life.augmented

STM32 for graphics

Accelerating HMI of things

STM32

STM32 for running graphics

life.augmented

The evolution of embedded HMIs

Smarter user interfaces for smarter products

The user experience provided by smartphones sets a new standard for smart devices

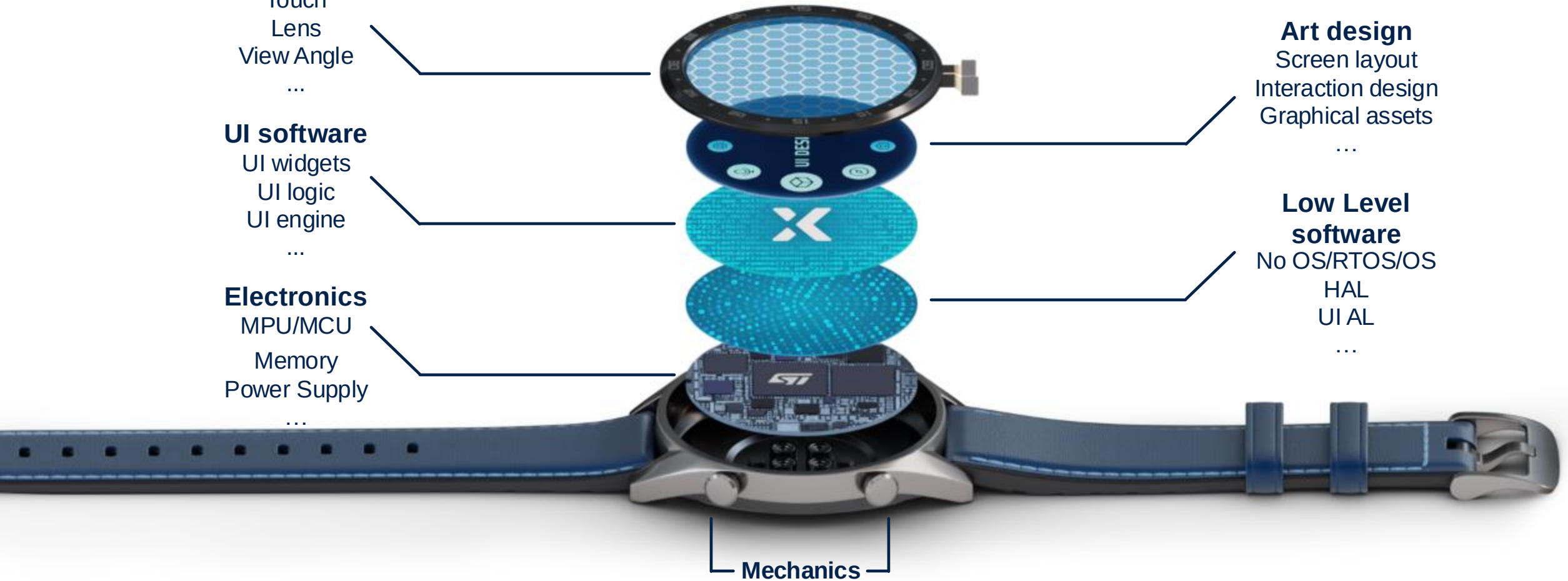
life.augmented

What it takes to develop GUIs

Display
Touch
Lens
View Angle
...

UI software
UI widgets
UI logic
UI engine
...

Electronics
MPU/MCU
Memory
Power Supply
…



Art design
Screen layout
Interaction design
Graphical assets
…

Low Level software
No OS/RTOS/OS
HAL
UI AL
…

Mechanics
Casing
Plugs
Buttons
…

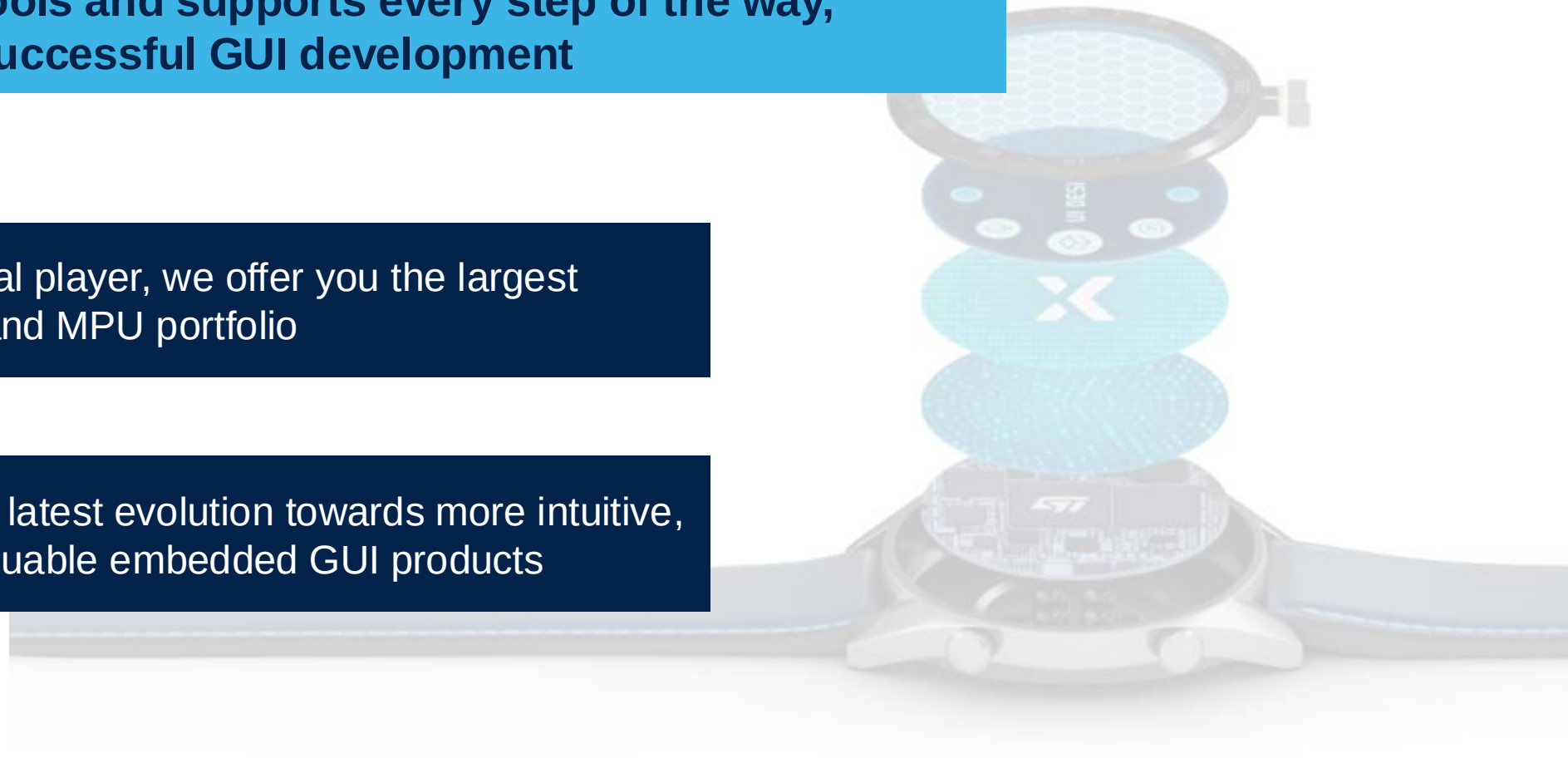
life.augmented

Get the greatest GUI in your embedded devices

ST provides you with tools and supports every step of the way, enabling smooth and successful GUI development

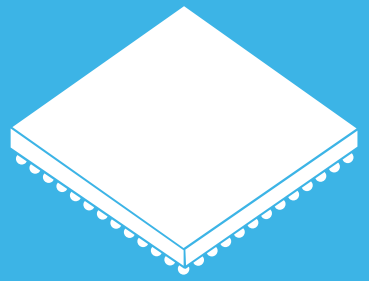
As a major global player, we offer you the largest graphics MCU and MPU portfolio

Benefit from the latest evolution towards more intuitive, modern, and valuable embedded GUI products



life.augmented

STM32 graphics offer



STM32 hardware

TouchGFX

Full support for MCU

MPU add-on available

+

Third-party libraries

STM32 software

Authorized Partner

Extensive ecosystem

Accelerating the HMI of things

Examples of high-end user experience enabled by STM32

SOMFY NINA	sDataway E-Ink	Linak	Flyer D1	iBeat	Chris
Remote for shutters and blinds STM32F405 inside	Weather station STM32F412xG inside	Touch-based patient panel STM32429 inside	Bike operating display STM32F469 inside	Smart watch and heart monitor STM32F469 inside	Digital assistant for drivers STM32 inside
					

life.augmented

STM32 MCU graphics examples of achievable UI performance

STM32C0

+

TouchGFX

Display resolution
up to 320x240

Entry level - internal RAM

High level - internal RAM

STM32U5

+

TouchGFX

Display resolution
up to 1024x768

STM32H5

+

TouchGFX

Display resolution
up to 640x480

Mid level – internal RAM

High level - external RAM

STM32H7

+

TouchGFX

Display resolution
up to 1280x800

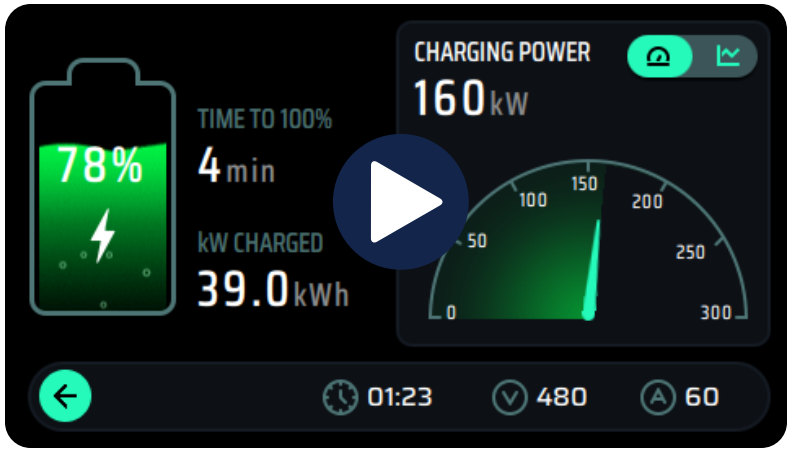
STM32 MPU graphics examples of achievable UI performance

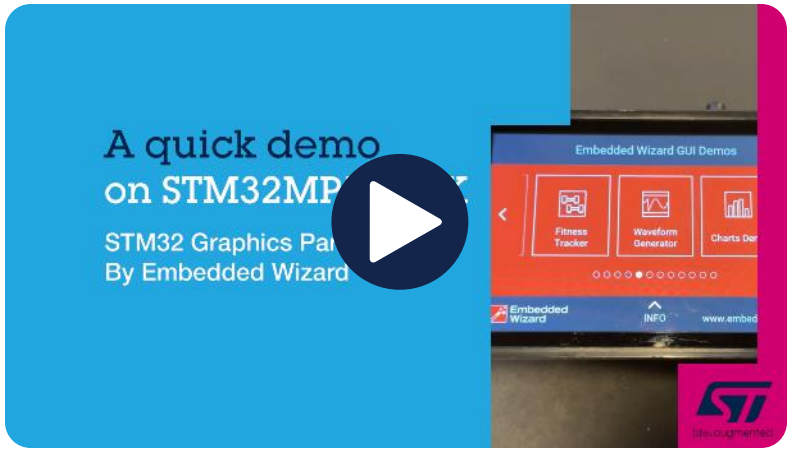
STM32MP135

+

Qt

Display resolution
up to 480x272





STM32MP157

+

Embedded Wizard

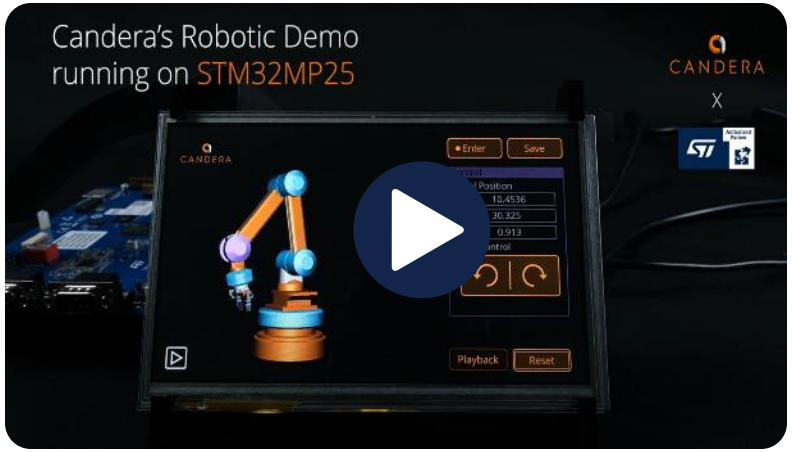
Display resolution
up to 480×800
MIPI DSI®

STM32MP157

+

CANDERA

Display resolution
up to 480×800
MIPI DSI®



STM32MP25

+

CANDERA

Authorized Partner

STM32 hardware
MCU/MPU for any UI needs

GUI software
any UI and any STM32

Out-of-the-box GUI software available for STM32

	TouchGFX	MICROEJ	emWin	LVGL	CRANK SOFTWARE	altia	GTK	CANDERA	Qt		Embedded Wizard
STM32 mainstream	●		●								●
STM32 ultra-low power	●		●	●	●			●	●		●
STM32 high performance	●	●	●	●	●			●	●		●
STM32 wireless	●										
STM32 MPUs			●	●	●	●	●	●	●	●	●

More info on st.com/stm32gui

life.augmented

Graphics on STM32 MCUs

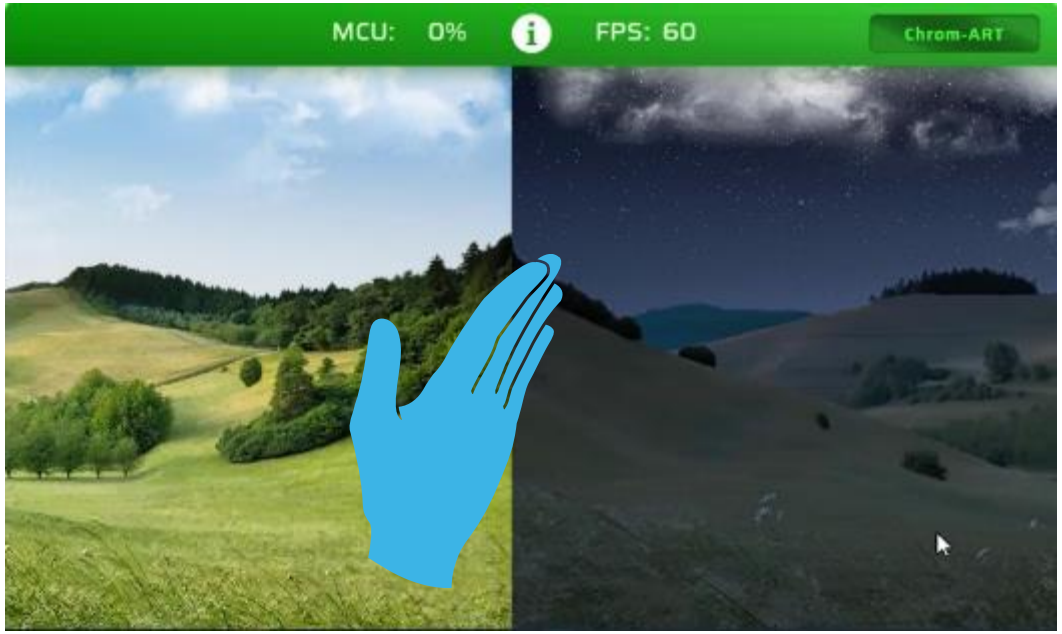
STM32 MCU hardware for graphics

life.augmented

STM32 MCUs for UIs

Leveraging the best IP and technologies embedded on MCUs

- STM32 hardware can run UI
- Several STM32 MCUs are designed to enable graphics performance. They leverage the latest ST technology enabling smooth animations on larger screens.



Let’s have a closer look at the ST technologies enabling smooth animation on larger screens.

STM32 hardware embedded graphics hardware acceleration

Chrom-ART Accelerator

Offloads the CPU from graphics tasks
Lower memory consumption
Higher GUI performance – smooth and richer graphics effects

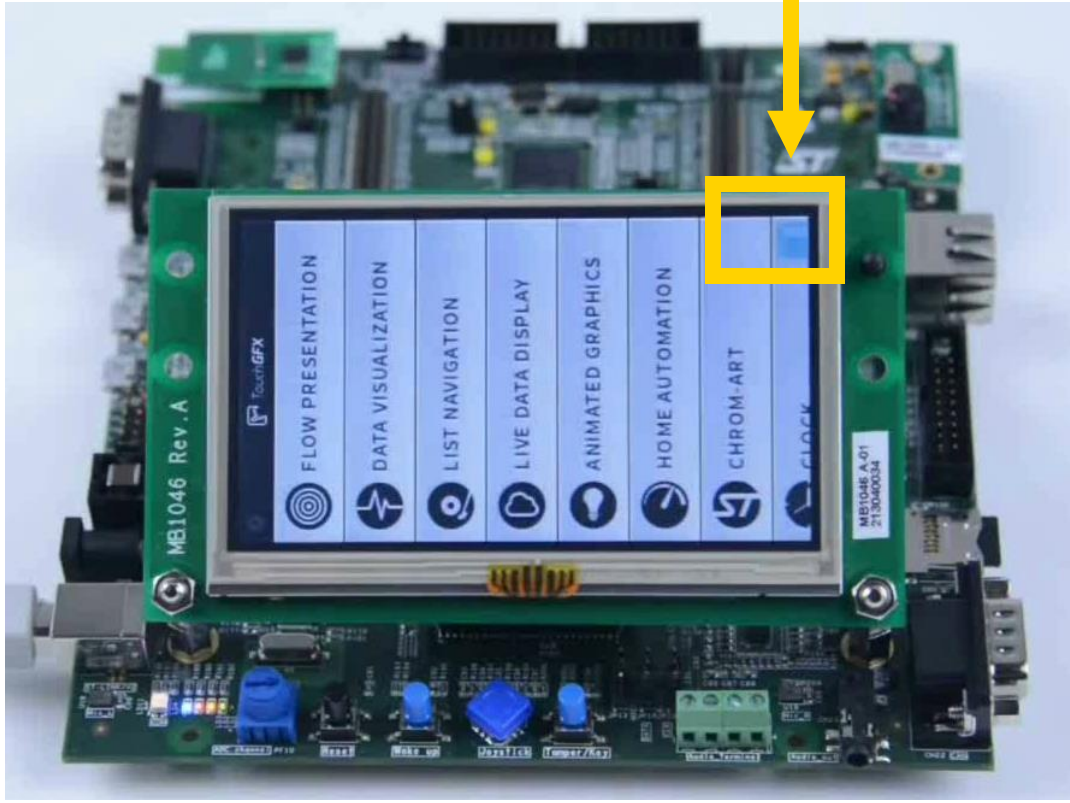
- Fluid motion and transparency effects with **80% less CPU resources** (watch video)

➔ The enabled graphics

- Simple drawing
- 2D Copy
- Alpha blending
  - For transparency effects
  - Antialiased bitmap fonts
- Color format conversion

Check out the perf value!

4% CPU load with Chrom-ART™
Up to 84% without Chrom-ART™



STM32 hardware embedded graphics hardware acceleration

JPEG hardware accelerator

Enhancing branding and user experience
- Instructions/Guiding videos
- Branding videos

Minimizing CPU load

Enables play of high-quality (30-60 FPS) motion JPEG videos

➔ The enabling technology

- JPEG compression and decompression
- Full and easy management of JPEG headers
- ChromART supports the pixel reordering and YCbCr to RGB conversion

Example of instruction video

JPEG hardware acc.	FPS	CPU load
OFF	12	>90%
ON	**90**	**<10%**

STM32H7, 240 MHz, 640x480 resolution
JPEG Codec hardware accelerator enables:
High quality video
Nine times less CPU recourses required

life.augmented

STM32 hardware embedded graphics memory optimization

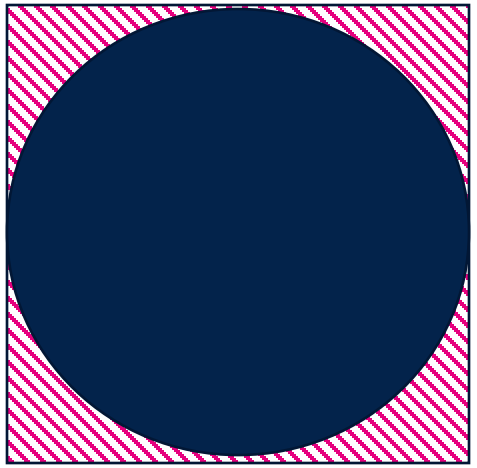
Chrom-GRC

Memory management unit (GFX-MMU) – virtual buffers for graphical framebuffers.

- **Saves up to 20%** of the framebuffer for round display
- Supports **partial framebuffer** strategy for **LTDC driven displays**

➔ The enabling technology

- Graphic resource cutter for nonsquare displays
- No modification nor special management at software level
- RAM needs using Chrom-GRC for a 400 x 400 round display
  @16bpp: 250kBytes (vs. 312 Kbytes)
  @24bpp: 372kBytes (vs. 469 Kbytes)



Saved memory (up to 20%)

life.augmented

STM32N6 Graphics accelerators
NeoChrom GPU

NeoChrom GPU

NeoChrom GPU benefits:

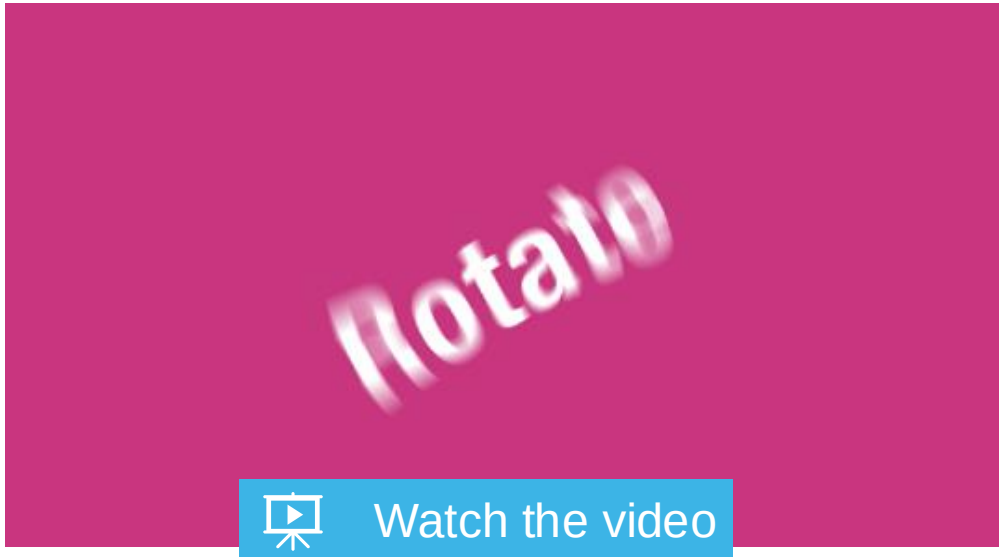
- Offload CPU from graphical operations
- Lower memory consumption and access
- Higher GUI performance = 60 FPS
- 2.5D GUI effects

New graphical operations supported by NeoChrom GPU

2D features
Simple drawing
2D copy
Alpha blending
Color format conversion

&

Advanced GUI features
Advanced drawing
Scaling and rotation
Perspective correct texture mapping
Image format compression



life.augmented

Smoother and richer graphics with NeoChrom GPU

The NeoChrom GPU offloads the CPU from the graphic computations, freeing up the memory and boosting performance.

Fully supported by TouchGFX and partner GUI software.

NeoChrom GPU

Scale/animate bitmaps

Full screen transitions

360° Bitmap rotations

Text scrolling

Vector graphics (software)

Perspective correct texture mapping

Fast 2D bitmap copy color format conversion

MJPEG videos

NeoChrom GPU

Vector graphics

Vector graphics with NeoChromVG GPU

Scalable vector graphics (SVG)

- To gain nice dynamic effects
- To save flash memory

Fonts

- Drawing and manipulating characters and text-strings
- To enable dynamic graphics effects
- To save flash memory

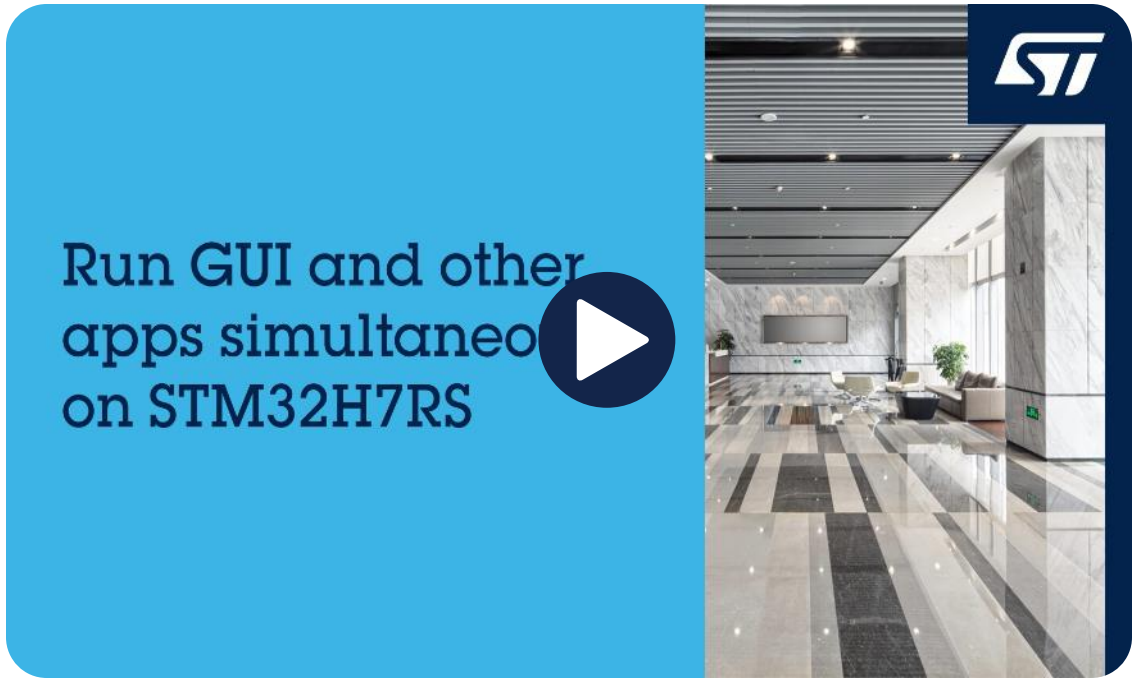
Map

Vector graphics are required to make map navigation possible (significant and dynamic maps, zooming)

Read the blog

life.augmented

STM32 hardware embedded graphics hardware acceleration



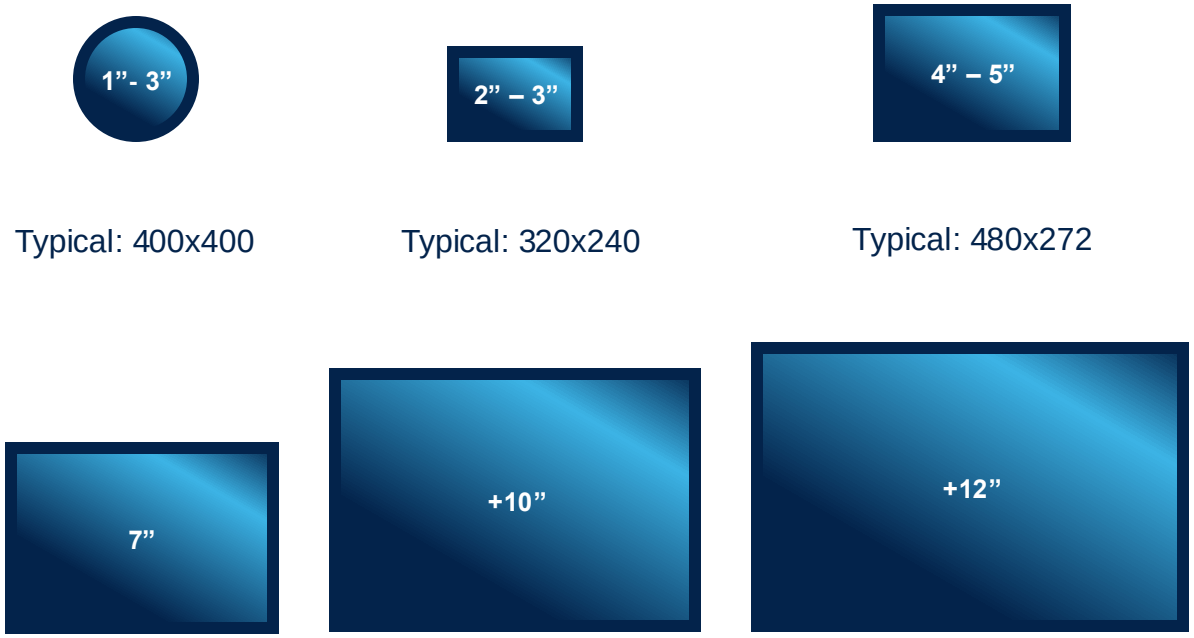
STM32 hardware supported displays

Display support

Supporting any embedded display
Display sizes **up to approx. 12” with a resolution of 1280*720**
Display with and without embedded GRAM

Supporting multiple display interfaces

- LCD-TFT display controller (LTDC)
- MIPI-DSI Host controller
- Parallel (FMC) Interface
- Serial interface



Typical: 400x400 | Typical: 320x240 | Typical: 480x272

Typical: 800x480 | Typical: 1024x600 | Typical: 1280x720

https://en.wikipedia.org/wiki/Display_resolution

life.augmented

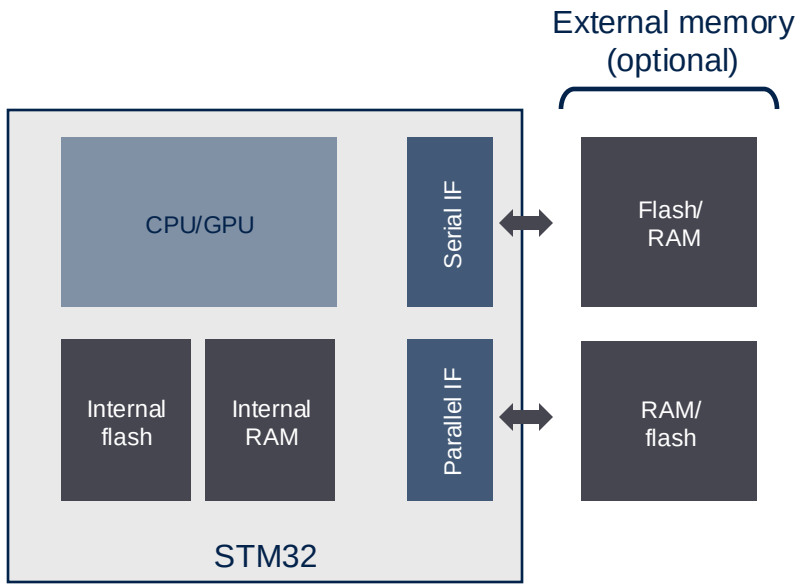
STM32 hardware
Memory

Internal memory + memory interfaces

Supporting **smooth animations** with fast access to internal and external memory – avoiding bottlenecks.
One-chip solution, no need for external RAM and flash for small resolution displays.
High flexibility secures your system architecture, buffer strategy and memory budget

➔ The enabling technology

Embedded SRAM – up to 3.0 MB (STM32U5F9)
- Scattered SRAM – r/w to banks at same time
- Embedded flash – up to 4MB (STM32U5F9)
- Serial memory interface – SPI, quad-SPI (4) OctoSPI (8) HexadecaSPI (16) for NOR flash and PSRAM
- Parallel memory interface (8.16, 32 bit) for NOR flash and SRAM/PSRAM/SDRAM
- SDIO (e.g. eMMC, SD-card)



STM32 memory setup

life.augmented

STM32 hardware
Bus architecture

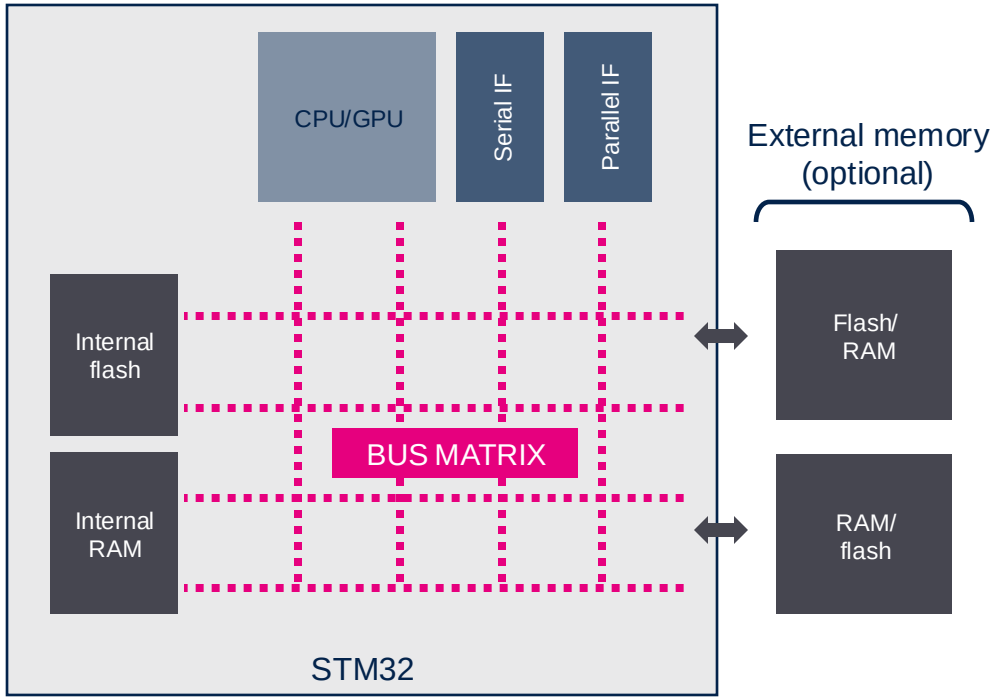
Internal bus

Supporting **smooth animations** with an internal bus structure allowing parallel operations:

- CPU can execute code from internal flash,
- Fetching data in RAM and
- GPU is composing a framebuffer without any collision

➔ The enabling technology

AHB or AXI based multilayer interconnect matrix allowing concurrent parallel transfers between main controllers (CPU, GPU, DMA, LCD controller) and targets (any internal or external memories and peripherals)



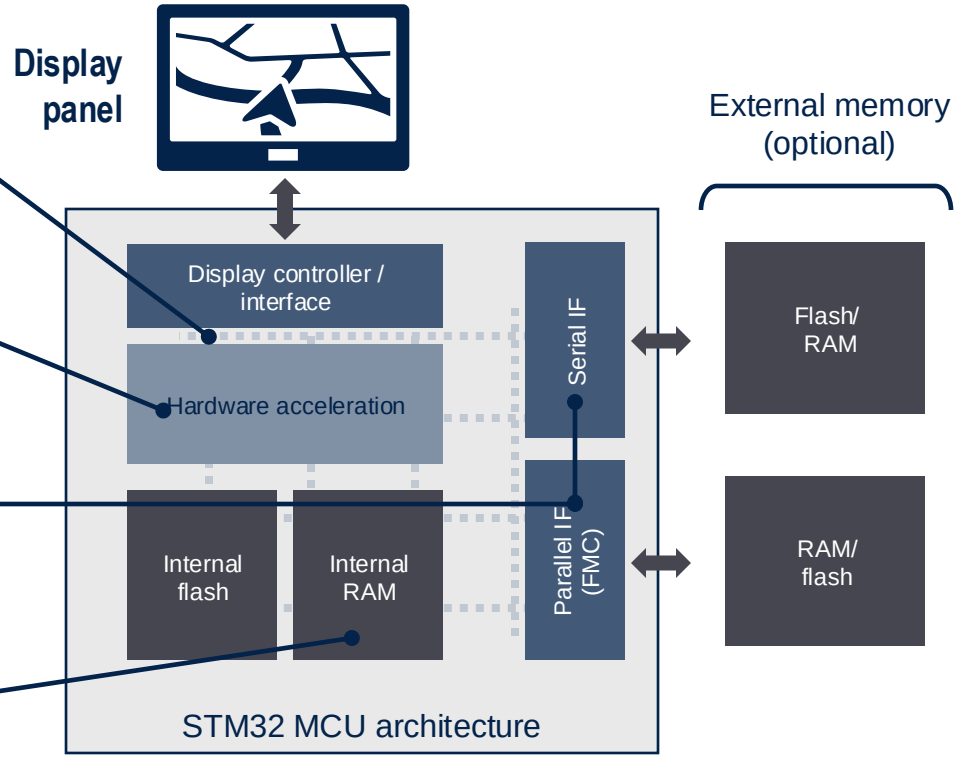
STM32 bus matrix principle

life.augmented

STM32 hardware
A holistic approach for optimized graphics performance

Smart integration ensures system performance

- Bus Matrix multilayer interconnect
- Smart integration of hardware acceleration
- Fast access to external RAM and flash memories
- I/D cache and SRAM Blocks



General STM32 GUI hardware architecture

life.augmented

Featured STM32 MCUs for graphics

Up to 1280*800 | Up to 1280*720 | Up to 800*480 | Up to 480*320 | Up to 320*240

Advanced — **Graphic performance** — **Entry-level**

Framebuffer placement	**External**			**Internal**							
Display interface	RGB-TFT	RGB-TFT	MIPI-DSI RGB-TFT	RGB-TFT	RGB-TFT MIPI-DSI	RGB-TFT	Parallel SPI	Parallel SPI	SPI	SPI	SPI
STM32 MCU	**STM32H7R/S**	**STM32H750**	**STM32H747**	**STM32N6x5**	**STM32U5x9**	**STM32H7A/B**	**STM32H5**	**STM32U575**	**STM32U0**	**STM32C0**	**STM32WB**
Main differentiator	High-perf, external memories Lowest cost H7	External memories 1 MB RAM	MIPI-DSI Dual-core	High resolution advanced graphics with internal RAM- 4.2 MB	Vector graphics Ultra-low power Large memory for single chip solution	Large SRAM for internal FB	Low cost Large memory for single chip solution	Ultra-low power Large memory for single chip solution	Ultra low power with internal RAM only	Ultra low cost with internal RAM only	Wireless + GFX

life.augmented

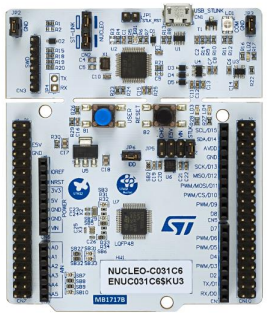
STM32 hardware
Extensive graphics portfolio, 200+ part numbers

Series	Frequency	Graphics acceleration & optimizer	Display interfaces	Supported Resolutions	Packages
STM32G0 Cortex®-M0	64 MHz	-	SPI	Up to 480x272	QFP, CSP
STM32U0 Cortex®-M0+	56 MHz	-	SPI	Up to 320x240	QFP, BGA, CSP
STM32C0 Cortex®-M0+	48 MHz	-	SPI	Up to 320x240	CSP, SON, TSSOP, QFP
STM32WB Cortex®-M4	64 MHz	-	SPI	Up to 480x272	QFP, BGA, CSP
STM32H5 Cortex®-M33	250 MHz	-	Parallel SPI	Up to 240*240	QFP, BGA, CSP
STM32F4 Cortex®-M4 advanced lines	180 MHz	Chrom-ART	RGB-TFT MIPI-DSI	Up to 1024x768	QFP, BGA, CSP
STM32L4 Cortex®-M4 Low Power	80 MHz	Chrom-ART	Parallel SPI	Up to 240x480	QFP, BGA, CSP
STM32L4+ Cortex®-M4 Low Power	120 MHz	Chrom-ART Chrom-GRC	RGB-TFT MIPI-DSI	Up to 450x450	QFP, BGA, CSP
STM32U5 Cortex®-M33 Low Power	160 MHz	Chrom-ART Neochrom GPU VG Chrom-GRC, MJPEG	RGB-TFT MIPI-DSI	Up to 800x480	QFP, BGA, CSP
STM32F7 Cortex®-M7	216 MHz	Chrom-ART MJPEG	RGB-TFT MIPI-DSI	Up to 1280x800	QFP, BGA, CSP
STM32H7 Cortex®-M7 (Cortex®-M7 + Cortex®-M4)	600 MHz	Chrom-ART Neochrom GPU Chrom-GRC, MJPEG	RGB-TFT MIPI-DSI	Up to 1280x800	QFP, BGA, CSP
STM32N6 Cortex®-M55	800 MHz	Chrom-ART Neochrom GPU Chrom-GRC, MJPEG	RGB-TFT	Up to 1280x720	BGA
NEW STM32MP1 Cortex®-A7	800 MHz – 1 GHz	3D Graphic PU	MIPI-DSI	UP to 1366x768	BGA
STM32MP2 Cortex®-A35	1.5 GHz	GPU/NPU	LVDS/HDMI MIPI-DSI	1920x1080 Full HD	BGA

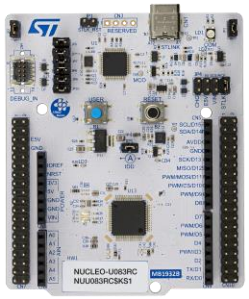
Focus on STM32 entry-level GUI offer

STM32 hardware

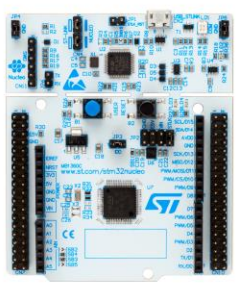
STM32WB with NUCLEO-WB55RG



STM32C0 with NUCLEO-C071RB



STM32U0 with NUCLEO-U083RC



STM32G0 with NUCLEO-G071RB

STM32H5 with NUCLEO-H503RB

+

X-NUCLEO-GFX01M2

RVA15MD-NUC64A
NUCLEO64 extension display from Riverdi
1.5” PCAP touch IPS display

Authorized Partner

STM32 software

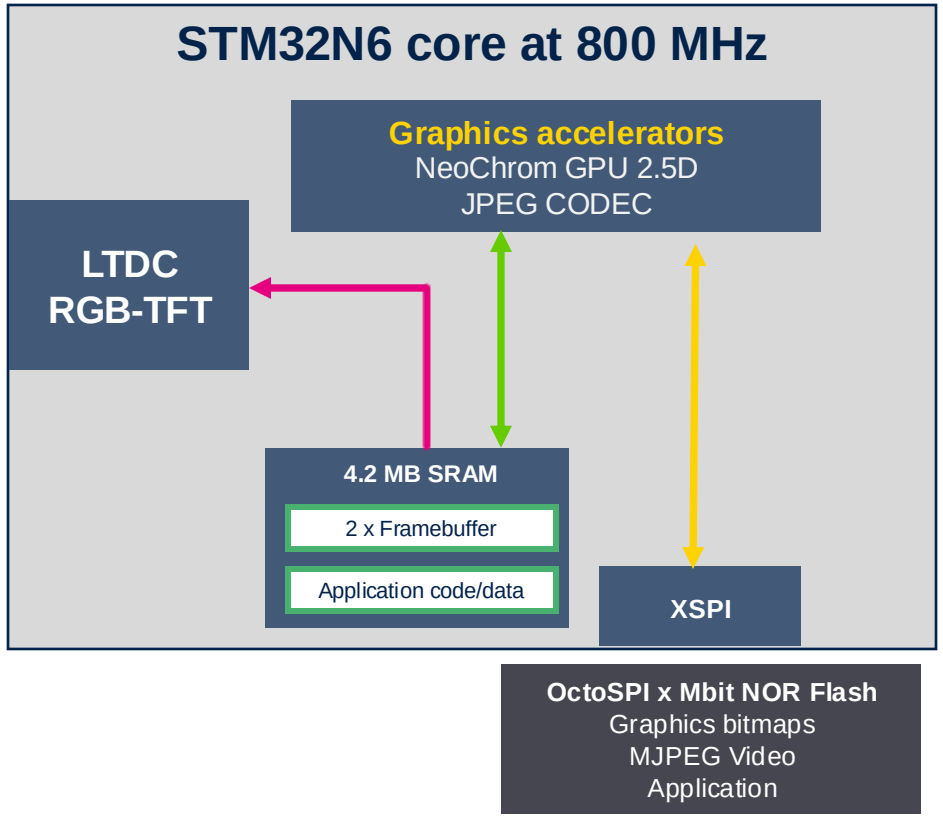
A complete STM32 software offer, free of charge

TouchGFX + STM32 Cube

Find the complete slide set
[Upgrade your segment display with STM32]

Run up to 1280 x 720 GUIs using internal SRAM only

RGB-TFT display
16BPP: 1280 x 720 resolution
24BPP: 1024 x 600

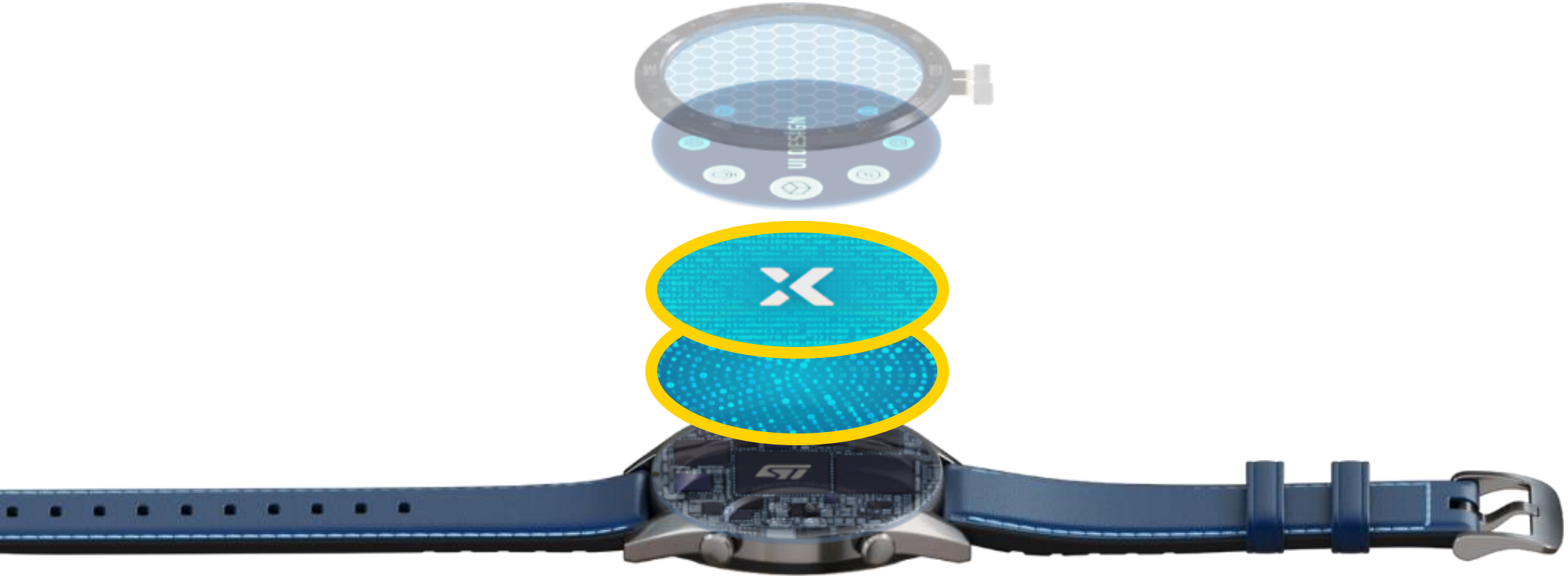


- **No external RAM needed**
- **Fastest framebuffers on STM32**
- **2.5D GUIs on high resolution**
- **Down to 2-3% CPU Load**

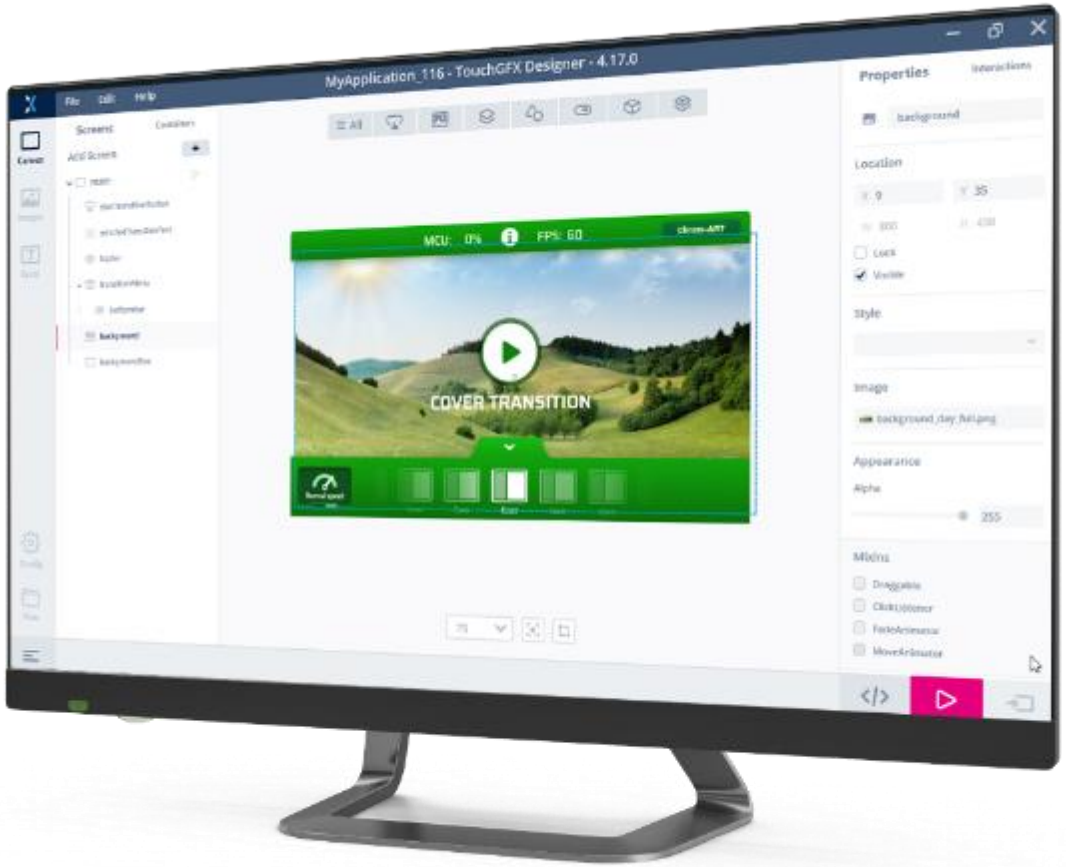
Step 1: NeoChrom call back to get the assets from external flash.
Step 2: NeoChrom processes the image. The image is stored into dedicated memory in internal RAM.
Step 3: The framebuffer is transferred to the display.

life.augmented

STM32 MCU graphics software



TouchGFXDesigner



Let's watch it live!

STM32 software leveraging STM32 hardware capabilities

TouchGFX GUI library

TouchGFX DESIGNER

PC GUI-builder and -simulator

TouchGFX GENERATOR

Configure and generate a TouchGFX project

TouchGFX ENGINE

Optimized and hardware accelerated graphics library

Delivered as an X-CUBE-TOUCHGFX package

STM32 software
TouchGFX GUI software

TouchGFXDesigner

Easy development
Develop great GUIs effortlessly with the WYSIWYG GUI builder, the TouchGFXDesigner.
Release your creativity
The structure and flexibility of TouchGFX gives developers control to easily create unique UI designs

➔ The enabling technology

- Run on a PC-simulator or your target hardware
- Combine your user-code with TouchGFXDesigner 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 stock

TouchGFX Stock is integrated in the TouchGFXDesigner tool and lets you access to a library of thousands of ready-to-use free graphical assets for embedded user interfaces.

life.augmented

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 enabling technology

- STM32CubeMX plugin to configure and generate TouchGFX Abstraction Layer (AL) for their STM32-based hardware.
- **TouchGFX AL** enables available graphics hardware acceleration and optimization
- **IDE independent**
  Works smoothly with CubeIDE, IAR Workbench, Arm® Keil®

TouchGFX Generator
Low Level software
RTOS
HAL
➔ **TouchGFX AL**

TouchGFXDesigner
UI software
UI widgets
UI logic
UI engine

life.augmented

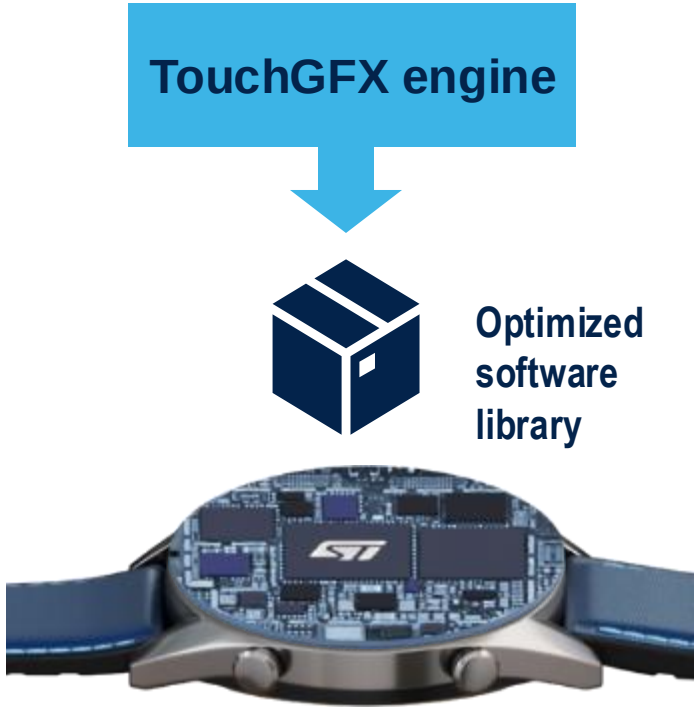
STM32 software
TouchGFX GUI software

TouchGFX engine

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

➔ The enabling technology

- **Optimized for minimum MCU load and memory footprint**
  compile and runtime 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



life.augmented

STM32 software
Minimum hardware requirements

TouchGFX engine

Run TouchGFX engine on any STM32 MCU

CPU RESOURCES

- CPU cycles: 1 to 90%
  Depending on application and available hardware acceleration

OPERATION SYSTEM

- No RTOS
  or
- Any RTOS
  out of the box supported:
  FreeRTOS™ / Azure- ThreadX RTOS

RAM (INTERNAL / EXTERNAL)

- Framework and stack: 10-30 Kbytes
- Widgets: 1-15 Kbytes
- Framebuffers: 10 Kbytes – 3 Mbytes (depending on display resolution, color depth and number of framebuffers)

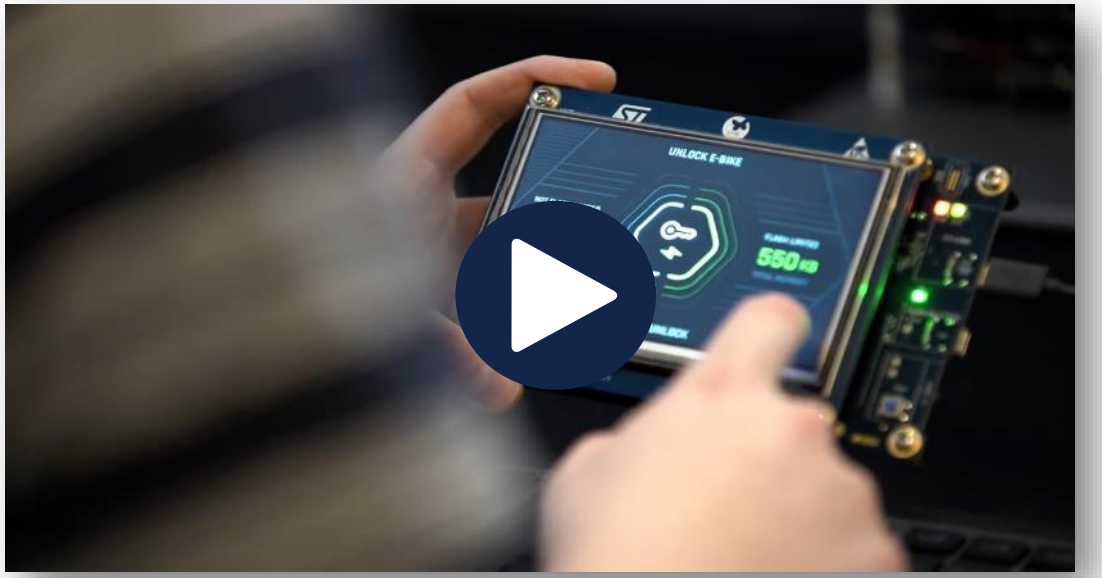
FLASH (INTERNAL / EXTERNAL)

- Framework: 60-100 Kbytes
- Screen definitions, GUI, logic: 1-100 Kbytes
- Image and font data: 1-40 Mbytes (depending on application size and use of compression)

RAM for Framebuffers, example:
480x272, 16-bit color, 2 framebuffers:
480x272 x 2 bytes x 2 = 520 kbytes

life.augmented

A complete hardware and software offer to optimize flash memory usage in graphical interfaces



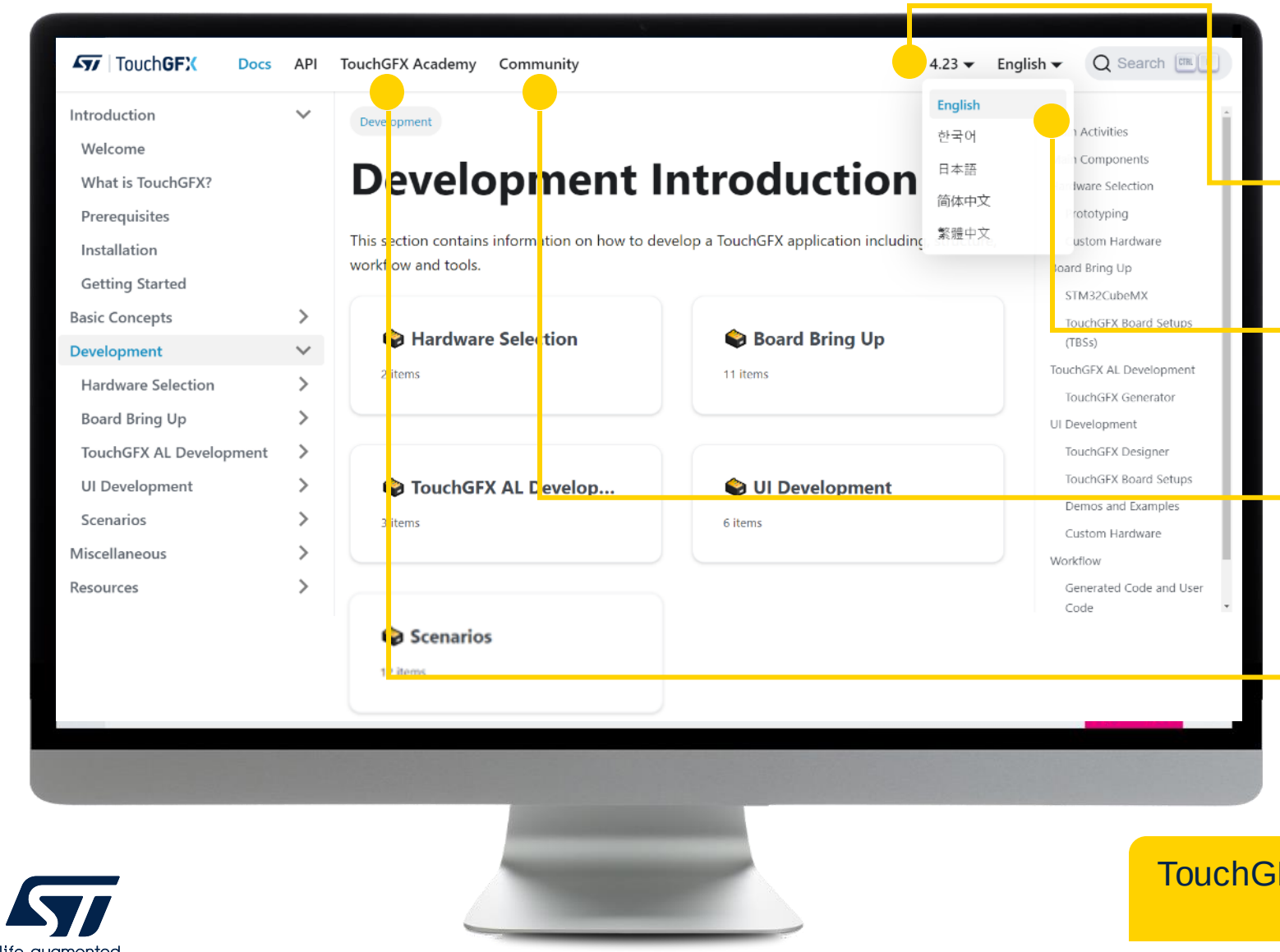
Supported with hardware acceleration in STM32 MCUs
(ChromART, NeoChrom GPU)

+

Built-in features in TouchGFX software

life.augmented

Get access to hours of training and detailed documentation



Select your TouchGFX **version**

Select your **language** (5 languages available)

Ask questions and learn from peers on the **Community**

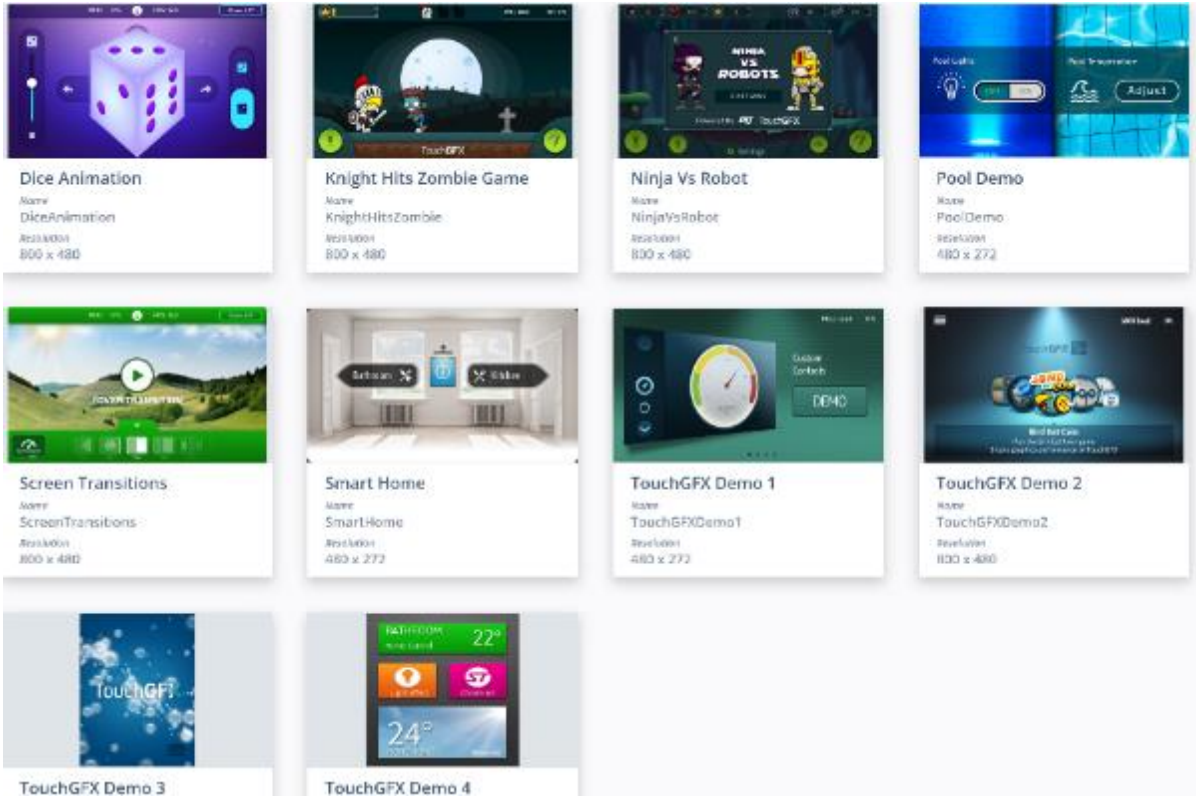
Build up your TouchGFX competences at the **Academy**

TouchGFX documentation site (3,000 pages): **support.touchgfx.com/**

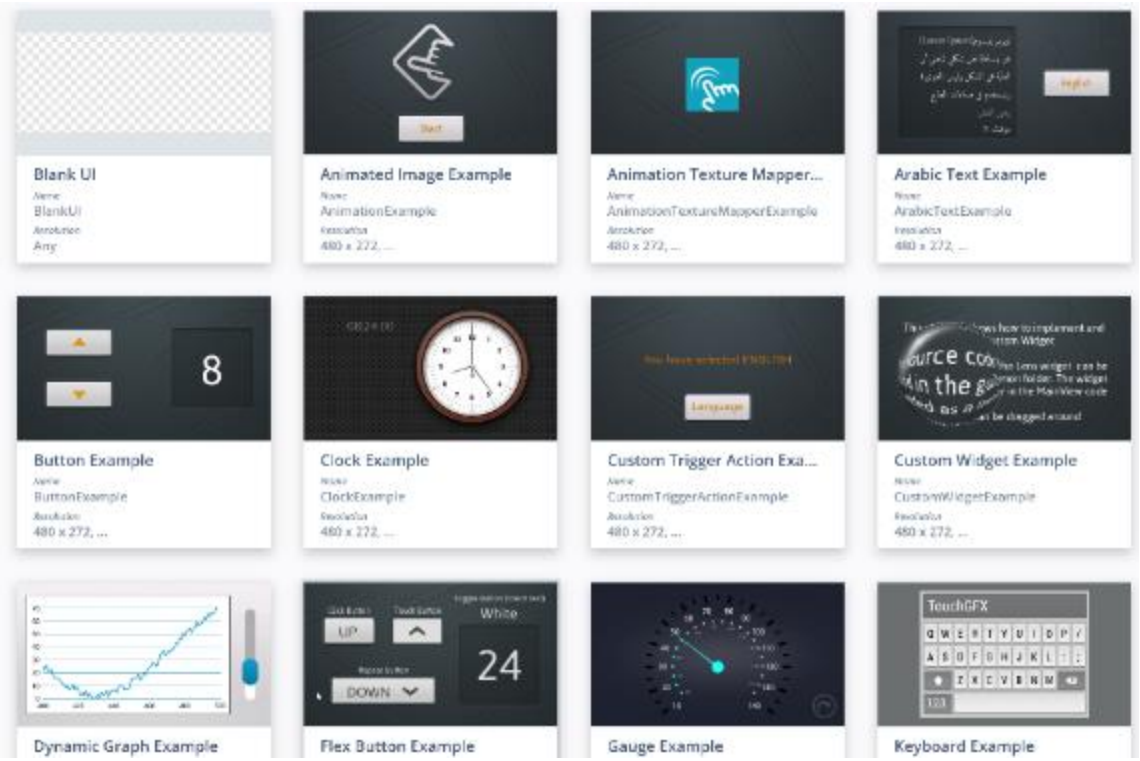
life.augmented

Start your project TouchGFXDesigner

Demos available in full source code

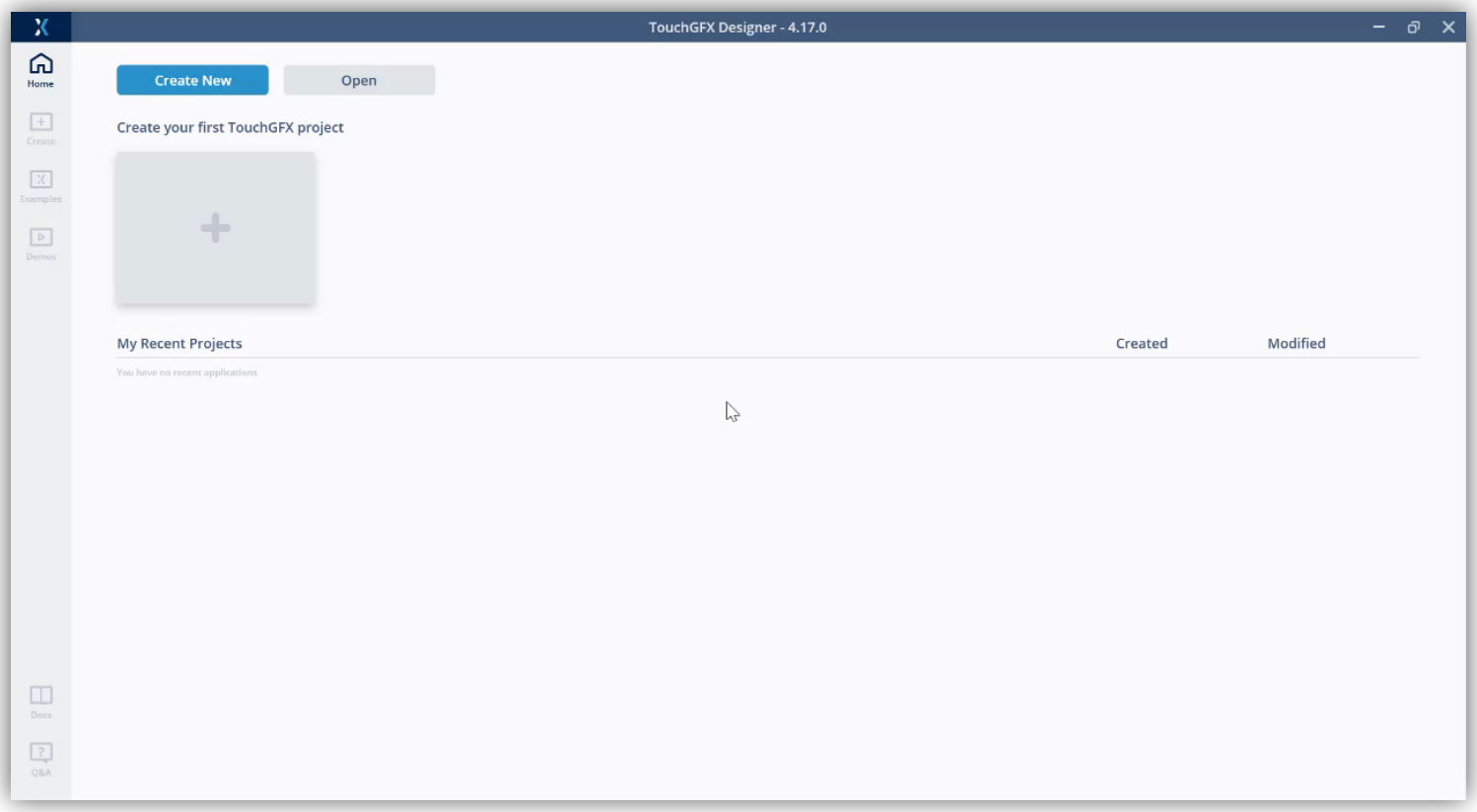


Examples are available for all widgets



Start your project with TouchGFXDesigner

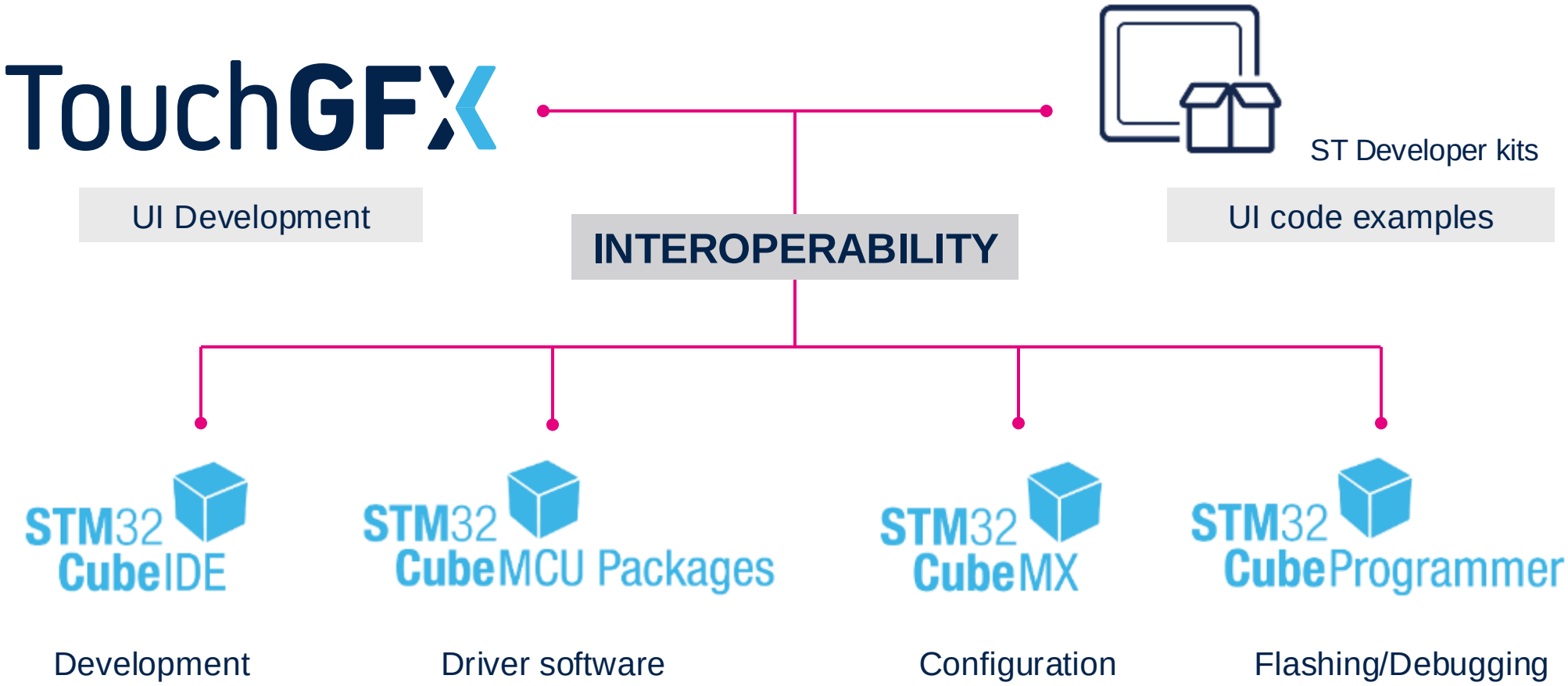
Select an example, your target board, and run directly from the TouchGFXDesigner tool



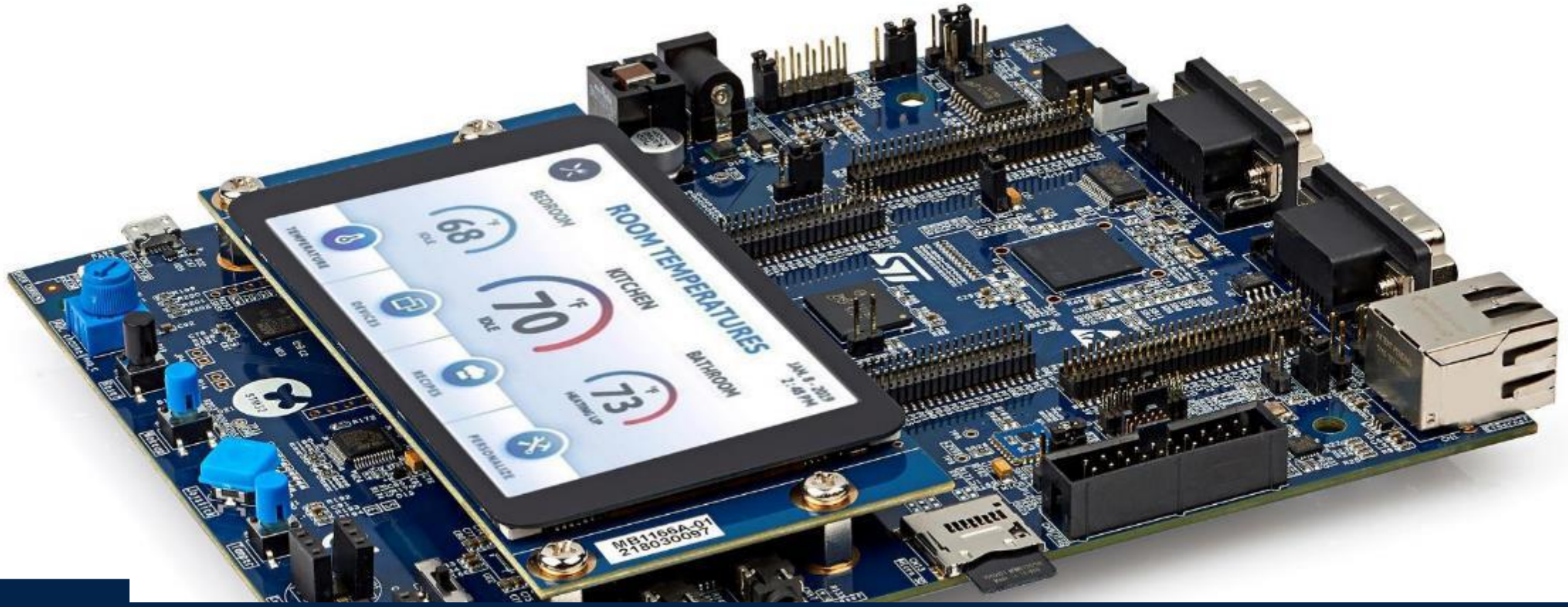
Watch the video

life.augmented

Free, advanced STM32 software

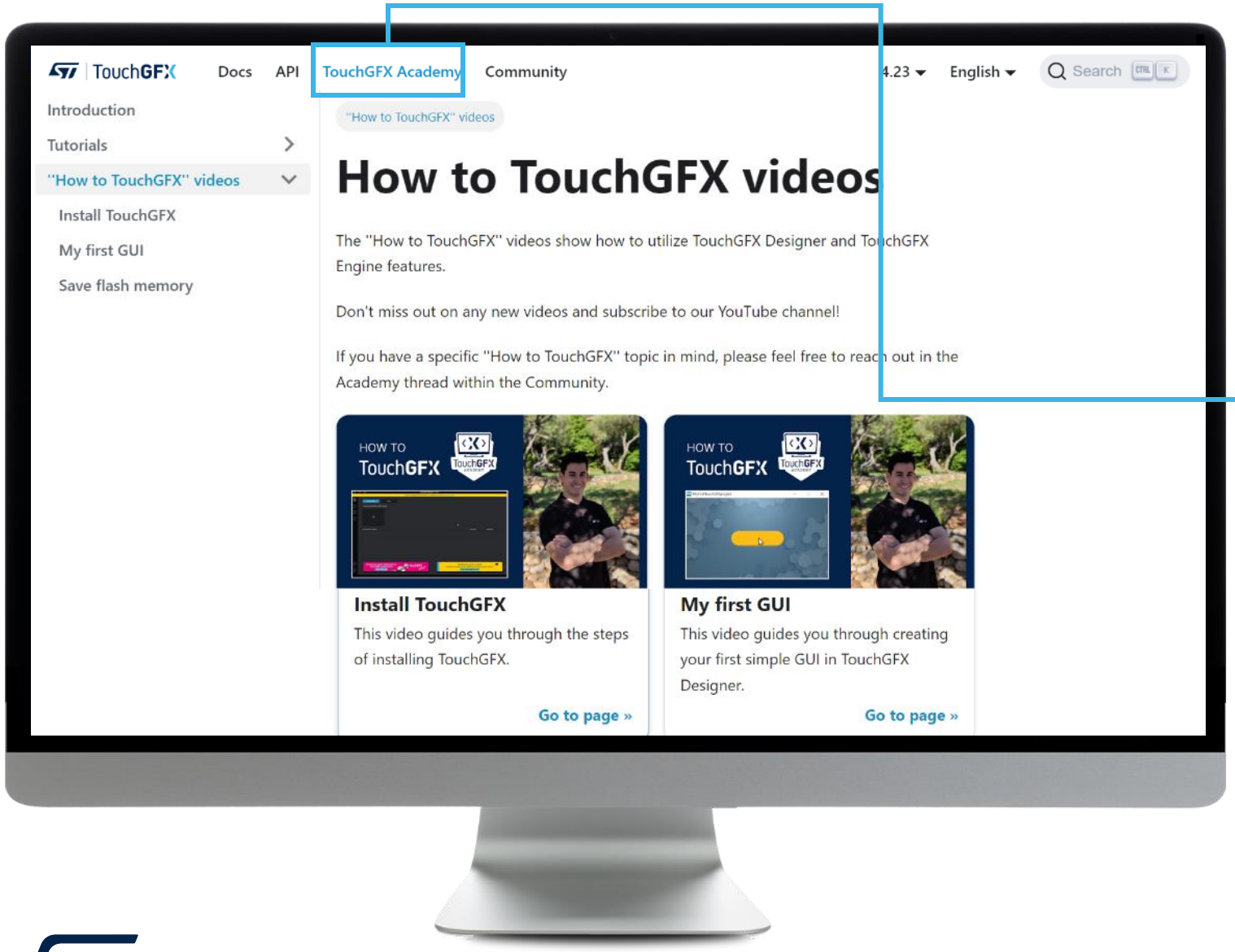


Extensive STM32 graphics ecosystem



life.augmented

TouchGFX Academy



NEW

The place to go to learn about the features and functionalities of TouchGFX. Explained by our experts and showcased through practical examples.

On documentation

YouTube

STM32 graphics ecosystem overview

	In-house solutions	Solutions from partners
STM32 based boards	Developer Boards	Developer boards + production boards
Development tools	TouchGFX	Graphics libraries / development **tools**
Support/ Services	Documentation site One-on-one support Forum & community*	UI/TouchGFX development **services**

* also supported by many external contributors

life.augmented

Getting started

Watch the video

1. Select the MCU and pick the associated developer kit
2. Download TouchGFXDesigner here
3. Find your display kit
4. Create/select a demo
5. Flash your display kit

life.augmented

MCU Resources

Find out more on st.com/stm32gui

Download TouchGFX software package

TouchGFX documentation

TouchGFX videos

Community

From ST Partners

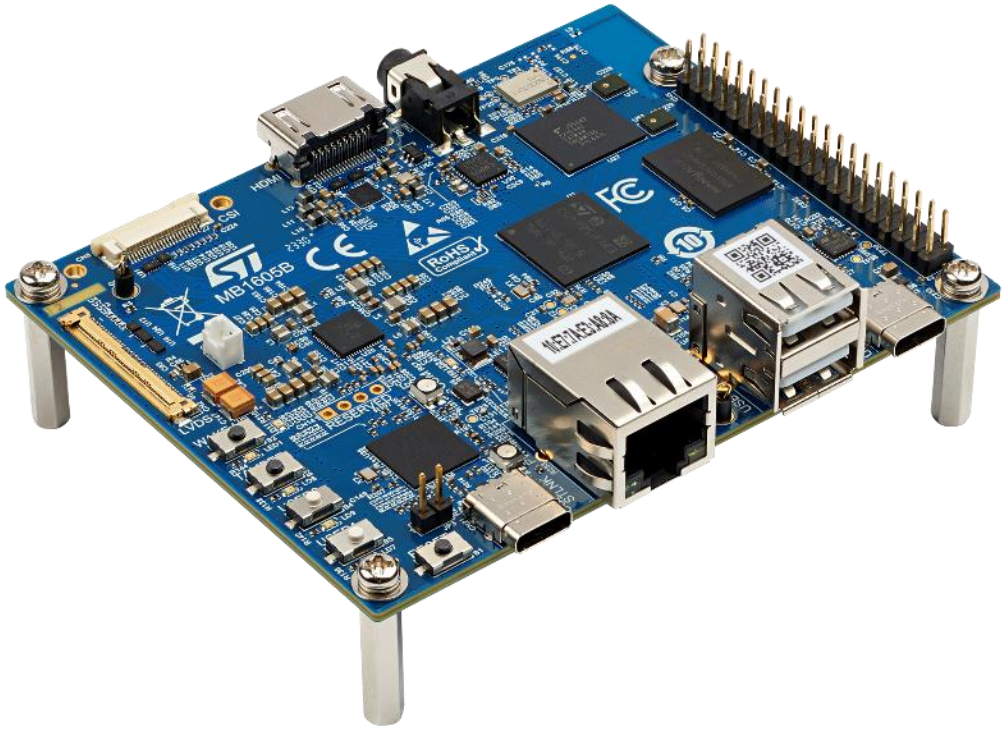
ST Partner Program

TouchGFX experts

life.augmented

Graphics on STM32 MPUs

STM32 MPU hardware for graphics



STM32 hardware
MPU for any UI needs

Smartphone- like

GUI Performance

STM32MP25

STM32MP15

STM32MP13

Entry level

CPU Performance

Cortex®-A7

Dual Cortex®-A7

Dual Cortex®-A35

STM32 hardware
MPU for any UI needs

	STM32MP13	STM32MP15	STM32MP25
Camera interface	DCMI Up to 240 Mbytes using a 120 MHz pixel clock and 16-bit of data. 3 megapixels @30 fps in color 5 megapixels @15 fps in color	DCMI Up ot 140 Mbytes using an 80 MHz pixel clock and 14-bit of data	MIPI CSI-2 with Lite-ISP (5 megapixels @30 fps DCMI 1 megapixels @15 fps)
Display interface	LCD-TFT WXGA (1366×768) @60 fps up to full HD (1920 x 1080) @ 30 fps	LCD- TFT WXGA (1366 × 768) @60 fps up to full HD (1920 × 1080) @30 fps MIPI DSI 2 data lanes	LCD-TFT FHD (1920 × 1080) @60 fps LVDS Up to QXGA (2048 × 1536) @60 fps with dual link DSI Up to QXGA (2048 × 1536) @60 fps
NEON (Arm Cortex®-A)	video encode/decode, 2D/3D graphics	video encode/decode, 2D/3D graphics	audio, video, 3D graphics, image, and speech processing
GPU		3D GPU: Vivante® OpenGL® ES 2.0 - Up to 27 Mtriangle/s, 133 Mpix/s	3D GPU: VeriSilicon® - up to 900 MHz OpenGL® ES 3.2.8 - Vulkan 1.2-OpenCL™ 3.0, OpenVX™ 1.3 Up to 150 Mtriangle/s, 900 Mpix/s

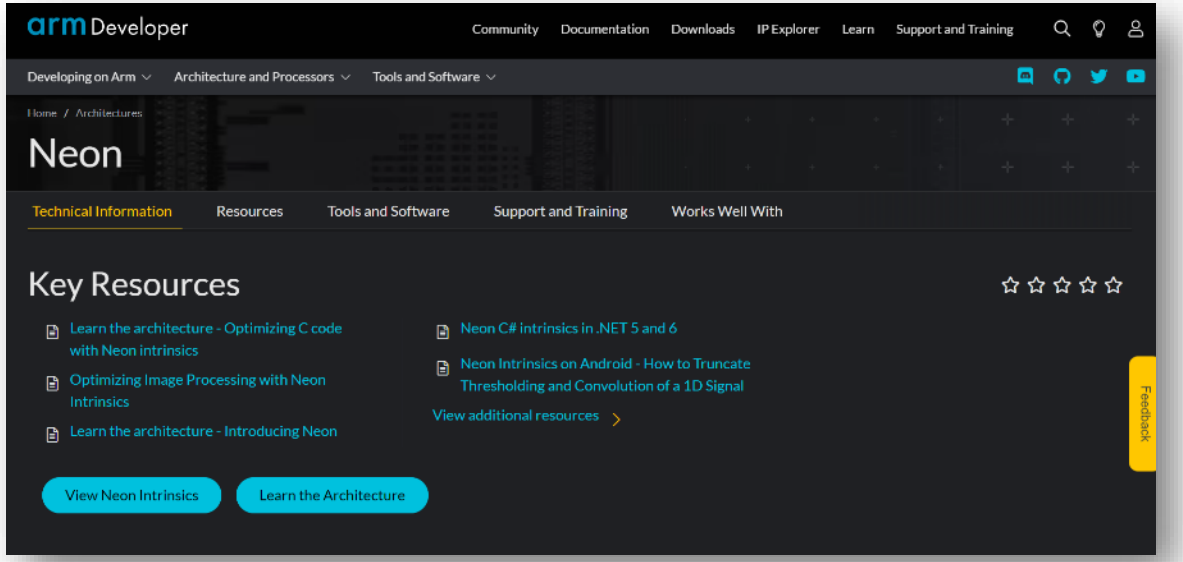
life.augmented

STM32 hardware
embedded graphics hardware acceleration

Arm® Neon™ Technology

NEON technology improves the multimedia user experience by accelerating audio and video encoding/decoding, user interface, 2D/3D graphics or gaming.

Find out more at:
https://developer.arm.com/Architectures/Neon



STM32 hardware
embedded graphics hardware acceleration

VeriSilicon GPU Vivante

STM32MP15:

Dual Arm® Cortex®-A7
3D GPU: Vivante®
OpenGL® ES 2.0
Up to 27 Mtriangle/s, 133 Mpix/s

STM32MP25:

Dual Arm® Cortex®-A35
3D GPU: Vivante® - Up to 900 MHz
OpenGL® ES 3.2.8 - Vulkan ® 1.2-OpenCL™ 3.0, OpenVX™ 1.3
Up to 150 Mtriangle/s, 900 Mpix/s

life.augmented

STM32 hardware embedded graphics hardware acceleration

VeriSilicon VPU Hantro

STM32MP25:

Flexible Video Processor Unit (VPU):

- VPU IP is a microprocessor IP for video codecs and video processing, with outstanding capabilities in supporting mainstream video formats, multicore scalability, frame compression, encoding quality and bit rate control.
- Target applications: video surveillance, multimedia consumer products, IoT devices, cloud service products, data centers, aerial photography, and recorders.

H264/VP8 encode and decode: 1080p 60 fps or 2x 1080p 30 fps
Jpeg encode and decode: 500 Mpix/s

https://www.verisilicon.com/en/IPPortfolio/HantroVPUIP

H264/VP8 dec 1080p hardware acc.	FPS	CPU load
OFF	60	~80%
ON	**60**	**<8%**

STM32 hardware
Supported displays

Display support

Supporting any embedded display
Display sizes **up to approx. 10” with a resolution of 2048x1536**

Supporting multiple display interfaces
- LVDS (FDP-1/OpenLDI 0.95)
- MIPI-DSI host controller
- Parallel LCD-TFT display controller (LTDC)
    - YUV and rotation features (STM32MP25)
    - Secure layer (STM32MP13 and STM32MP25)

- Parallel (FMC) / serial (I2C, SPI) Interfaces (for small panel)

Typical: 480x272

Typical: 800x480

Typical: 1024x600

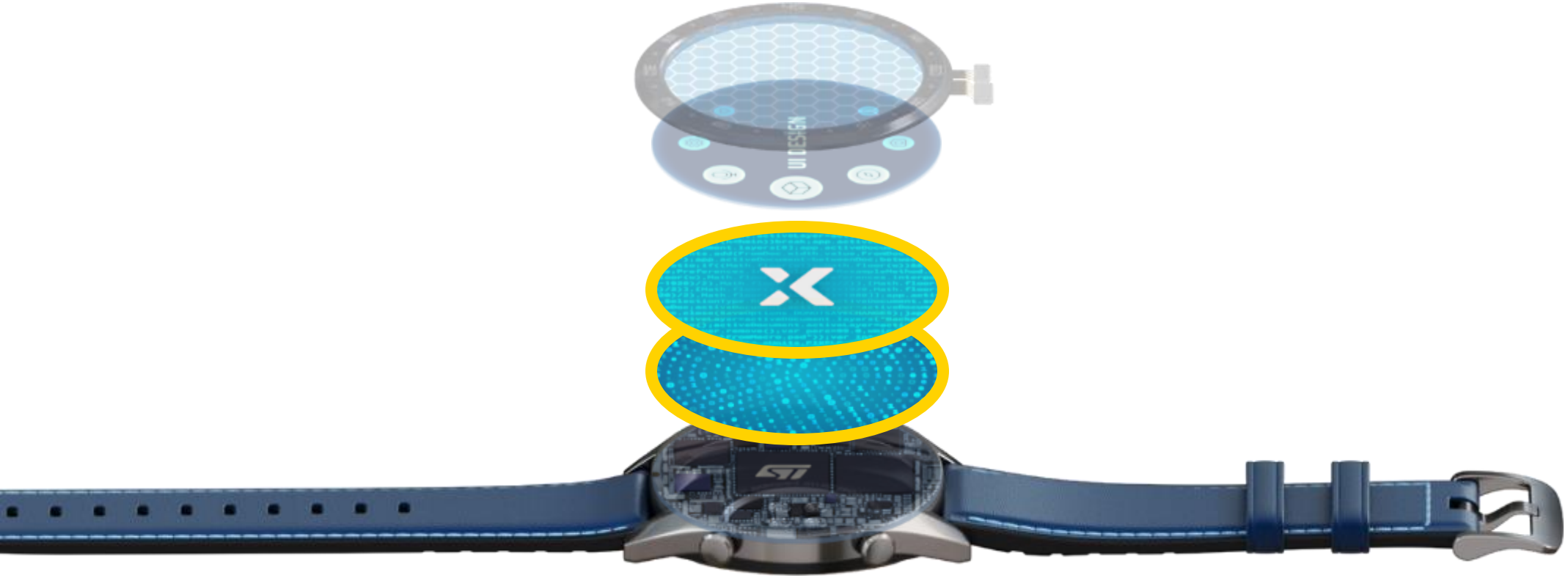
Typical: 1920x1080

Typical: 2048 x1536

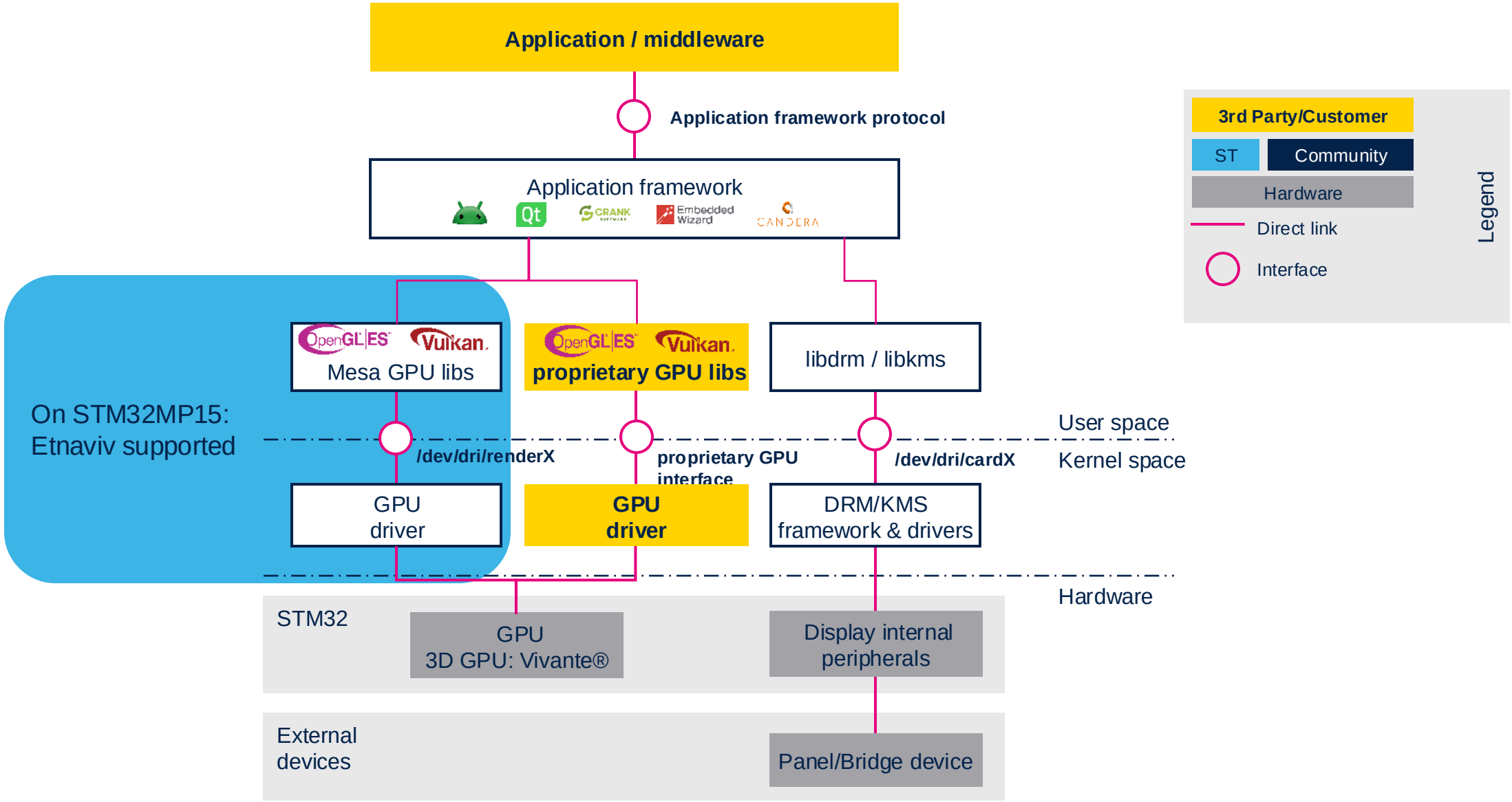
https://en.wikipedia.org/wiki/Display_resolution

life.augmented

STM32 MPU graphics software



GPU stack software implementation



Software stack

GCNano

GCNano is a complete OpenGL ES 2.0 GPU architected for MCU / MPU systems with limited power, memory, and bandwidth configurations.

The graphics core is optimized to offload and significantly.

OpenGL® ES 3.2.8

OpenGL (Open graphics library) is a cross-language, cross-platform application programming interface (API) for rendering 2D and 3D vector graphics.

The API is typically used to interact with a graphics processing unit (GPU), to achieve hardware-accelerated rendering.

Vulkan

Vulkan is a new-generation graphics and compute API for high-efficiency, cross-platform access to GPUs.

As the industry's only open standard modern GPU API, Vulkan is unique in enabling developers to write applications that are portable to multiple diverse platforms.

OpenCL™ 3.0

OpenCL™ is a free, open standard for parallel programming across various platforms and devices such as supercomputers, servers, PCs, mobile devices, and embedded systems.

It enhances performance and responsiveness for many applications in fields like creative tools, scientific and medical programs, vision processing, and neural network operations.

OpenVX™

OpenVX™ is a royalty-free standard for accelerating computer vision applications across different platforms.

It optimizes performance and power for real-time and embedded scenarios, supporting use cases like tracking, surveillance, ADAS, reconstruction, AR, inspection, and robotics.

Libraries running with the STM32 MPU ecosystem

life.augmented

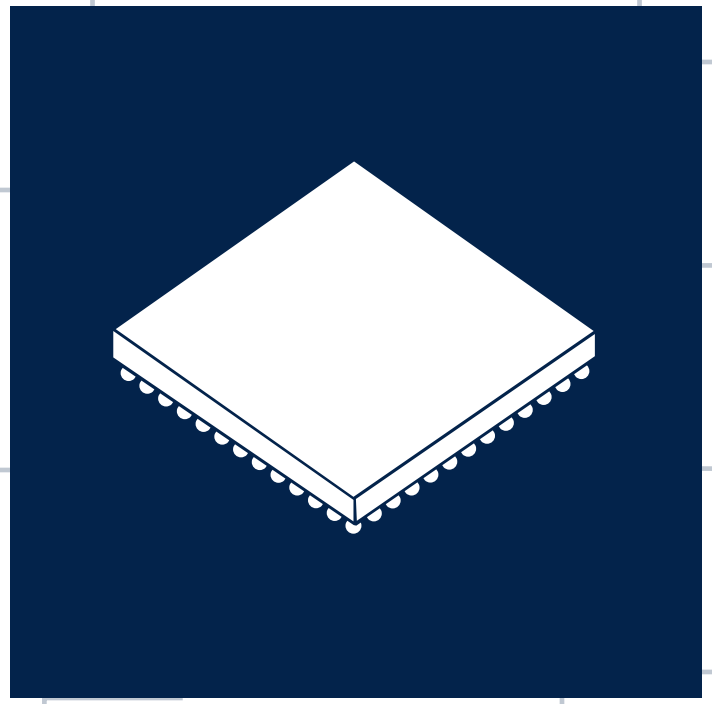
Libraries running with the STM32 MPU ecosystem

GTK - GIMP ToolkitFree and open-source
- C and many other languages
- Set of widgets ready to use
- OpenSTlinux support (Yocto and Buildroot)

- Free and open-source (Android open-source project)
- Variety of graphics rendering APIs for 2D and 3D
- Android support

QT
- Set of widgets ready to use
- C++ and many other languages
- Supported on many platforms
- OpenSTlinux support (Yocto and Buildroot)

LVGL - Light and Versatile graphics Library
- Free and open source
- C language
- Set of widgets ready to use
- OpenSTlinux support (Yocto and Buildroot)
- Bare metal support



- WYSIWYG tools
- Drag and drop interface

Embedded Wizard

- WYSIWYG tools
- Drag and drop interface

CRANK SOFTWARE

- WYSIWYG tools
- Drag and drop interface

CANDERA

- WYSIWYG GUI editor
- Can be scaled to a variety of STM32

altia

- Works with LVGL or GTK libraries
- Programming language needed

slint

- WYSIWYG GUI editor
- Scalable on any STM32 for free

TouchGFX

Available
Planned

Libraries running on the STM32 ecosystem

	STM32MP13x			STM32MP15x		STM32MP25x			Via partners
	Bare metal	Yocto	Buildroot	Yocto	Buildroot	Yocto	Buildroot	Android	
		●	●	●	●	●	●		
LVGL	●	●		●		●			
Qt		●	●	●	●	●			
CANDERA	●	●		●		●			●
Embedded Wizard	●	●		●		●			●
CRANK SOFTWARE		●		●		●			●
altia		●		●					●
slint		●		●					●
								●	
TouchGFX	●								

NEW

X-LINUX-Qt

STM32 MPU OpenSTLinux Expansion Package for QT framework

It contains Linux® Qt™ frameworks, as well as an ST Application Launcher based on Qt™ framework and application examples to get started with Qt™ application development.

This expansion package is a complete ecosystem that allows developers working with OpenSTLinux to create Qt™ based application very easily.

Download now **Learn more here**

life.augmented

STM32 graphics accelerating the HMI of things

www.st.com/stm32gui

community.st.com

TouchGFX documentation

X-CUBE-TOUCHGFX

life.augmented

Our technology starts with You

Find out more at www.st.com/STM32GUI

© STMicroelectronics - All rights reserved.
ST logo is a trademark or a registered trademark of STMicroelectronics International NV or its affiliates in the EU and/or other countries.
For additional information about ST trademarks, please refer to www.st.com/trademarks.
All other product or service names are the property of their respective owners.

life.augmented

Additional information

life.augmented

Selecting the right MCU/MPU

life.augmented

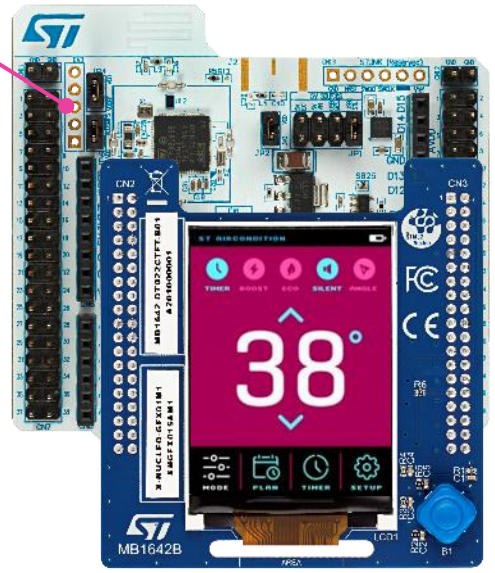
Featured STM32 MCUs for graphics - detailed

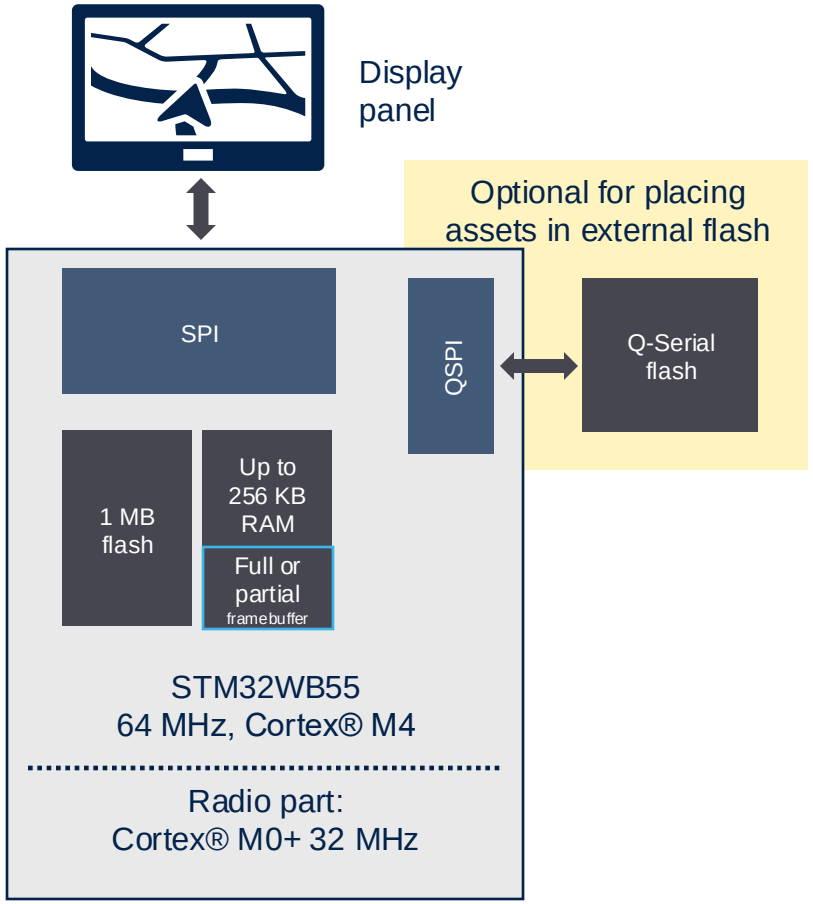
Graphic performance	Up to 1280*800			Up to 1280*720		Up to 800*480		Up to 480*320			Up to 320*240
	ADVANCED to MEDIUM GUI						MID LEVEL		ENTRY-LEVEL		
Framebuffer placement	External			Internal							
Display interface	RGB-TFT	RGB-TFT	MIPI-DSI RGB-TFT	RGB-TFT NEW	RGB-TFT MIPI-DSI	RGB-TFT	Parallel SPI	Parallel SPI	SPI	SPI	SPI
STM32 MCU	**STM32H7R/S**	**STM32H750**	**STM32H747**	**STM32N6**	**STM32U5F/G9**	**STM32H7A/B**	**STM32H5**	**STM32U575**	**STM32U0**	**STM32C0**	**STM32WB**
Main features	CM7, 600 MHz 620 KB SRAM 64 KB flash	CM7, 480 MHz 1 MB SRAM 128 KB flash	CM7+CM4, 480 MHz 1 MB SRAM 2 MB flash	CM55, 800MHz 4.2 MB SRAM	CM33, 160 MHz Max 3 MB RAM Max 4 MB flash	CM7, 280 MHz 1.400 KB RAM 2.048 KB flash	CM33, 250 MHz Max 640 KB RAM Max 2 MB flash	CM33, 160 MHz 784 KB RAM 2 MB flash	CM0+, 56 MHz Max 40 KB RAM Max 256 KB flash	CM0+, 48 MHz 36 KB RAM 256 KB flash	CM0+, 64 MHz Max 256 KB RAM Max 1 MB flash
Framebuffer details	Double in external 16/32 SDRAM or 200MHZ x8/x16 serial RAM	Double in external 16/32 SDRAM or x8 serial RAM	Double in external 16/32 SDRAM or X8 serial RAM	Double in internal SRAM up to 1280x720	Double in int Ram up to 800*480 Single in int: >800x480	Double in int. SRAM up to 480x320	Partial/Single/ double in internal RAM	Partial/Single/ double in internal RAM	Partial internal RAM	Partial internal RAM	Partial/single in internal RAM
Asset storage (flash memory)	External QSPI/OSPI/HSPI	External QSPI/OSPI	External QSPI/OSPI	external in QSP/OctoSPI	Inernal/External QSPI/OSPI/HSPI	Internal/External QSPI/OSPI	Internal/external SPI/QSPI/OSPI	Internal/ external QSPI	External SPI flash	External SPI flash	Internal/external QSPI flash
Graphic accelerators	NeoChrom GPU Chrom-GRC JPEG CODEC	Chrom-ART JPEG CODEC	Chrom-ART JPEG-CODEC	NeoChrom GPU Chrom-ART Chrom-GRC JPEG-CODEC	NeoChromVG GPU Chrom-ART Chrom-GRC JPEG-CODEC	Chrom-ART Chrom-GRC JPEG CODEC	NA	Chrom-ART	NA	NA	NA
Main Differentiator	High-perf, external memories Lowest cost H7	External memories 1 MB RAM	MIPI-DSI Dual-core	High resolution advanced graphics with internal RAM- 4.2 MB	Vector graphics ULP Large memory for single chip solution	Large SRAM for internal FB	Low cost Large memory for single chip solution	Ultra-low power Large memory for single chip solution	Ultra low power with internal RAM only	Ultra low cost with internal RAM only	Wireless + GFX

STM32WB55
Entry-level graphics on wireless MCU

Displays up to 4.3” and up to 480x272

- **NUCLEO-WB55RG + X-NUCLEO-GFX01M2**
  - 2.2” SPI QVGA 320x240 display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX Board setup
  - Note:
    TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)





No external RAM due to partial framebuffer

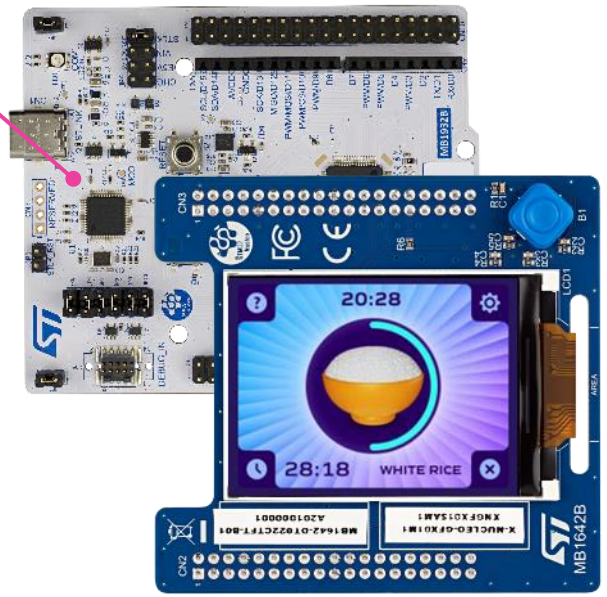
STM32U0
Entry-level graphics with ULP MCU

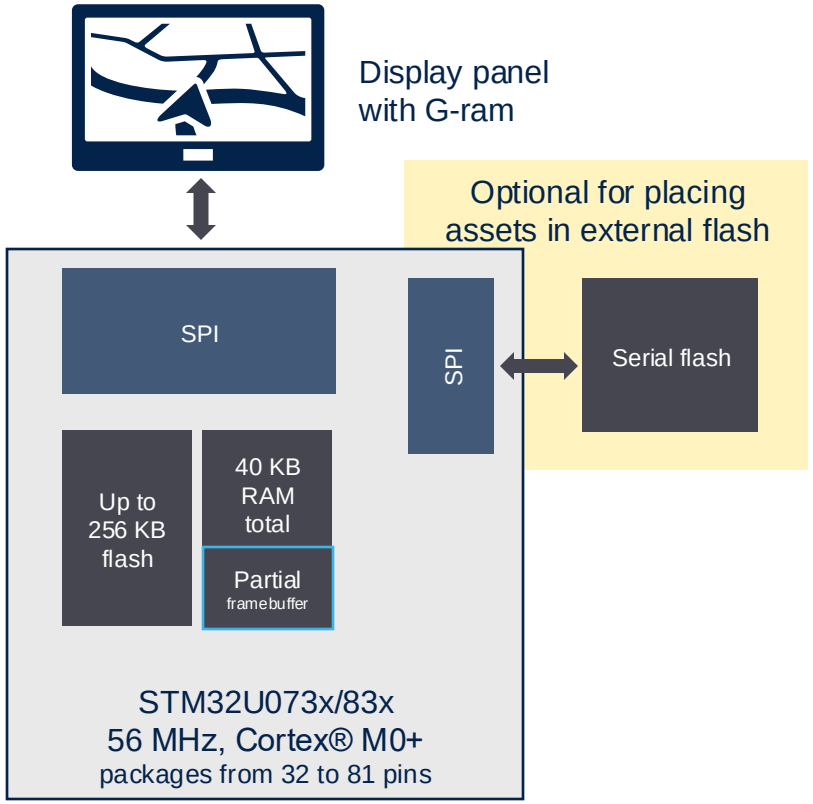
Displays up to 3.5” and up to 320x240

- **NUCLEO-U083RC + X-NUCLEO-GFX01M2**
  - 2.2” SPI QVGA 320x240 display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX Board setup
  - Note: TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)

STM32U0 running the rice cooker demo:

- Flash Internal: 102 KB (TouchGFX app Code)
- SPI flash External: 880 KB (GFX assets)
- Internal RAM: 20.8 KB (Partial framebuffer + TouchGFX)





No external RAM due to partial framebuffer

STM32C0
Entry-level graphics with cost-effective MCU

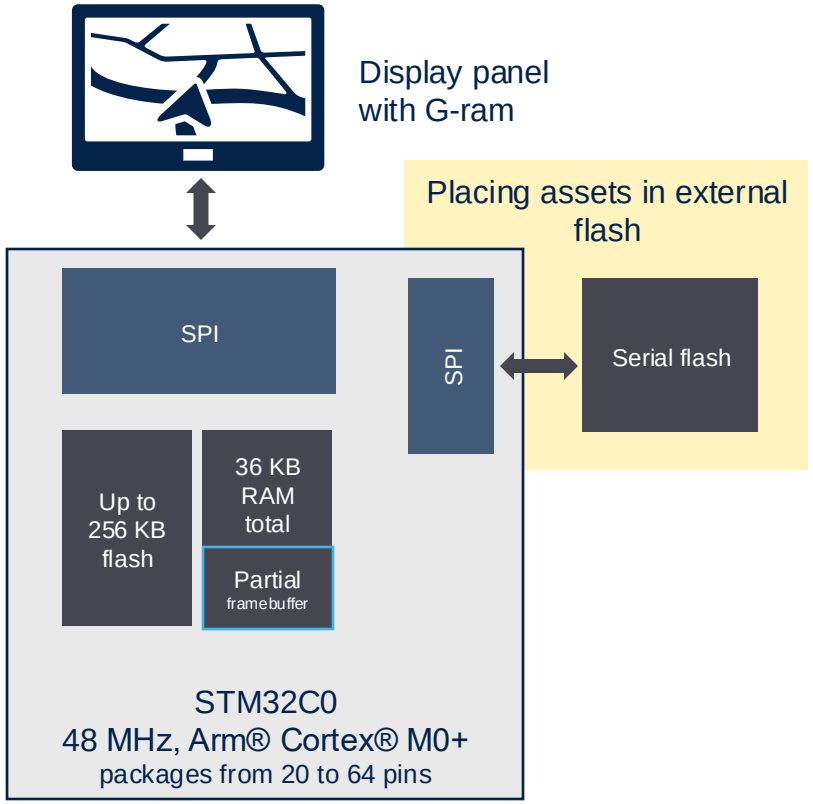
Displays up to 3.5” - 320 x 240

- **NUCLEO-C092RC + RVA15MD-NUC64A** (from Riverdi)
  - 1.5” SPI 240x240 touch display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX Board setup
  - Note: TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)

STM32C0 running demo 8:

- Flash internal: 19 KB (TouchGFX app + text)
- SPI flash external: 551 KB (GFX assets)
- Internal RAM: 18 KB (partial framebuffer (6 K) + TouchGFX (12k)

Demo 8: Three screens

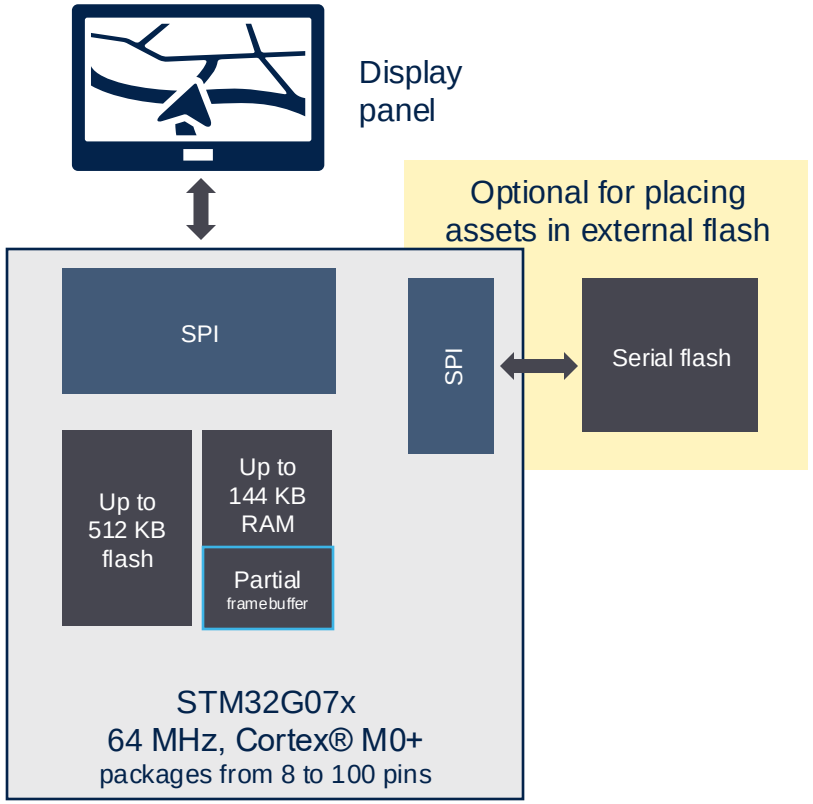


No external RAM due to partial framebuffer

STM32G07x
Entry-level graphics on cost-effective MCU

Displays up to 3.5” and up to 320x240

- **NUCLEO-G071RB + X-NUCLEO-GFX01M2**
  - 2.2” SPI QVGA 320x240 display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX Board setup
  - Note:
    TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)

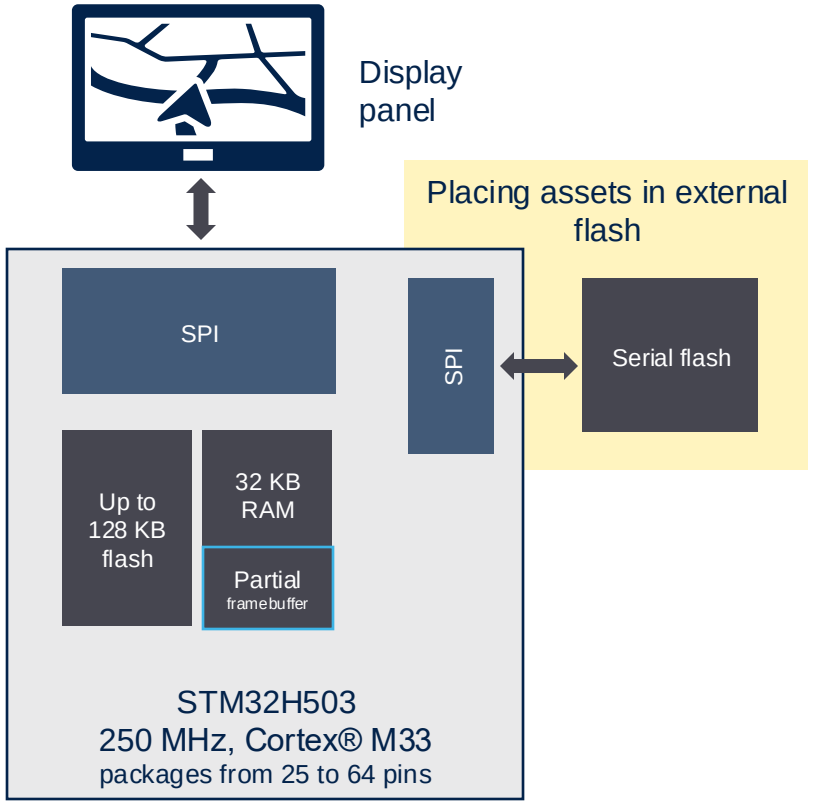


No external RAM due to partial framebuffer

STM32H503
Entry-level graphics on low cost MCU

Displays up to 3.5” and up to 320x240

- **NUCLEO-H503RB + X-NUCLEO-GFX01M2**
  - 2.2” SPI QVGA 320x240 display
- **TouchGFXDesigner**
  - Board specific demos in full source
  - TouchGFX Board setup
  - Note:
    TouchGFX GUI footprint starting from 50 KB of flash memory and 16 KB of RAM (including partial framebuffer)



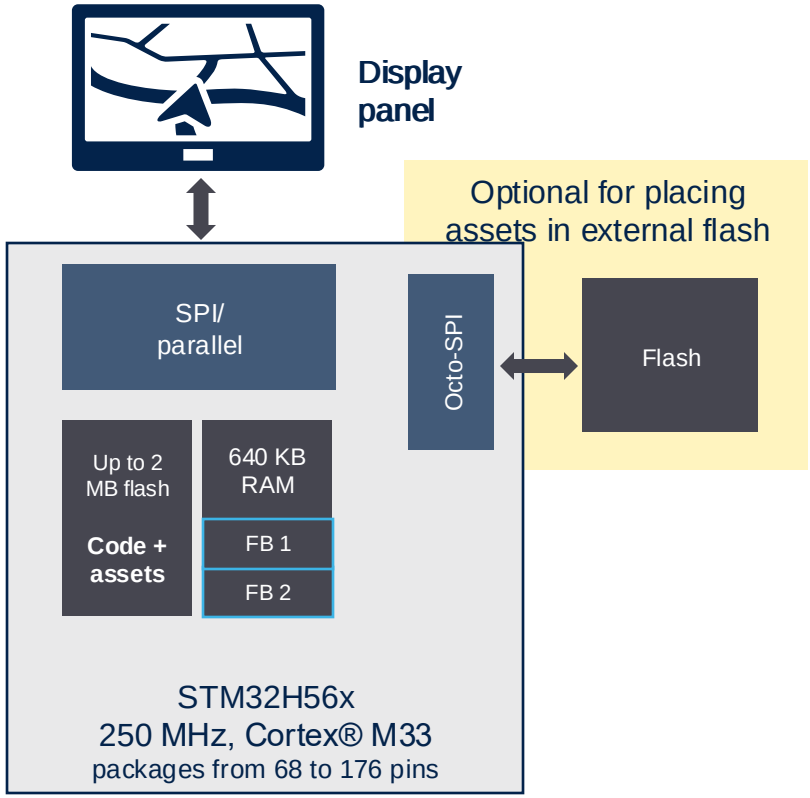
No external RAM due to partial framebuffer

Midlevel graphics on optimum cost/performance MCU STM32H56x

Displays up to 4.3” - Approx. 480x320

- **STM32H573I-DK**
  - 1.54" 240×240 touch
  - Preloaded TouchGFX demo
- **TouchGFXDesigner**
  - Demo 4 in full source
  - TouchGFX Board setup

- **NUCLEO-H563ZI+ Riverdi RVA35HI-NUCLEO144A**
  - Riverdi Nucleo 144 Display kit: 3.5” parallel 480x320 IPS display, PCAP touch
  - 8 MB QSPI flash
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup

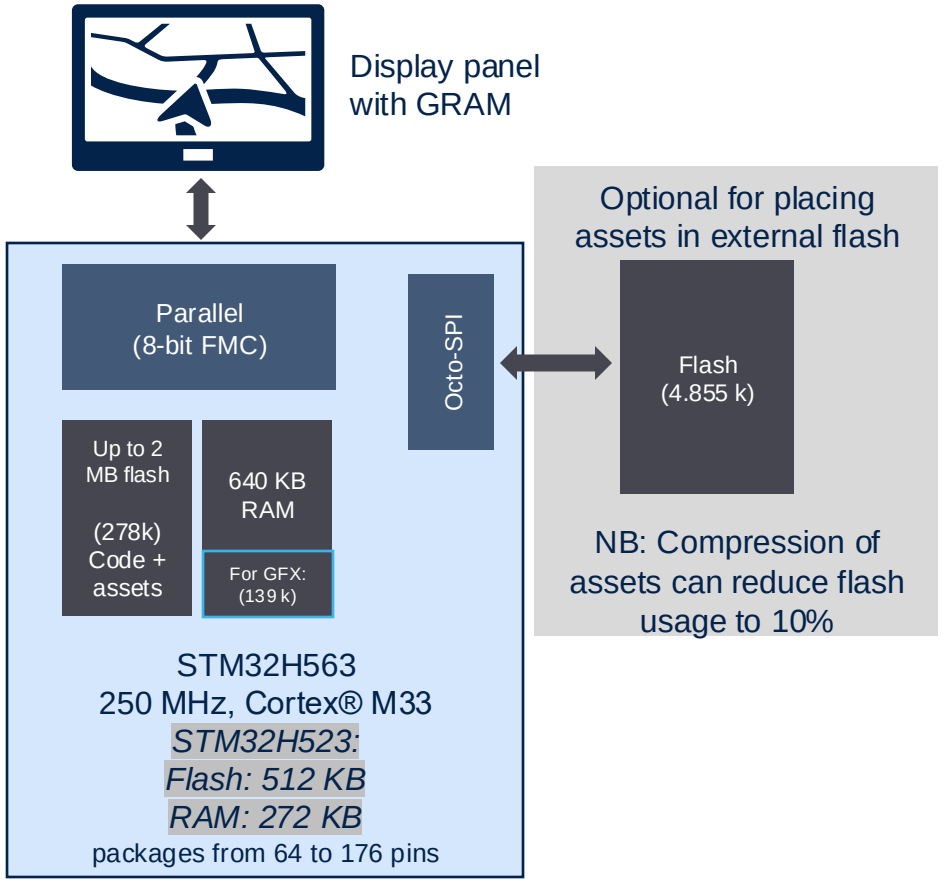


NO external memory needed

Memory setup and footprint for Midlevel graphics on STM32H563/523

Displays up to 4.3” - Approx. 480x320

- **NUCLEO-H563ZI+ Riverdi RVA35HI-NUCLEO144A**
  - Riverdi Nucleo 144 Display Kit: 3.5” Parallel 480x320 IPS display, PCAP touch
  - 8 MB QSPI flash
- **TouchGFXDesigner**
  - TouchGFX Board setup
  - Demo in full source
    Memory footprint:
    - Internal RAM: 139 KB
      - 16 bpp partial framebuffer: 51k
      - FreeRTOS™: 50k
      - TouchGFX demo app: 38k
    - Flash Internal, TouchGFX demo app 278k
    - Flash external, Assets 4.855k



Partial framebuffer strategy
NO external memory needed

Midlevel graphics on ultra-low-power MCU STM32U575

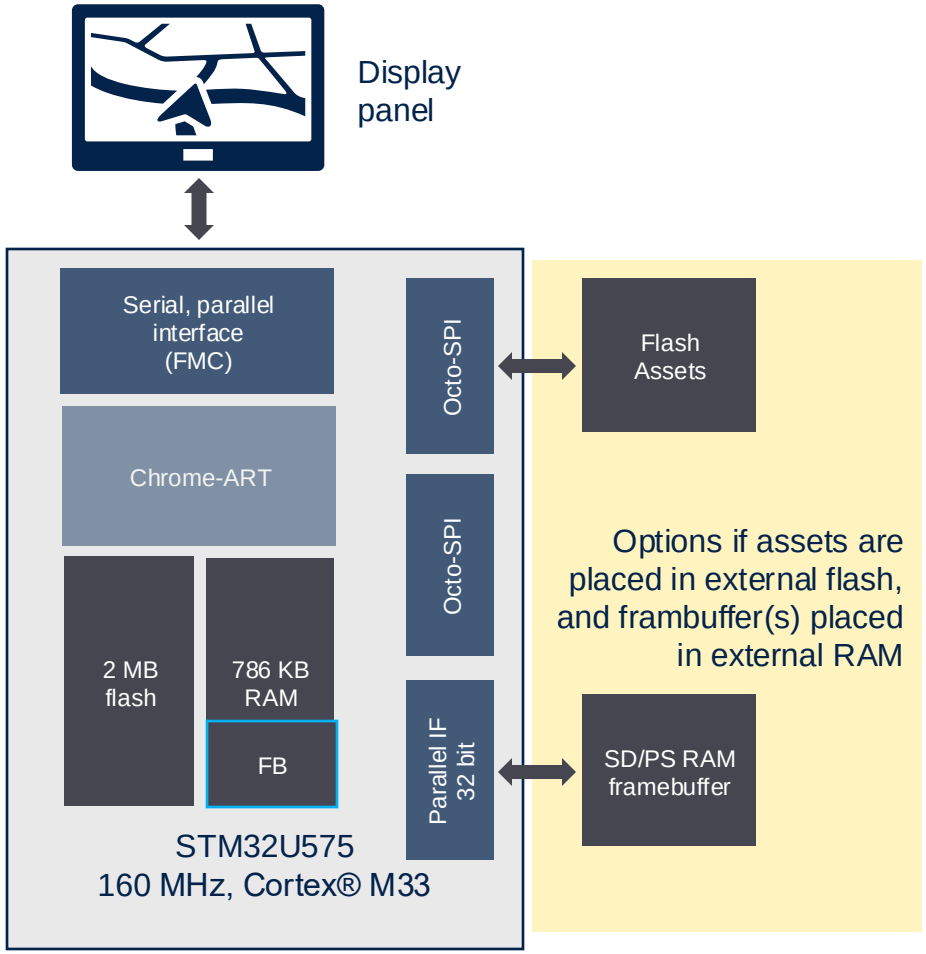
Displays up to 4.3” - Approx. 480x320

NUCLEO-U575ZI-Q + X-NUCLEO-GFX02Z1
- 2.2” parallel QVGA 320x240 display

- **TouchGFXDesigner**
  - Demos in full source
  - TouchGFX Board setup

- **NUCLEO-U575ZI-Q + Riverdi RVA35HI-NUCLEO144A**
  - Riverdi Nucleo 144 display kit: 3.5” parallel 480x320 IPS display
  - Cap. touch

- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup

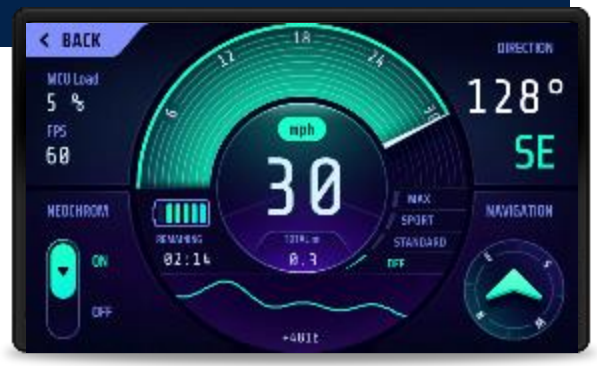


NO external memory needed

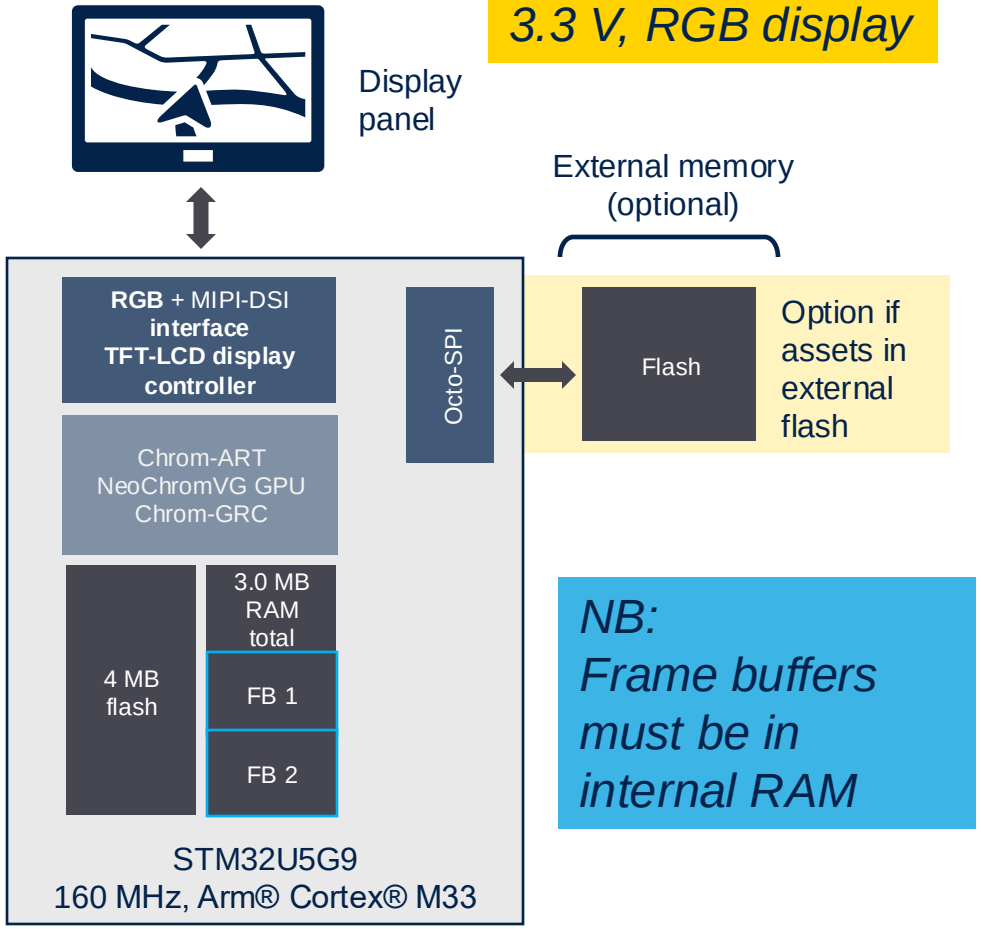
Advanced Graphics on ULP MCU STM32U5F9/G9

Displays up to 7” - Approx. 800x480

- **STM32U5G9J-DK2**
  - 5” WVGA, RGB 800x480 display
  - STM32U5F9 in LQFP144 pack
  - Preloaded TouchGFX demo
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup



Target: industrial, 3.3 V, RGB display



NB: Frame buffers must be in internal RAM

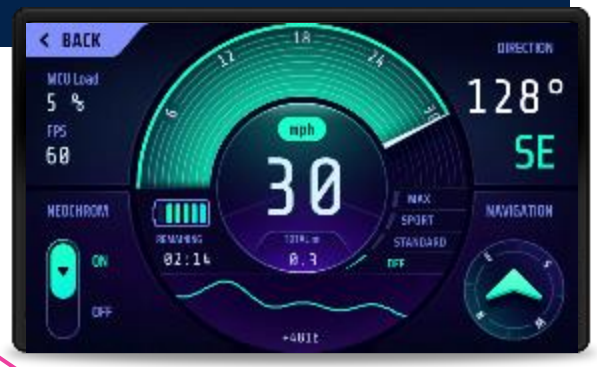
NO external memory needed

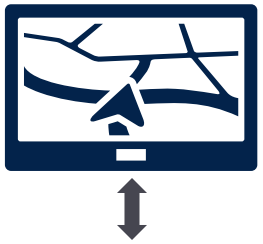
life.augmented

Advanced Graphics on ULP MCU STM32U5F9/G9

Displays up to 7” - Approx. 800x480

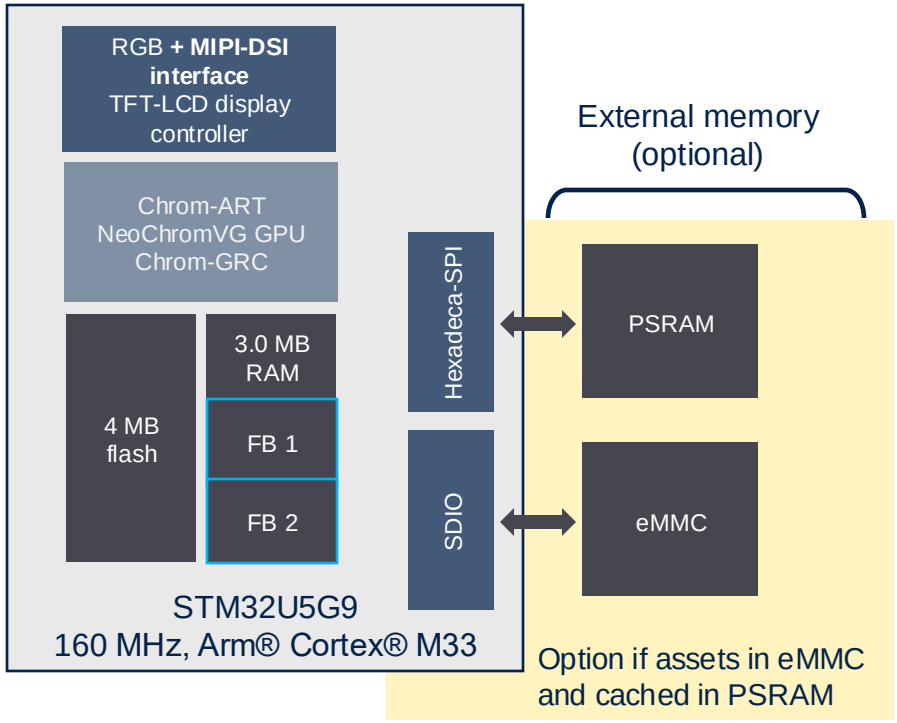
- **STM32U5G9-DK1**
  - 2.5” round 480x480 MIPI-DSI display – video mode
  - STM32U5F9 in TFBGA 216
  - Preloaded TouchGFX demo
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup





Display panel

Target: consumer, ULP, 1.8 V, MIPI-DSI display



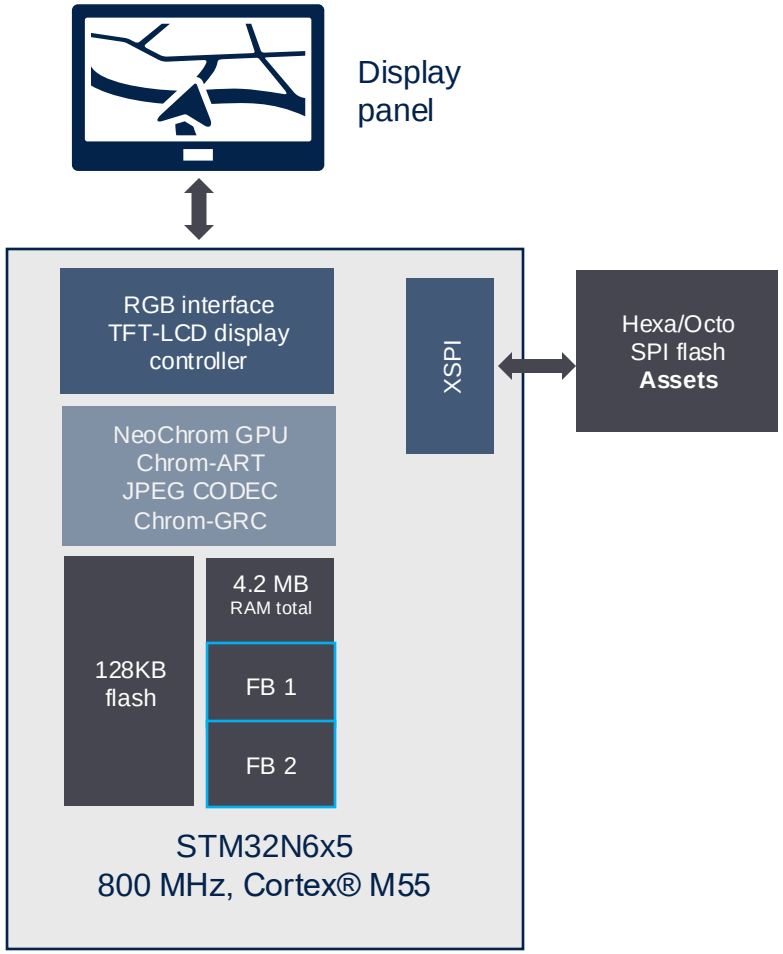
NB: Frame buffers must be in INTERNAL RAM

High resolution advanced graphics with INTERNAL RAM STM32N6x5 (General purpose line)

Displays up to 12” / 1280x720 resolution

- **Display resolution up to**
  - 1280x720 16-bit color
  - 1024x600 24-bit color

- **STM32N6750-DK**
  - 5” WVGA, 800x480 display
  - Preloaded TouchGFX demo, Available as binary
- **TouchGFXDesigner**
  - Various demos are available
  - TouchGFX Board setup

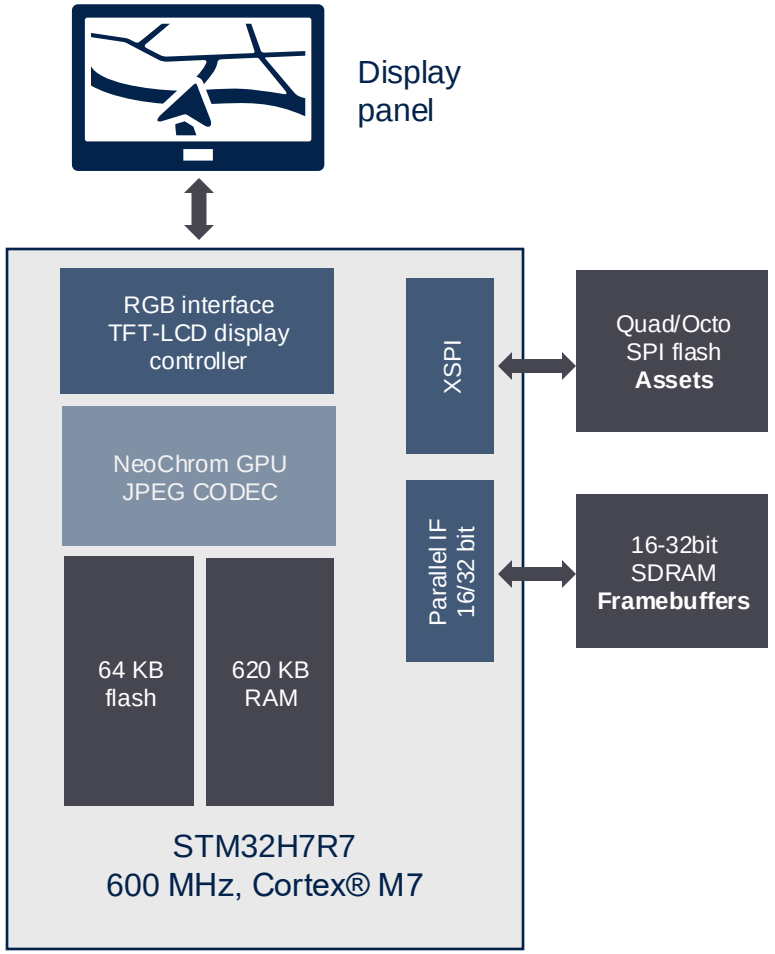


life.augmented

Advanced graphics with external RAM STM32H7R7 with SDRAM

Displays up to 10.1” - Approx. 800x480 / 1280x800

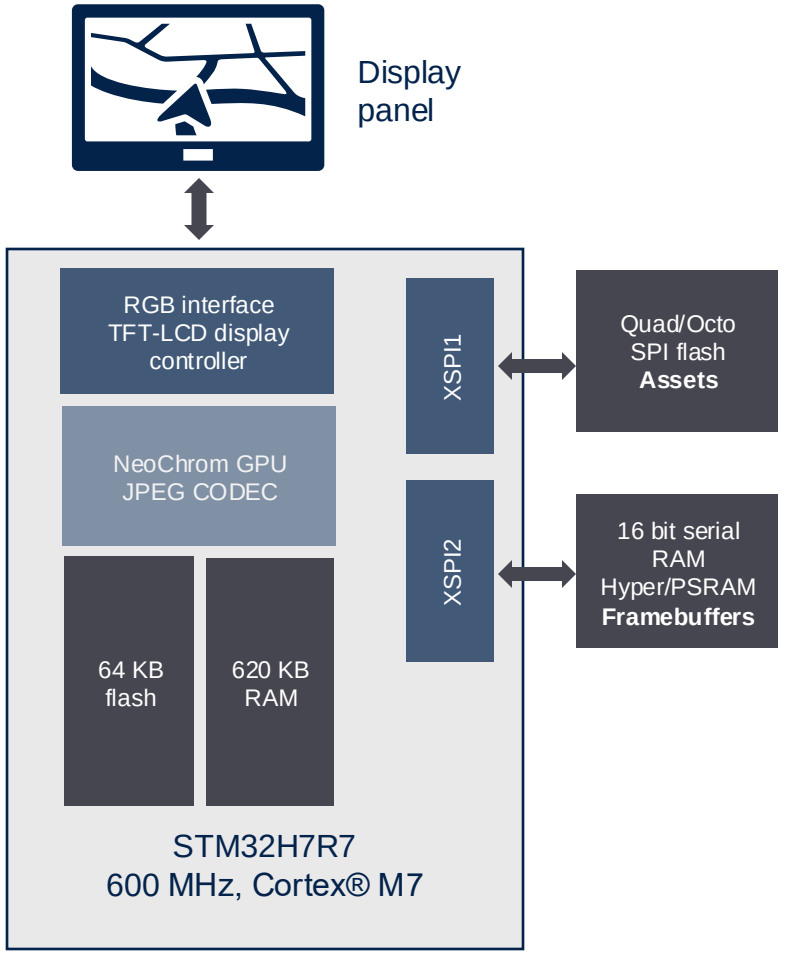
- **STM32H7S78-DK**
  - 5” WVGA, 800x480 display
  - Preloaded TouchGFX demo
  - LQFP to BGA
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup
- **Memory**
  - OctoSPI flash
  - Hexadeca SPI Serial RAM



Advanced graphics with external RAM
STM32H7R7 with Serial RAM

Displays up to 10.1” - Approx. 800x480 / 1280x800

- **STM32H7S78-DK**
  - 5” WVGA, 800x480 display
  - Preloaded TouchGFX demo
  - LQFP to BGA
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup
- **Memory**
  - OctoSPI flash
  - Hexadeca SPI Serial RAM

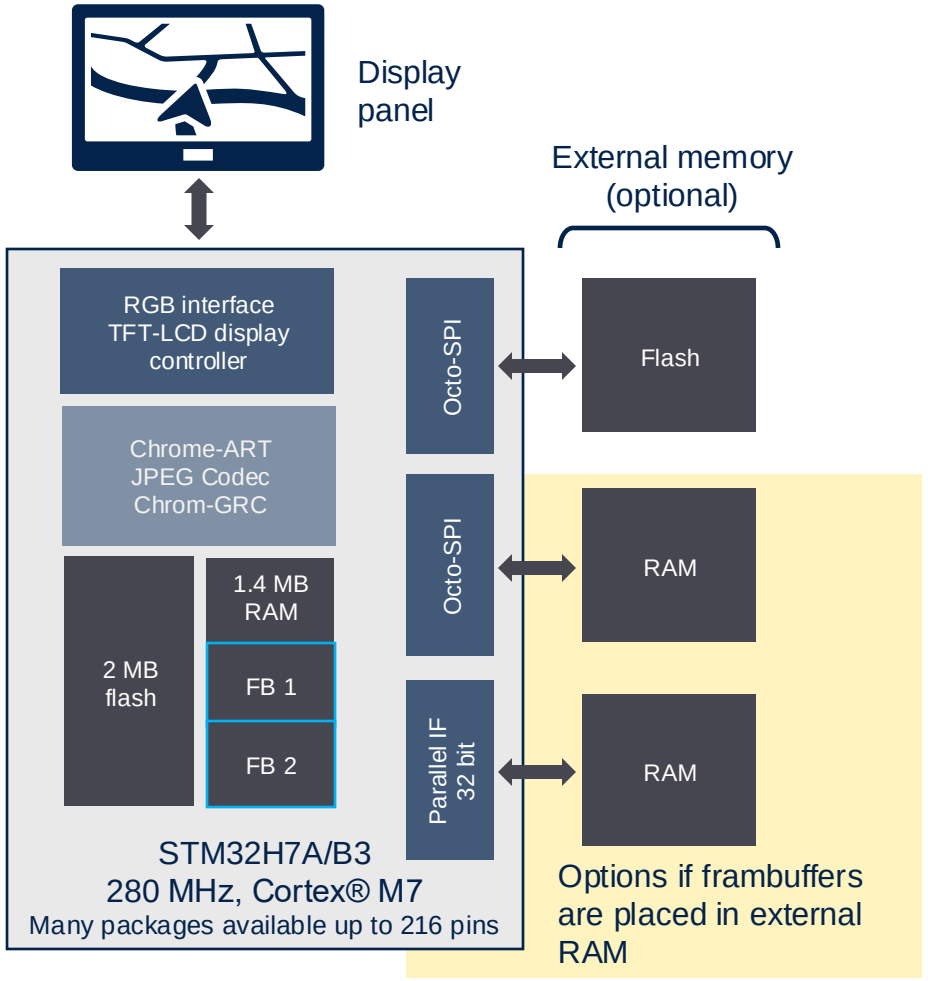


life.augmented

Advanced graphics with internal RAM only STM32H7A/B3/B0

Displays up to 5” - Approx. 480x320 in 24 bpp

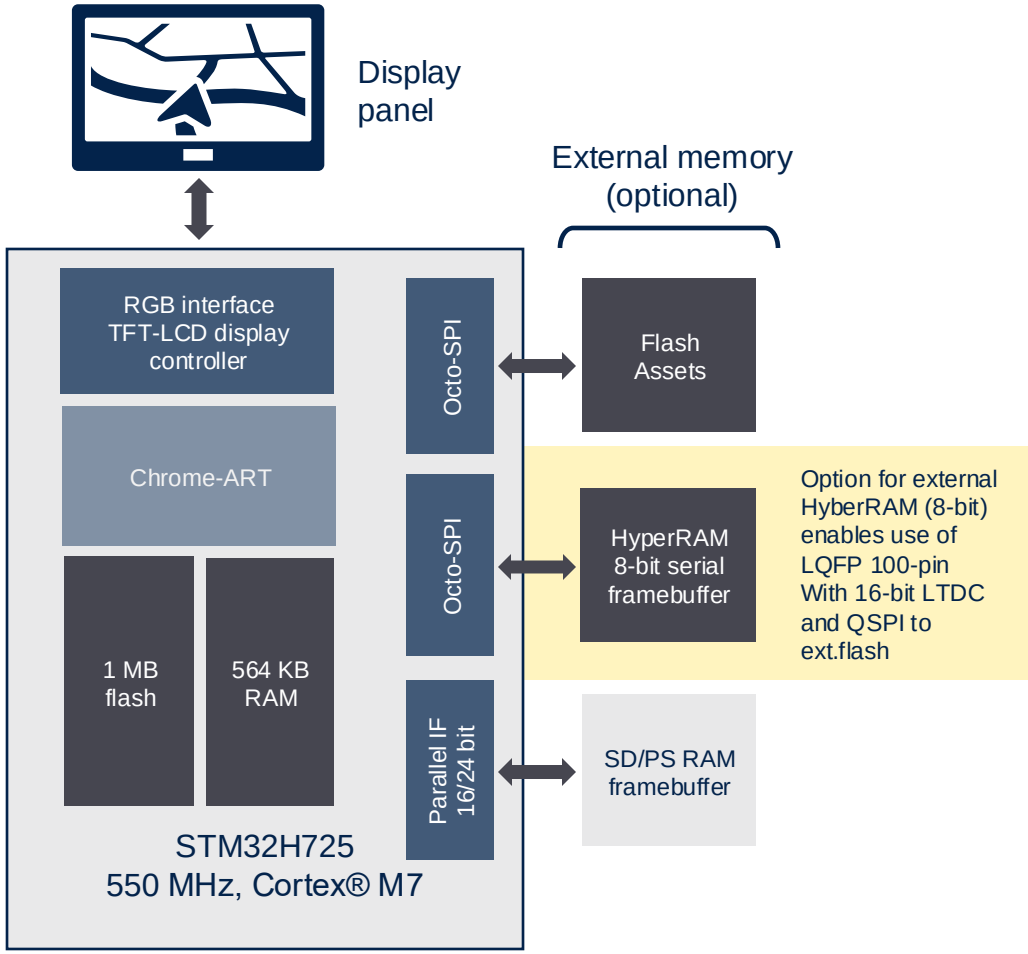
- **STM32H7B3I-DK**
  - 4.3” WQVGA, 480x272 display
  - Preloaded TouchGFX demo
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup



Advanced graphics with external RAM STM32H723/H725/H730

Displays up to 7” - Approx. 800x480 / 1024x600

- **STM32H735G-DK**
  - 4.3” WQVGA, 480x272 display
  - Preloaded TouchGFX demo
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup

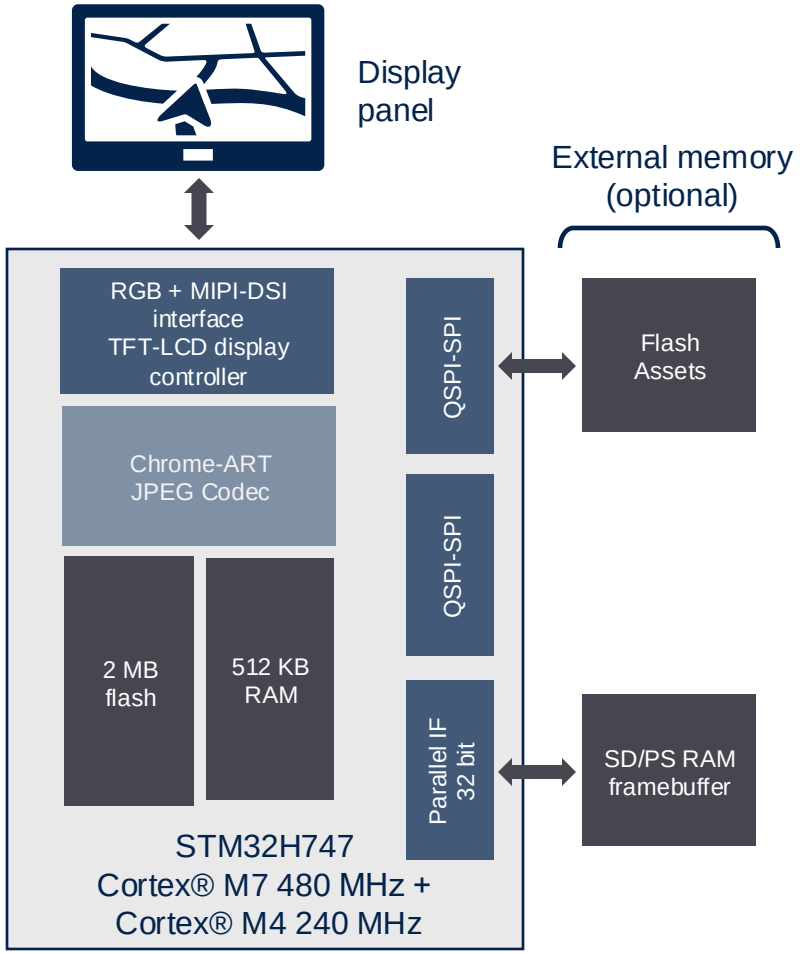


life.augmented

Advanced graphics with MIPI-DSI display interface STM32H747/H750

Displays up to 7” - Approx. 800x480 / 1024x600

- **STM32H747I-DK**
  - 4” WVGA, 800x480 display
  - Preloaded TouchGFX demo
- **TouchGFXDesigner**
  - Demo in full source
  - TouchGFX Board setup



life.augmented

Fill the form

UI specification project

	Parameter	UI specification	Comments
Display	*Type, size, resolution, interface, Ram embedded?*		
UI performance	*Color depth, Basic, full screen transition, cool animations.*		
Power constrains	*Battery driven*		
CPU tasks	*Only graphics, no other features*		
RAM memory	*External RAM available*		
Flash memory	*External flash available Type*		
Volume, Cost			

life.augmented

Fill the form

CPU selection – Project

CPU	Pros	Cons	Developer kits
STM32H7A/B 1 MB RAM JPEG Codec 250 MHz			STM32H7B3I-DK 4.3” 480x272 cap touch TouchGFX OOB supported
STM32H723/25 550 MHz. Octo-SPI. Cost optimized for graphics			STM32H735G-DK 4.3” 480x272 cap touch TouchGFX OOB supported *JHD Display: 7” 800x480 soon available*
STM32H745/747 Dual core. JPEG Codec. MIPI-DSI			STM32H747I-DISCO 4” 800x480 cap touch, MIPI-DSI TouchGFX OOB supported
STM32H750 JPEG Codec. Value line, bootflash only			STM32H7B3I-DK 4.3” 480x272 cap touch TouchGFX OOB supported

life.augmented

Where STM32 supports your GUI development

DISCOVERY KITS

Display
Touch
Lens
View Angle
...

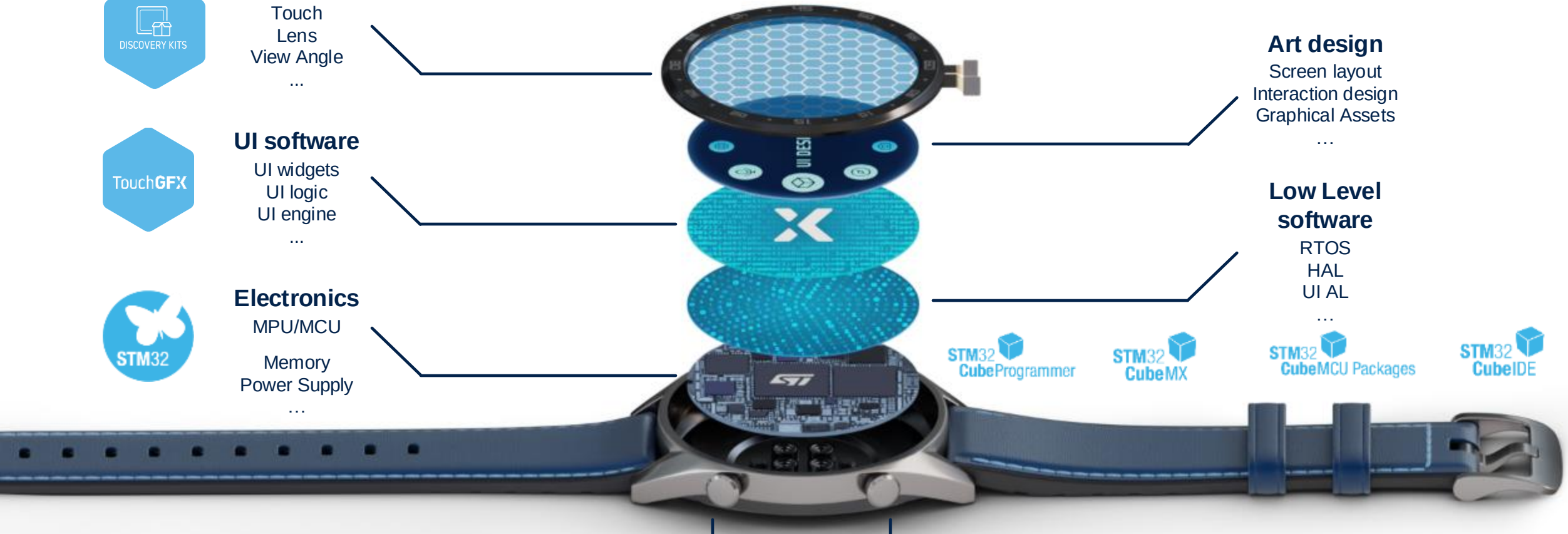
TouchGFX

UI software
UI widgets
UI logic
UI engine
...

STM32

Electronics
MPU/MCU

Memory
Power Supply
...



Art design
Screen layout
Interaction design
Graphical Assets
...

Low Level software
RTOS
HAL
UI AL
...

STM32 CubeProgrammer
STM32 CubeMX
STM32 CubeMCU Packages
STM32 CubeIDE

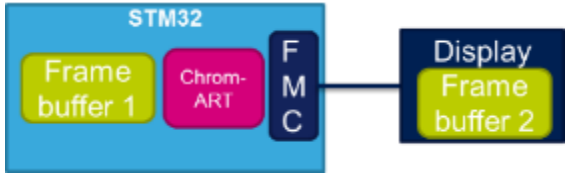
Mechanics
Casing
Plugs
Buttons
...

life.augmented

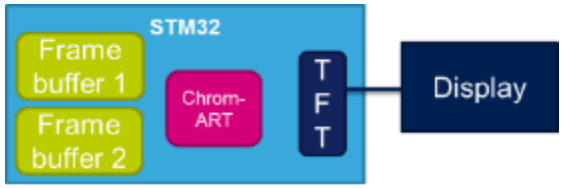
Advanced Graphic MCU Portfolio

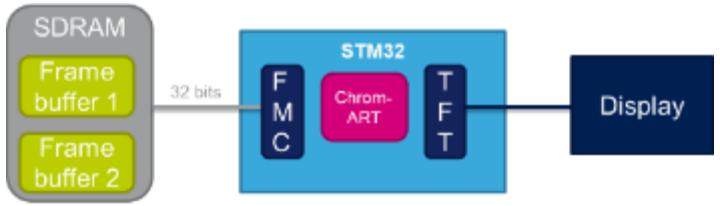
Support for a wide range of display interfaces

- Intel 8080 and Motorola 6800 LCD interfaces for small resolutions

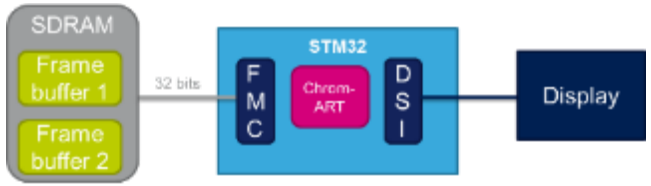


- TFT controller for medium resolutions (up to XGA) and new generation MIP low power displays





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



AN4861 Application note
LCD-TFT display controller (LTDC) on STM32 MCUs

2.2 LTDC and graphic portfolio across STM32 MCUs

The table below summarizes the STM32 MCUs embedding an LTDC and details the corresponding available graphic portfolio.

Table 3. STM32 MCUs embedding an LTDC and their available graphic portfolio

Device	FLASH (bytes)	On chip SRAM (bytes)	Quad-SPI(1)	Octo -SPI	Max AHB/AXI frequency (MHz)(2)	Max FMC SRAM and SDRAM frequency (MHz)	Max Octo-SPI frequency (MHz)	Max pixel clock (MHz) (3)	JPEG codec	DMA2D (4)	MIPI-DSI host (5)	Graphic libraries
STM32 F429/439	Up to 2 M	256 K	No	No	180	90	-	83	No	Yes	No	TouchGFX embedded wizard SEGGER STemWin
STM32 F469/479	Up to 2 M	384 K	Yes	No	180	90	-	83	No	Yes	Yes	
STM32 F7x6	Up to 1 M	320 K	Yes	No	216	100	-	83	No	Yes	No	
STM32F7x7	Up to 2 M	512 K	Yes	No	216	100	-	83	Yes	Yes	No	
STM32 F7x8/9	Up to 2 M	512 K	Yes	No	216	100	-	83	Yes	Yes	Yes	
STM32H7A3/B3	Up to 2 M	1.4 M	No	Yes	280	110	140	140	Yes	Yes	No	
STM32H7B0	128 K	1.4 M	No	Yes	280	110	140	140	Yes	Yes	No	
STM32H742/43/45/53/55	Up to 2 M	1 M	Yes	No	240	110	-	150	Yes	Yes	No	
STM32H747/57	Up to 2 M	1 M	Yes	No	240	110	-	150	Yes	Yes	Yes	
STM32H750	128 K	1 M	Yes	No	240	110	-	150	Yes	Yes	No	
STM32L4P/Q	Up to 1 M	320 K	No	Yes	120	60	92	83	No	Yes	No	
STM32L4R/S	Up to 2 M	640 K	No	Yes	120	60	86	83	No	Yes	Yes	

1. The Quad-SPI and Octo-SPI interfaces allow interfacing with external memories in order to extend the size of the application. Refer to the application notes *Quad-SPI interface on STM32 microcontrollers and microprocessors* (AN4760) and *Octo-SPI interface on STM32 microcontrollers* (AN5050) for more details.
2. LTDC fetches graphical data at AHB/AXI speed.
3. Maximum pixel clock value at I/O level, refer to *Table 10* to *Table 15* for maximum pixel clock at system level. Pixel clock (LCD_CLK) form relevant STM32 datasheet.
4. Chrom-Art Accelerator
5. The integrated MIPI-DSI controller allows easier PCB design with fewer pins, lower EMI (electromagnetic interference) and lower power consumption. For more details on STM32 MIPI-DSI host refer to application note (AN4860).

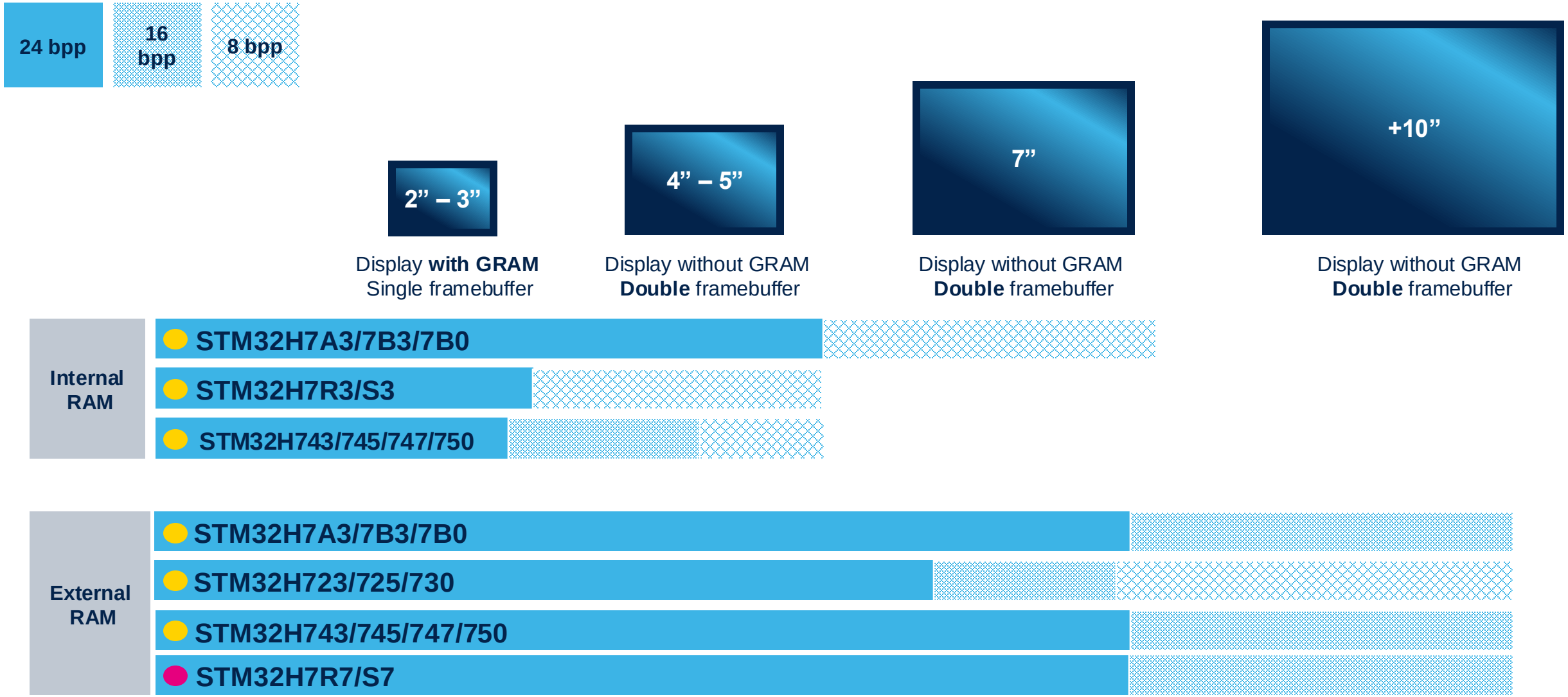
life.augmented

Display resolution, color depth and framebuffer size

resolution→

bpp ↓ 1 BUFFER SIZE (Kbytes) ↘	CGA (320x200)	QVGA (320x240)	WQVGA (480x272)	HVGA (480x320)	VGA (640x480)	WVGA (800x480)	SVGA (800x600)	XGA (1024x768)
1 (2 colors)	7.8	9.4	15.9	18.8	37.5	46.9	58.6	96.0
2 (4 colors)	15.6	18.8	31.9	37.5	75.0	93.8	117.2	192.0
4(16 colors)	31.3	37.5	63.8	75.0	150.0	187.5	234.4	384.0
8 (256 colors)	62.5	75.0	127.5	150.0	300.0	375.0	468.8	768.0
16 (high color)	125.0	150.0	255.0	300.0	600.0	750.0	937.5	1536.0
24 (true color)	187.5	225.0	382.5	450.0	900.0	1125.0	1406.3	<20FPS
32 (deep color)	250.0	300.0	510.0	600.0	1200.0	1500.0	<20FPS	<20FPS

Enhanced graphic UI for any resolution



NeoChrom GPU

Chrom-ART

NeoChrom GPU
New STM32 graphics 2.5D accelerator

Note: All features are out of the box supported in TouchGFX except light blue marked

Graphic feature	Chrom-ART	NeoChrom GPU	NeoChrom VG GPU
Color formats	• 32 bit: ARGB8888 • 16 bit: RGB888, RGB565, ARGB4444, ARGB1555, AL88 • 8 bit: L8, A8 • 4 bit: A4, AL44, • YUV (read only)	• 32 bit: RGBA8888, ARGB8888, RGBX8888, XRGB8888 • 16 bit: RGB888, RGB565, RGBA5551 • 8 bit: L8, A8, • 4 bit: A4, L4 • 2 bit: A2, L2 • 1 bit: A1	As NeoChrom GPU
Compression formats	• CLUT (256 entry)	• TSc4 (4 bits per pixel) • TSc6 and TSc6A(b bits per pixel with/out alpha	
Command list based		Yes	
Drawing	Rectangle filling	Rectangle filling pixel, line, triangles, quadrilaterals drawing 8xMSAA antialiasing	
Blitting	Copy Alpha blending Pixel format conversion	Copy Alpha blending, Color keying Pixel format conversion	
Texture mapping		Any angle rotation, Scaling, Mirroring 3D perspective correct projections Texture mapping with bilinear and point sampling	
Vector operations		Polygons, Bezier curves and lines. Linear gradients, bitmap, and solid color fill. Software assisted	As NeoChrom GPU Hardware accelerated