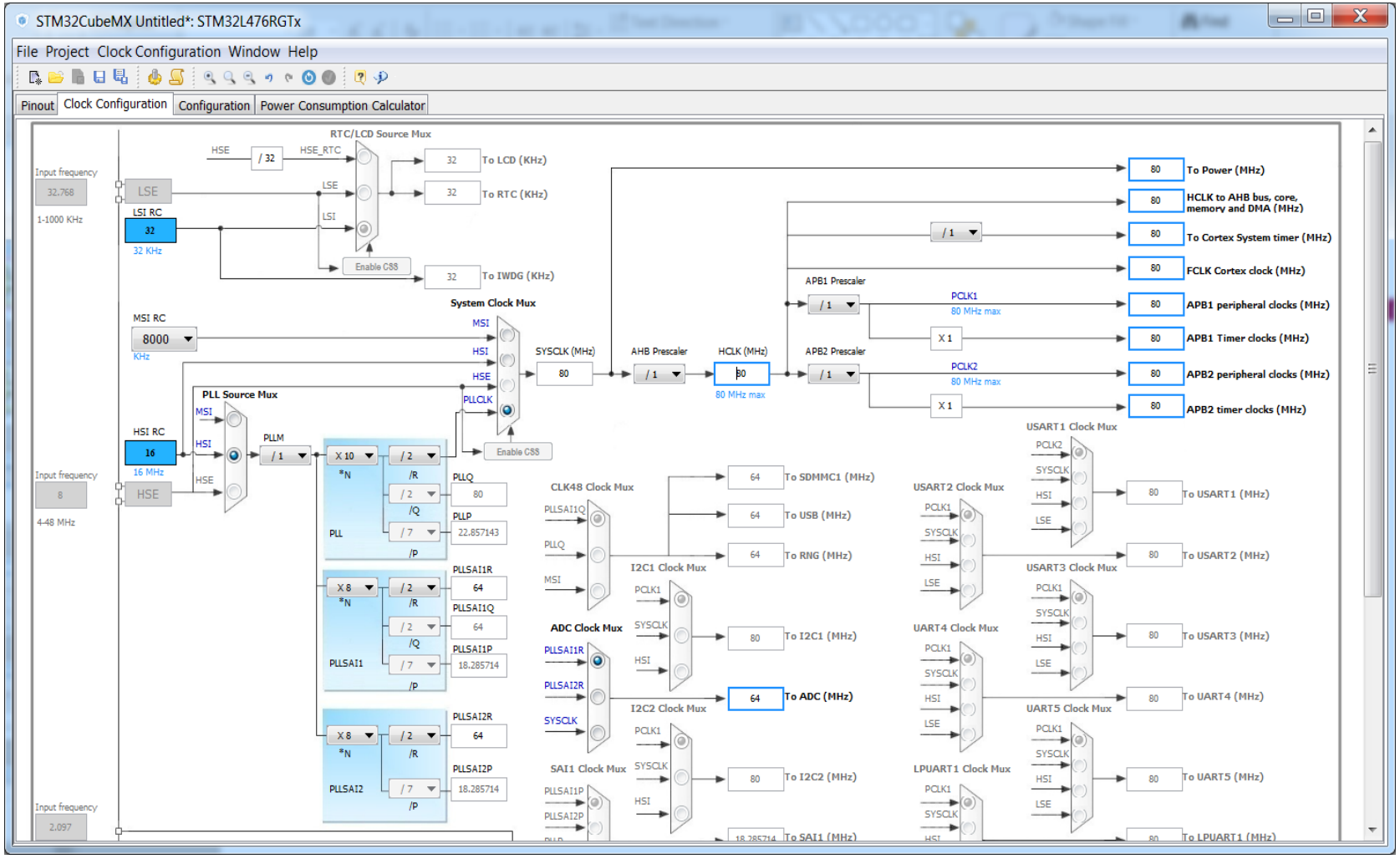
Project tuning after migration
clock configuration - solution

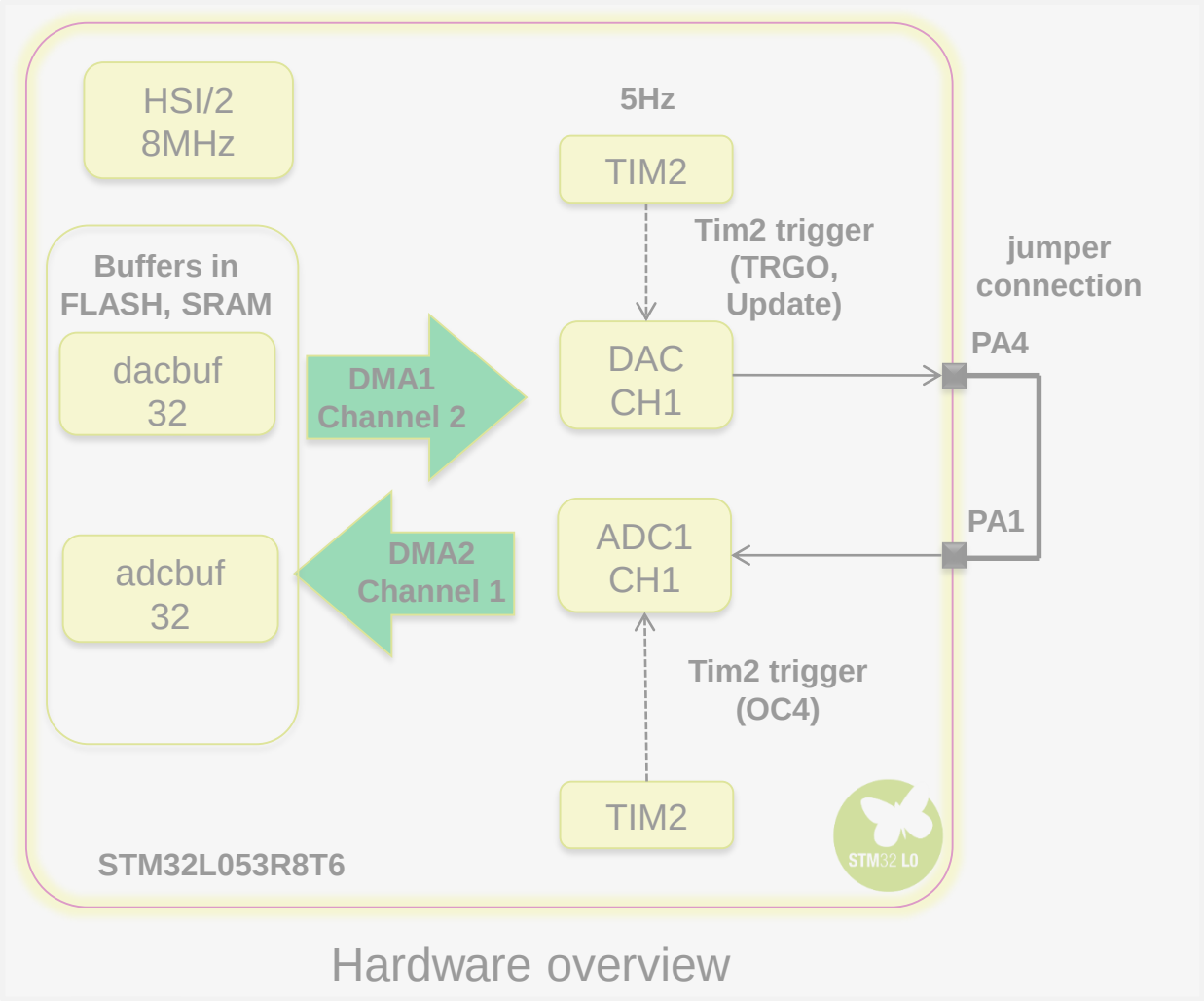
Correct clock configuration of new L4_DAC_ADC project on STM32L476RGT6 MCU can be done by the following procedure:

1. Select HSI as **PLL Source Mux**
2. Select PLLCLK in **System Clock Mux**
3. Set 80 in **HCLK** field and press Enter
4. All PLL settings will be re-calculated automatically

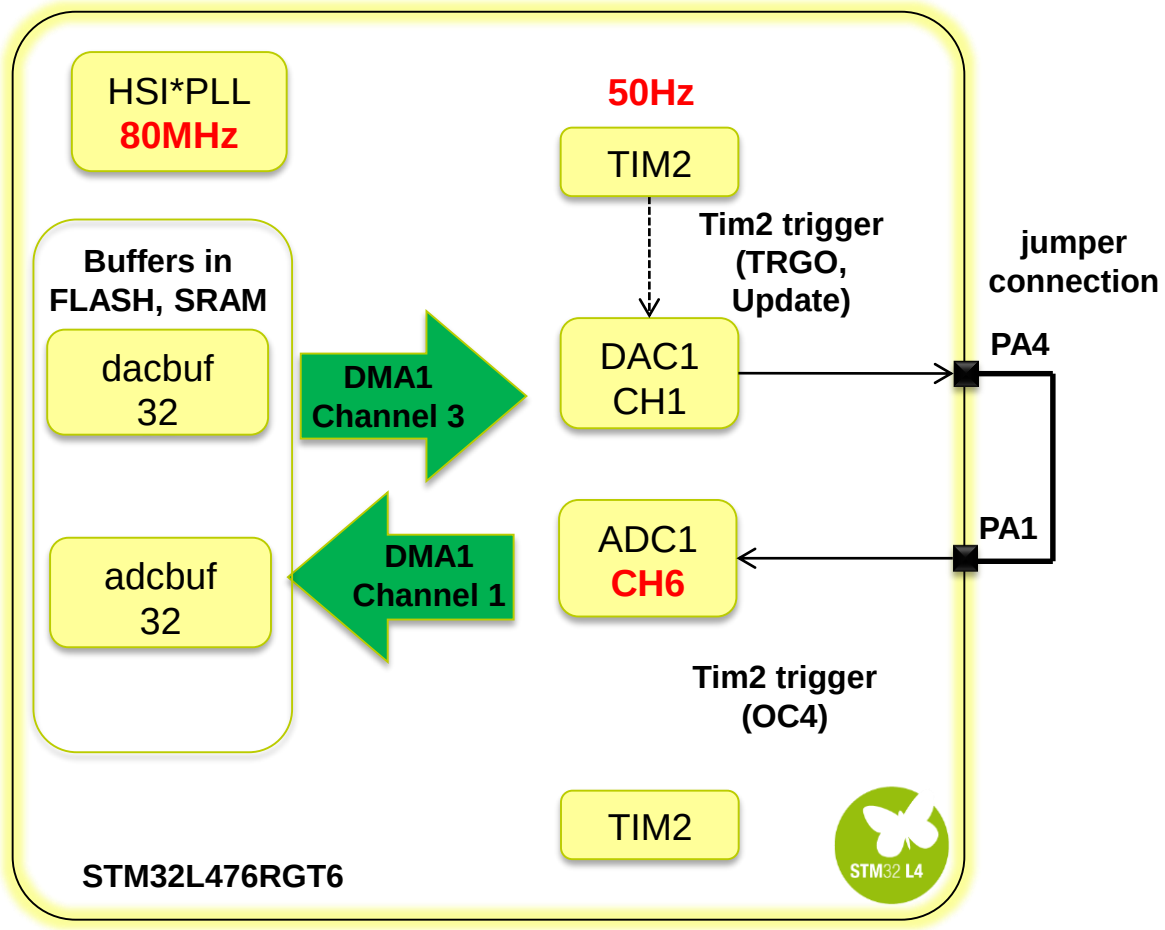


Concept of the system

after migration to NUCLEO-L476RG – clock fixed



Hardware overview

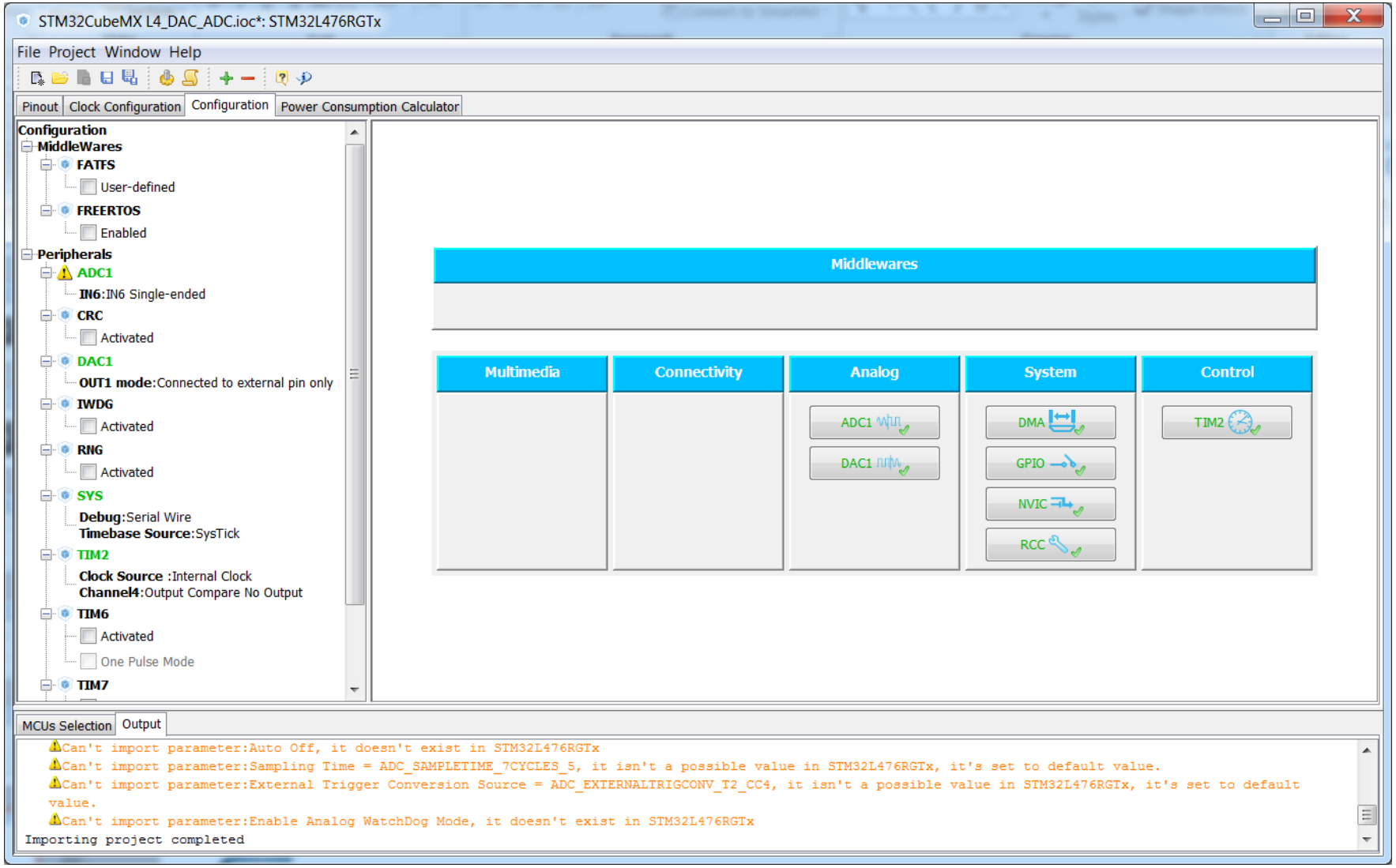


Hardware overview

Project tuning after migration
configuration - task

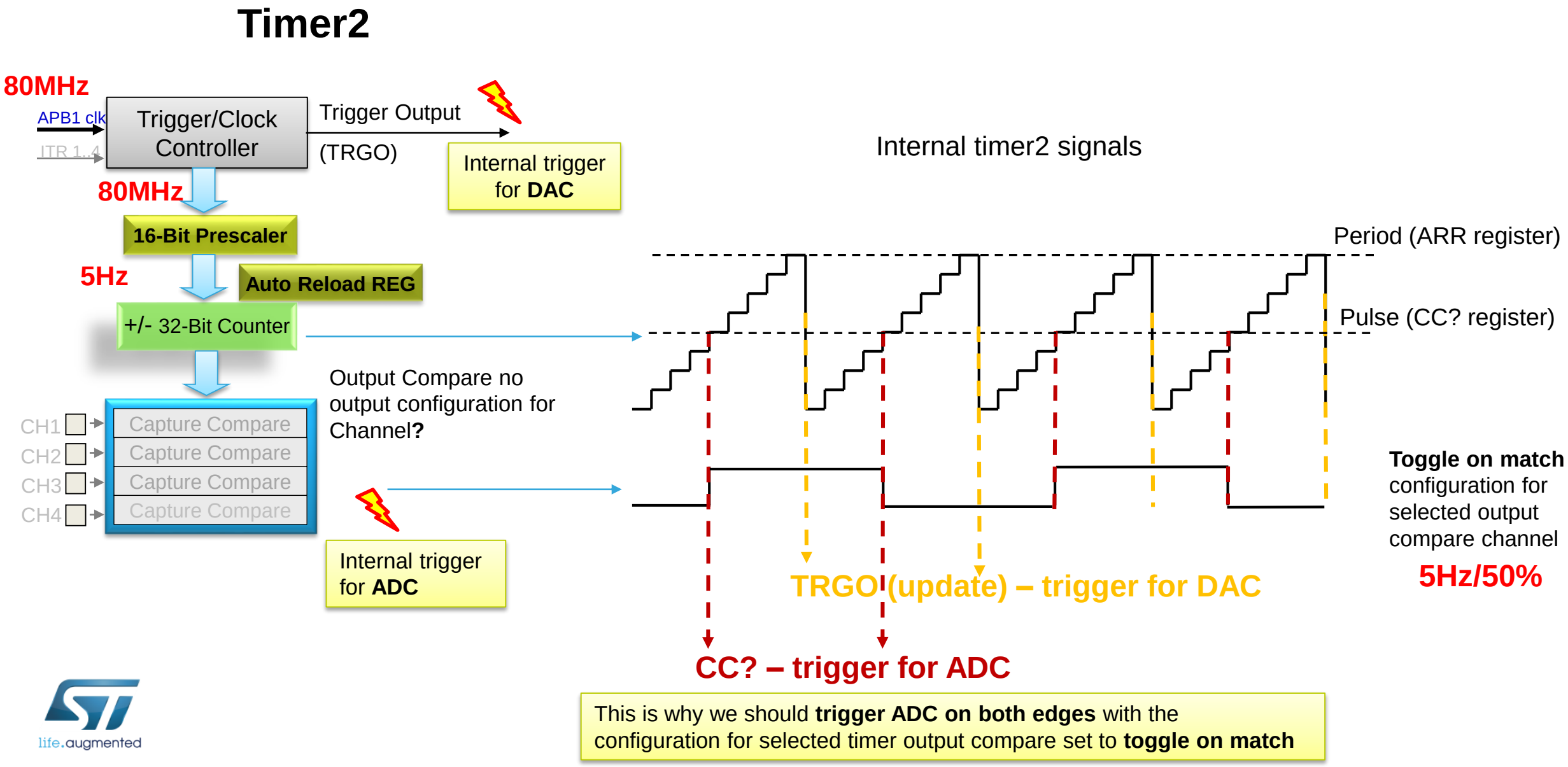
Check and adapt if necessary configuration of used peripherals:

- ADC
- DAC
- DMA
- TIM2



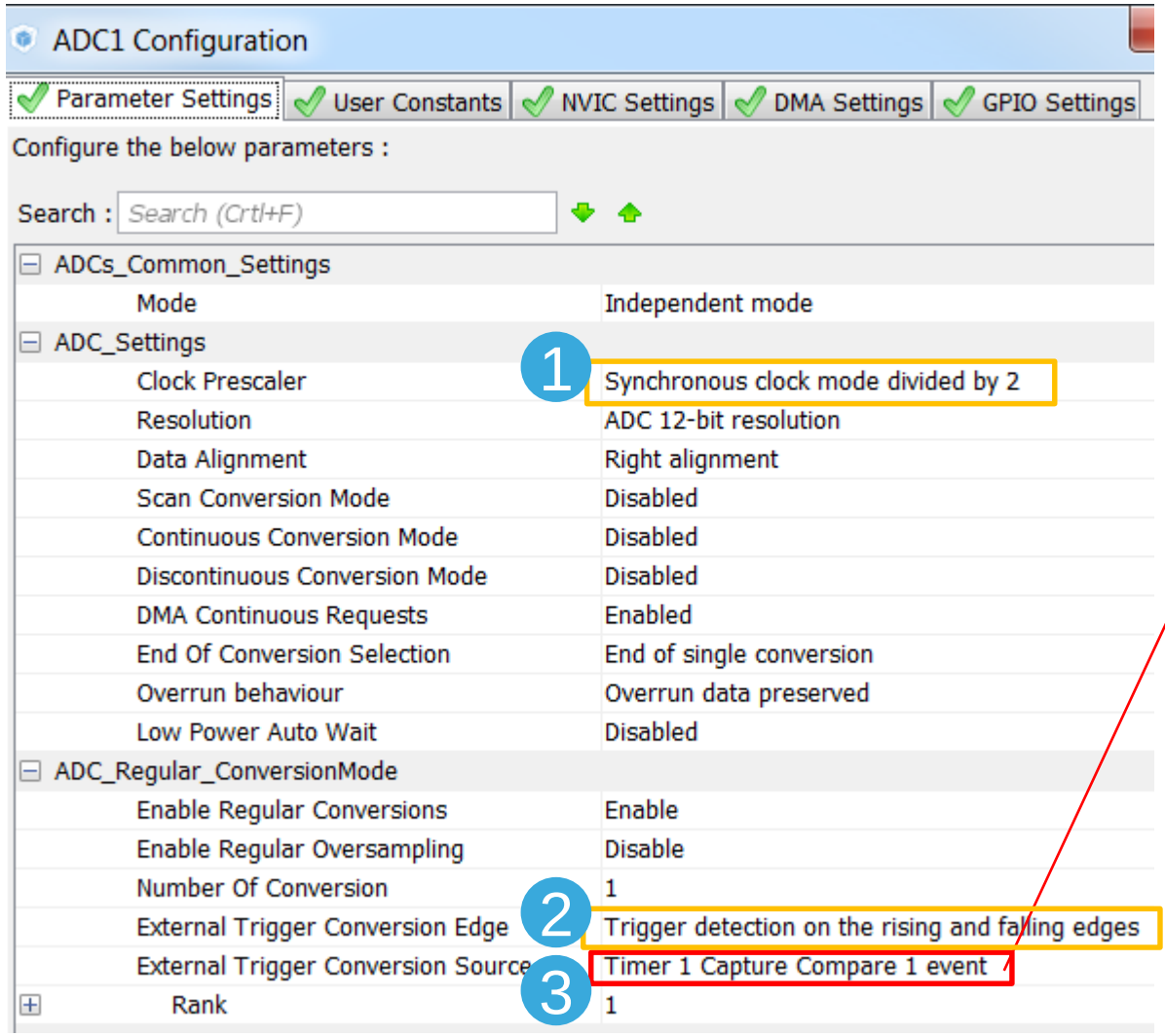
Concept of the system

triggering of ADC and DAC by TIM2

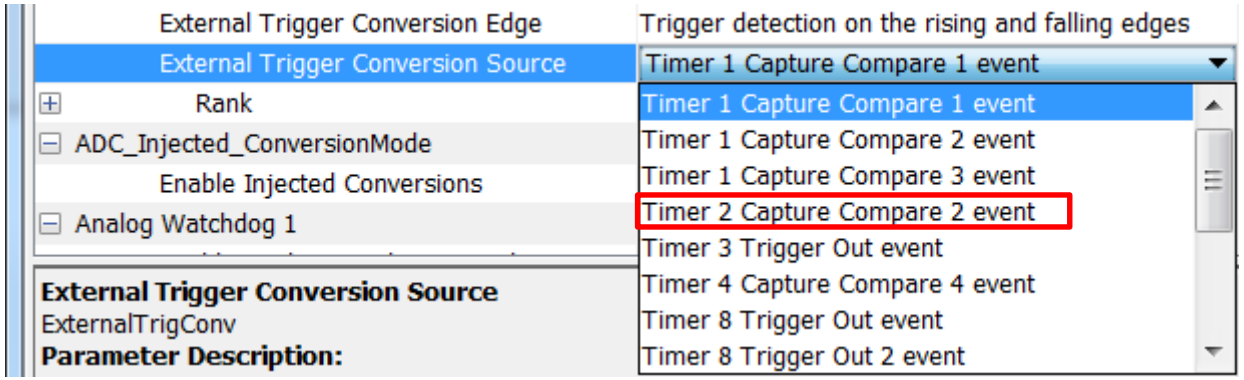


Concept of the system

Tuning of ADC1 trigger source



Steps 1 and 2 only for verification. Should contain correct value if ADC configuration was not reset to default (slide 18).

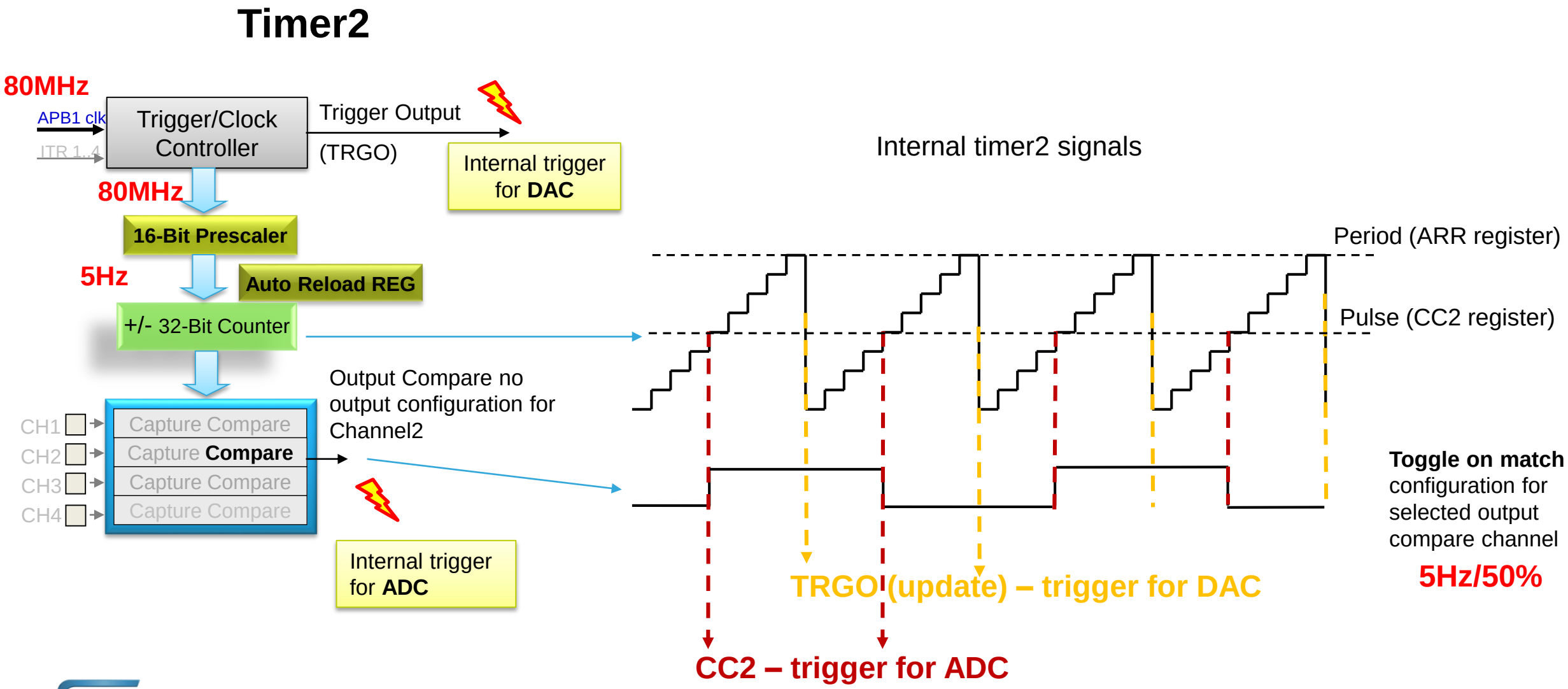


To use single timer we should select trigger from Timer2. Timer2 Capture Compare 2 event would be the best choice

Default trigger setting is Timer1 Capture Compare 1 event

Concept of the system

triggering of ADC and DAC by TIM2



This is why we should **trigger ADC on both edges** with the configuration for selected timer output compare set to **toggle on match**

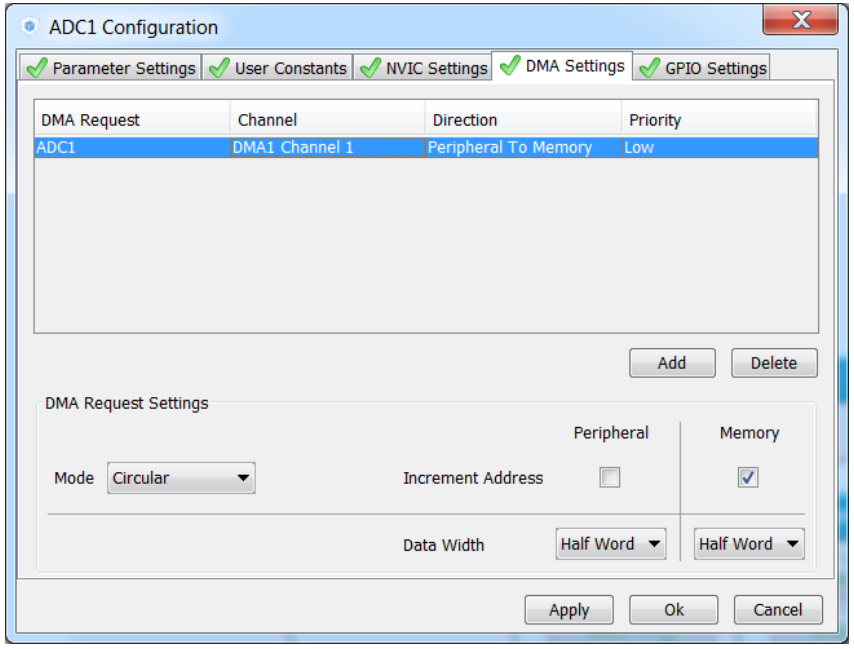
Project tuning after migration

ADC re-configuration

Some of ADC parameters need to be modified according to STM32L4 capabilities.

In particular:

- ADC1 Channel1 (PC0) should be changed to Channel6 (PA1) in order to use the same jumper connection on Nucleo board (PA1-PA4) – already done
- Different DMA channel is available for ADC in STM32L4 (DMA1, Channel1)
- There are different sampling time values available (suggested 12.5 cycles)
- Different external triggers are available for ADC conversions (as we are using Timer2 - capture compare on channel 2 event will be used)



ADC1 Configuration

Parameter Settings | User Constants | NVIC Settings | DMA Settings | GPIO Settings

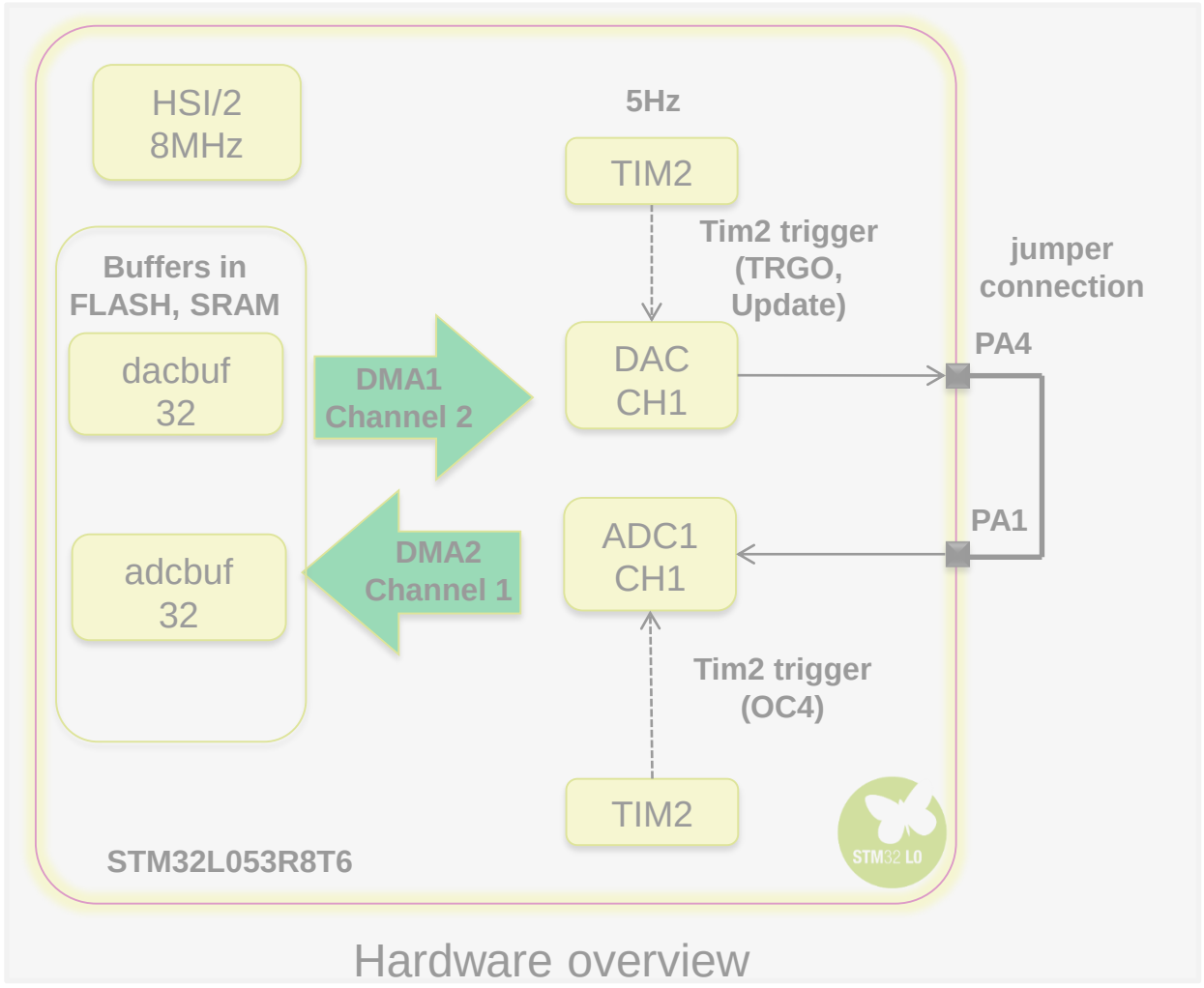
Configure the below parameters :

Search : Search (Crtl+F)

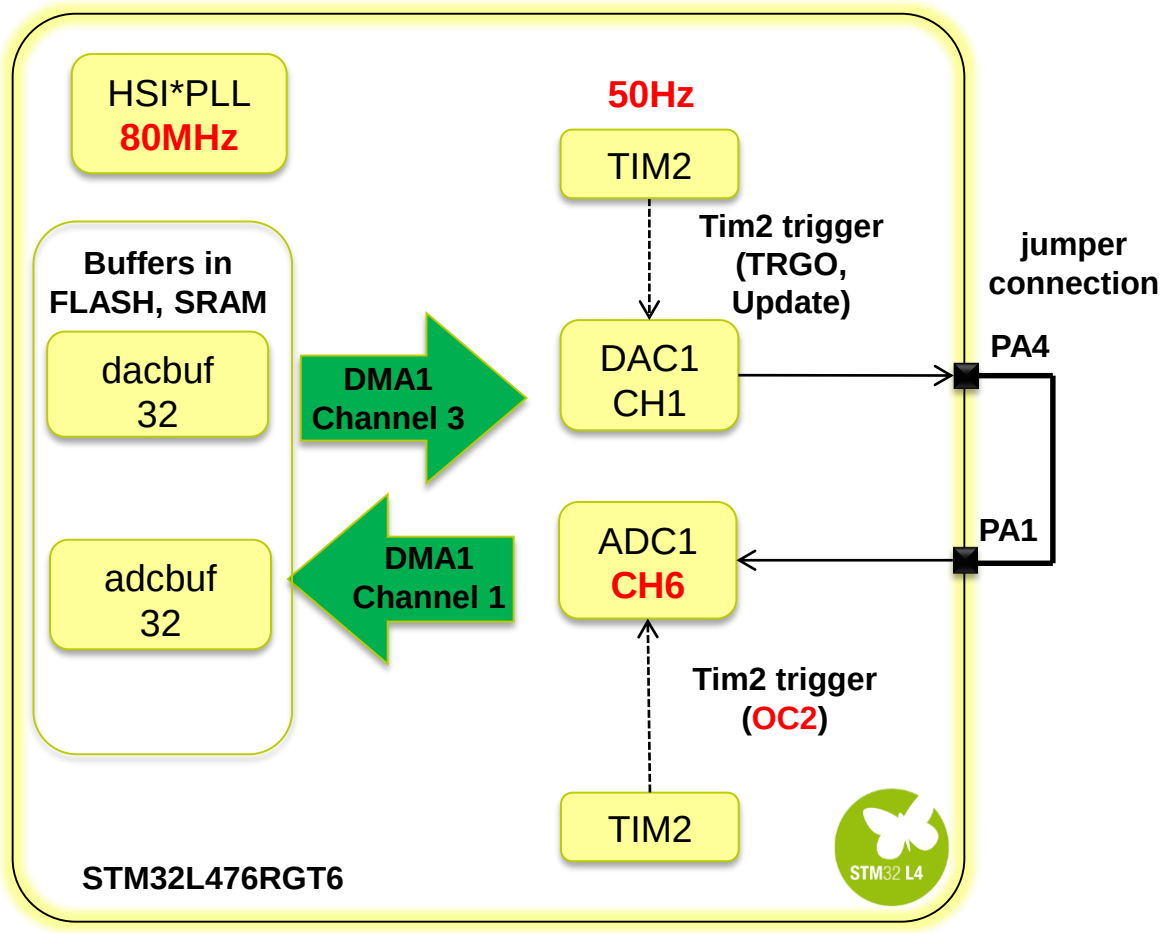
ADCs_Common_Settings	
* Mode	Independent mode
ADC_Settings	
Clock Prescaler	Synchronous clock mode divided by 2
Resolution	ADC 12-bit resolution
Data Alignment	Right alignment
* Scan Conversion Mode	Disabled
Continuous Conversion Mode	Disabled
Discontinuous Conversion Mode	Disabled
DMA Continuous Requests	Enabled
End Of Conversion Selection	End of single conversion
Overrun behaviour	Overrun data preserved
Low Power Auto Wait	Disabled
ADC_Regular_ConversionMode	
Enable Regular Conversions	Enable
Enable Regular Oversampling	Disable
Number Of Conversion	1
External Trigger Conversion Edge	Trigger detection on the rising and falling edges
External Trigger Conversion Source	Timer 2 Capture Compare 2 event
Rank	1
Channel	Channel 6
Sampling Time	12.5 Cycles
Offset Number	No offset

Concept of the system

after migration to NUCLEO-L476RG – ADC config fixed



Hardware overview

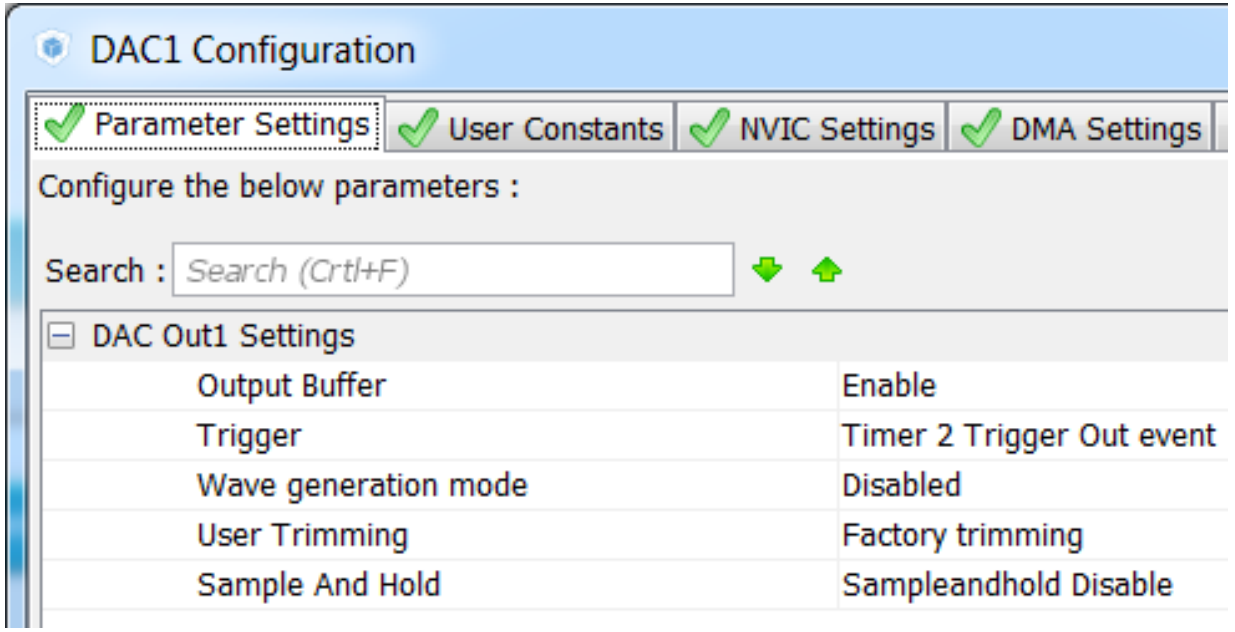


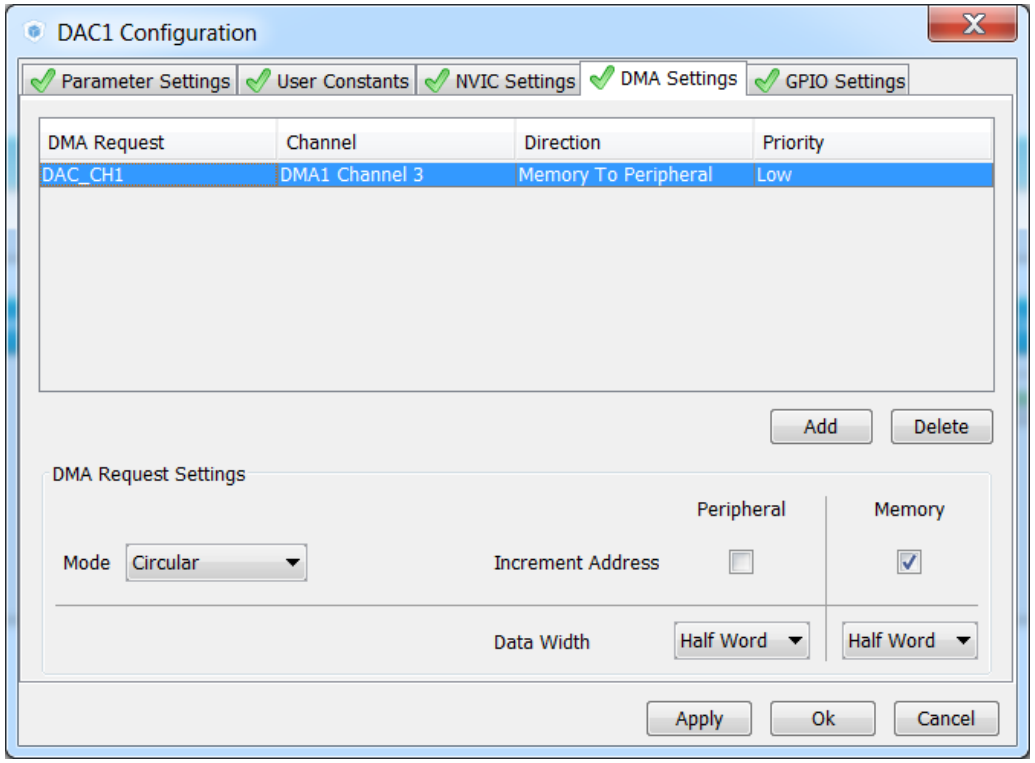
Hardware overview

Project tuning after migration

DAC re-configuration

There is **no need** to do any manual reconfiguration of the DAC





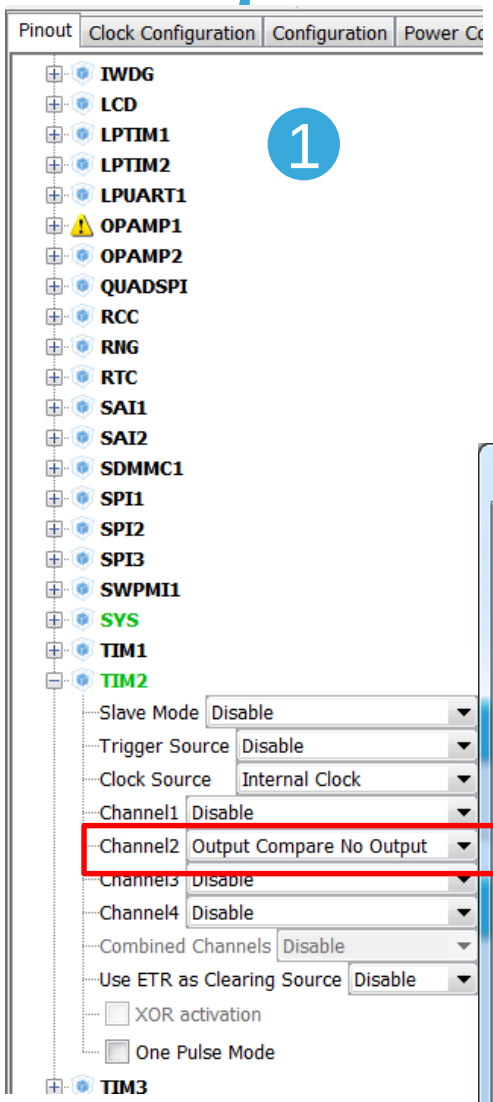
Project tuning after migration

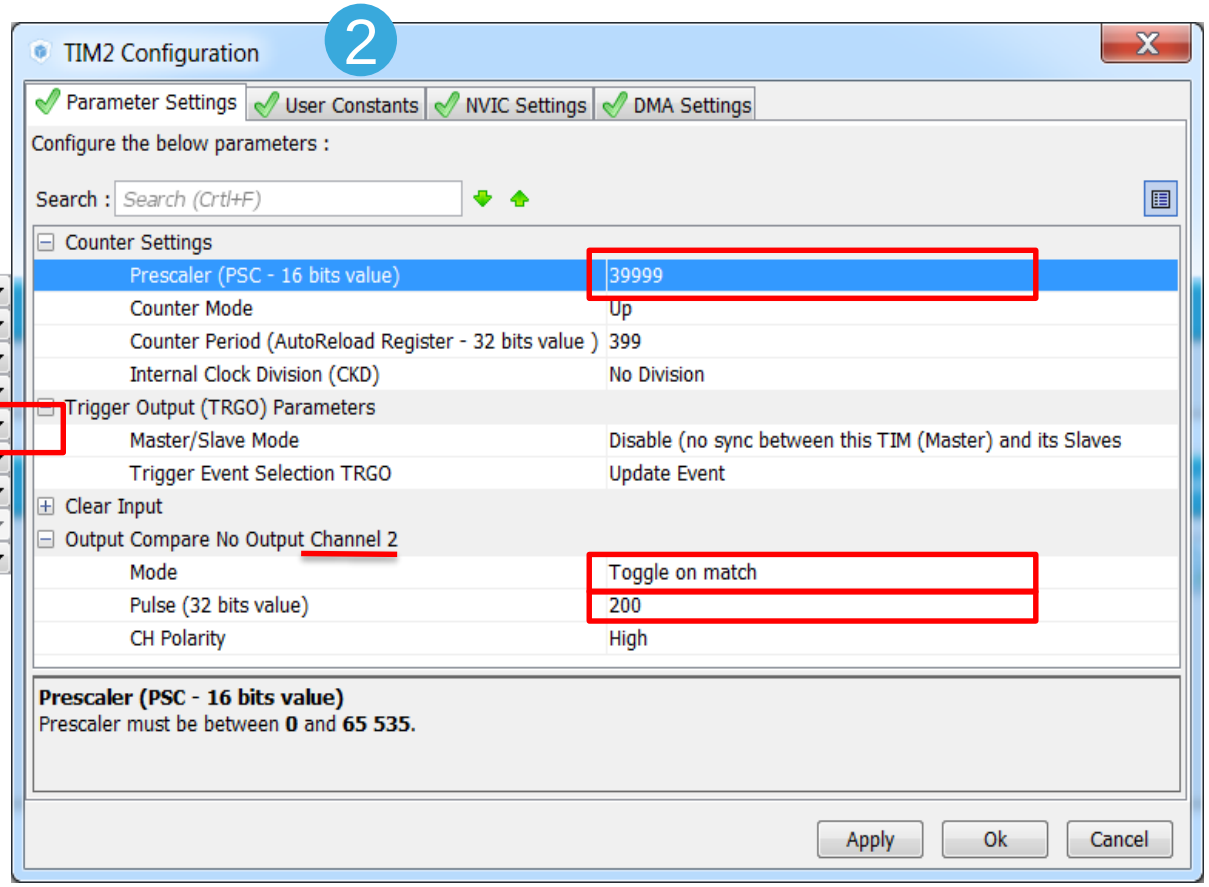
Timer2 re-configuration

Some of Timer2 parameters need to be modified according to STM32L4 and clock capabilities.

In particular:

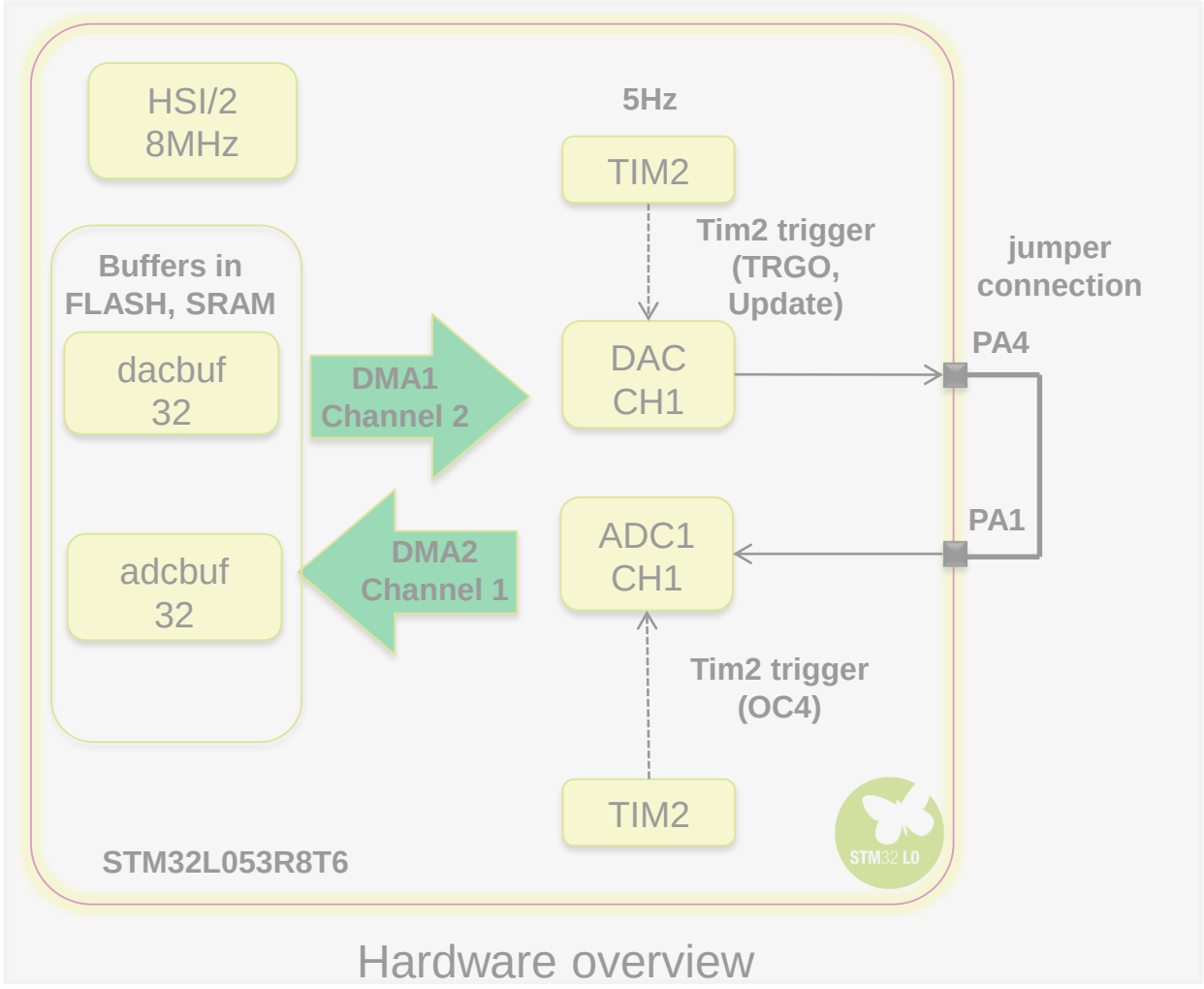
1. Change **Channel 4** to **Channel 2** (output compare, no output mode) to have trigger signal for ADC – **pinout tab**
2. Prescaler, period and pulse values to get 5Hz output signal with 50% duty cycle @80MHz clock on the bus – **configuration tab**
   - Prescaler: **39999** (/40000)
   - Period: **399** (/400)
   - Mode for channel 2: **Toggle on match**
   - Pulse: **200** (Period/2)



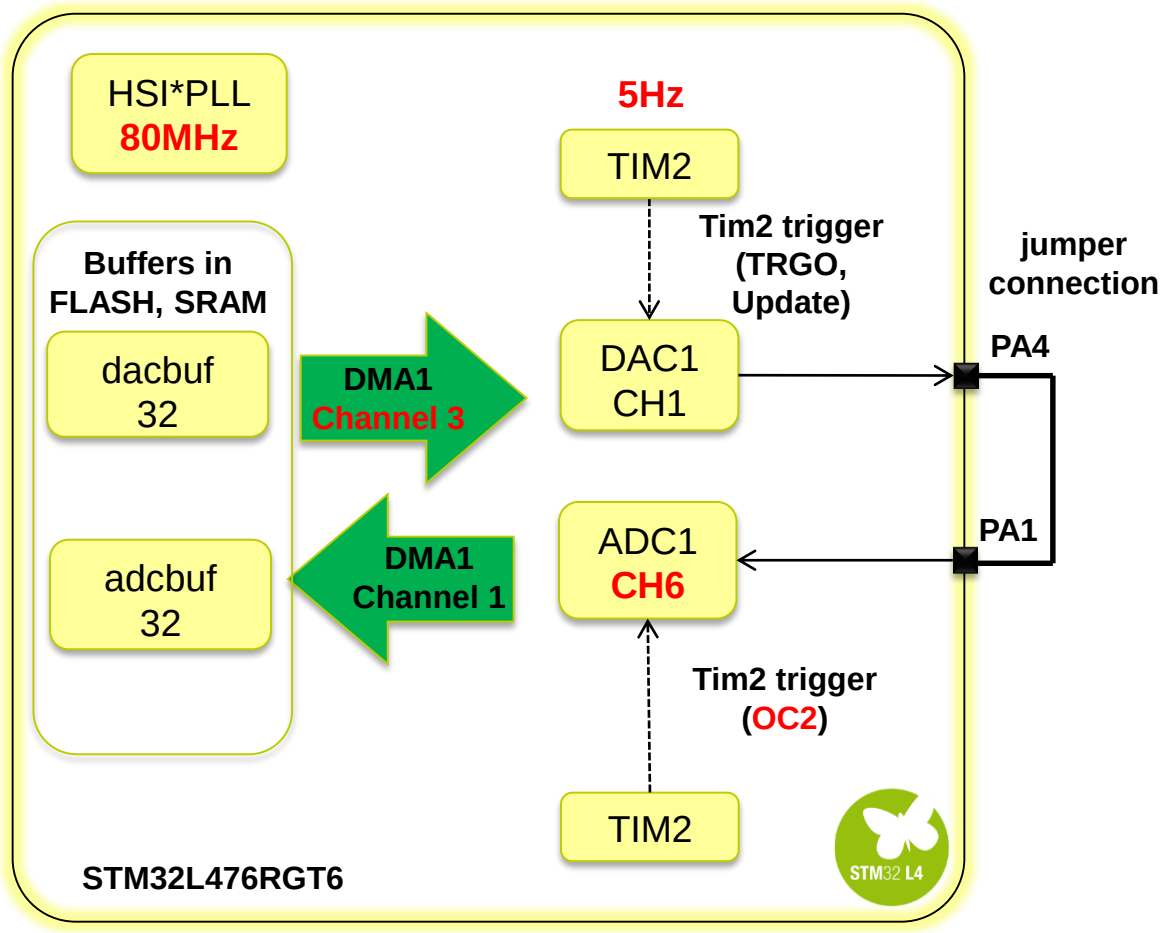


Concept of the system

after migration to NUCLEO-L476RG – DAC & Timer2 fixed



Hardware overview

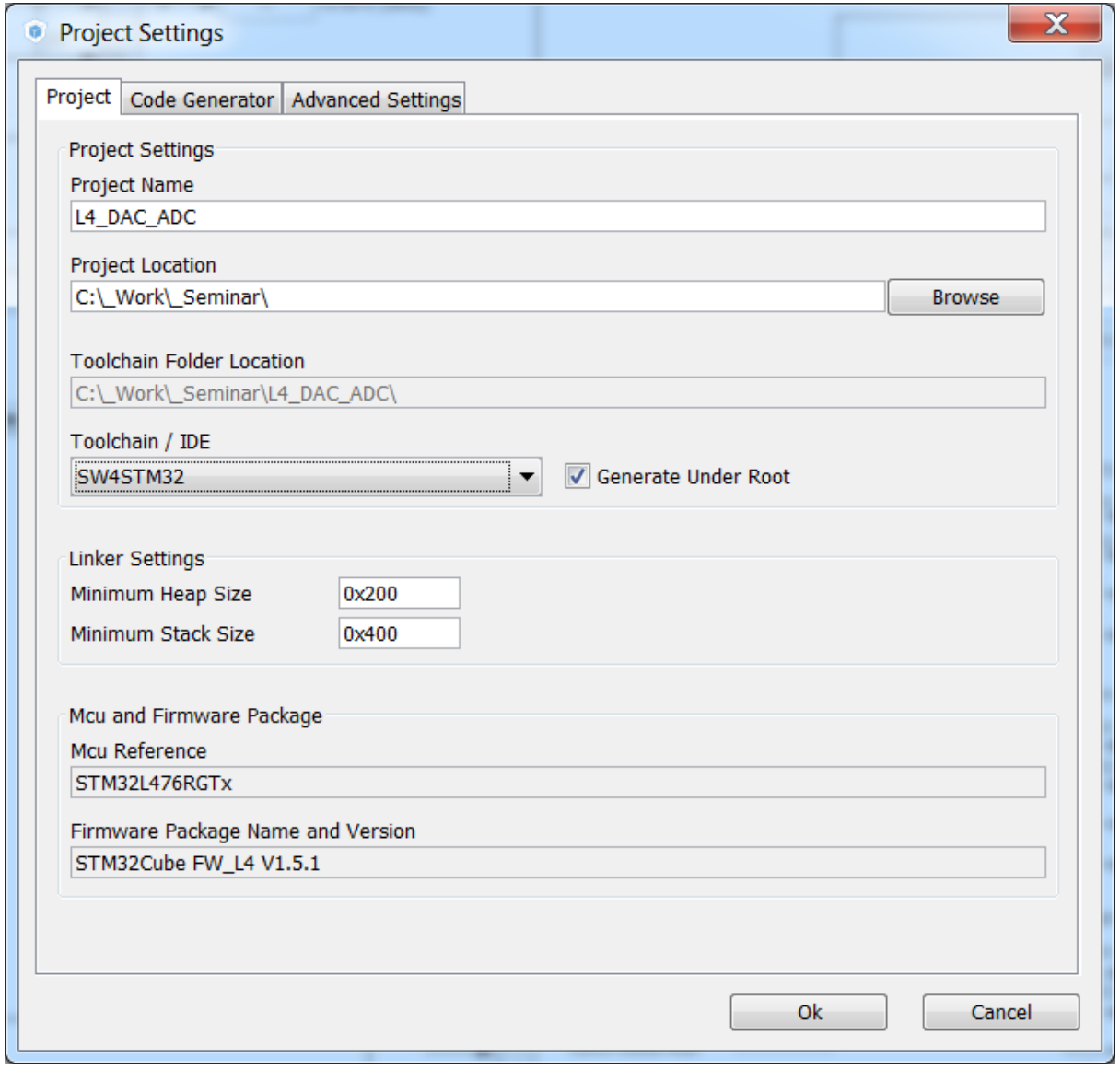


Hardware overview

Project tuning after migration

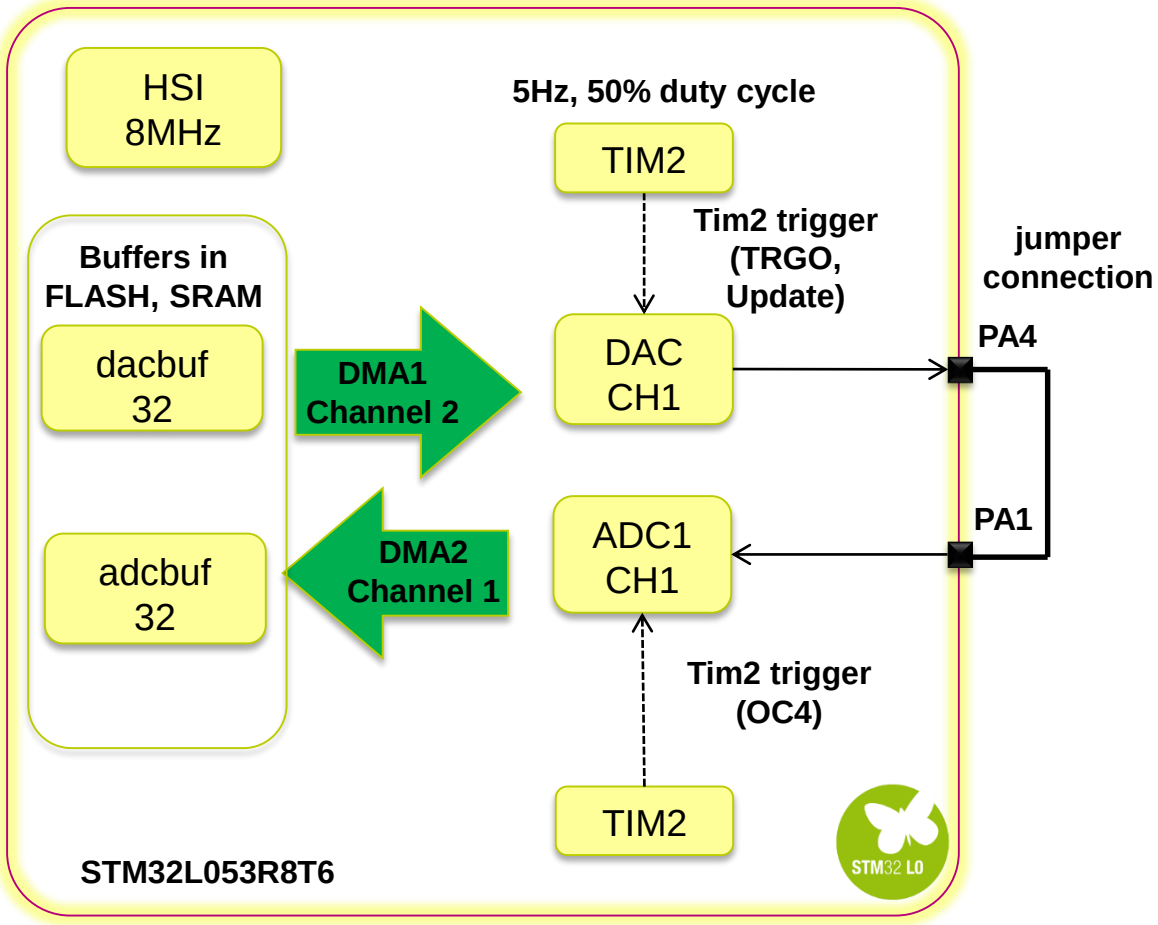
Code generation for STM32L4xx device

After all necessary configuration modifications, final project for NUCLEO-L476RG board can be saved as L4_DAC_ADC and code for SW4STM32 can be generated.

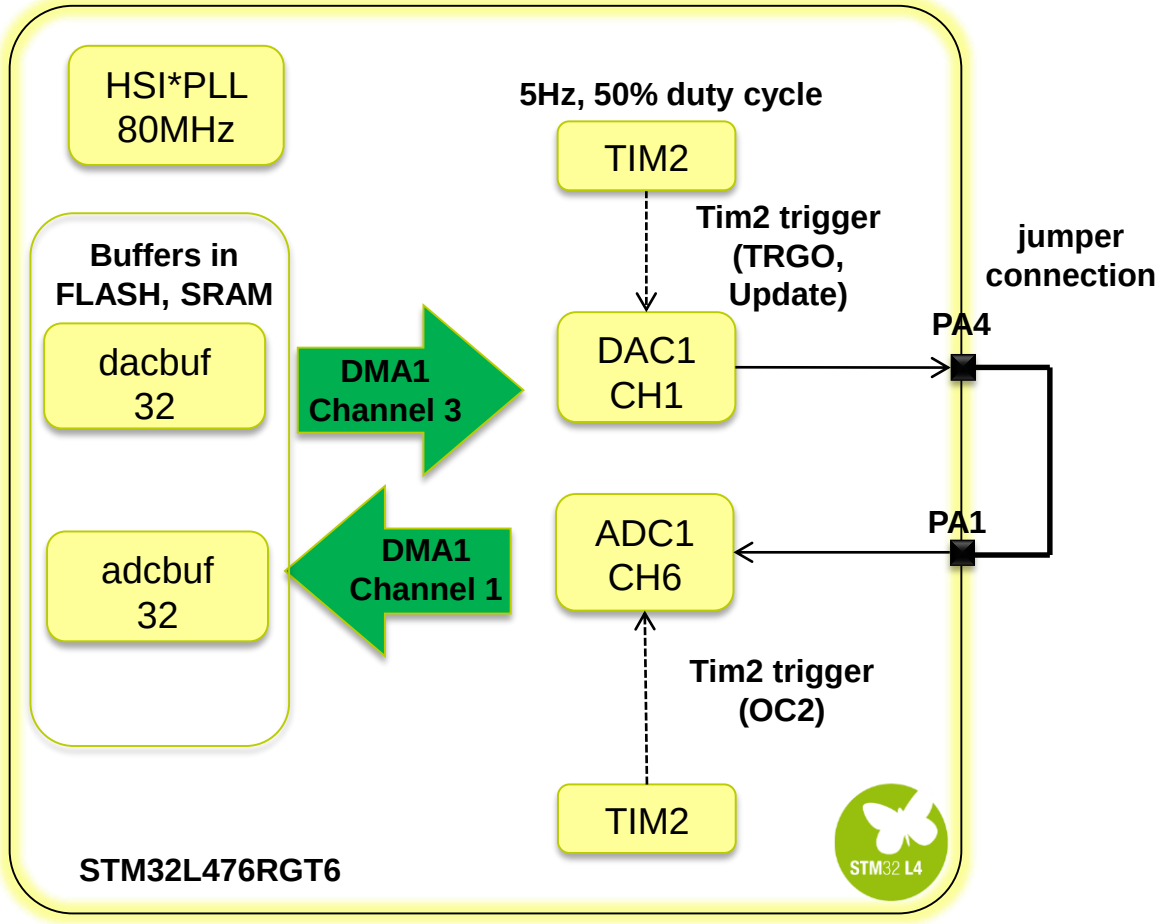


Concept of the system

migration to NUCLEO-L476RG completed



Hardware overview



Hardware overview

What have we learnt?

- ✓How to migrate the project between two different microcontrollers:
  - ✓Importing STM32CubeMX project
  - ✓Running automatic migration to new platform (STM32L476RGT6 MCU)
  - ✓Tuning project in STM32CubeMX:
    - ✓ Updating clocks
    - ✓ Re-configuring peripherals
    - ✓ Generating project for new MCU
  - ❑Tuning project in SW4STM32:
    - ❑ Importing modified project to the same workspace
    - ❑ Apply necessary modifications to generated sources
    - ❑ Compile and run project on the new platform

Further reading

More information can be found in the following documents:

- **UM1718 -** STM32CubeMX for STM32 configuration, available on the web:

  http://www.st.com/resource/en/user_manual/dm00104712.pdf

Enjoy!

www.st.com/mcu

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