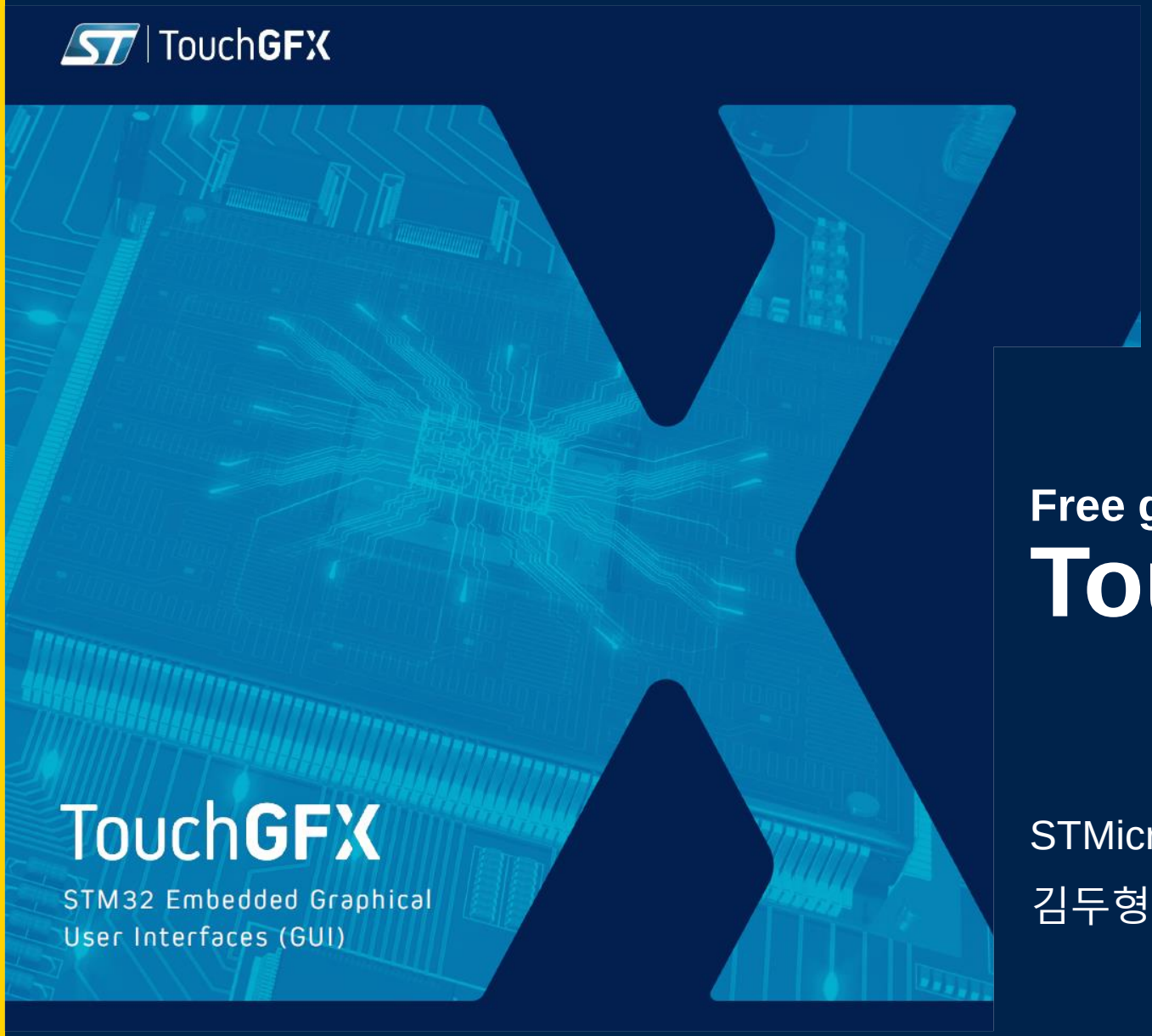

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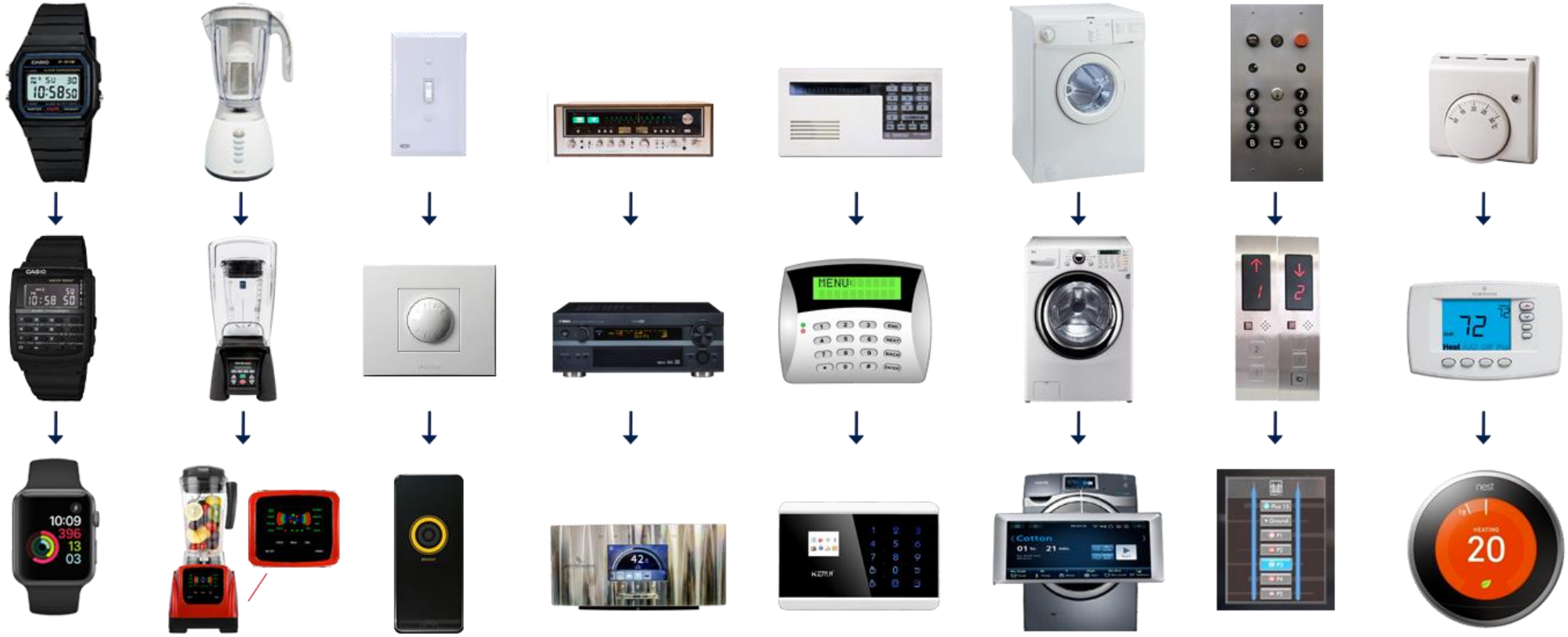
Free graphic interface optimized for STM32

TouchGFX

STMicroelectronics Korea MCD team

김두형 과장

Accelerating the HMI of things



Enabling high-end user experience in embedded devices

Smarter and richer devices requiring Advanced Graphic User Interfaces

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STM32 graphics solutions

Enabling you to create high-end user experience in embedded devices

- Advanced Graphic MCU Portfolio
- State-of-the-art Graphic Software and Tools
- Reference Designs and Worldwide Support
- Live Demonstration

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Advanced Graphic MCU Portfolio

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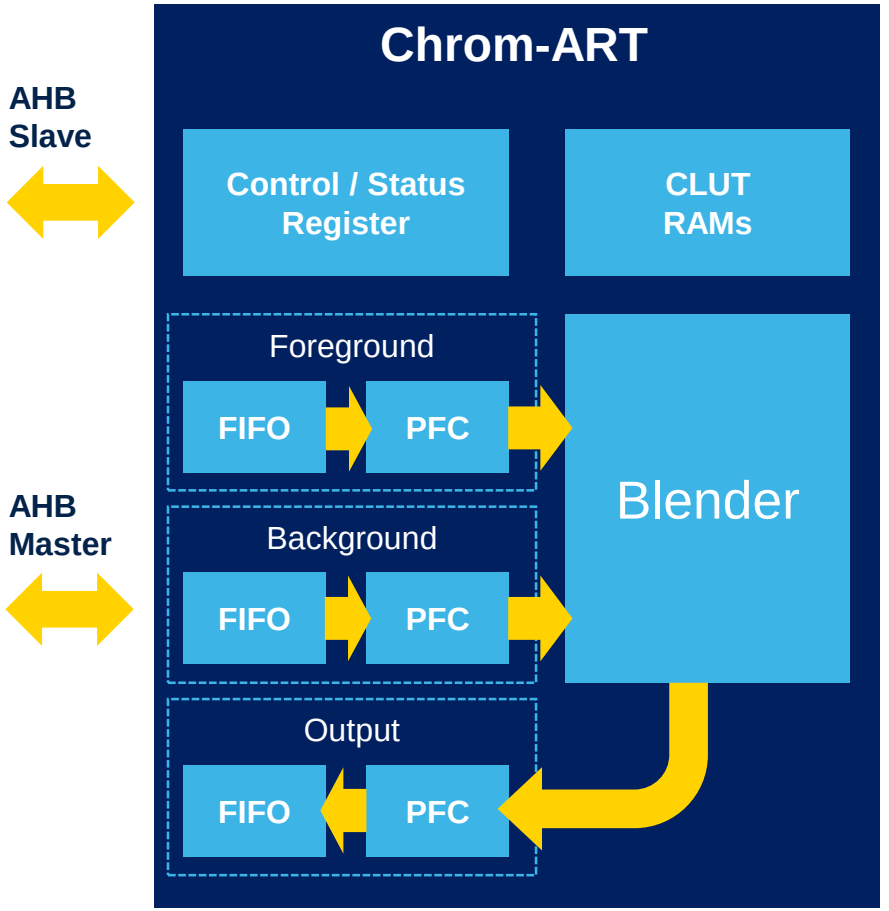
Advanced graphics MCU portfolio

Efficient 2D graphics acceleration for high-end transitions and effects

- **Offloads the CPU from repetitive graphics tasks**
  - Efficient 2D image copy
  - Transparency
  - Pixel format conversion
  - Efficient Fonts management



Advanced graphics MCU portfolio

Chrom-GRC™ for memory optimization

- **Chrom-GRC™**
  - Graphic Resources Cutter for non square displays
  - No modification nor special management at SW level.

  → Saving up to 20% of RAM needs

Saved Memory

- For **360x360** round display
  - @16bpp : **~205KB** (vs.253KB)
  - @24bpp : **~307KB** (vs.380KB)
- For **400x400** round display
  - @16bpp : **~250KB** (vs. 312KB)
  - @24bpp : **~372KB** (vs. 469KB)

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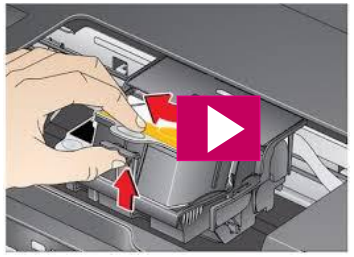
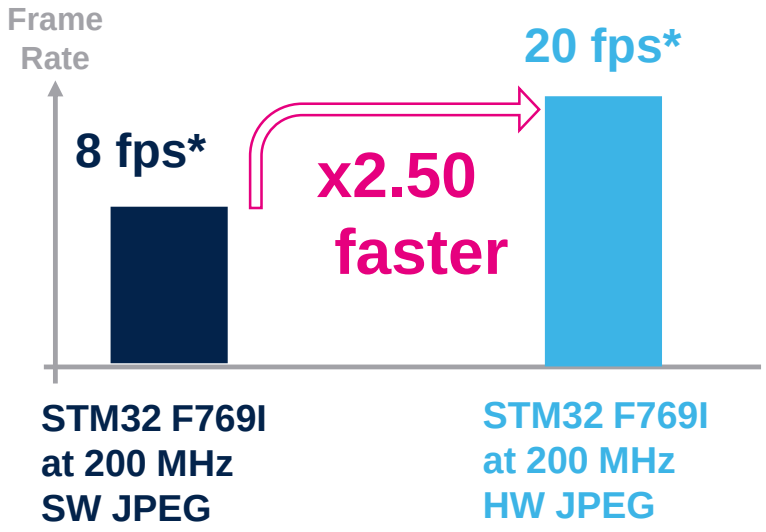
Advanced graphics MCU portfolio

MJPEG video acceleration for branding and tutorial videos

- **HW JPEG accelerator**
  - Fast and simple hardware JPEG compression and decompression
  - Full management of JPEG headers
  - Supporting motion JPEG videos
    → Saving CPU load for MJPEG management
    → Enhancing branding and user experience
    - Branding animations at startup
    - End-product embedded tutorials





* : frames per second

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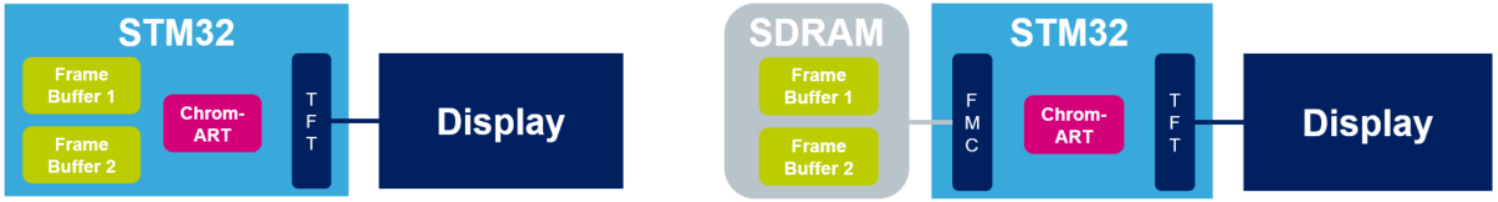
Advanced graphics MCU portfolio

Support for a wide range of display interfaces

- SPI and Intel 8080 / Motorola 6800 LCD interfaces for small resolutions

- TFT controller for medium resolution (up to XGA)



- MIPI-DSI interface for medium resolution, high pixel density GUI, mainly consumer today

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Advanced graphics MCU portfolio

Different display interface support

STM32 SERIES	FREQUENCY	HARDWARE ACCELERATION	DISPLAY INTERFACES	SUPPORTED RESOLUTIONS
STM32G0 (CM0+)	64 MHz	-	SPI	Up to 320*240
STM32L4 (CM4)	80 MHz	Chrom-ART™	Parallel SPI	Up to 480*272
STM32L4+ (CM4)	120 MHz	Chrom-ART™ Chrom-GRC™	Parallel LCD TFT MIPI-DSI	Up to 450*450
STM32F4 (CM4)	180 MHz	Chrom-ART™	Parallel LCD TFT MIPI-DSI	Up to 800*480
STM32F7 (CM7)	216 MHz	Chrom-ART™ MJPEG	Parallel LCD TFT MIPI-DSI	Up to 1024*768
STM32H7 (CM7)	480 MHz	Chrom-ART™ MJPEG	Parallel LCD TFT MIPI-DSI	Up to 1024*768

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State-of-the art graphic software and tools

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State-of-the-art graphic software and tools

TouchGFX – Unbeatable GUI performance on STM32

Maximum Performance

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

Create Anything

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

Easy to Use

TouchGFX combines a WYSIWYG designer, auto code generation and a PC-simulator with the efficiency and flexibility of the C++ language

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State-of-the-art graphic software and tools

TouchGFX – All you need to quickly start and achieve a high-end GUI

- **Two main development steps**
  - Running TouchGFX on your STM32-based board
    - Use TouchGFX Generator – an STM32CubeMX plugin that lets you to configure and generate the TouchGFX setup code
    - Develop the UI application

- **Advantage of the new TouchGFX Generator solution**
  - Intuitive and seamlessly interaction and workflow between CubeMX/TouchGFX Generator and the TouchGFX Designer.
  - An open solution – no restriction on selected IPs
    - All STM32 devices with Arm Cortex-M0+, M4 and M7 cores are supported
  - Support for special cases where custom code is required

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State-of-the-art graphic software and tools

X-CUBE-TOUCHGFX

TouchGFX GENERATOR

TouchGFX DESIGNER

TouchGFX ENGINE

STM32CubeMx plugin

Graphic HW and SW configuration and project generation

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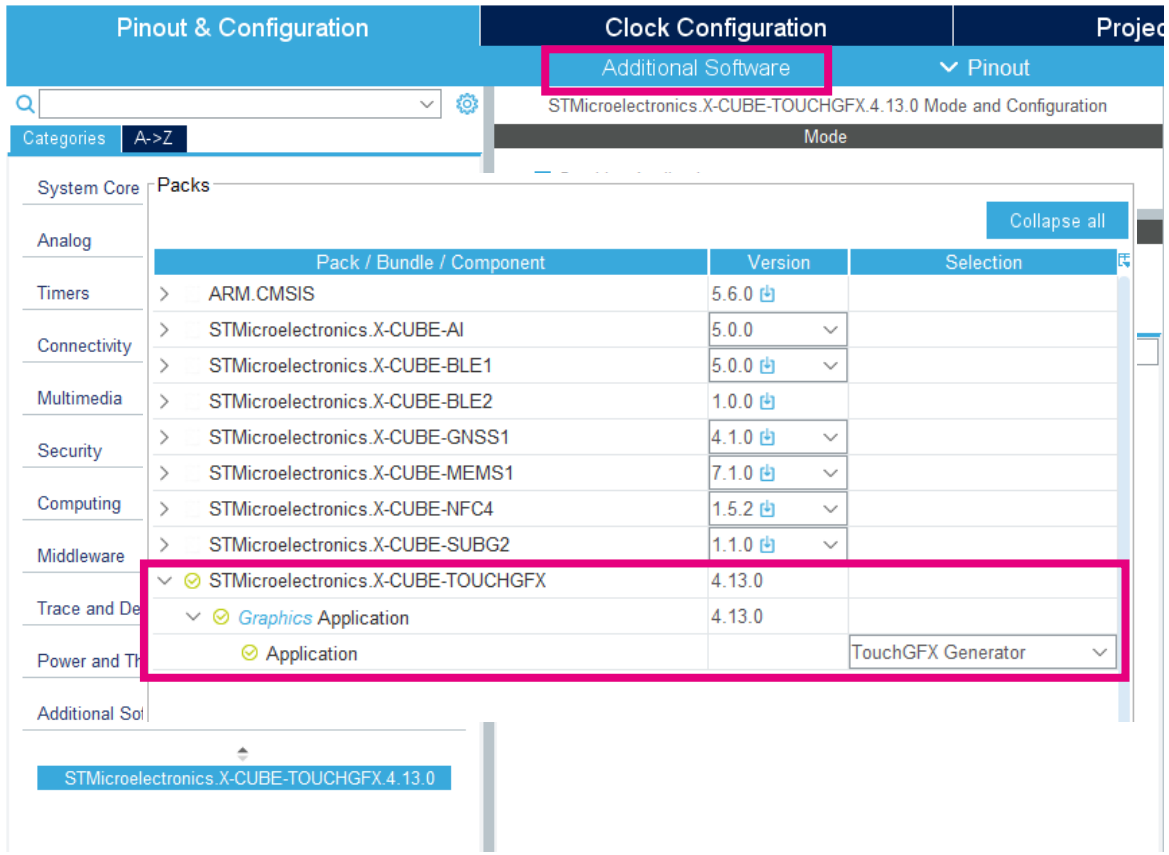
State-of-the-art graphic software and tools

STM32CubeMx plugin

Graphic HW and SW configuration and project generation



- **Smooth generation of TouchGFX project**
  - Helps create and configure your project on your custom hardware based on any STM32 MCU, making you ready to develop your UI application in TouchGFX Designer.
- **Seamless interoperability with STM32CubeMX**
  - When developing your project, you can now change project configuration in STM32CubeMX, which automatically updates the graphical settings in your project in TouchGFX Designer
- **IDE support**
  - You can select your preferred IDE (CubeIDE, IAR or Keil) in STM32CubeMX and the TouchGFX project files will be generated for your selected IDE.

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State-of-the-art graphic software and tools

X-CUBE-TOUCHGFX

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Graphic HW and SW configuration and project generation

TouchGFX PC tool

Graphic application development and simulation

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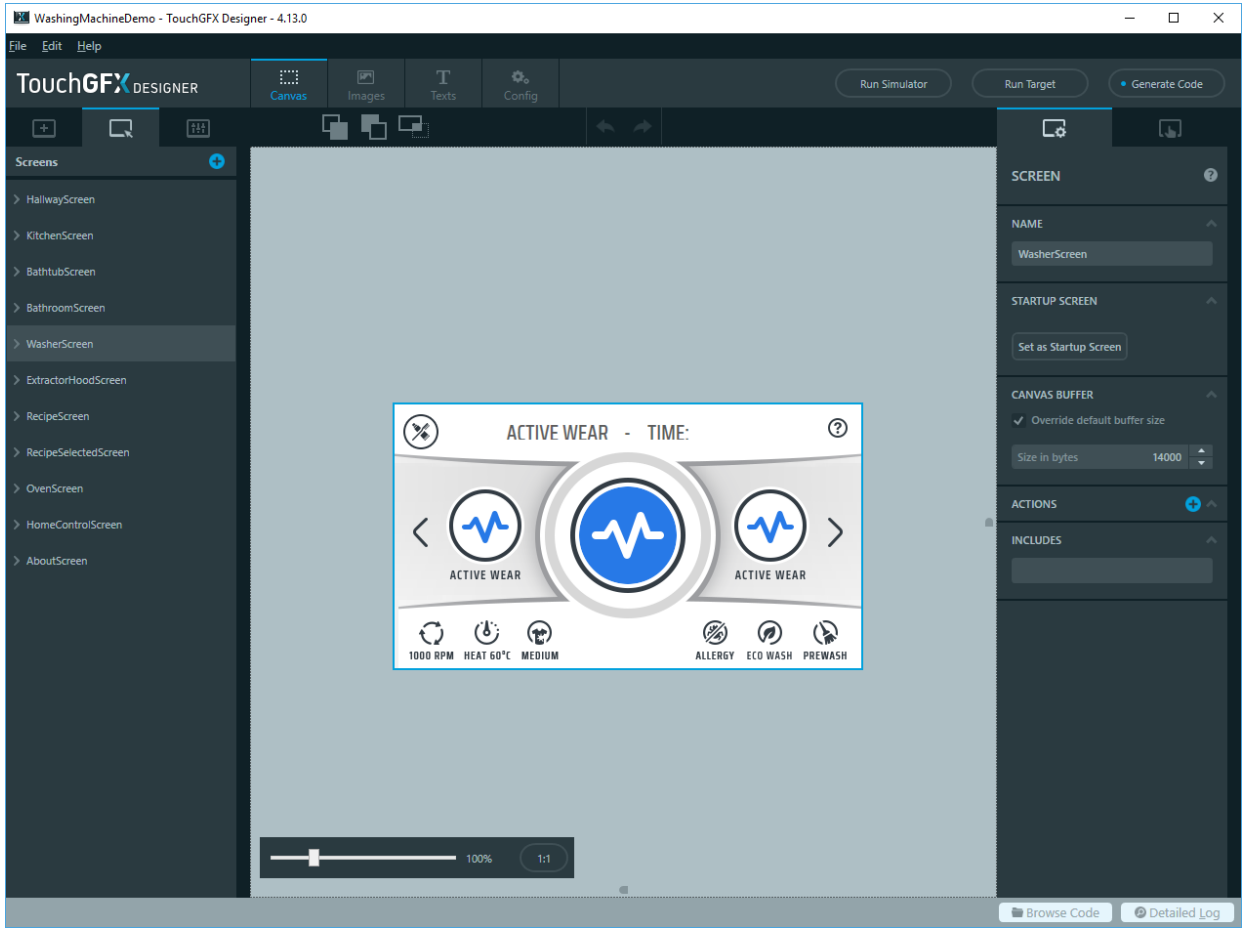
State-of-the-art graphic software and tools

TouchGFX PC tool

Graphic application development and simulation



TouchGFX Designer

From Idea to Prototype

A simple drag n' drop approach combined with ready-to-use high quality sample graphics enable you to create stunning prototypes in minutes with no need for advanced design and programming skills or TouchGFX knowledge.

From Prototype to Product

TouchGFX Designer will support you throughout your entire UI project by simplifying the process of creating the visual design and layout of your screens and custom controls. Your TouchGFX application code is automatically updated with the changes done in the Designer.

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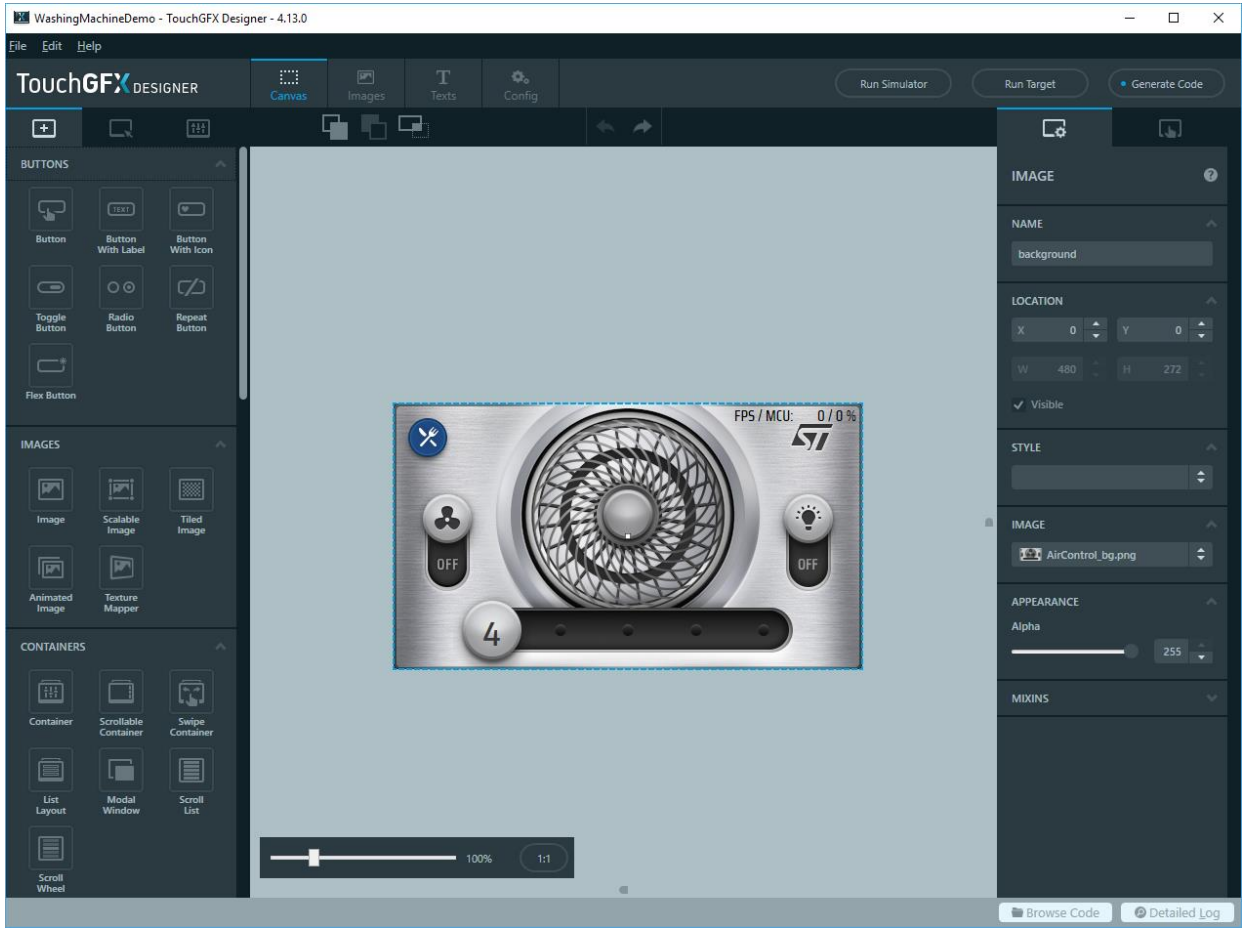
State-of-the-art graphic software and tools

TouchGFX PC tool

Graphic application development and simulation



TouchGFX Designer

- **Structure :** Easy creation of multiple screen contents and associated transitions.
- **Widgets :** Wide selection of customizable widgets like Swipe container, Scrollable list etc.
- **Interactions :** Dynamic interactions for the creation of user-friendly applications.
- **Custom Container :** Create custom reusable controls for your application.
- **Text Handling** Fonts and typographies specified and managed in on single place.
  And multiple alphabets and scripts, such as Korean, Latin, Cyrillic, Arabic, Chinese …

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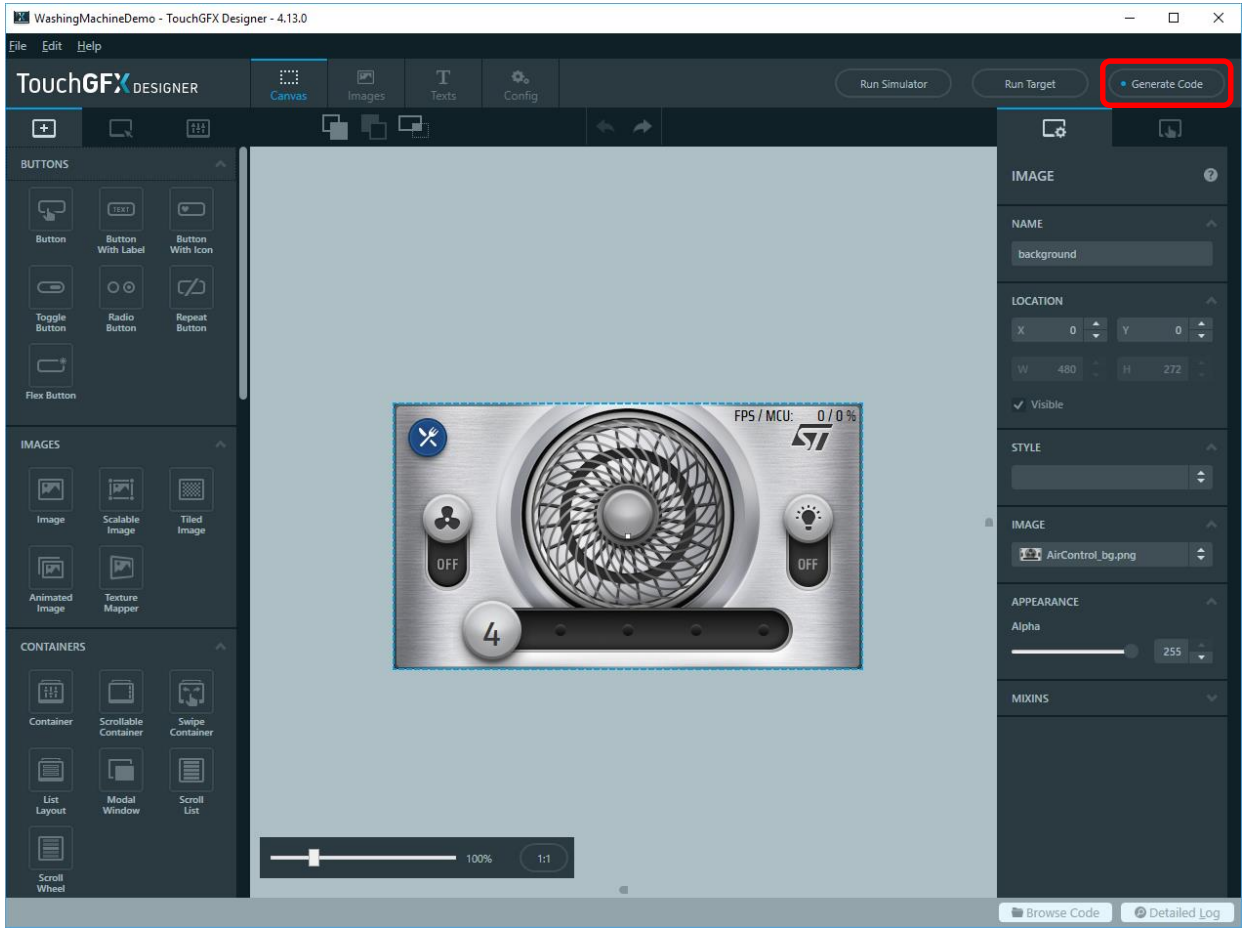
State-of-the-art graphic software and tools

TouchGFX PC tool

Graphic application development and simulation



TouchGFX Designer

- **Code Generation :**
  - Generate and maintains performant C++ code.
  - Tool-generated code entirely separated from user code
  - All types of code extensions possible for unique animations as well as system interconnections
  - Support of several integrated development environment such as STM32CubeIDE, IAR, KEIL and GCC-based IDEs.

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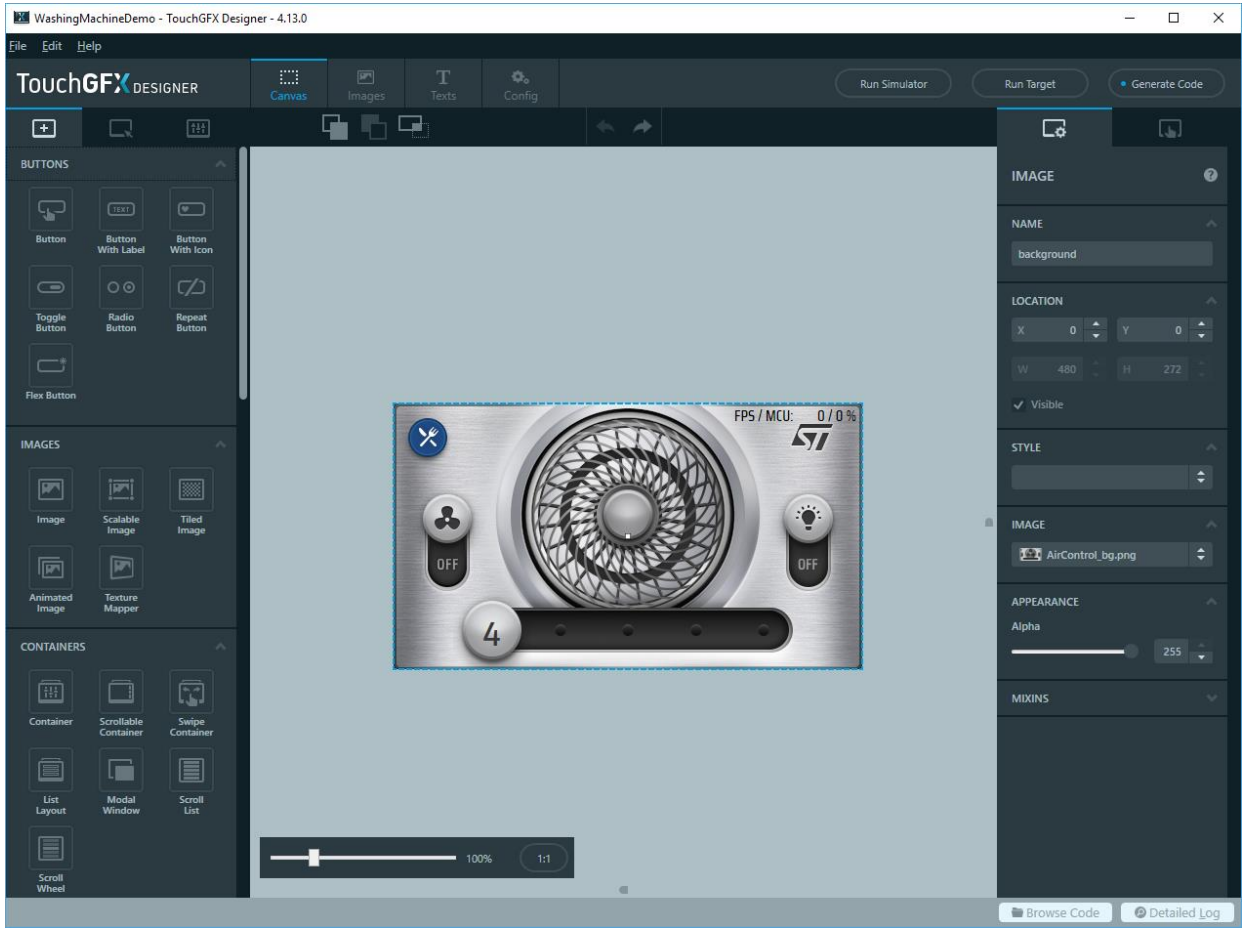
State-of-the-art graphic software and tools

TouchGFX PC tool

Graphic application development and simulation



TouchGFX Designer

PC Simulator for easy UI development

TouchGFX Designer show your UI project through PC simulator.

It will provide efficiency and give useful in order to make UI application you desired.

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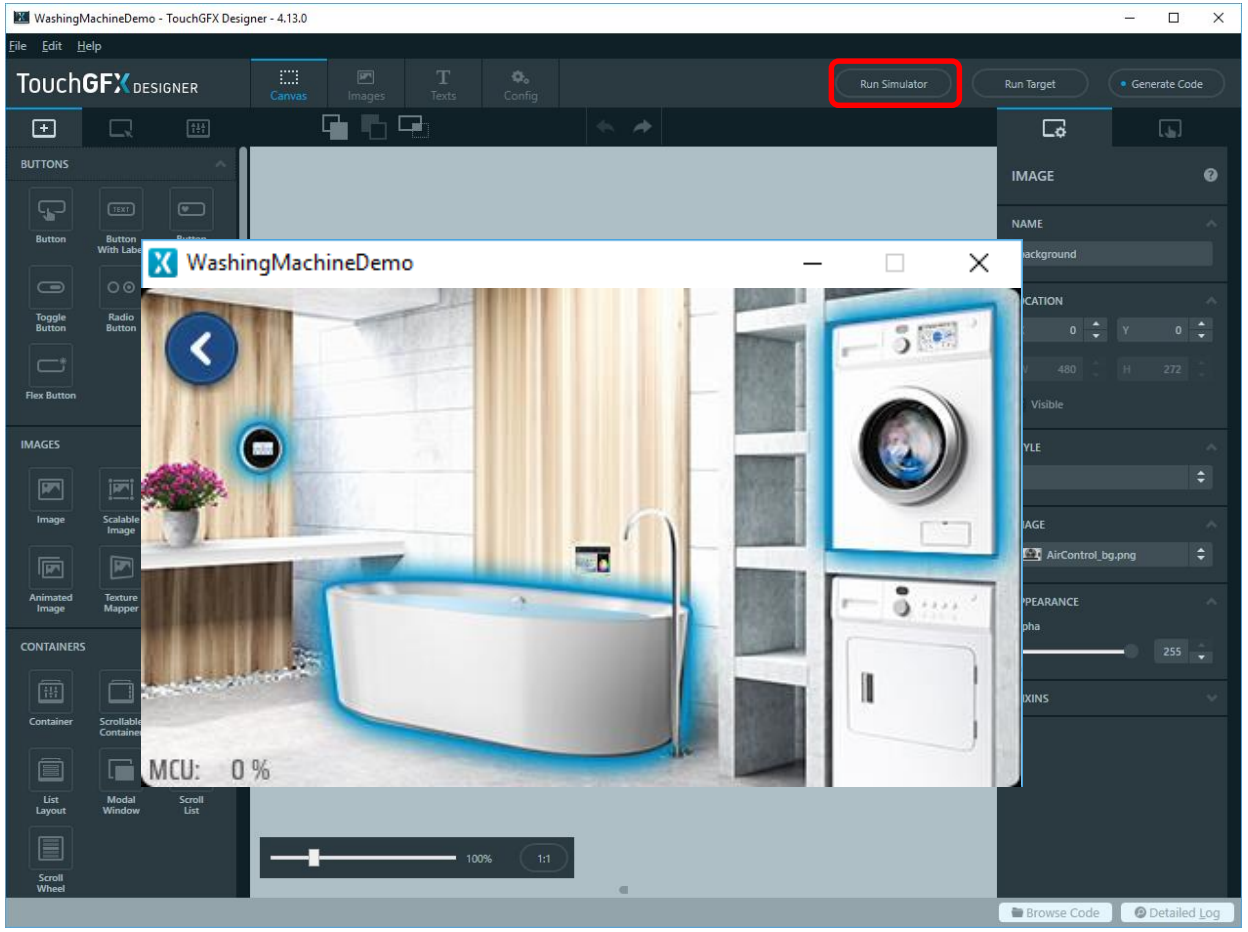
State-of-the-art graphic software and tools

TouchGFX PC tool

Graphic application development and simulation



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TouchGFX embedded library

Optimized and Hardware accelerated graphic library

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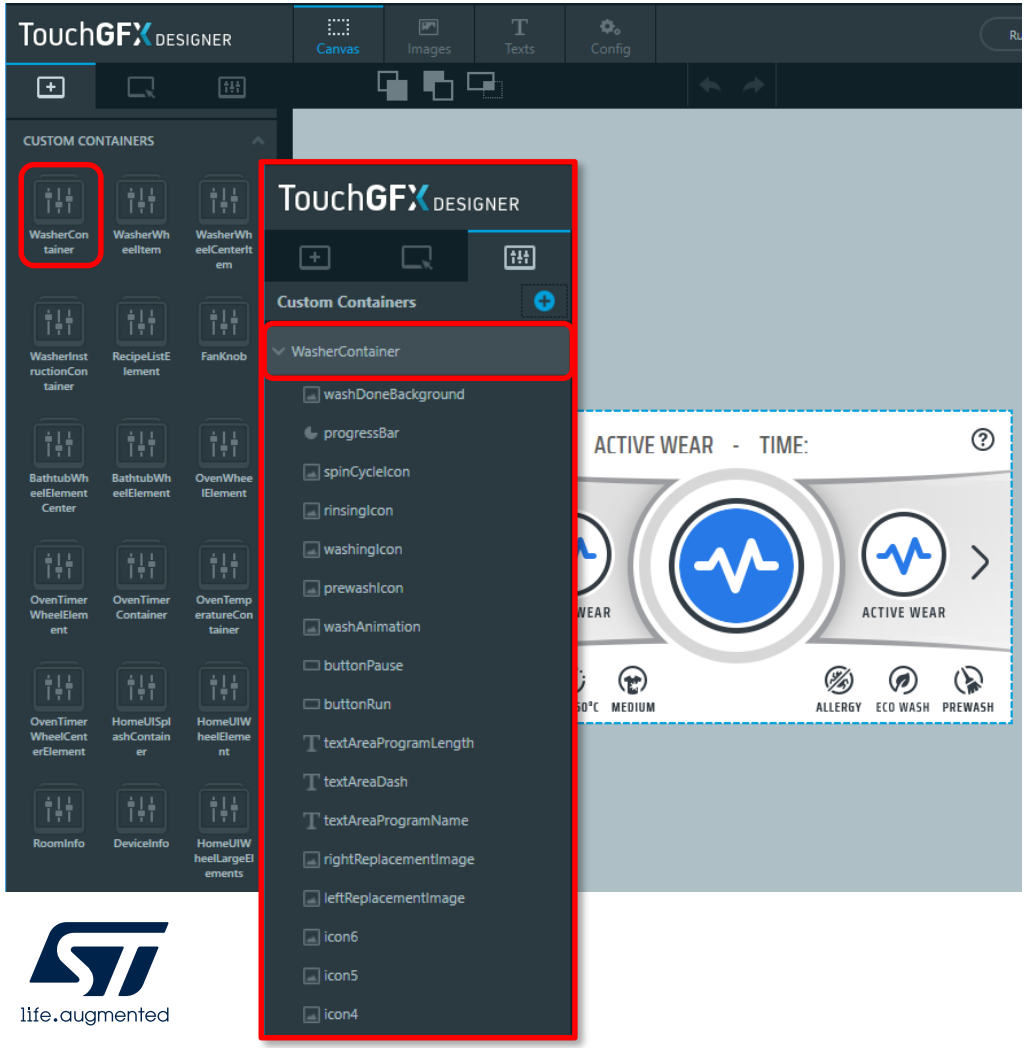
State-of-the-art graphic software and tools

TouchGFX embedded library

Optimized and Hardware accelerated graphic library



- **Custom Containers**
  - Complexed object

    Contains other existing widget and combines the visual appearance and behaviors of these widgets.
  - High drawing performance

    It will utilize the underlying drawing mechanisms of TouchGFX and will determine which parts of a container and the children needs to be redrawn automatically.

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State-of-the-art graphic software and tools

TouchGFX embedded library

Optimized and Hardware accelerated graphic library

- **Caching Bitmaps**
  - The dedicated RAM buffer where bitmaps can be stored (or cached) by the application.
  - Use the RAM cache as pixel source when drawing the bitmap.
  - Anticipate to increase the performance of drawing UI.
    - Generally, reading data from RAM is often faster than reading from flash (e.g. when using the Texturemapper because it use non-linear memory access)
  - Useful when need to store your bitmaps on slow external storage like an USB-disk or SD card.
  - **Bitmap Cache Configuration**

BoardConfiguration.cpp (extract) – Pass the start address and size of the buffer

```
/* Place cache start address in SDRAM at address 0xC0008000; */
uint16_t* cacheStartAddr = (uint16_t*)0xC0008000;
uint32_t cacheSize = 0x300000; //3 MB, as example
HAL& hal = touchgfx_generic_init<STM32F4HAL>(dma, display, tc, DISPLAY_WIDTH, DISPLAY_HEIGHT, cacheStartAddr, cacheSize);
```

BoardConfiguration.cpp (extract) – Declare an array and just pass the address and size of the array

```
/* Define an array for the bimap cache */
uint16_t cache[128*1024]; // 128 KB cache
HAL& hal = touchgfx_generic_init<STM32F4HAL>(dma, display, tc, DISPLAY_WIDTH, DISPLAY_HEIGHT, &cache, sizeof(cache));
```

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State-of-the-art graphic software and tools

TouchGFX embedded library

Optimized and Hardware accelerated graphic library

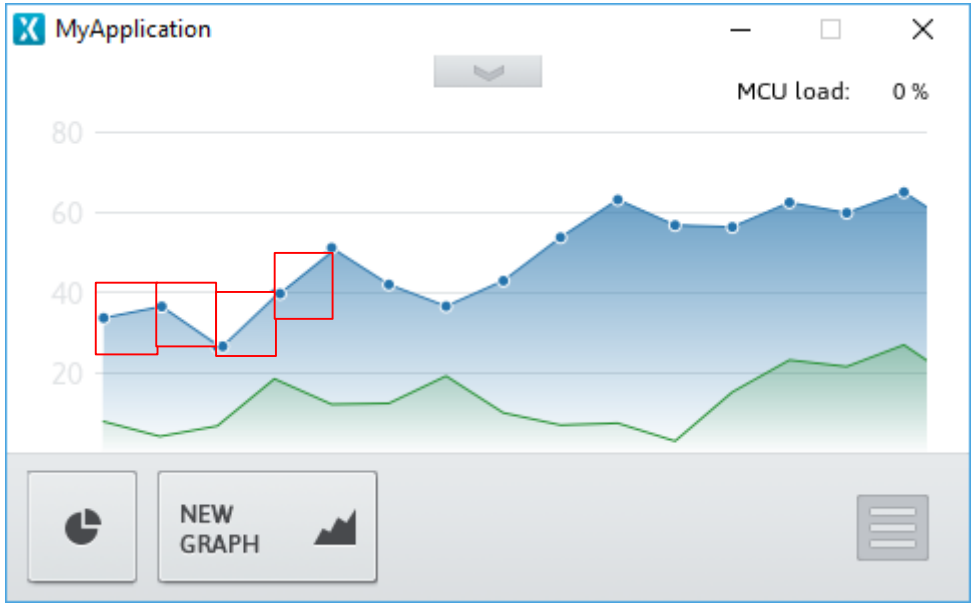
- **Partial FrameBuffer**
  - Improve your UIs with less MCU and Memory resources
  - Create an exciting and impactful entry-level GUI.
  - Intuitive and simple animations
  - Configurable framebuffer size starting from 6KBytes
  - Total RAM needs for UI starting from 12KBytes (Framebuffer + TouchGFX framework)
  - Useable on any STM32 including Cortex-M0+ cores
  - Display interface : DSI, SPI, Parallel/8080/FMC
  - Limitation :
    - Partial display update limits UI performance like Texturemapper.
    - Require Display holding display controller and GRAM

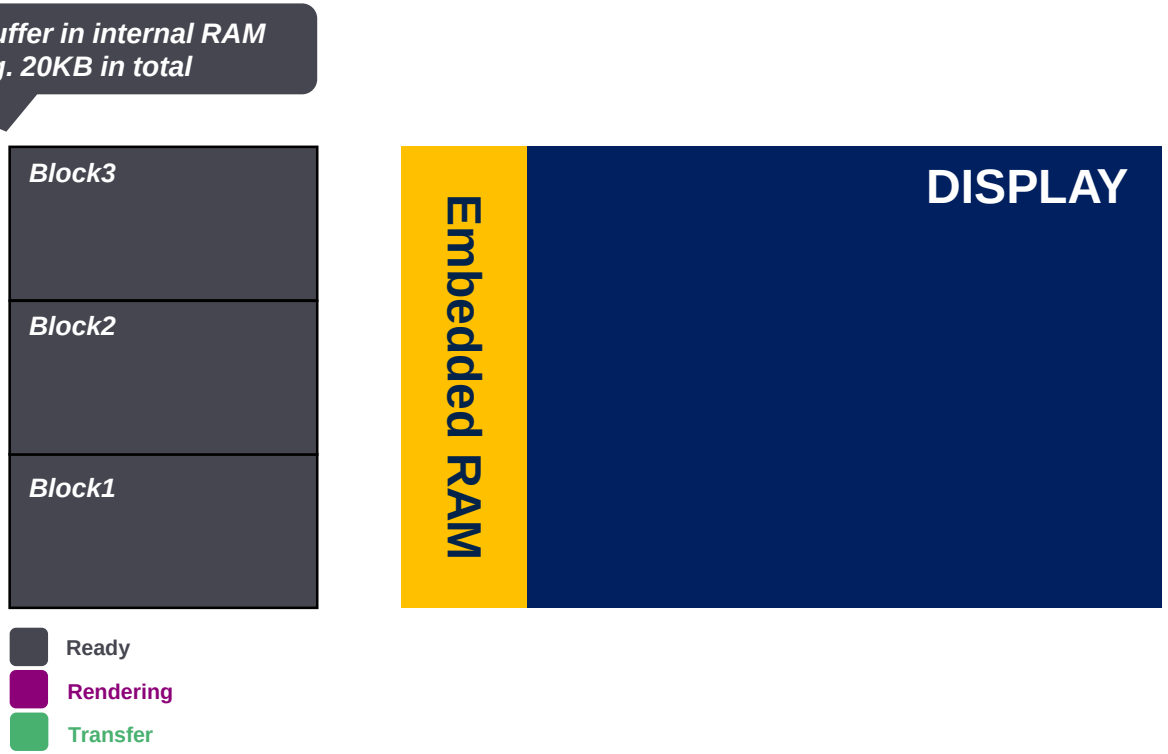
State-of-the-art graphic software and tools

TouchGFX embedded library

Optimized and Hardware accelerated graphic library

- **Partial FrameBuffer**





TouchGFX renders the parts of the View that needs to be updated into many small framebuffer blocks.
Whenever a block is rendered it can be transferred to the display, and the block memory can be reused for rendering one of the next parts.

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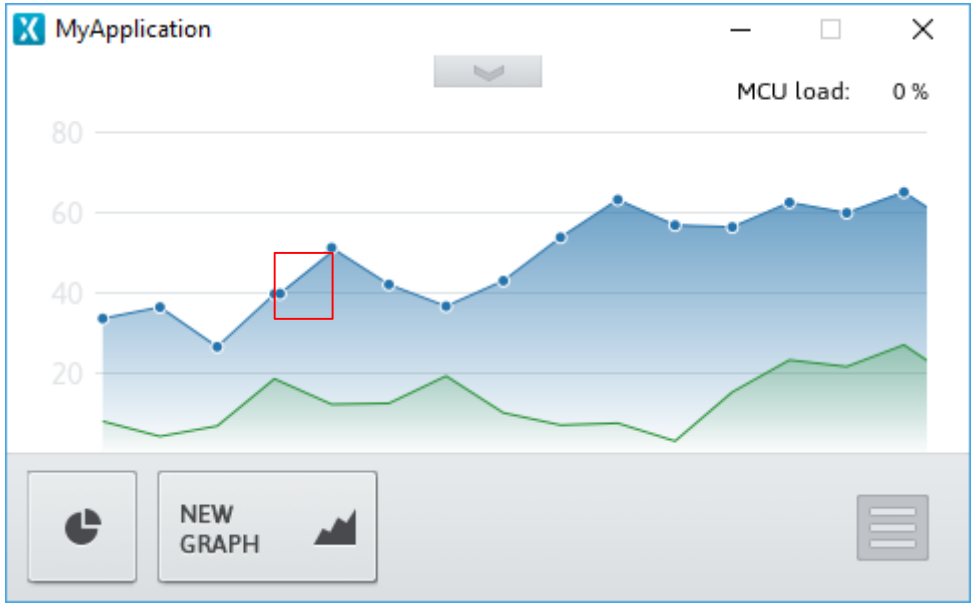
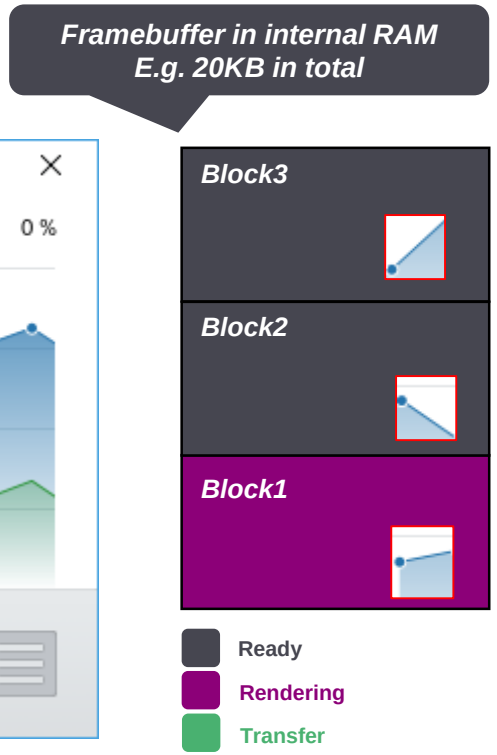
State-of-the-art graphic software and tools

TouchGFX embedded library

Optimized and Hardware accelerated graphic library

- **Partial FrameBuffer**





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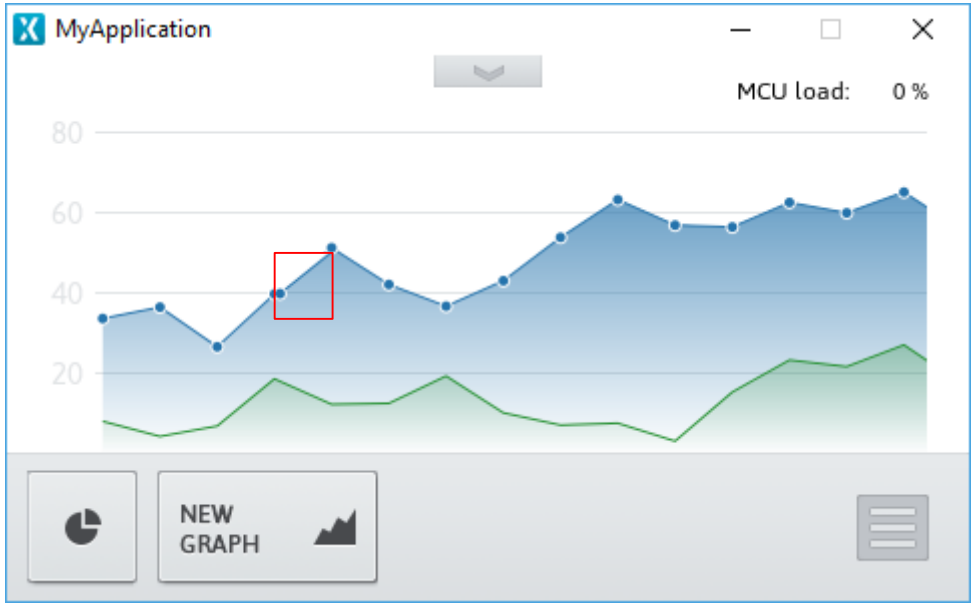

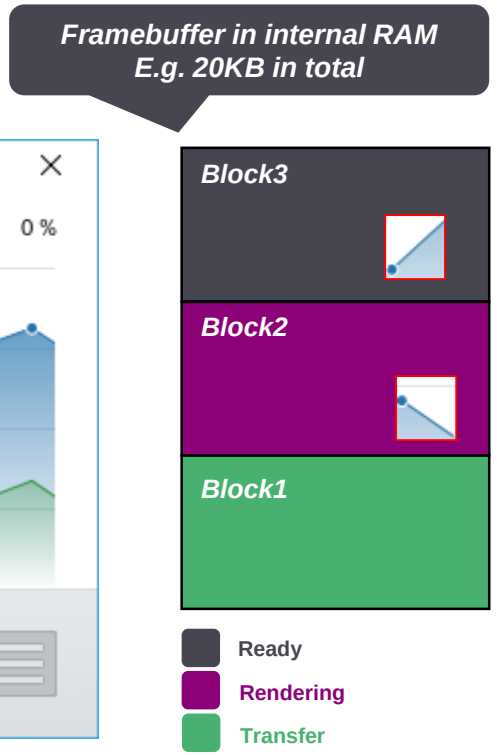

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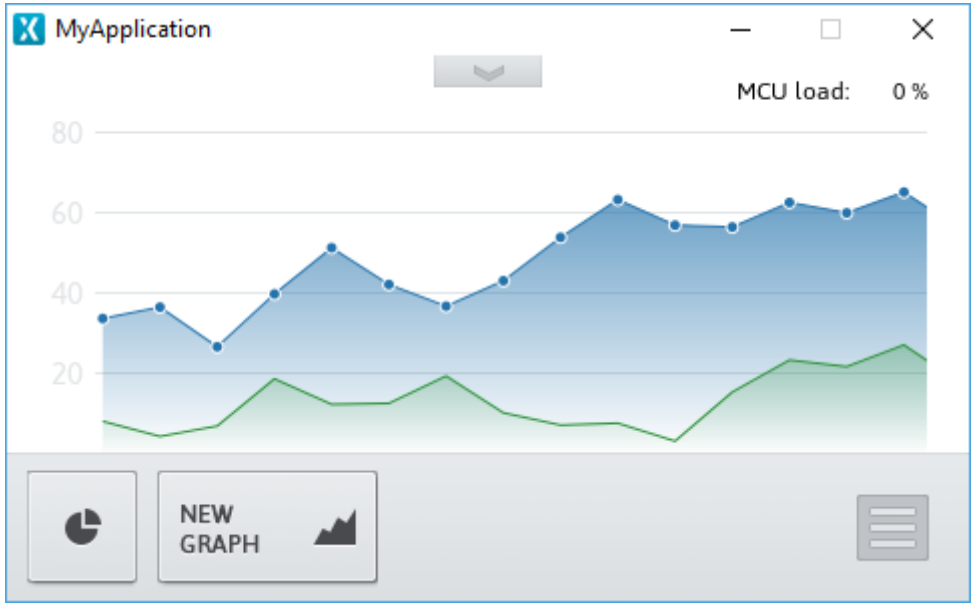

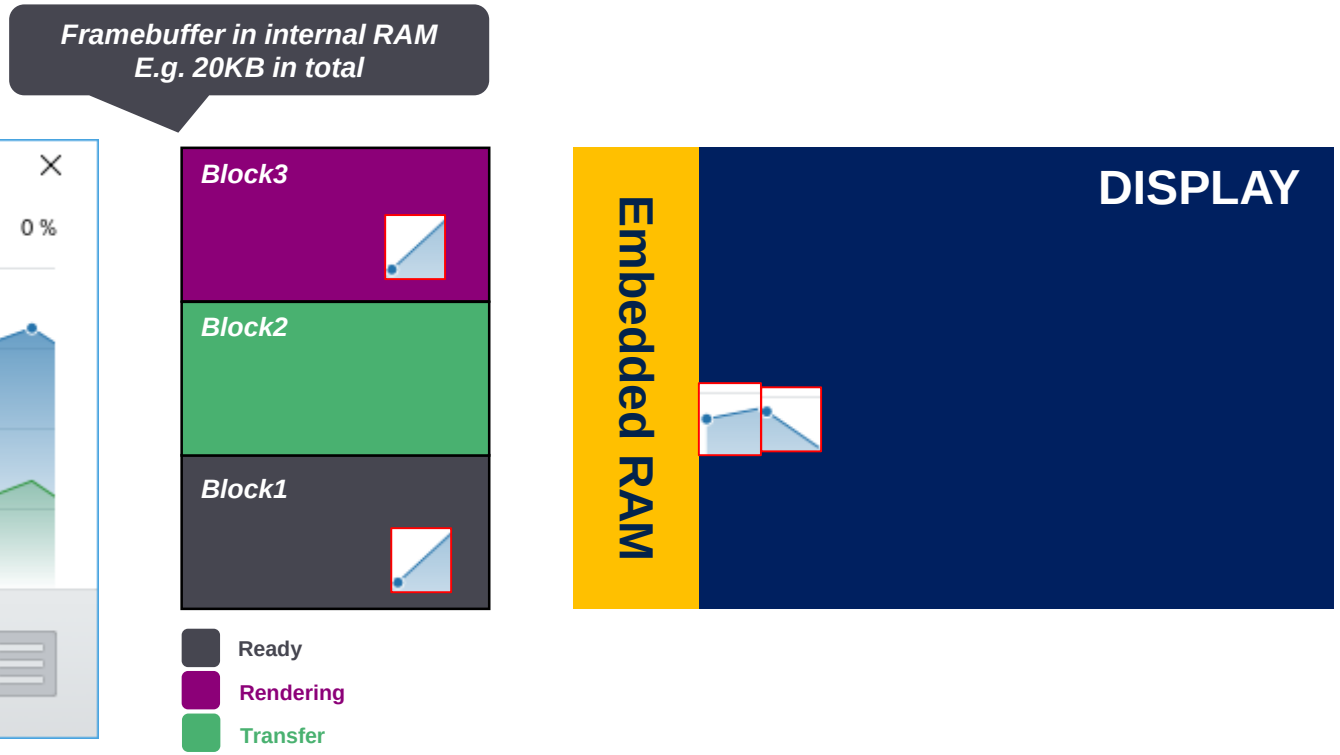

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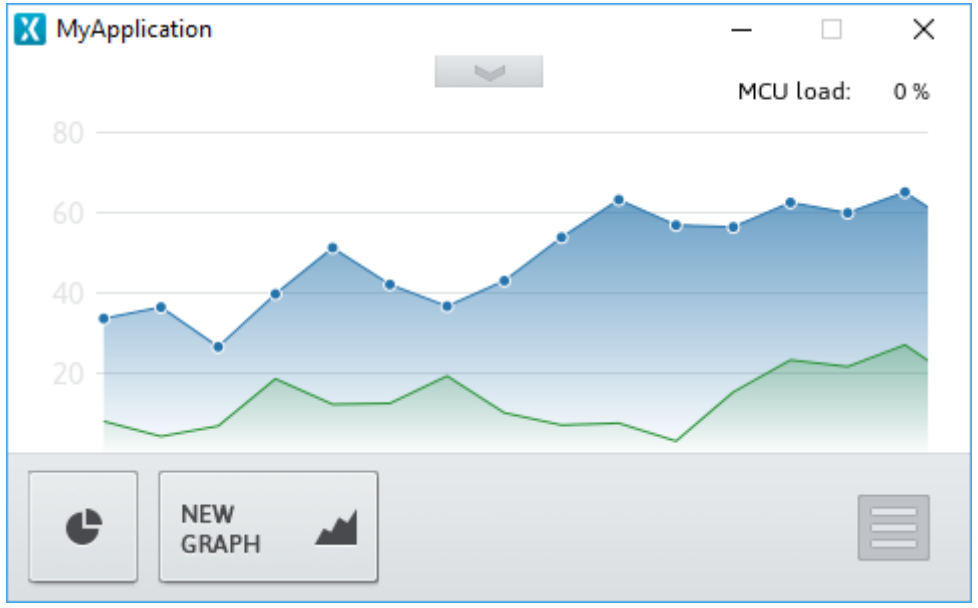

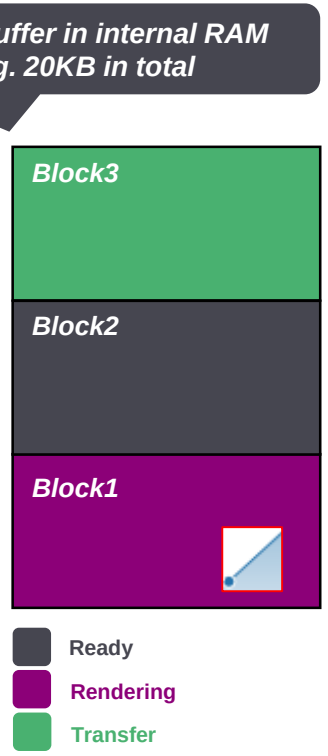

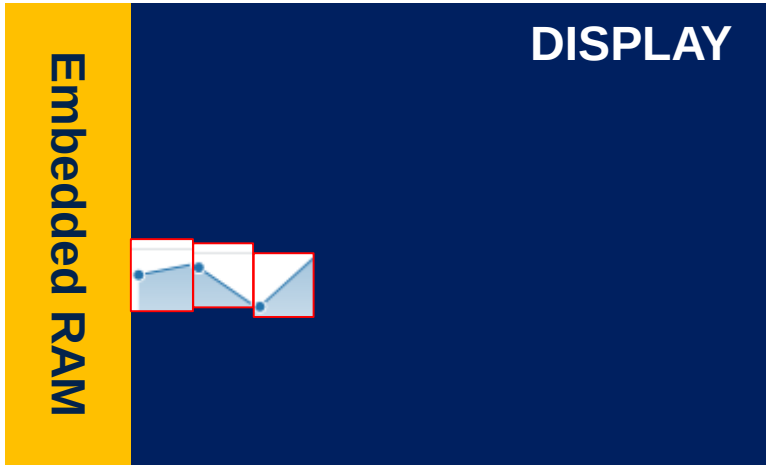

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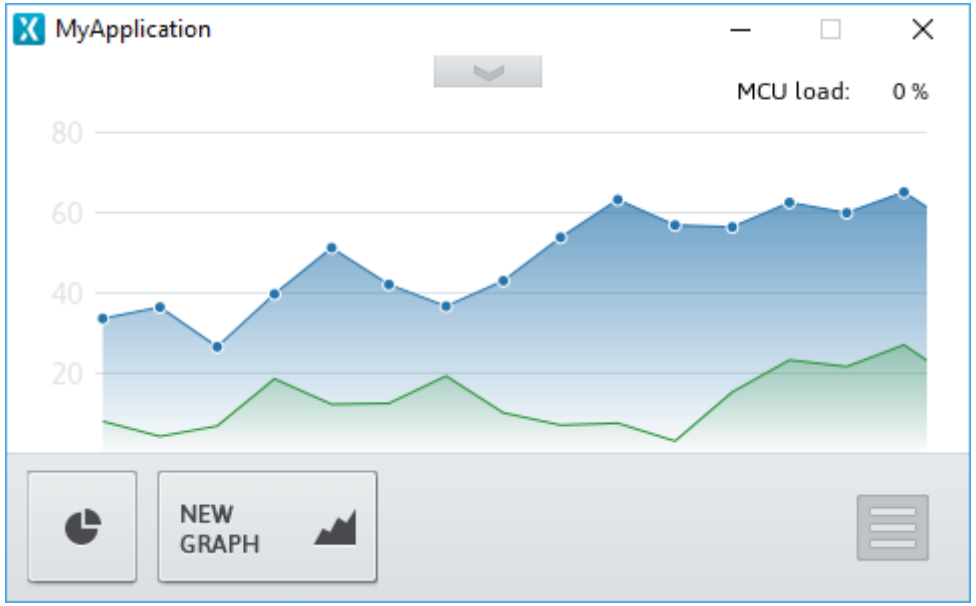
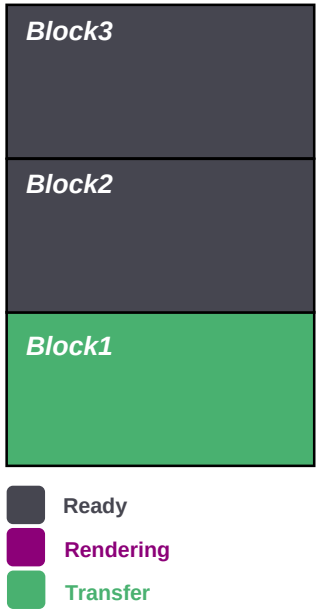
State-of-the-art graphic software and tools

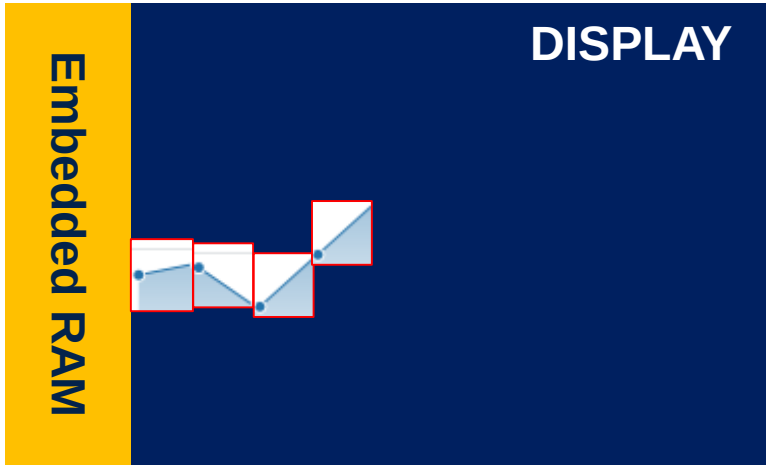
TouchGFX embedded library

Optimized and Hardware accelerated graphic library

- **Partial FrameBuffer**







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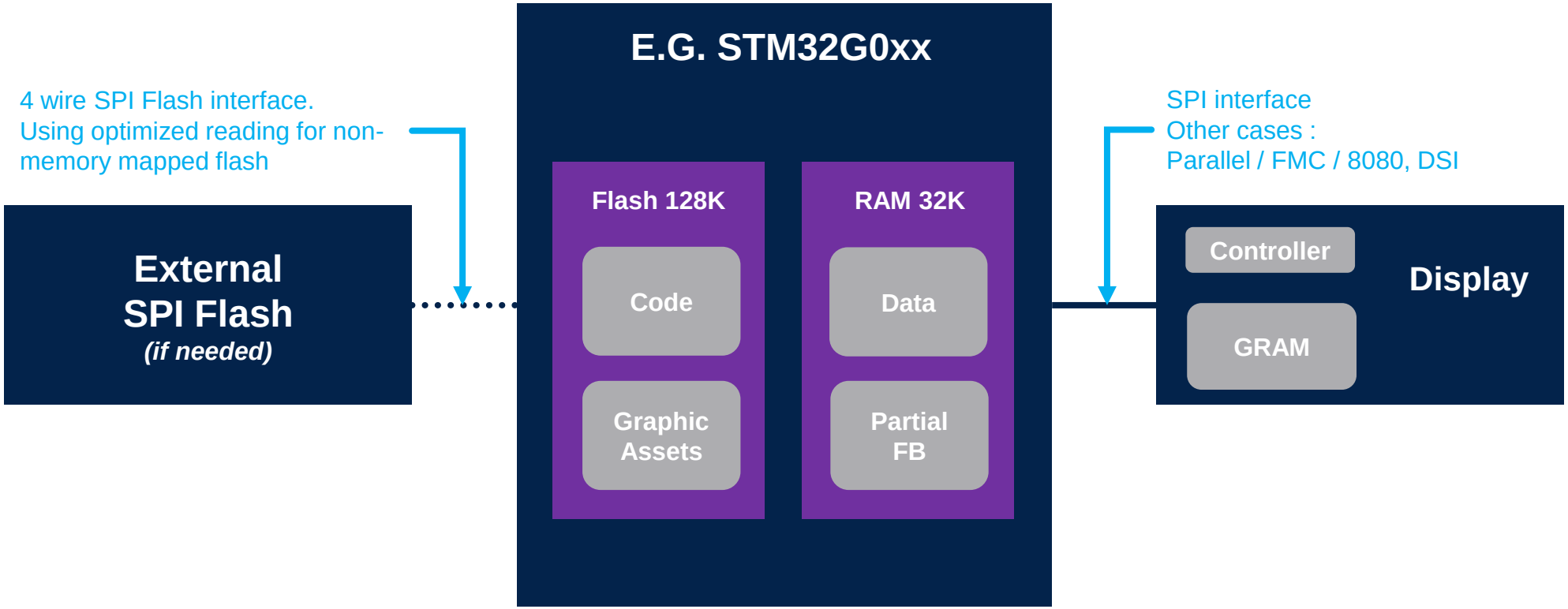
State-of-the-art graphic software and tools

TouchGFX embedded library

Optimized and Hardware accelerated graphic library

- UI memory setup on STM32G0
  Using Partial Framebuffer and SPI flash



State-of-the-art graphic software and tools

TouchGFX embedded library

Optimized and Hardware accelerated graphic library

- VISION for STM32 Entry-Level Solution

- Replace traditional segment display with modern graphical display solutions
- Smartphone-inspired User Experience
- Low Power / Long Battery Life
- BOM cost remains at the same level

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Reference Designs and Worldwide Support

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Reference Designs

32F429IDISCO
STM32F429
320x240
QVGA LCD
64 MBits SDRAM

32F469IDISCO
STM32F469
800x480
WVGA LCD
128 MBits SDRAM
128 Mbit QSPI Flash
Arduino Uno

32F769IDISCO
STM32F769
800x480
WVGA LCD
128 Mbits SDRAM
512 Mbit QSPI Flash
Arduino Uno

32L4R9IDISCOVERY
STM32L4R9
390x390
AMOLED
16 Mbits PSRAM
512 Mbit OctoSPI Flash
Arduino Uno

32F750GDISCO
STM32F750
480x272
WQVGA LCD
64 MBits SDRAM
128 Mbit QSPI Flash
Arduino Uno

STM32H747IDISCOVERY
STM32H747XIH6U
800*480
WVGA LCD
256 Mbit SDRAM
2*512 Mbit QSPI NOR Flash
Arduino Uno

STM32H750BDISCOVERY
STM32H750
480*272
WQVGA LCD
128 Mbit SDRAM
2*512 Mbit QSPI NOR Flash
4-Gbyte on-board eMMC
Arduino Uno

STM32H7B3I-DK
STM32H7B3
480*272
WQVGA LCD
128 Mbit SDRAM
512 Mbit OctoSPI Flash
Arduino Uno

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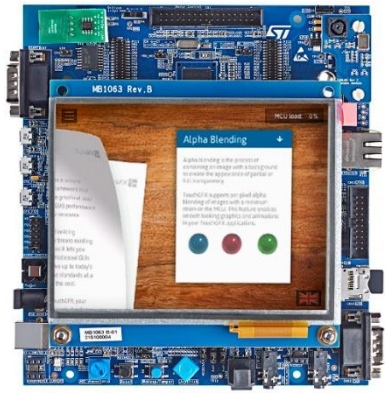
Reference Designs

STM32429I-EVAL
- STM32F429
- 480x272 WQVGA LCD
- 256 MB SDRAM
- 128 MB NOR Flash

STM32439I-EVAL
- STM32F439
- 640x480 VGA LCD
- 256 MB SDRAM
- 128 MB NOR Flash

STM32469I-EVAL
- STM32F469
- 800x480 WVGA LCD
- 256 MB SDRAM
- 128 MB NOR Flash
- 512 MB QSPI Flash



STM32756G-EVAL
- STM32F756
- 640x480 VGA LCD
- 256 MB SDRAM
- 128 MB NOR Flash
- 512 MB QSPI Flash

STM32769G-EVAL
- STM32F769
- 800x480 WVGA LCD
- 256 MB SDRAM
- 128 MB NOR Flash
- 512 MB QSPI Flash

STM32743I-EVAL
- STM32H743
- 800x480 WVGA LCD
- 256 MB SDRAM
- 128 MB NOR Flash
- 512 MB QSPI Flash

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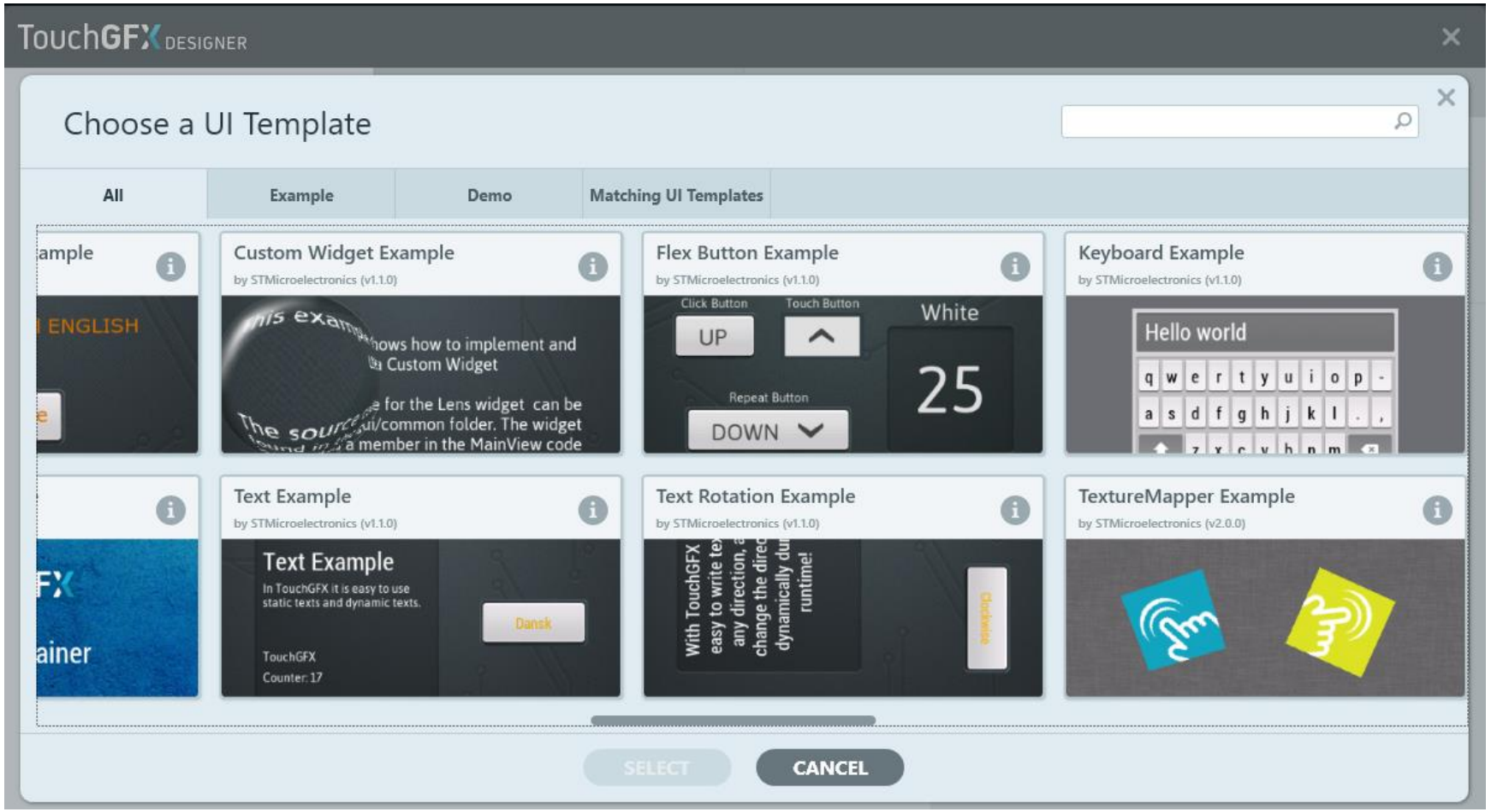
Reference Designs

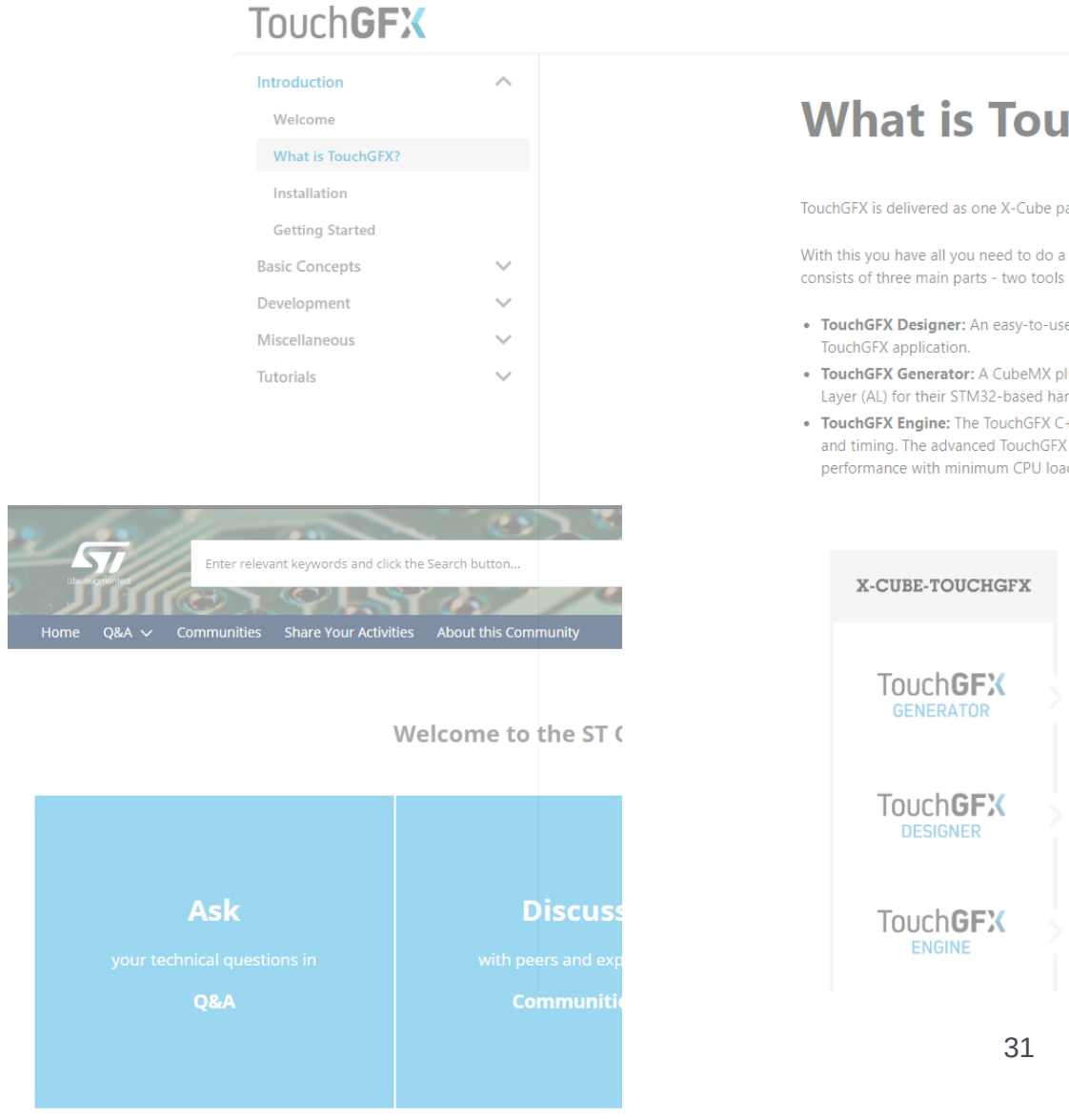


TouchGFX Designer – Examples & Demo

Worldwide Support

- **Documentation**
  - TouchGFX Documentation
    https://support.touchgfx.com

- **Q&A**
  - ST Community
    https://community.st.com



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LIVE Demonstration

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Objective

- How to configure your target on CubeMX
  - Configuration of STM32H7B3I-DK
    (Clock, OSPI NOR, DMA2D, LTDC …)
- 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
  - Implement a simple digital clock
- What is “Model – View – Presenter” design pattern
  - User LED controlled by widget or hardware button

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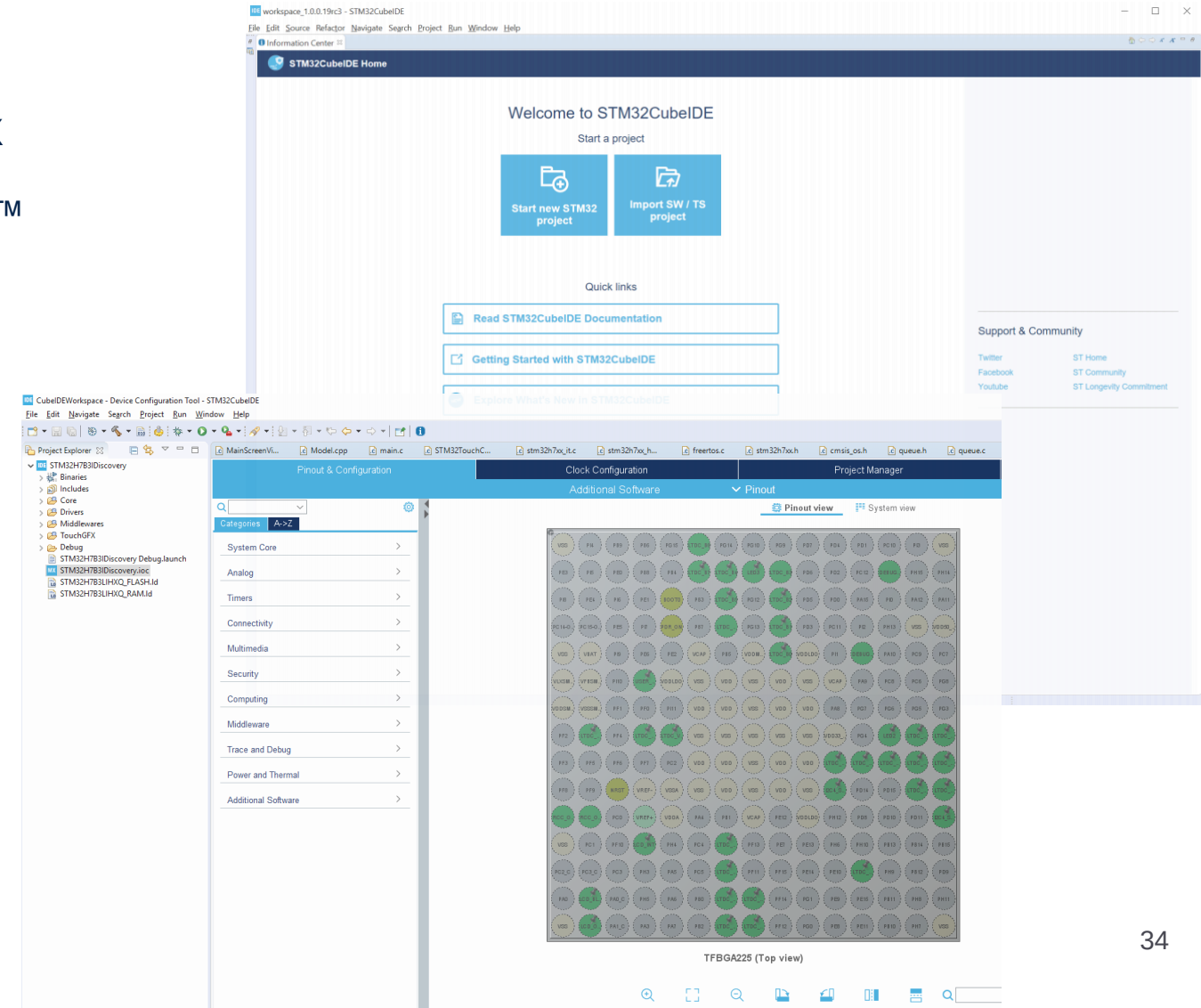
S/W Tools

- **STM32CubeIDE**
  - STM32 dedicated IDE integrated with STM32CubeMX
  - 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
    www.st.com/stm32cubeide



S/W Tools

- **TouchGFX Designer**
  - Drag-and-Drop-based graphic-building PC tool
  - GUI development
  - WYSIWYG simulator
  - Generate and maintain performant C++ code
  - Include various examples and demos
  - Support of several IDEs (IAR, KEIL, GCC-based)
  - Download
    https://www.st.com/en/development-tools/touchgfxdesigner.html

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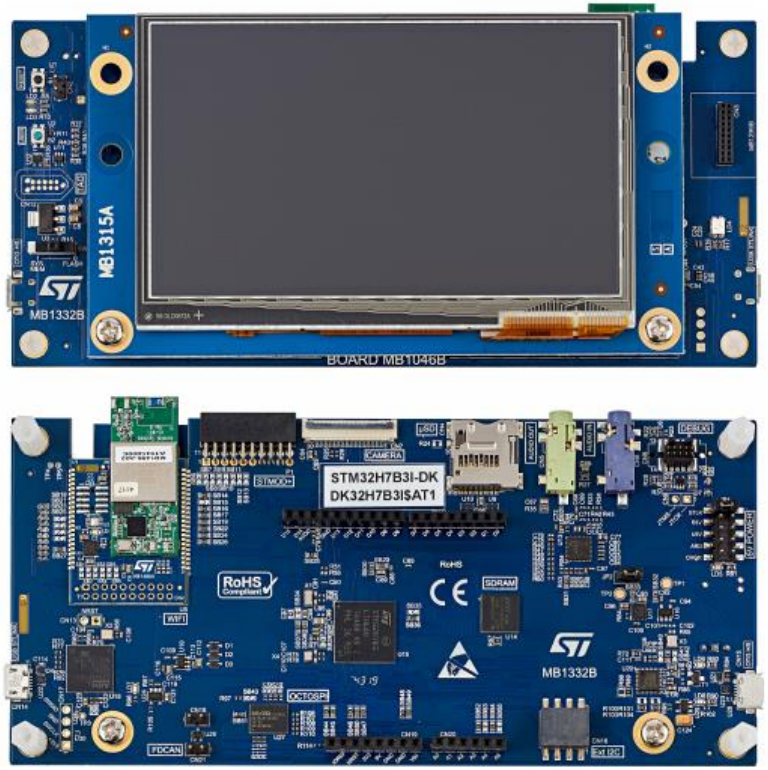
H/W Tools

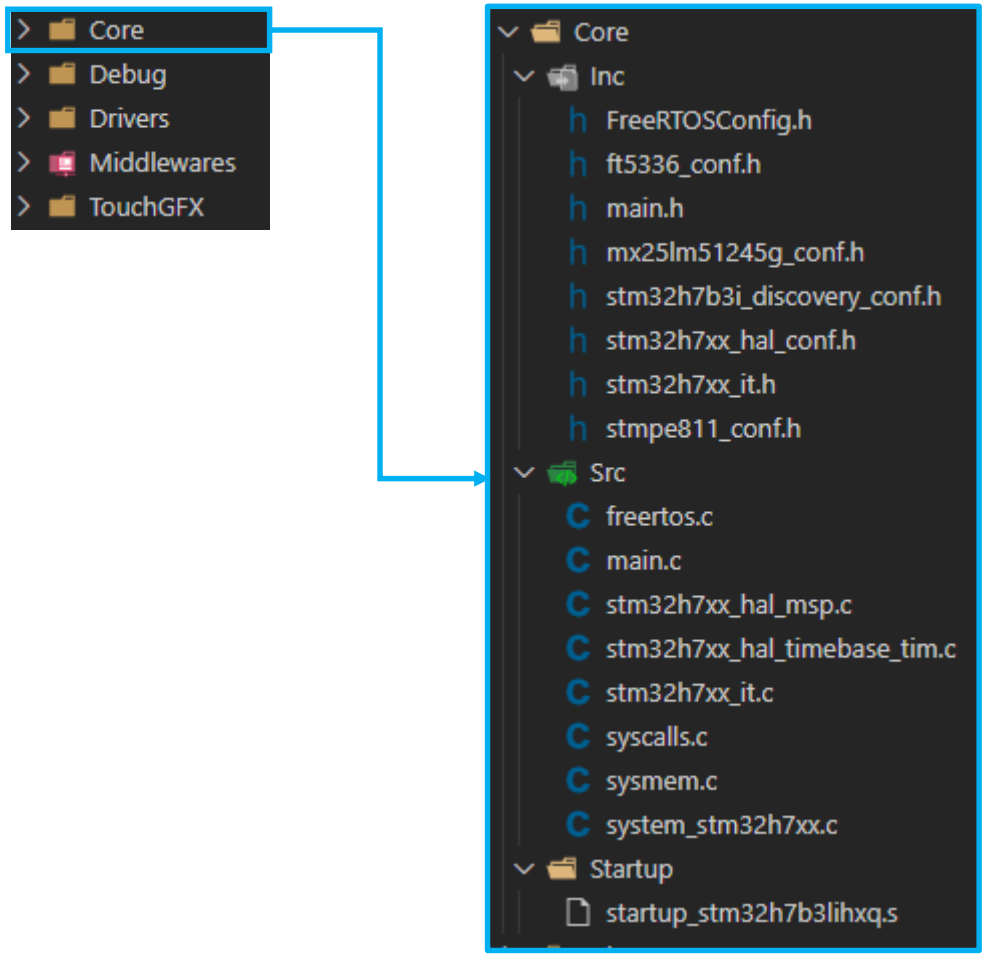
- **STM32H7B3I-DK**
  - STM32H7B3LI ARM® Cortex-M7
  - 2 MB Flash memory / 1.4MB RAM
  - 4.3" (480 x 272 pixel) TFT color LCD including a capacitive touch panel with RGB interface
  - Wi-Fi ® module compliant with 802.11 b/g/n
  - USB OTG HS
  - Audio codec
  - 512-Mbit Octo-SPI NOR Flash memory
  - 128-Mbit SDRAM
  - More information …
    https://www.st.com/content/st_com/en/products/evaluation-tools/product-evaluation-tools/mcu-mpu-eval-tools/stm32-mcu-mpu-eval-tools/stm32-discovery-kits/stm32h7b3i-dk.html



Live Demo … (STM32CubeIDE)

Play [**Webinar-CubeIDEConfiguration.mp4**]

TouchGFX Project Organization



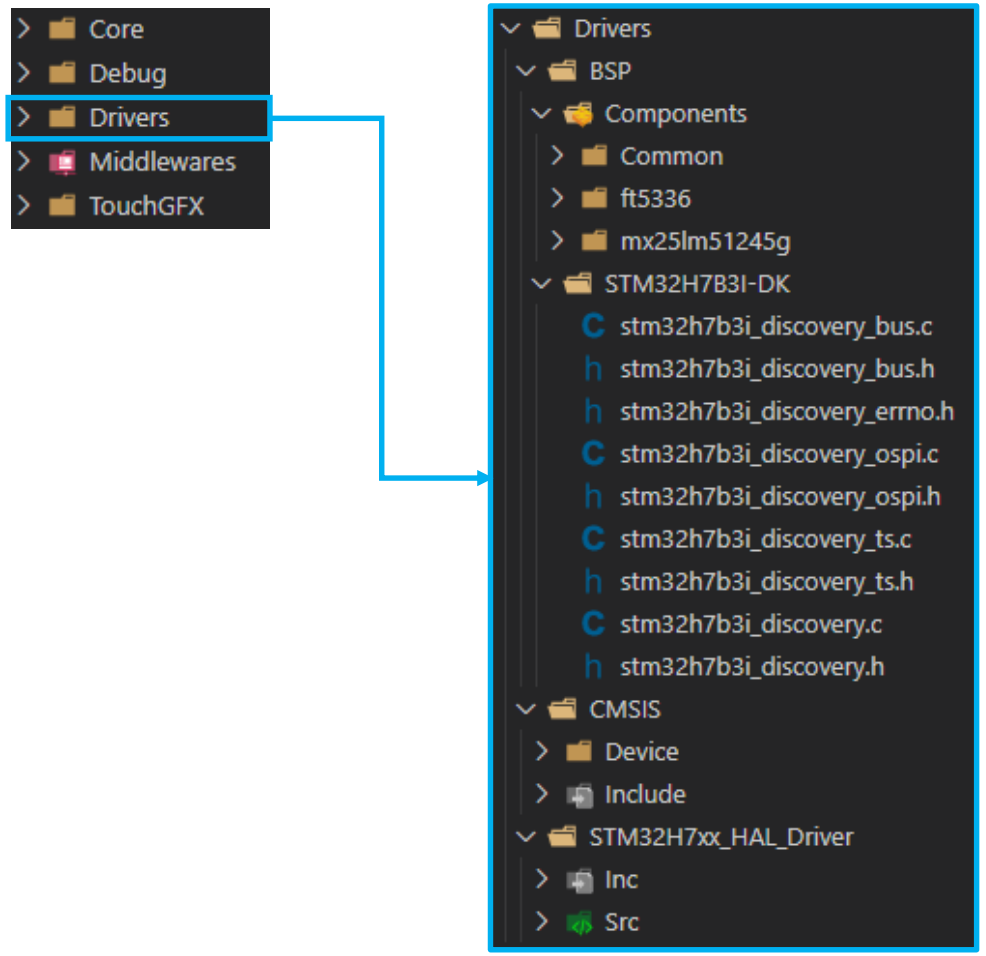
../Core

Contain CubeMX generated files for middleware, peripheral and GPIO initialization including main source and header files. Several header files related to configuration of STM32H7B3I-DK are also included.

../Startup

STM32H7B3LI Startup file for GCC based toolchain

TouchGFX Project Organization



../BSP/Components

Those files provide a set of functions needed to manage each components embedded on STM32H7B3I-DK (IO Expender and Touch, OctoSPI NOR Flash …)

../BSP/STM32H7B3I-DK

Those files provide a set of firmware functions to manage the external device available on STM32H7B3I-DK board

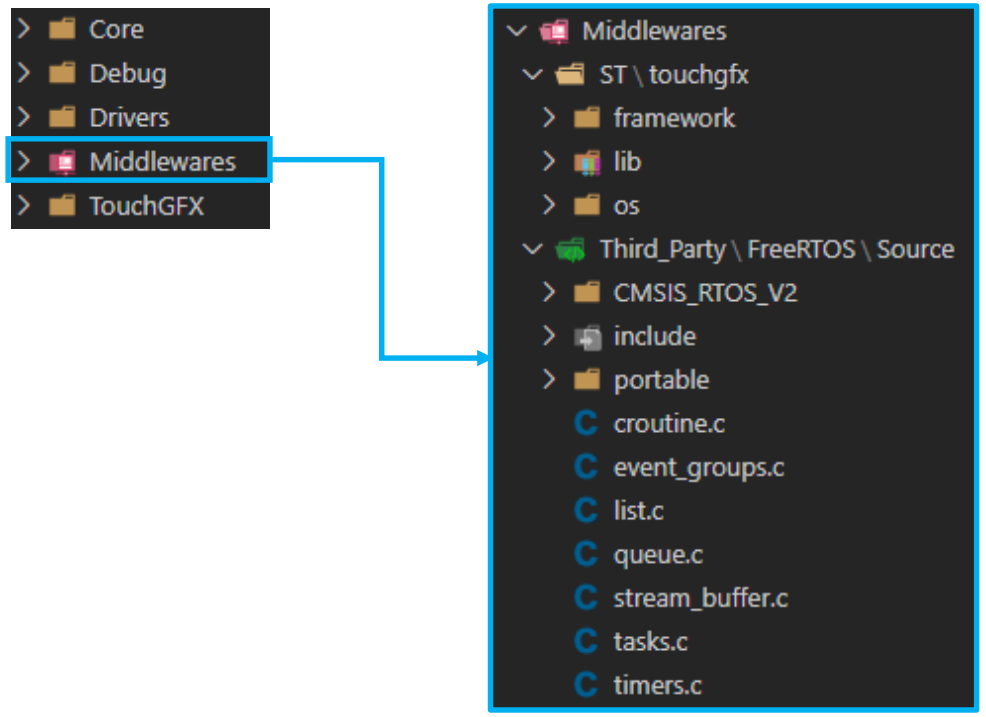
../BSP/CMSIS

Cortex Microcontroller Software Interface Standard, a vendor-independent hardware abstraction layer

../STM32H7XX_HAL_Driver

STM32Cube Hardware abstraction layer for STM32H7

TouchGFX Project Organization



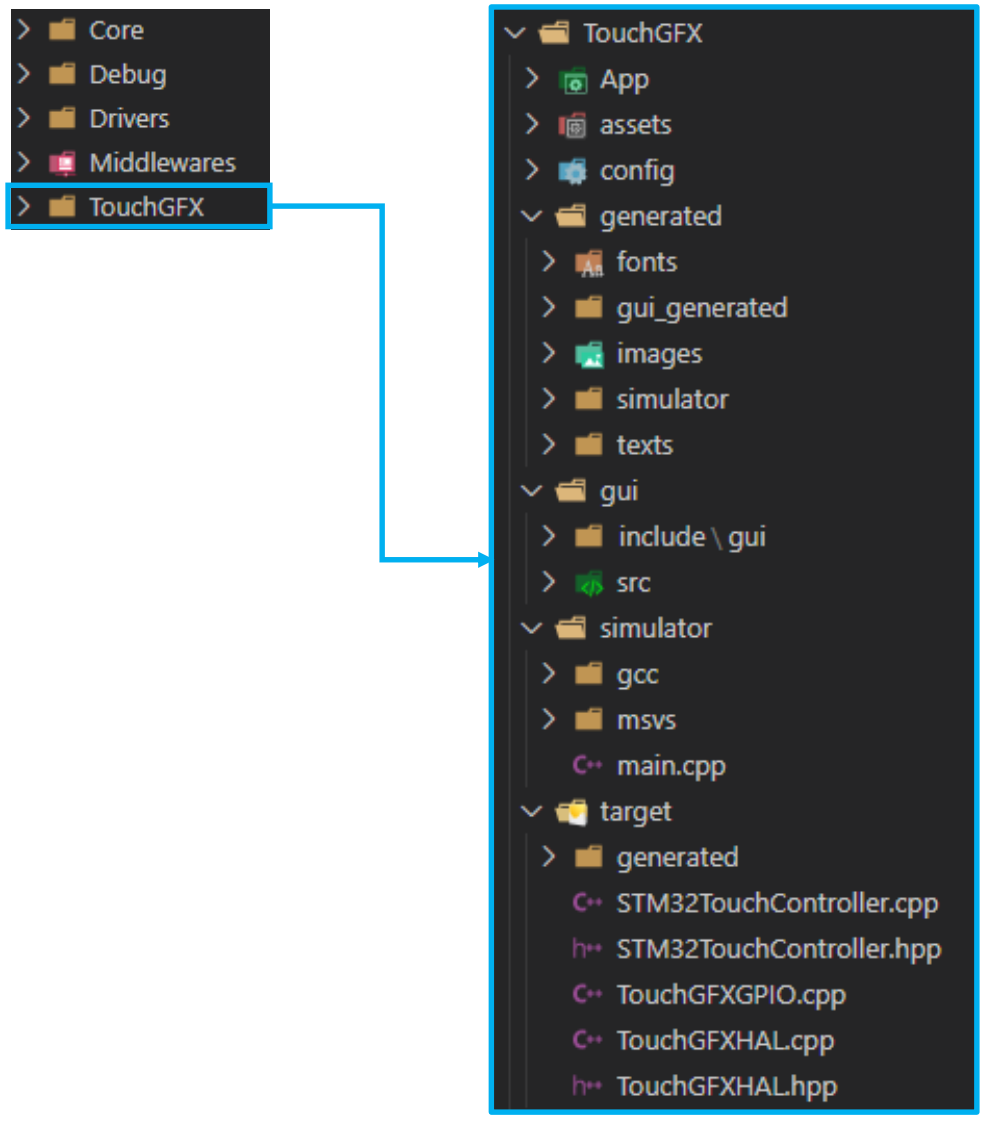
../ST/touchgfx

- TouchGFX framework including the widget and containers
- TouchGFX engine library

../Third_Party/FreeRTOS/Source

FreeRTOS source code(queue, task, timer…)

TouchGFX Project Organization



../App

To initialize TouchGFX and GUI Task, functions will call forward to TouchGFX hal class in C++ domain

../generated

Generated by TouchGFXDesigner(including UI, font, bitmap image and text). Those are basically not workspace for the user.

../gui

Consist of Model-View-Presenter source and header files so that user can write own code in order to actually implement GUI operation

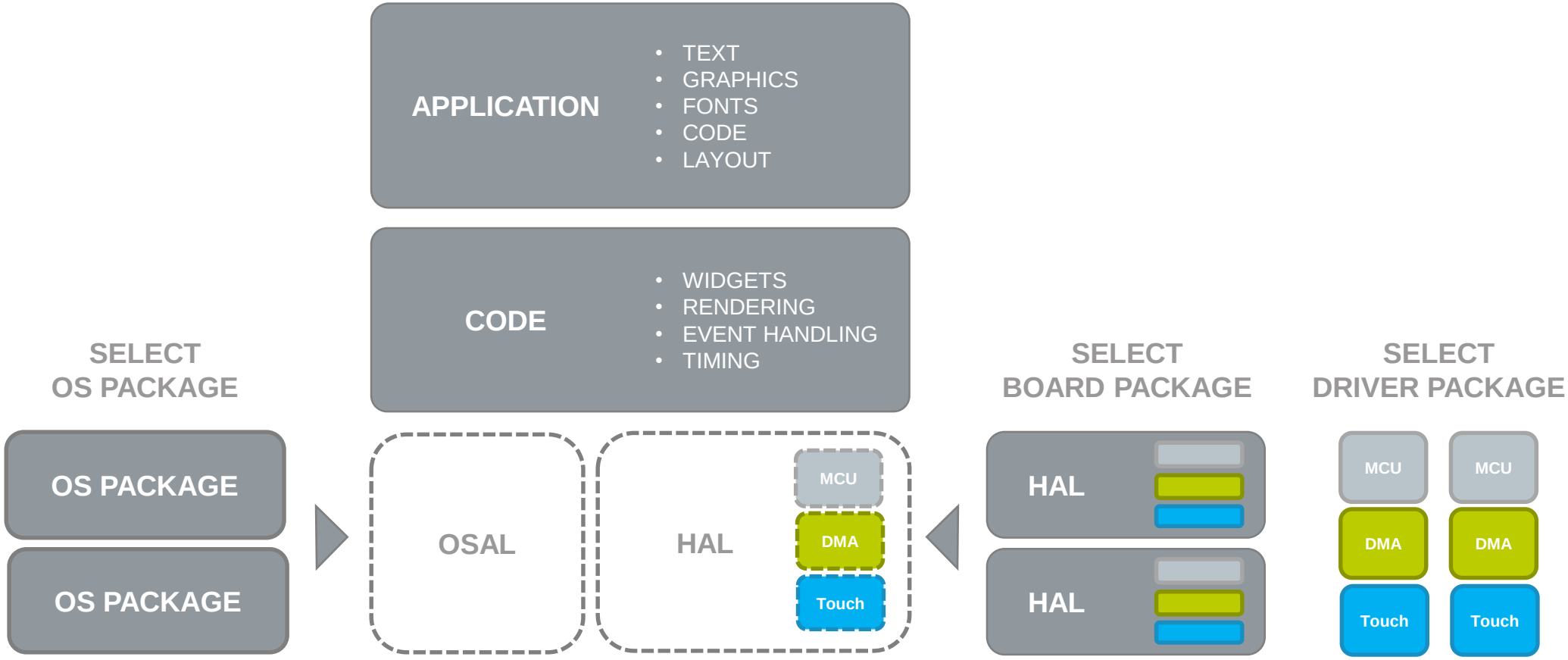
../simulator

This is for simulator and includes the project file for Visual Studio.

../target

Generated by X-Cube-TouchGFX to manage the display interfaces and touch control.
Files in “generated” folder is basically not workspace for the user but, you can overwrite the generated implementation.

TouchGFX Framework

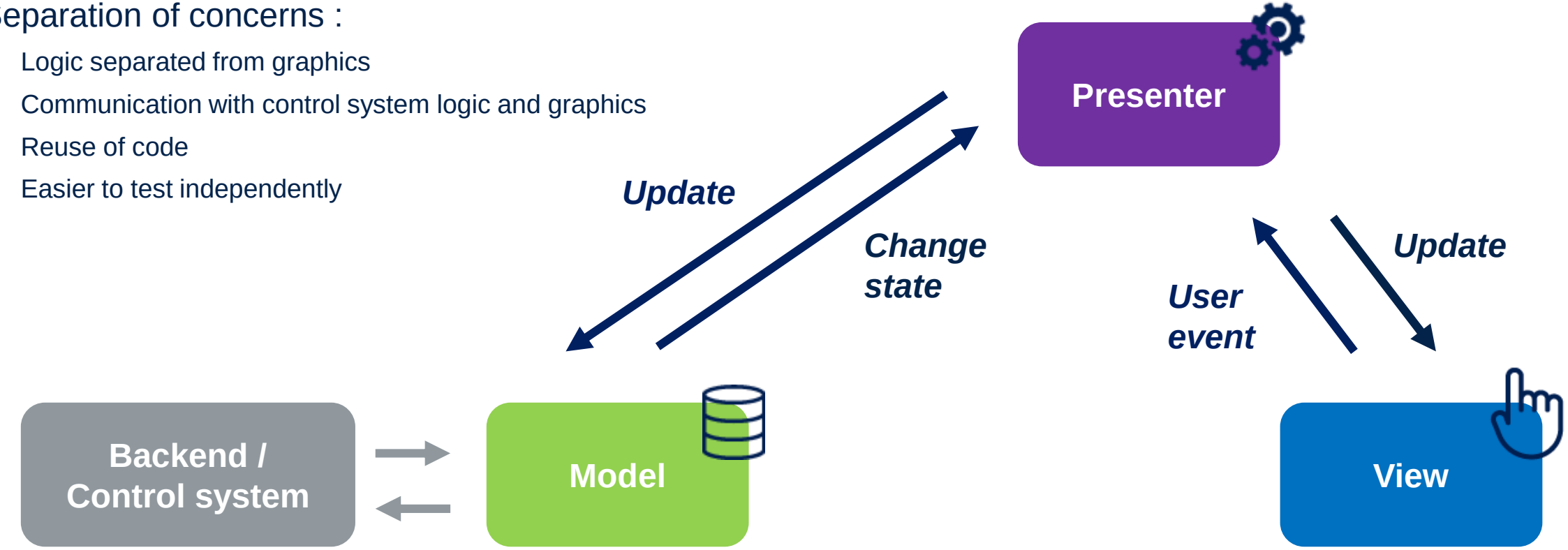


Live Demo … (STM32CubeIDE)

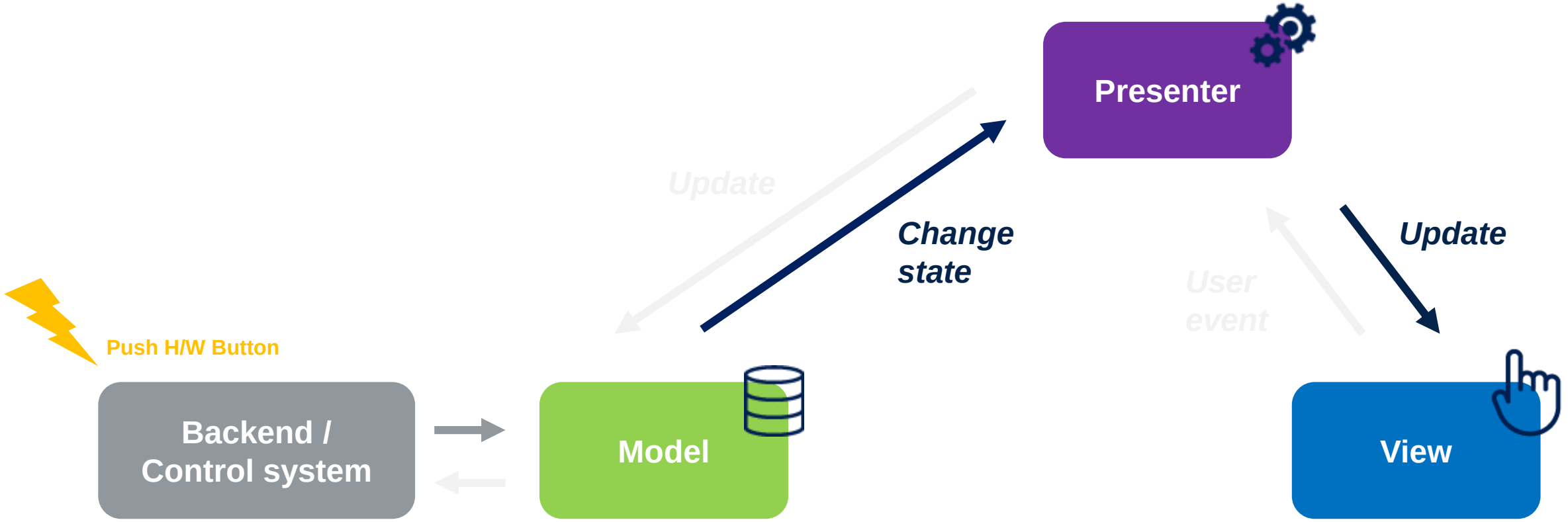
Play [**Webinar-TouchGFXDesigner.mp4**]

MVP Design Pattern

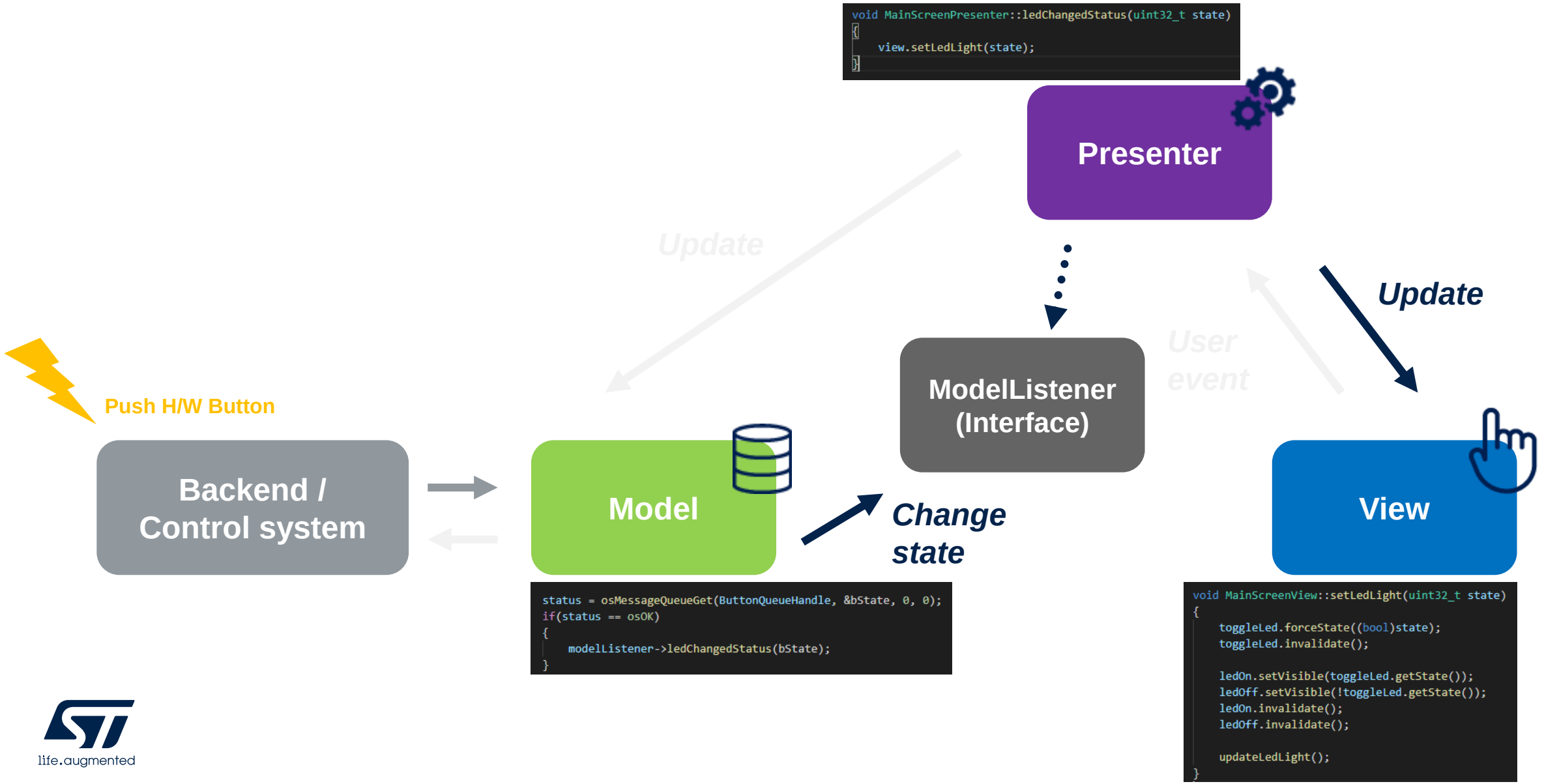
- Model-View-Presenter Software Architecture
  - Well known design pattern
  - Separation of concerns :
    - Logic separated from graphics
    - Communication with control system logic and graphics
    - Reuse of code
    - Easier to test independently



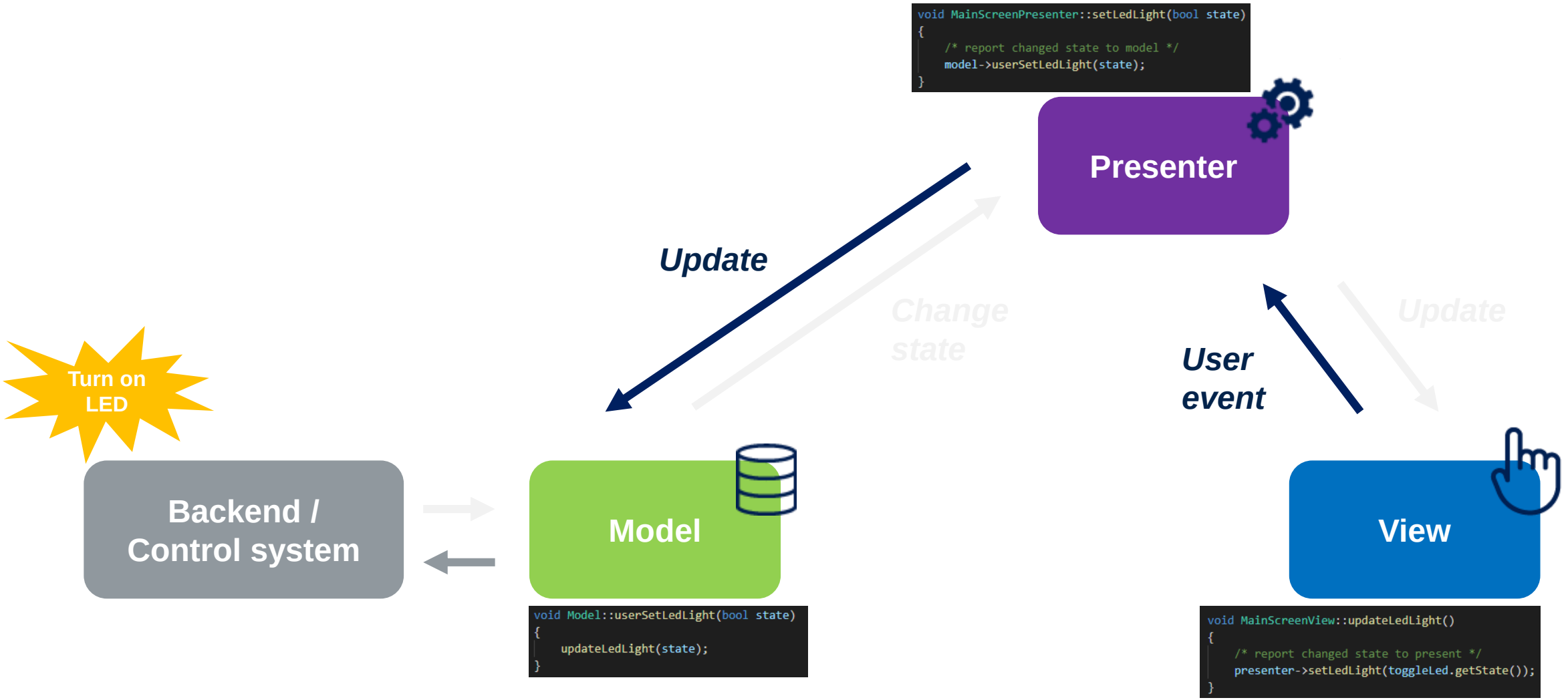
MVP Design Pattern



MVP Design Pattern



MVP Design Pattern



Live Demo … (STM32CubeIDE)

Play [**Webinar-TouchGFX_MVP.mp4**]

Thank you

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