



life.augmented

Free-of-charge graphic software framework optimized for STM32 TouchGFX

ST MDG Korea

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Agenda

1 The TouchGFX solution

5 Demonstration

2 TouchGFX Designer
New Design

3 TouchGFX latest features

4 Low-cost solution

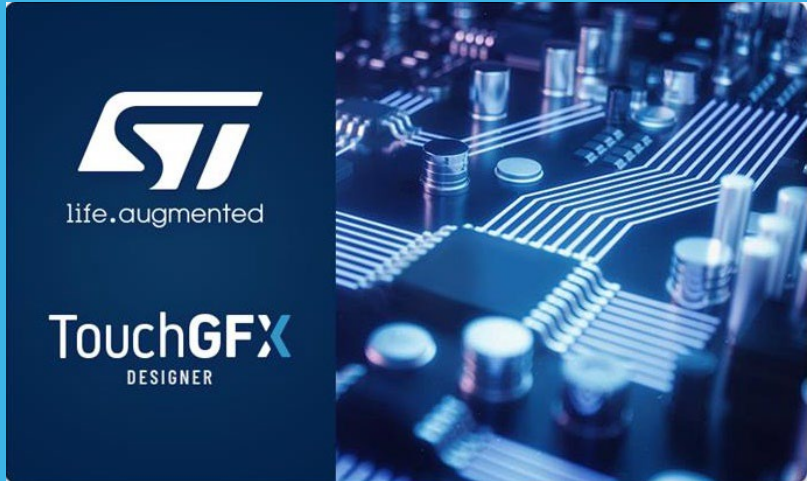
The TouchGFX solution





High-end UI with limited hardware performance

TouchGFX GUI library



Delivered as an X-Cube-TouchGFX Package



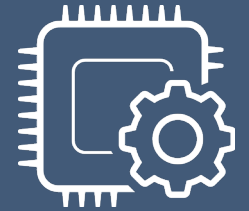
TouchGFX DESIGNER

PC GUI-builder
and -simulator



TouchGFX GENERATOR

Configure and
generate a
TouchGFX
project



TouchGFX ENGINE

Optimized and
hardware
accelerated
graphics library



STM32 software TouchGFX GUI software

TouchGFX Designer

Easy development

Develop great GUIs effortlessly with the WYSIWYG GUI builder, the TouchGFX Designer.

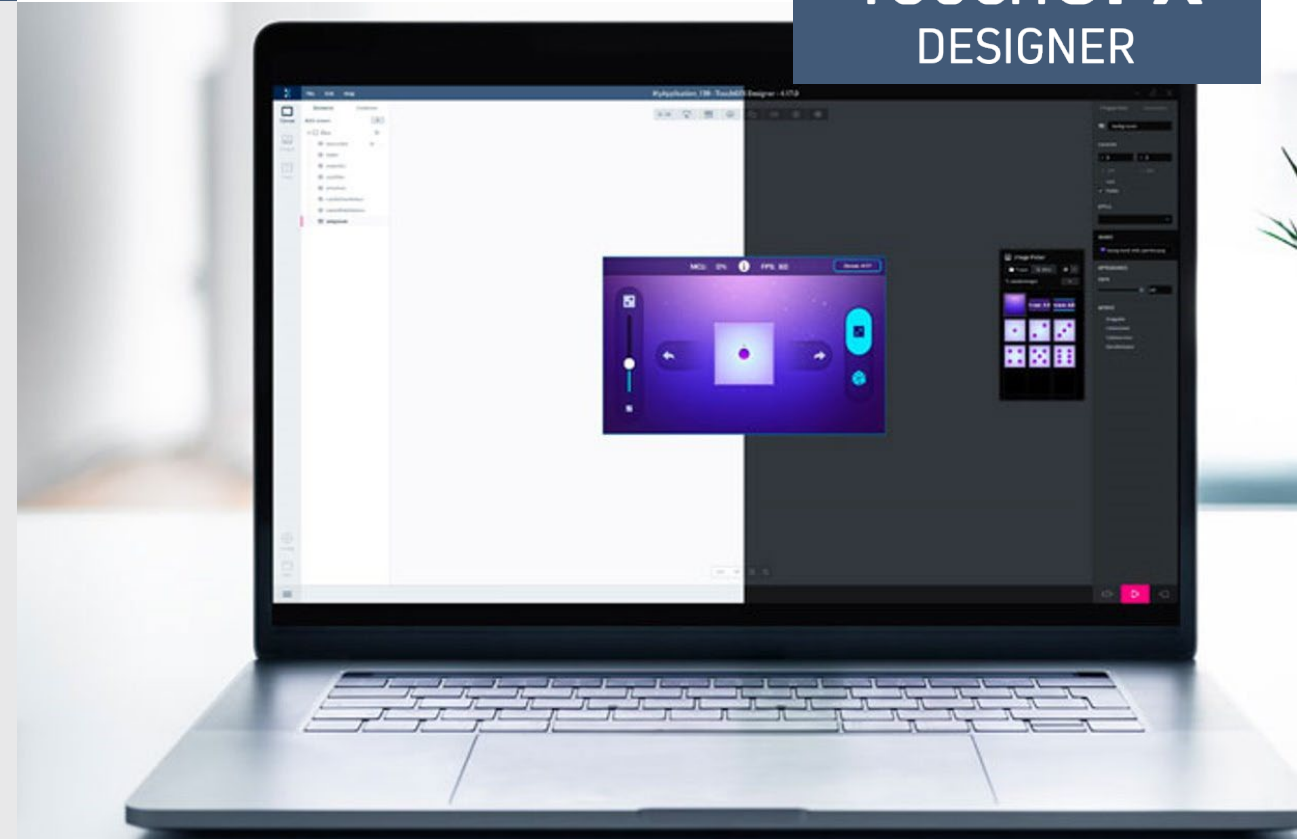
Create Anything

The structure and flexibility of TouchGFX gives the Developer control to easily create unique UI designs

→ The technology behind

- Run on PC-simulator or your target HW
- Combine your user-code with TouchGFX Designer generated code
- Create your own software elements with existing widgets.
- Design your own widgets.
- GUI written in C++.
- The Model-View-Presenter pattern gives way for easy interfacing with other C/C++ application components.

TouchGFX
DESIGNER





STM32 software TouchGFX GUI software

TouchGFX Generator

Faster UI project generation and low-level development

Easy configuration of:

- Memory
- Framebuffers
- Display resolution
- Color depth

Select your preferred IDE

Change to other RTOS or no RTOS

→ The technology behind

- CubeMX plugin to configure and generate TouchGFX Abstraction Layer (AL) for their STM32-based hardware.
- **TouchGFX AL** enables available graphics HW acceleration and optimization
- **IDE independent**
Works smoothly with CubeIDE, IAR Workbench, ARM Keil





STM32 software TouchGFX GUI software

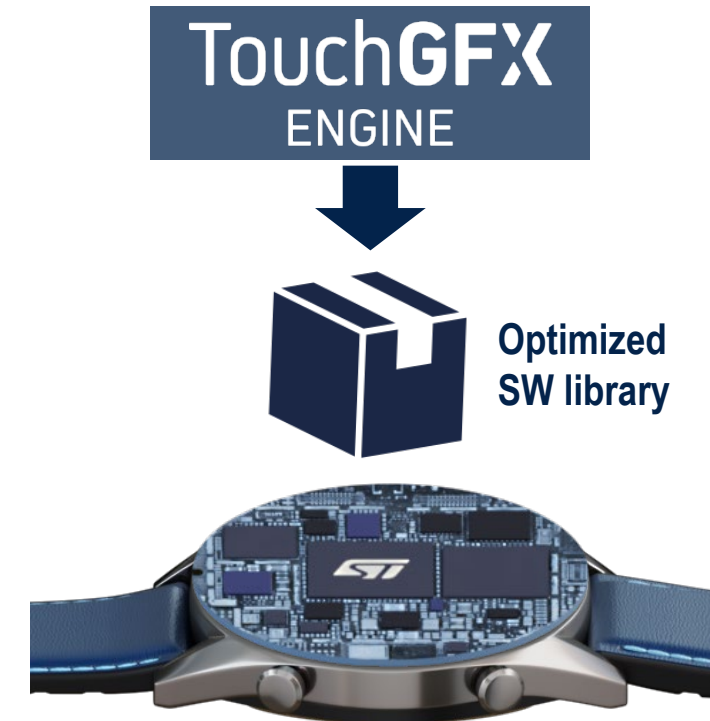
TouchGFX Engine

Maximum Performance

The TouchGFX Engine technology enables you to achieve the highest level of smartphone GUI performance on STM32 devices

→ The technology behind

- **Optimized for Minimum MCU Load and Memory Footprint**
Compile and Run time Analysis
Utilization of STM32 hardware acceleration
- **Advanced Rendering Algorithms**
Optimized visible surface determination algorithm and customized invalidation techniques minimize the number of drawn pixels
- **Advanced Graphical Objects**
Draw lines, circles, custom shapes, and graphics, or apply scaling and 3D rotation to images at runtime with highly optimized and memory efficient widgets





Getting started



1. select the MCU and pick the associated developer kit



2. Open TouchGFX Designer



3. Find your display kit



4. Create/select a demo

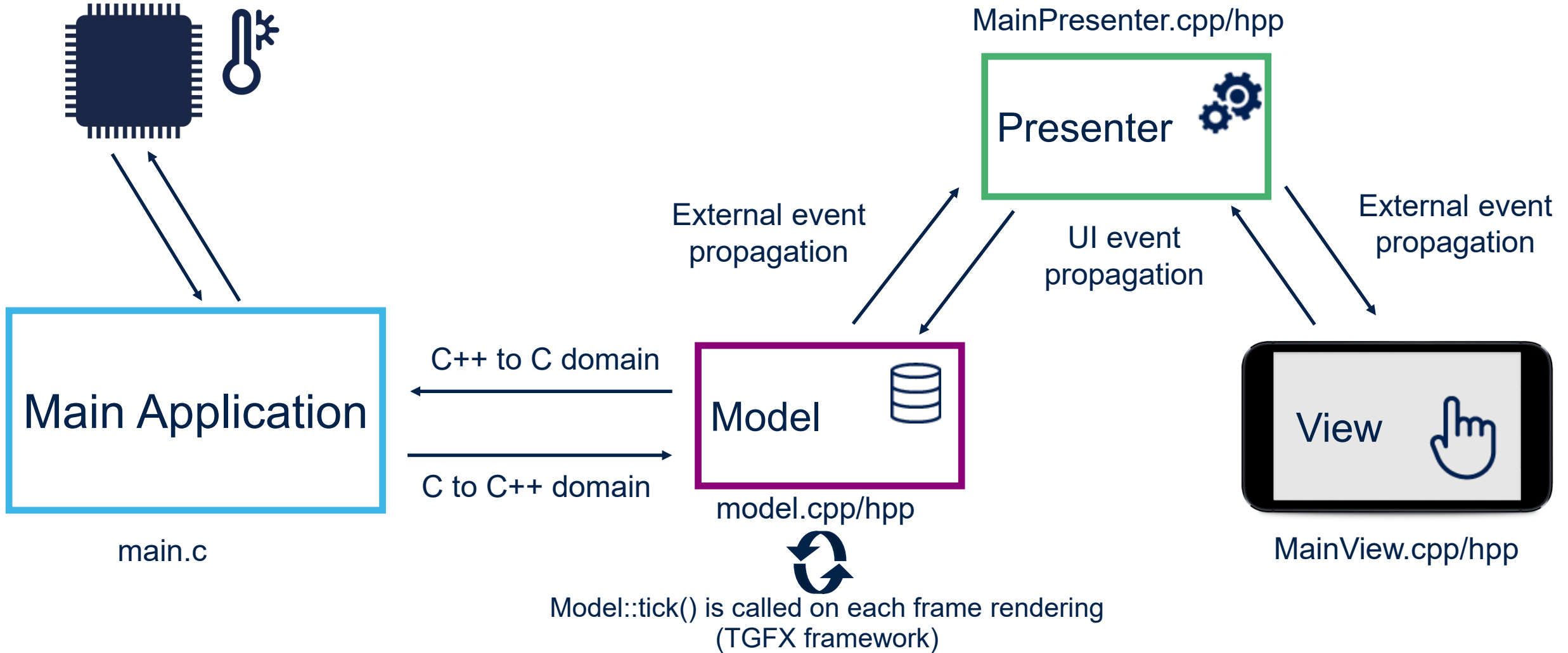


5. Flash your display kit

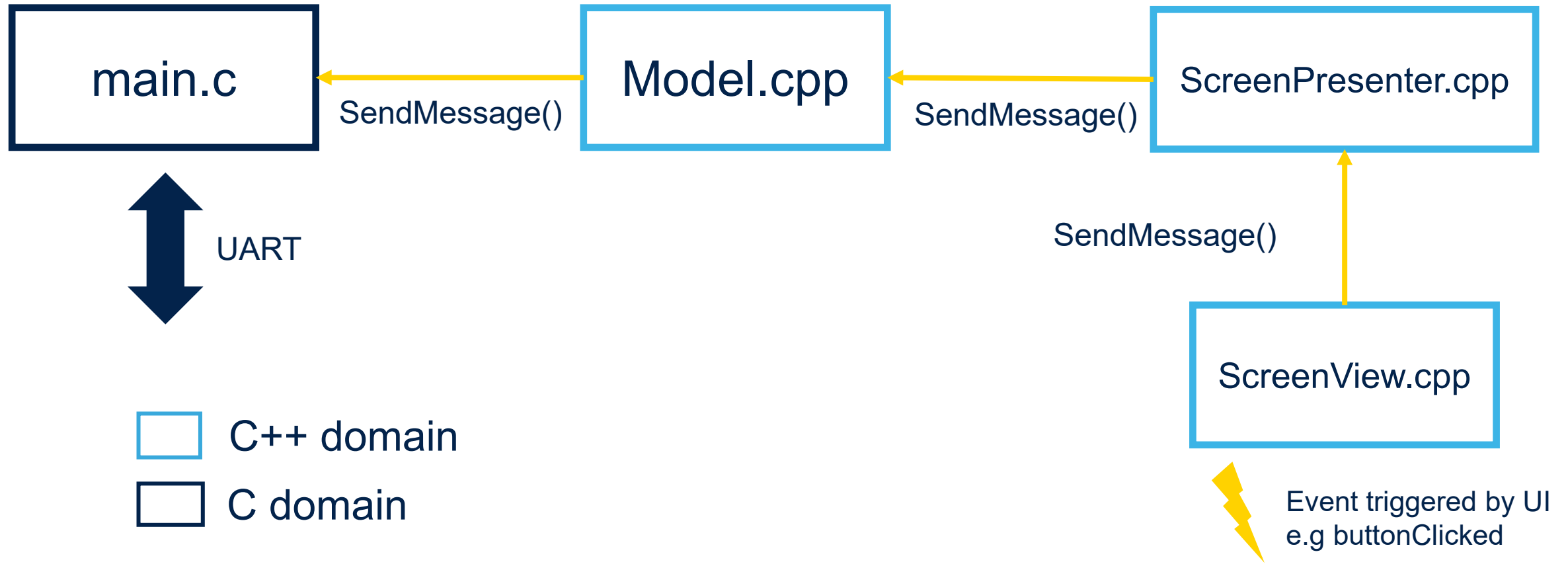


Video: [TouchGFX Designer: Design, Implement, Run!](#)

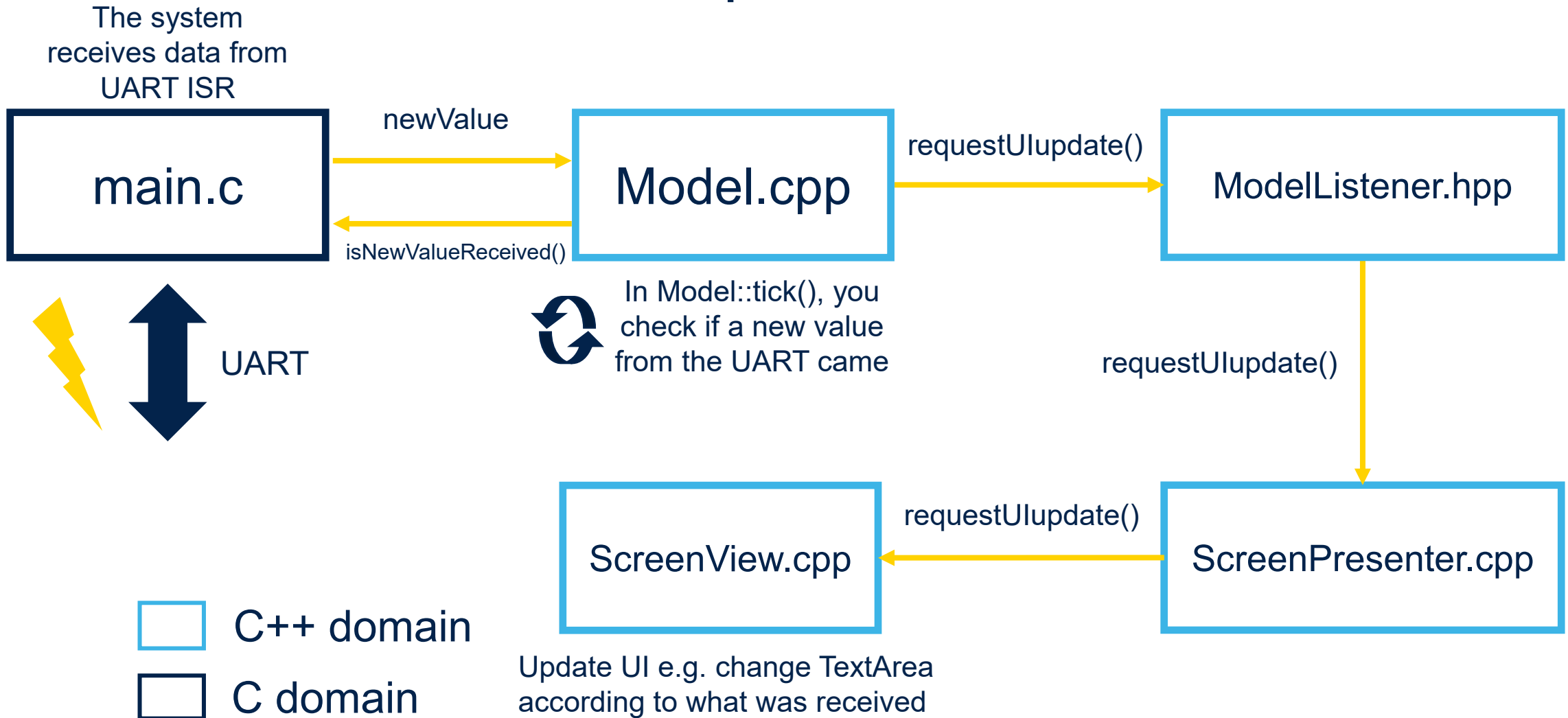
Model-View-Presenter



UART example – Overview - UI to Backend

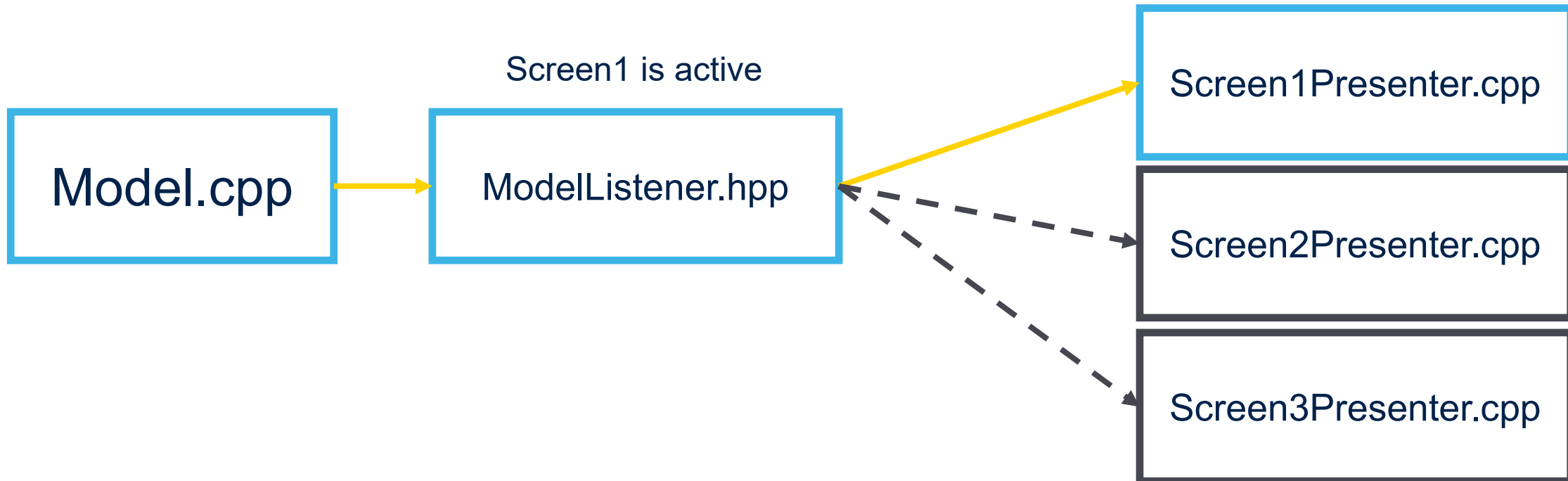


UART example – Overview – Backend to UI

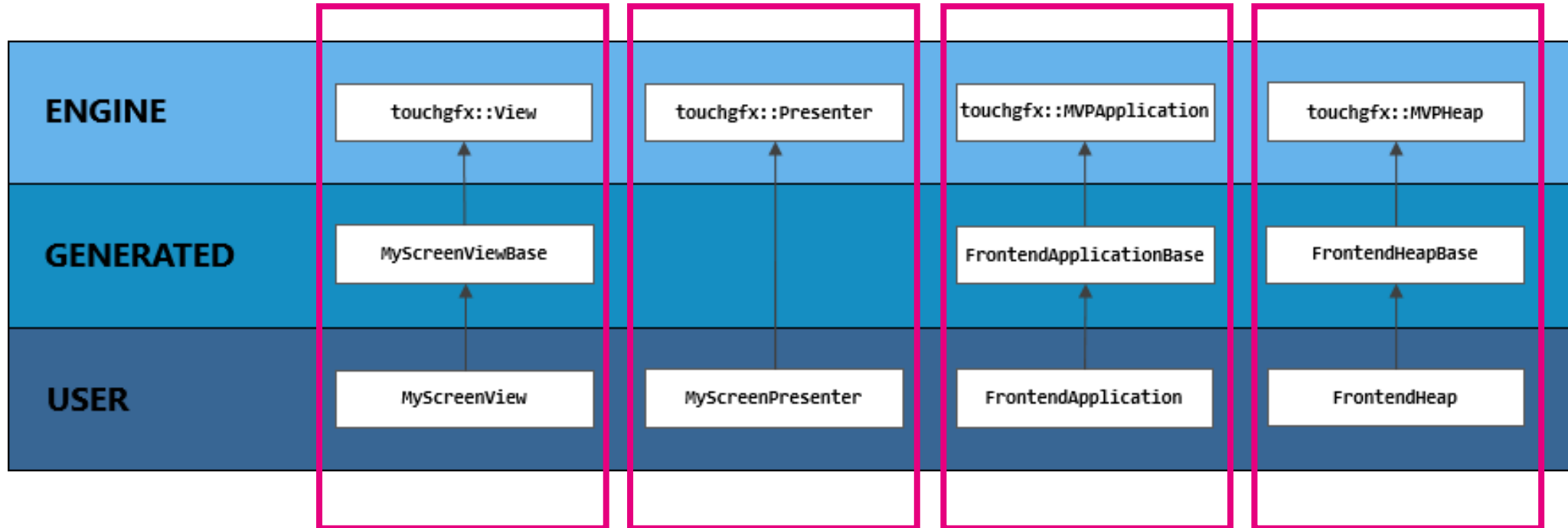


What's the ModelListener ?

- The Model has a pointer to the currently active Presenter. The type of this pointer is an interface (ModelListener) which you can modify to reflect the application-specific events that are appropriate.



Code structure



View
Visual appearance of the UI

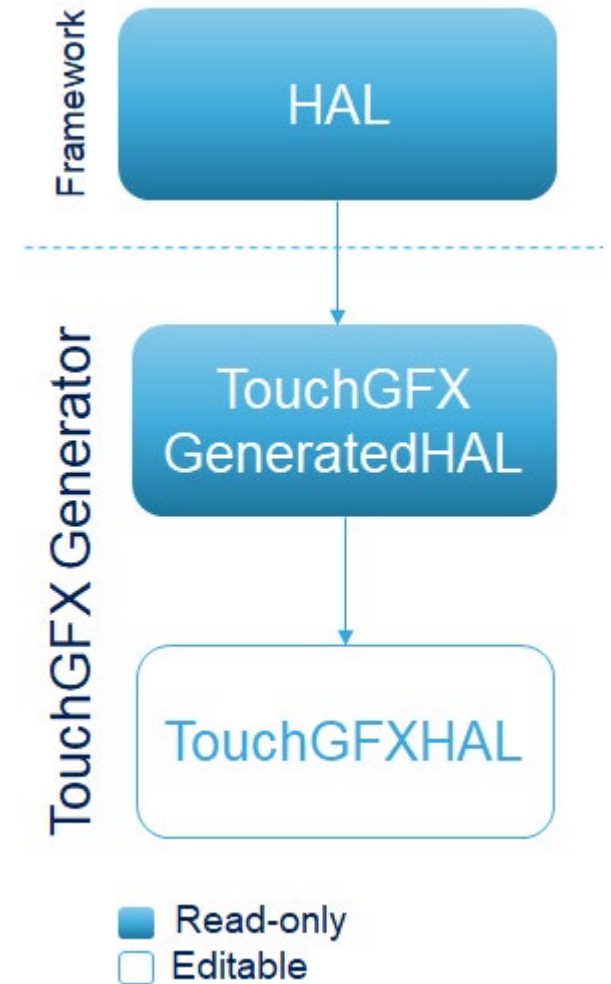
Presenter
The logic of the UI
Connects the Model and the View

Frontend Application
Takes care of the transitioning between screens

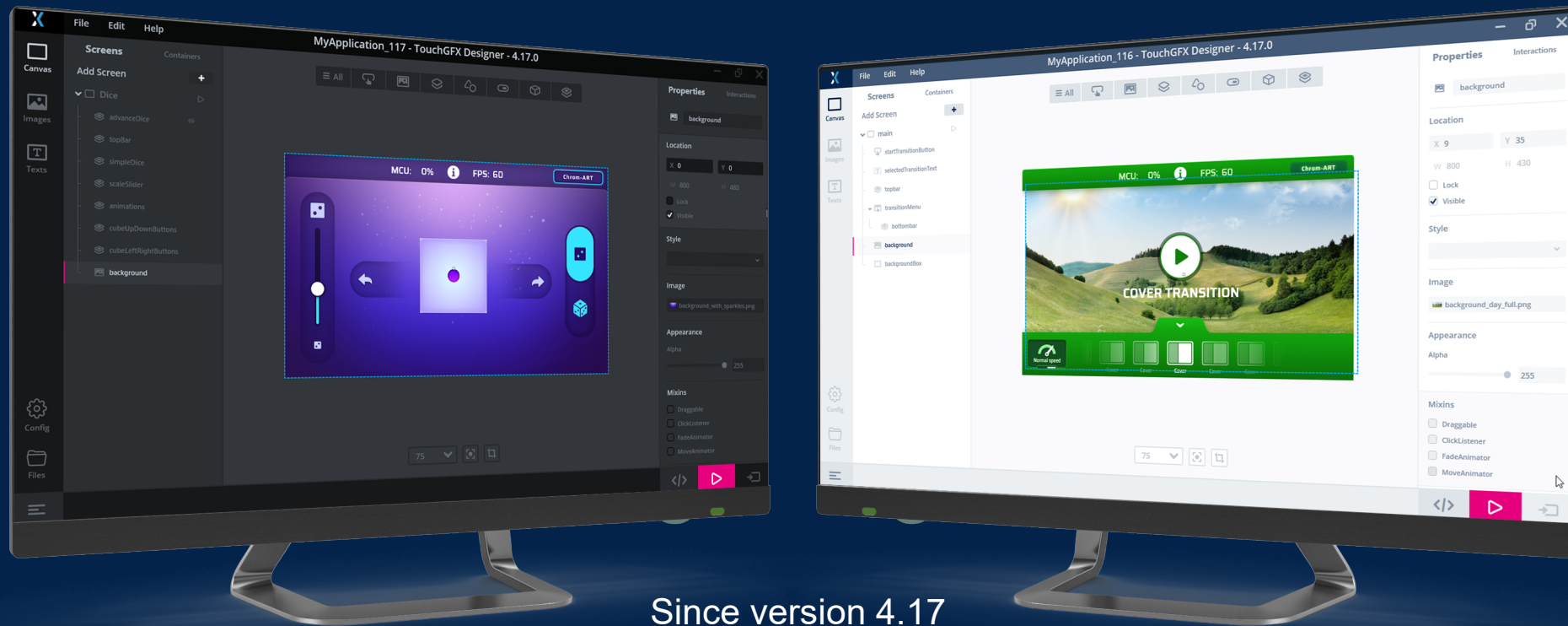
Frontend Heap
Makes sure the right amount of memory is allocated

TouchGFX Abstract Layer (AL)

- Abstract layer roles
 - Collect input (Touch coordinates, Buttons)
 - Update the Scene
 - Render the Scene to the framebuffer
- The TouchGFXHAL is responsible for :
 - Display – MCU synchronization
 - Transfer to display
 - Framebuffer control and access
 - Monitoring the rendering process



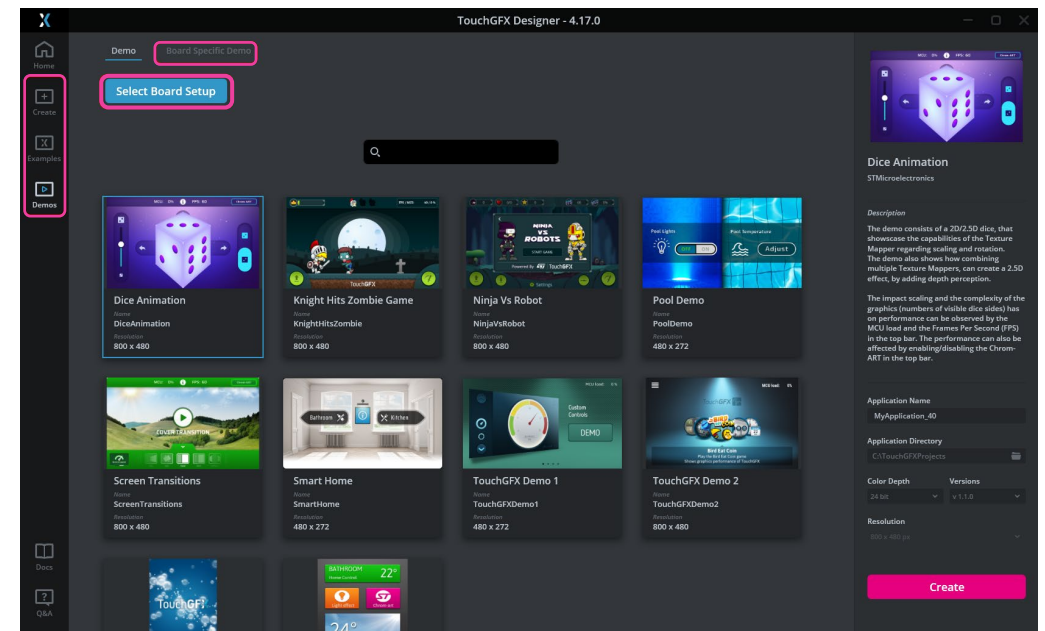
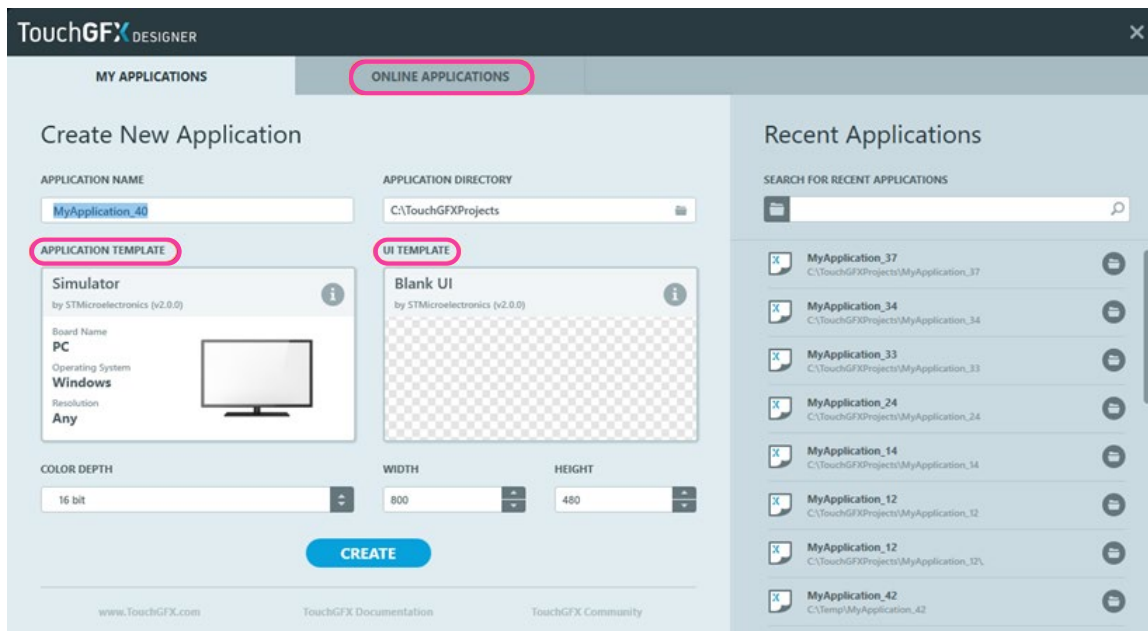
TouchGFX Designer – New Design



Since version 4.17

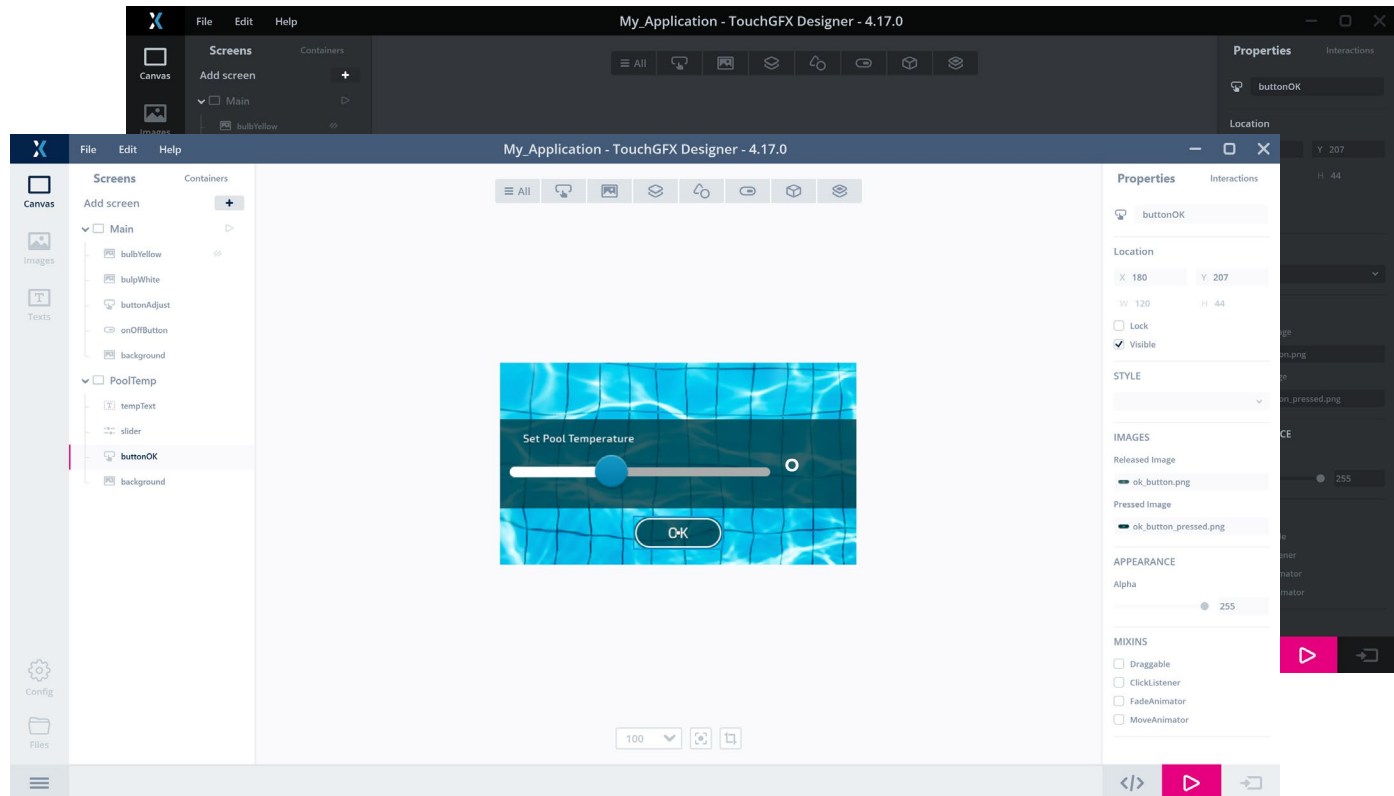
New terminologies

- New terminologies
 - Application Templates (AT) → **TouchGFX Board Setup (TBS)**
 - UI Template → Example and Demo tabs
 - Online Applications → Board Specific Demos

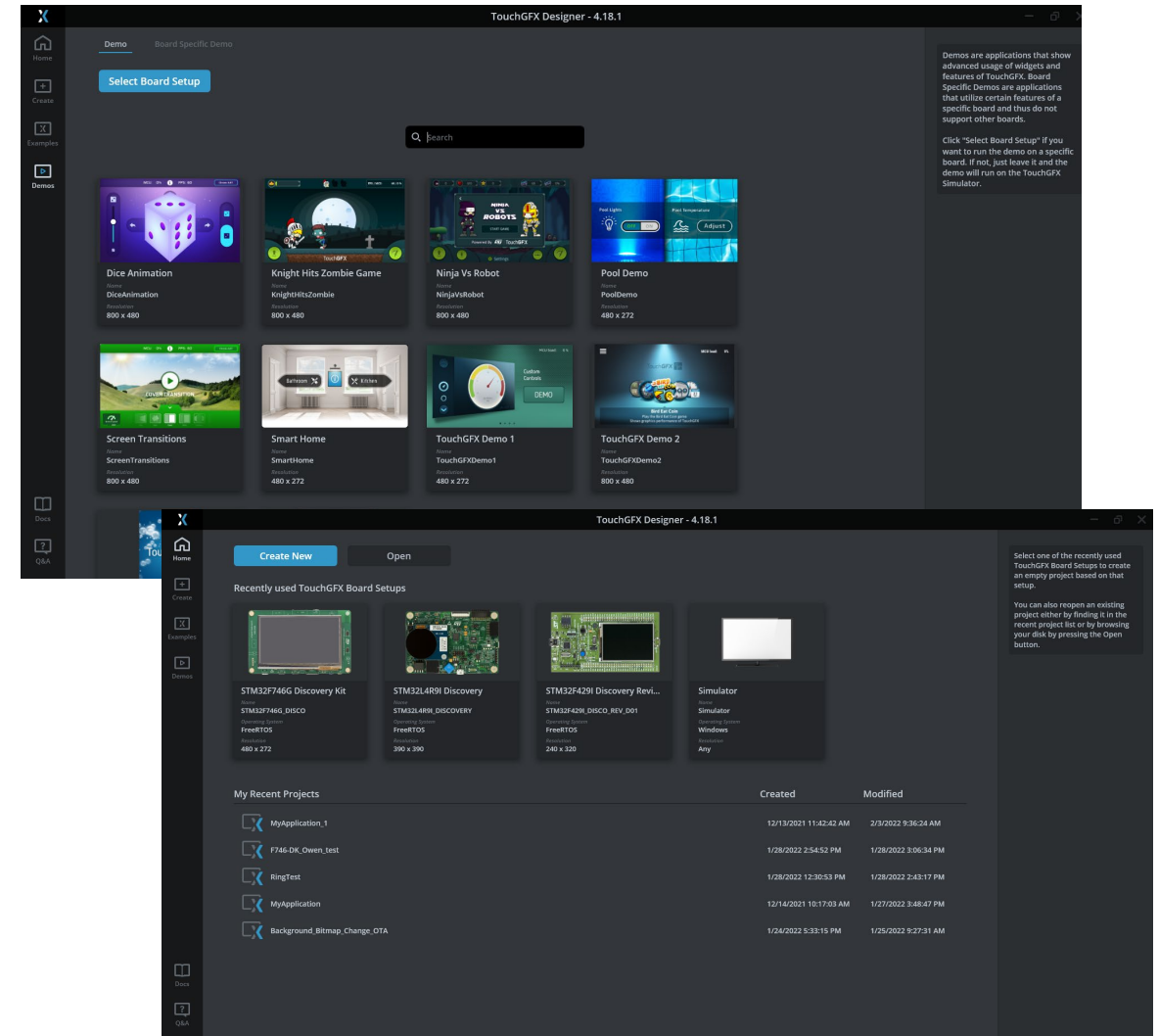
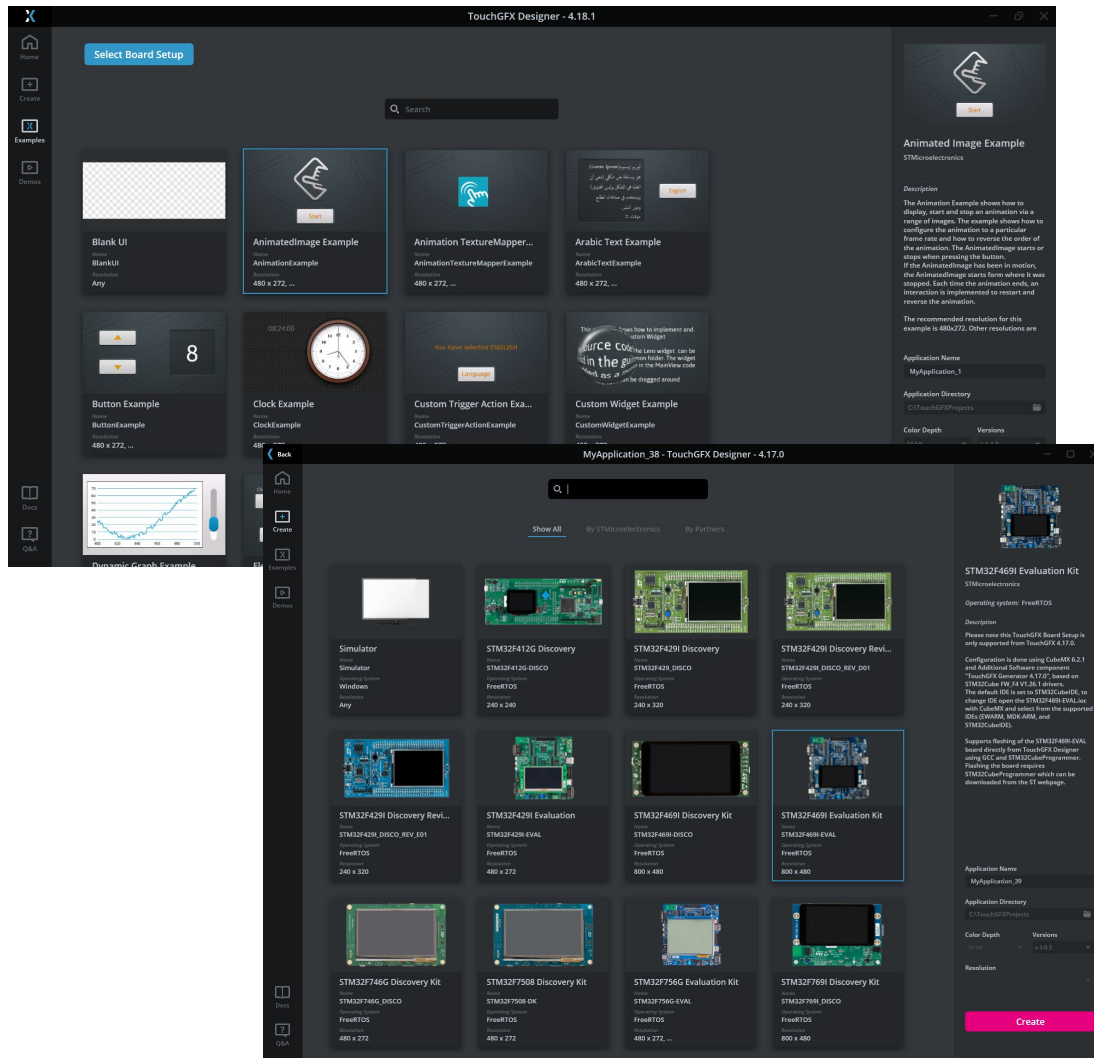


From TouchGFX 4.17

- Designer Redesign
 - Easier-to-use
 - Modern Design
 - Color theme

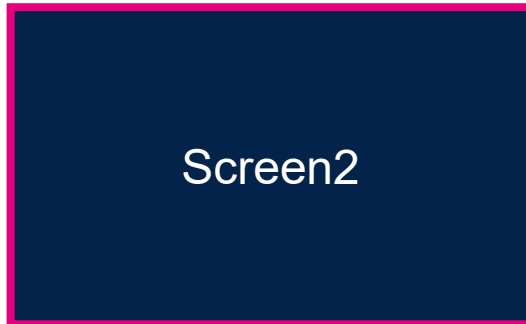
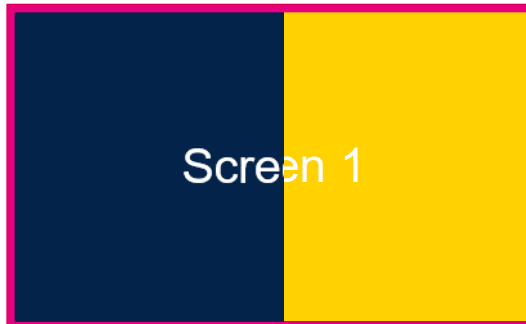
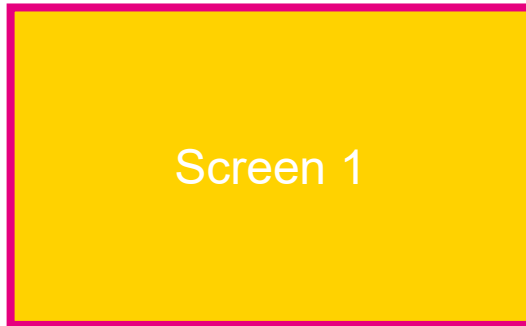


Work environment



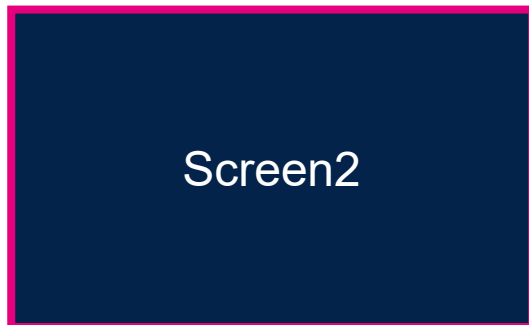
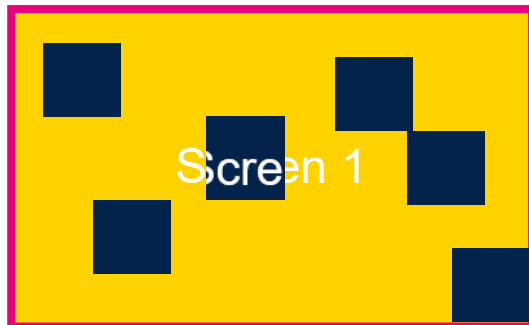
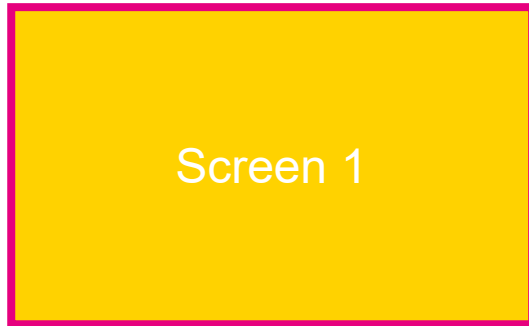
TouchGFX latest features

Wipe Transition (from 4.15)



- **No extra memory needed**
- **Only draws the pixels in the framebuffer once, and never moves any pixels**
=> Low MCU load
- **TouchGFX documentation [link](#)**

Block transition (from 4.16)



- **No extra memory needed**
- **Optimized for partial Framebuffer
=> Low MCU load**
- **TouchGFX documentation [link](#)**

Dynamic Graph widget (from 4.15)

- 3 dynamic behaviors (Wrap and Clear, Scroll and Wrap and Overwrite)
- 6 available element types (Area, Boxes, Diamonds, Dots, Histogram and Line)
- Labels and grid lines can also be added.



Dynamic Graph

A Dynamic Graph in TouchGFX is a widget that allows an application to display data points on a monotonous x-axis. The Dynamic Graph supports three types of *dynamic behavior*, that defines what happens when the graph runs out of space on the x-axis. The chosen dynamic behavior also greatly impacts the *performance* of the Dynamic Graph, as the behavior chosen impacts the area needed to be redrawn when inserting data points.

The Dynamic Graph, can have its visual appearance defined via, *Graph Elements*, *Grid Lines* and *Labels*

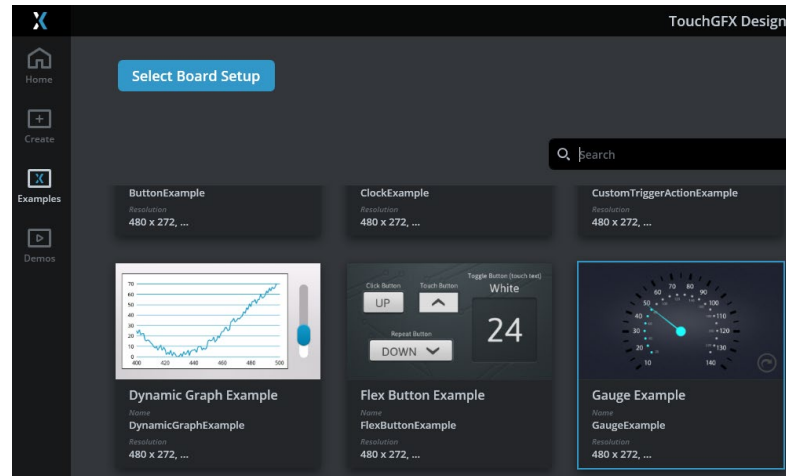
Dynamic Graph running in the simulator

<https://support.touchgfx.com/4.18/docs/development/ui-development/ui-components/miscellaneous/dynamic-graph>

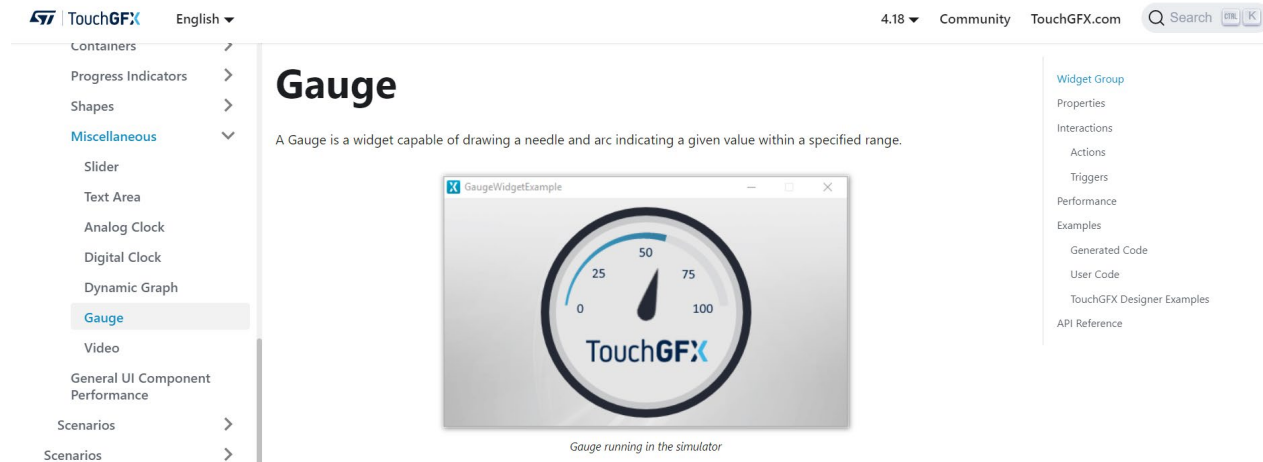
Example code in TouchGFX Designer

Gauge widget (from 4.16)

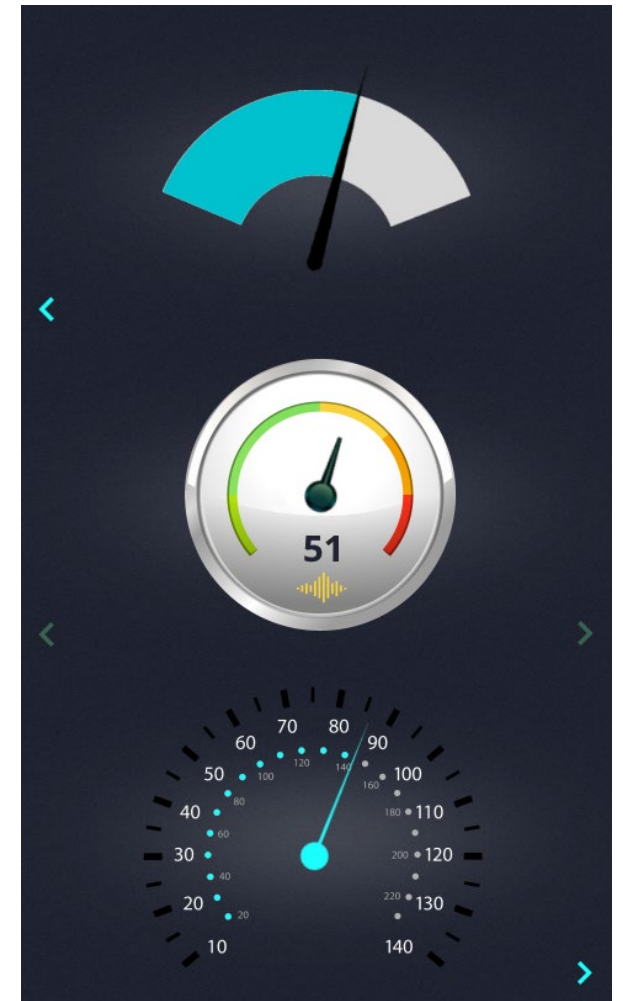
- Customizable gauge to indicate a value thanks to a needle and an arc indicator.



Example code in TouchGFX Designer



<https://support.touchgfx.com/4.18/docs/development/ui-development/ui-components/miscellaneous/gauge>



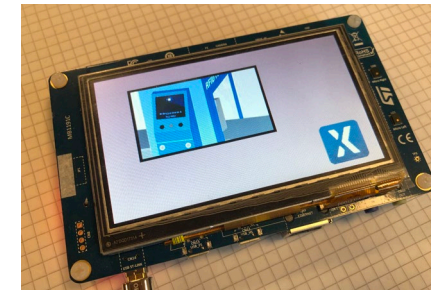
Available graphic for Gauge widget

Get Software

The screenshot shows the TouchGFX Designer software interface. At the top, there is a 'Get Software' section with a 'Download latest' button for 'X-CUBE-TOUCHGFX' version 4.18.0. Below this, the main workspace displays a video widget on a canvas. A 'Properties' panel on the right shows settings for 'video1', including Y (41) and H (372) coordinates. A 'Miscellaneous' widget palette is open, showing various widgets like Slider, Text Area, Analog Clock, Digital Clock, Dynamic Graph, Gauge, and Video. Below the workspace, a documentation page titled 'MJPEG Video' is visible, explaining that TouchGFX supports MJPEG video starting from version 4.18 and that the VideoWidget is used to display video. The page includes a screenshot of the video widget in the designer and a photograph of a physical device displaying the video.

Video widget (from 4.18)

- Playback of **Motion JPEG** video files
- MJPEG video (not a video player)
 - Start
 - Pause
 - Repeat
 - Go to Frame
- Can read directly from memory

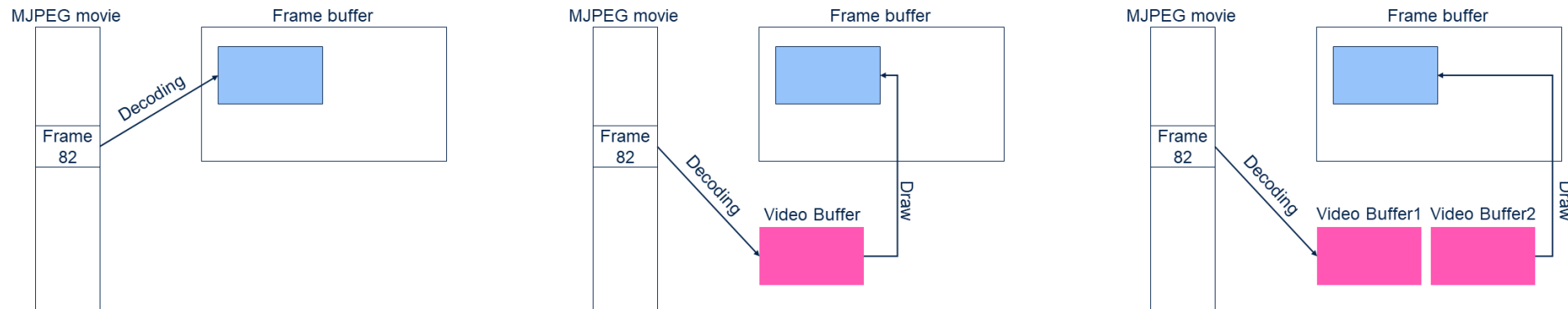


Video widget (from 4.18)

- Supports different buffering strategies

(<https://support.touchgfx.com/docs/development/ui-development/touchgfx-engine-features/video#decoding-strategies>)

- No video buffer: Render video directly to frame buffer.
- 1 full video buffer: Decompression impact GUI thread
- 2 full video buffers: Decompression no impact on GUI thread.



Important new features

- Generator FMC Support
- Generator Dual Core Support
- New invalidation algorithm for improved performance.
- Improved DMA2D algorithm
- New XML text database
- Export/Import translation tool
- Integration of LibJPEG in TouchGFX
- Bug fixes and small improvements

Coming soon...

- 2.5D accelerator – Neo-Chrom
- Vector graphics support
- Static Graph widget
- Import/Export custom containers and widgets
- AzureRTOS integration
- MIPI-DSI Video mode example
- More to come...

Low-Cost solution

Replace segment display with modern GUI



- **Smartphone inspired User Experience**
 - Intuitive UI ensures maximum product value
 - Richer content, colors and animations
 - Flexibility for localization and updates
- **5 USD achieved BOM cost**



Low-cost SPI + external Flash display kit

- **X-NUCLEO-GFX01M**

- 8 Mbytes Serial SPI Flash
- 2.2" SPI QVGA TFT LCD
 - Resolution : 240x320 px
 - Bit depth : 16 bpp
- Joystick for easy menu navigation

- **Out of the Box TouchGFX Designer support**

- Supporting NUCLEO-G071RB + X-NUCLEO-GFX01M extension
 - New Application Template in TouchGFX designer
 - 3 new Board Specific demos providing full project examples in source code

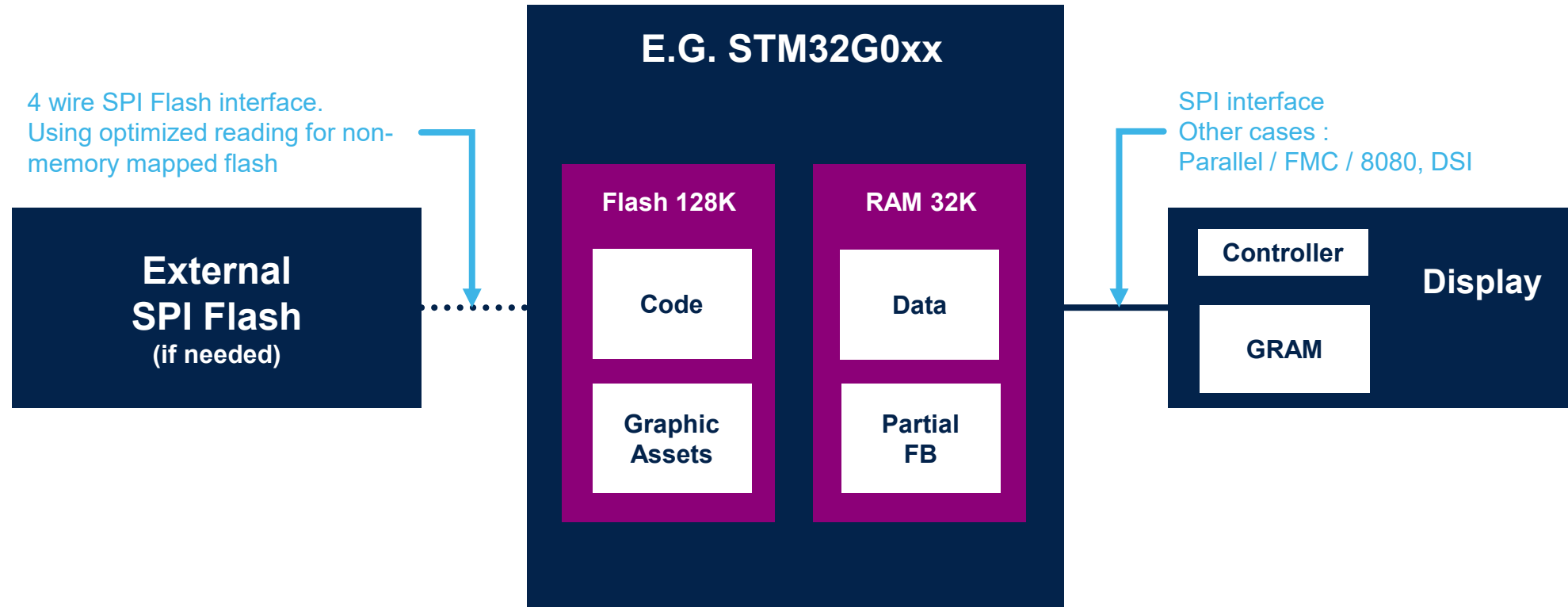
- **New Generic X-CUBE-DISPLAY software package**

- Basic drivers and hello world example
- Allows support of the display extension by partners software solutions



Hardware Compatible with the following Nucleo boards:
NUCLEO-F030R8, NUCLEO-F070RB,
NUCLEO-F072RB, NUCLEO-F091RC,
NUCLEO-F401RE, NUCLEO-F410RB,
NUCLEO-F411RE, NUCLEO-F446RE,
NUCLEO-G071RB, NUCLEO-L053R8,
NUCLEO-L073RZ, NUCLEO-L412RB-P,
NUCLEO-L433RC-P, NUCLEO-L452RE,
NUCLEO-L452RE-P and NUCLEOL476RG

Low-cost project ecosystem



What is appropriate for low-cost graphics ?

- Invalidating small areas
- Widgets with alpha
- Rotation
- Scaling
- Animated Image
- Box widget
- Full screen update
- RGB888
- SPI
- LTDC

- Appropriate for low-cost
- Appropriate for low-cost depending on circumstances
- NOT appropriate for low-cost

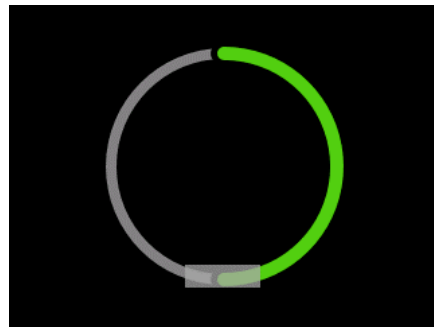
What can help improve performance in low-cost graphics ?

- Smart UI
- DMA
- Performant external memory
- DMA2D
- Avoiding concurrent tasks
- Display with TE signal

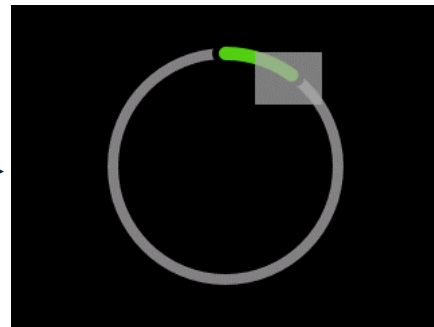
- Improves performance for low-cost
- Does NOT improve performance for low-cost

Sequential modification

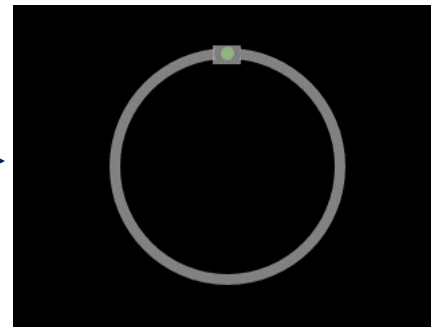
- A good UI implementation method for low-cost MCUs is to **sequentially modify** widgets. You can modify many elements on the screen but not at the same time.



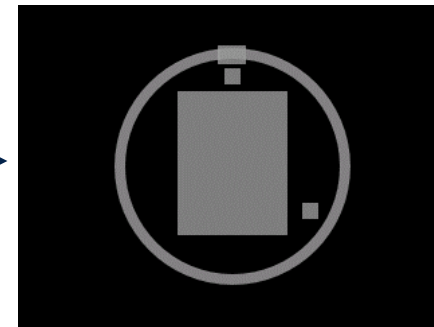
Circle reducing, only the modified part is updated



Circle reducing, only the modified part is updated



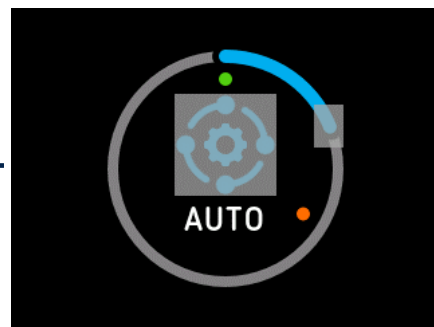
One dot remaining, we can now change the color and switch to the next mode



Fade in of the new elements : circle, dots, text and animated image



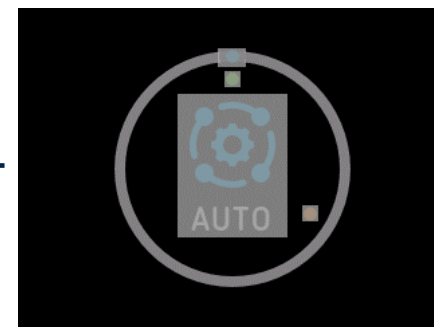
Circle expansion finished, we successfully changed to Auto mode



While expanding the circle, we start the animation



Fade in finished, now we expand the circle



Fade in of the new elements : circle, dots, text and animated image

Demonstration

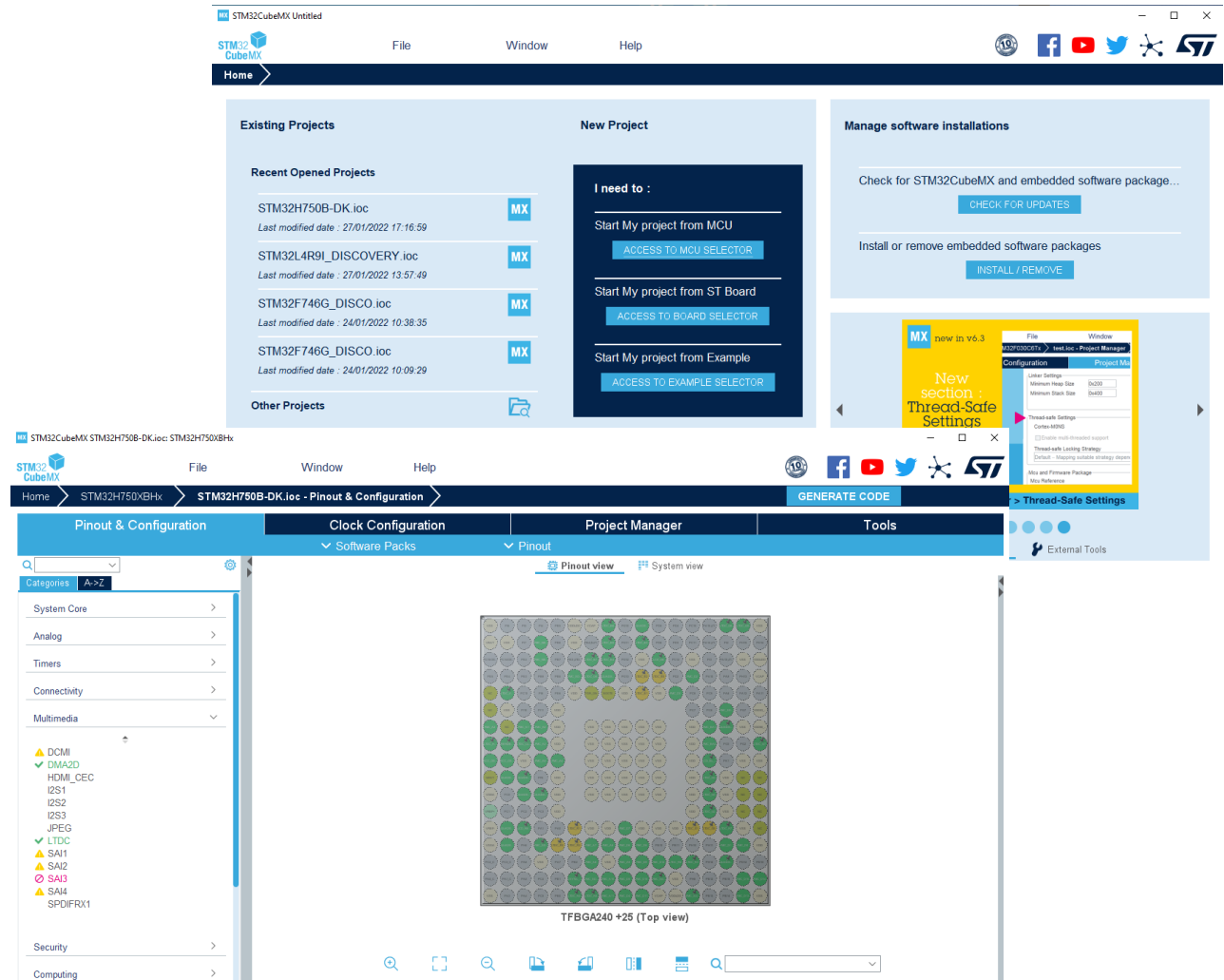
Objectives

- How to configure your target in CubeMX
 - Configuration of NUCLEO-G071RB (Clock, SPI, UART,...)
- How to add X-Cube-TouchGFX plug-in to CubeMX
 - Enable X-Cube-TouchGFX
 - Configuration of TouchGFX
 - Organization of TouchGFX code generated from CubeMX
- How to handle TouchGFX Designer to design your UI application
 - Add and manage custom images on the screen
 - Interaction & trigger
 - Import an existing UI
- How to start from a TouchGFX Board Setup (TBS) and debug with CubeIDE
 - Adding communication between TouchGFX and a PC through UART
 - Project debugging to understand the TouchGFX loop

- **STM32CubeMX**

- STM32 free-of-charge MCU graphical configuration tool
- Intuitive STM32 microcontroller and microprocessor selection
- Generation of initialization C code
- Multi-OS support
Windows[®], Linux[®],
and MacOS[®], 64-bit only
- Download

<https://www.st.com/en/development-tools/stm32cubemx.html>



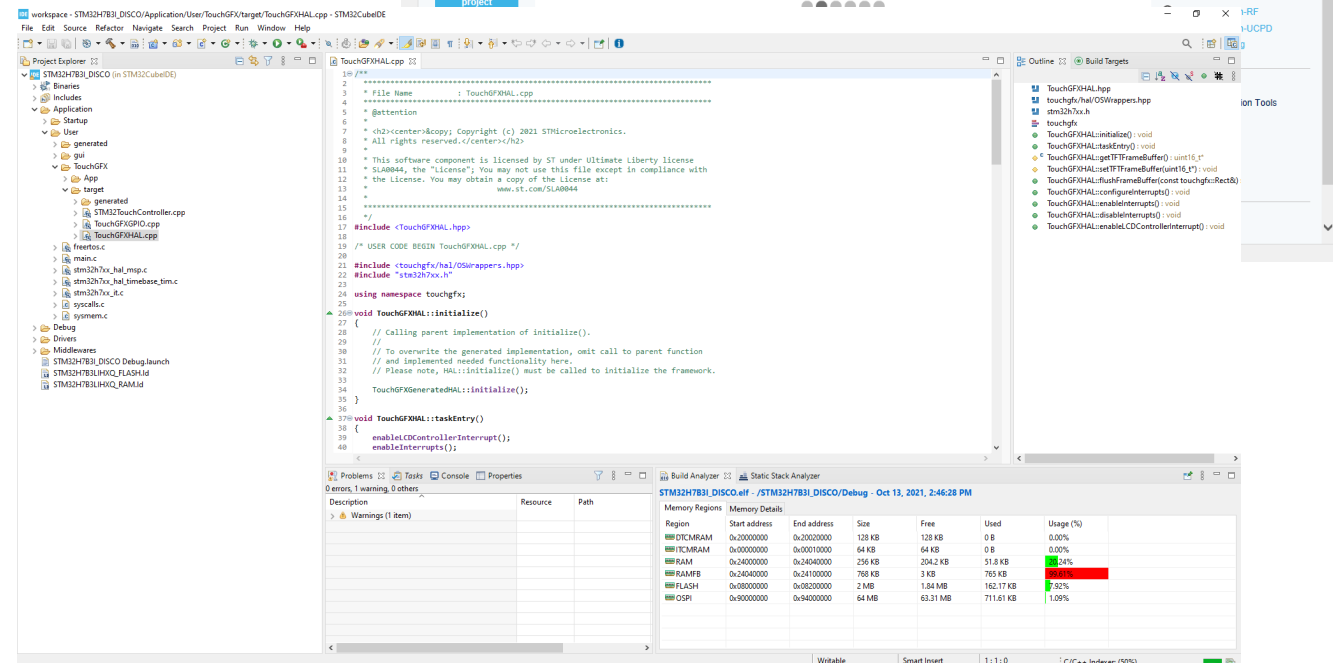
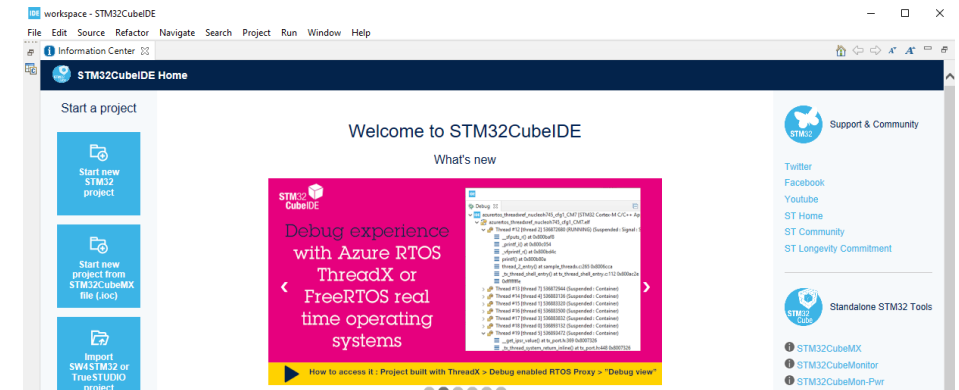
- **STM32CubeIDE**

- STM32 free-of-charge dedicated IDE
 - C/C++ development platform with peripheral configuration, code generation, **code compilation**, and **debug features** for STM32 microcontrollers and microprocessors.

- Based on ECLIPSE™/CDT, with support of ECLIPSE™ add-ons, GNU C/C++ for Arm® toolchain and GDB debugger
- Multi-OS support
Windows®, Linux®, and MacOS®, 64-bit only

- Download

<https://www.st.com/en/development-tools/stm32cubeide.html>



- **X-NUCLEO-GFX01M**

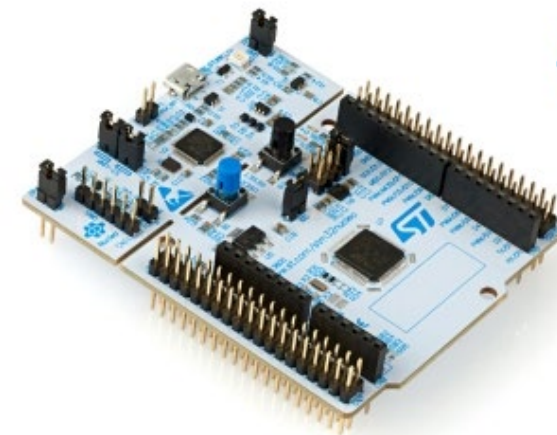
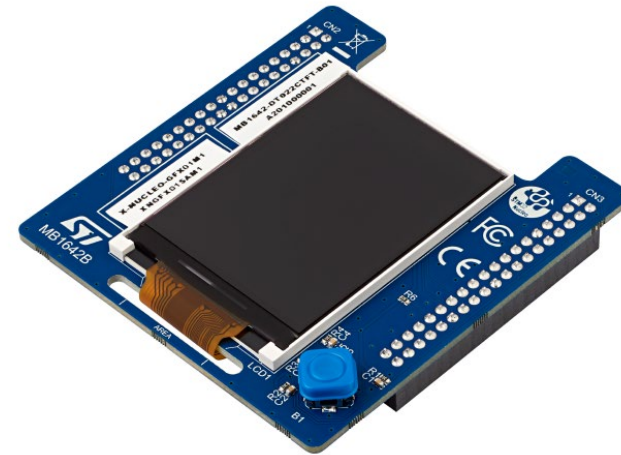
- 8 Mbytes Serial SPI Flash
- 2.2" SPI QVGA TFT LCD – 240x320px with 16bpp
- Joystick for easy menu navigation
- More information ...

<https://www.st.com/en/evaluation-tools/x-nucleo-gfx01m1.html>

- **NUCLEO-G071RB**

- STM32G071RB Cortex M0+ @64MHz
- 128kB flash – 36kB RAM
- On-board ST-LINK
- More information ...

<https://www.st.com/en/evaluation-tools/nucleo-g071rb.html>



Worldwide Support

- **Documentation**

- TouchGFX Documentation (한국어 지원 (일부))

<https://support.touchgfx.com/ko>

- **Q&A**

- ST Community

[https://community.st.com \(TouchGFX\)](https://community.st.com (TouchGFX))

TouchGFX는 X-Cube 패키지인 X-Cube-TouchGFX 로 제공됩니다.

이 패키지만 있으면 STM32 기반 하드웨어용 GUI 애플리케이션을 완벽히 구현하는 데 필요한 모든 기능을 확보할 수 있습니다. TouchGFX는 2개의 도구와 1개의 프레임워크, 이렇게 총 3개의 주요 부분으로 이루어져 있습니다.

- **TouchGFX Designer:** 손쉽게 TouchGFX 애플리케이션의 비주얼을 만들 수 있는 TouchGFX의 GUI 빌더입니다.
- **TouchGFX Generator:** A STM32CubeMX plugin where the user can configure and generate a custom TouchGFX Abstraction Layer (AL) for their STM32-based hardware.
- **TouchGFX Engine:** UI 애플리케이션을 구동하는 TouchGFX C++ 프레임워크로, 화면 업데이트, 사용자 이벤트 및 타이밍을 처리합니다. 첨단 TouchGFX 기술은 STM32 마이크로컨트롤러에 최적화되어 CPU 부하 및 메모리 사용량을 최소화하면서 성능을 극대화합니다.

Activity

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