

基于NXP i.MX RT系列MCU的边缘AI一站式解决方案 ——RT117H, RT117F

李玉婷/吴建斌
恩智浦半导体 边缘处理事业部
AUGUST 2022



SECURE CONNECTIONS
FOR A SMARTER WORLD

PUBLIC

NXP, THE NXP LOGO AND NXP SECURE CONNECTIONS FOR A SMARTER WORLD ARE TRADEMARKS OF NXP B.V.
ALL OTHER PRODUCT OR SERVICE NAMES ARE THE PROPERTY OF THEIR RESPECTIVE OWNERS. © 2022 NXP B.V.



边缘AI

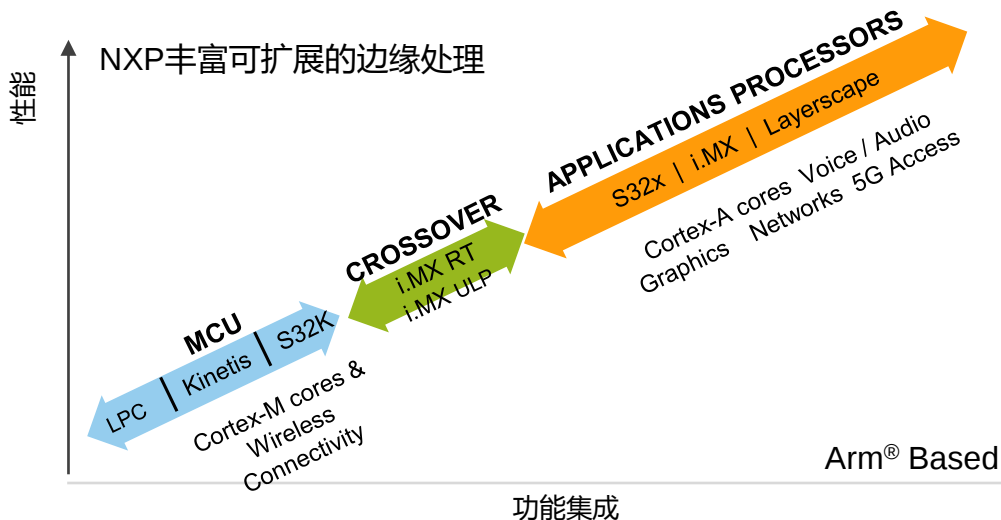
为什么从云端到边缘迁移

带宽
延迟
隐私

算力->硬件平台

AI 开发、训练、量化、部署、运行

智能化
实时性
更低成本
加强隐私
高可用性
持续改进



MCU-Based: 实时、功耗、成本

eIQ Software Environments

EdgeReady Solutions

DIY	Fully Tested
 eIQ™ Toolkit and Inference engine	 Turnkey Solution

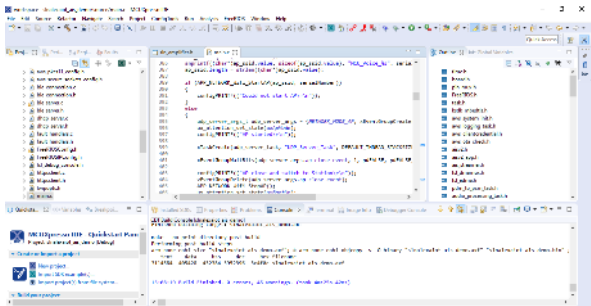
NXP EDGEREADY 一站式解决方案:接近量产, 认证合格

- 接近量产级别的硬件设计
 - 成本和硬件设计优化
- 预先集成的量产级别软件
 - 经过充分验证和认证
 - 提供源码
 - 除了 ML/AI IP
 - 远场语音前端
 - 语音识别
 - 人脸/手势识别
 - 活体检测
- NXP 一站式技术支持和授权
- 即插即用的开箱操作体验

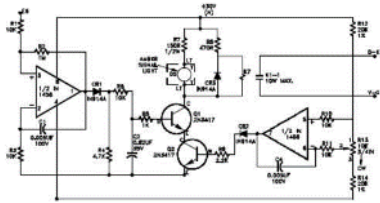
O O B H W / S W



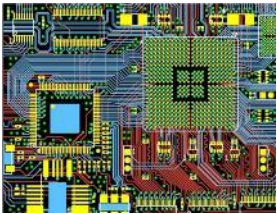
S O F T W A R E S O U R C E



S C H E M A T I C S



L A Y O U T S



C E R T I F I C A T I O N S



B O M S

U1	MIMXRT1052DVL6B	i.MXRT1050 Cross Processor
U3	W9812G6JB-6I	128Mbit SDRAM 3V 166MHz
U4	IS26KL256S-DABUQ	256Mb Hyperflash 3V 100MHz Fla
U5	A7101CHTK2	Secure IoT/Authentication Conn
U6	LBEE5KL1DX-883	IC WIFI BT/BLE B/G/N 3-4.8V LGA
U7	MKW21Z512VHT4	KINETIS L 32-BIT MCU CORTEx-M
U8,U9	NX3L2267GM,115	IC ANALOG SWITCH SPDT 10XQF
U10	XCL214B333DR	DC/DC CONVERTER 3.3V 5W

D O C U M E N T A T I O N



NXP EDGEREADY TURNKEY AND PLATFORM SOLUTIONS ROADMAP

Launched

Developing

Concept

Platform Solution

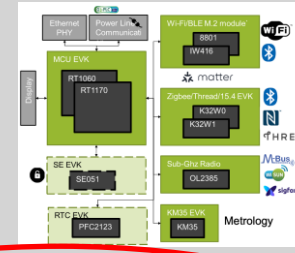
- ✓ Standard EP part number
- ✓ Solution kit based on EVK or purposed design
- ✓ Full design pack with HW/SW/Doc on nxp.com and Git
- ✓ Maintained and supported



Smart Access

LPC55, K32W, RT117F, IW416, QN9090, SR150

Scalable platform showcasing all NXP smart access technologies: Matter, UWB, Fingerprint, Face, NFC, etc.

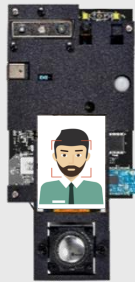


Connectivity Toolbox

i.MX RT1060/1170, K32W, IW416, KM35

Scalable platform with connectivity Software Packs for in-building, IoT and energy applications

EdgeReady Vision with Voice



SLN-VIZN3D-IOT

i.MX RT117F

3D Face Recognition with Liveness Detection
3D SLM & RGB Cameras



SLN-VIZNAS-IOT

i.MX RT106F

Offline Face Recognition with Liveness Detection, RGB + IR Cameras



SLN-TLHMI-IOT

i.MX RT117H

Smart Touchless HMI
ML Vision + Voice + Graphics UI

RGB+IR camera, 5.5" MIPI LCD

Face Recognition, Gesture Detection, Offline Voice Control, LVGL

Coffee Machine, Elevator, Smart Home Control APP

EdgeReady Voice



SLN-ALEXA-IOT

i.MX RT106A

Alexa for IoT
Frustration Free Setup
Alexa locales & smart home

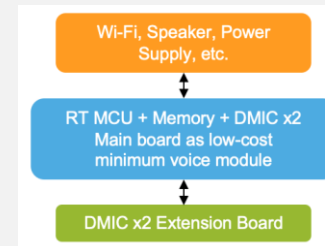


SLN-LOCAL2-IOT

i.MX RT106S/105S

Offline Voice Control, Phonemic Speech Models

- ✓ EP RSS part number
- ✓ Solution kit for sale
- ✓ Full design pack with HW/SW/Doc on nxp.com and Git
- ✓ Maintained and supported



SLN-SVUI-IOT

i.MX RT06V/P/C/105V

Smart Voice Control for IoT, VoiceSeeker as AFE with VIT/VoiceSpot/3P IP for offline or/and online voice control, including Alexa for IoT solution

Convergence from 106A and 106S to online/offline mixed Voice UI solution based on NXP voice IPs

Launched

Q1 2022

Q2 2022

Q3 2022

Q4 2022

PUBLIC

3



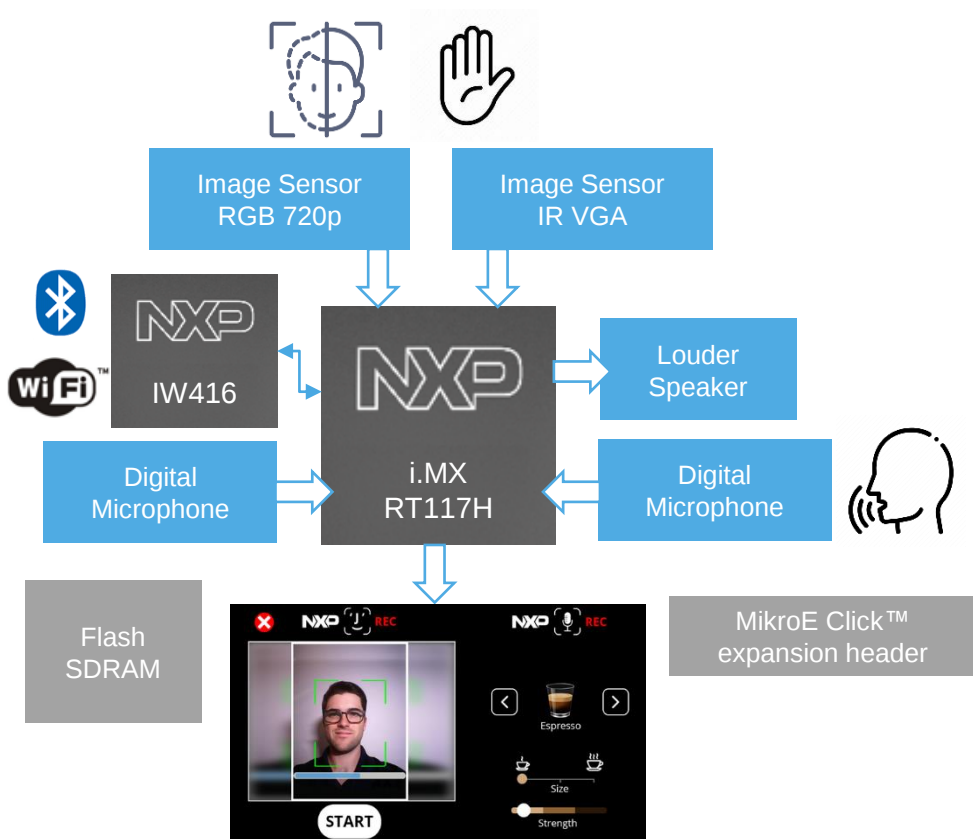
NXP RT117H MCU-BASED 一站式解决方案-智能非接触式HMI

Machine Vision, Voice Control and Graphics Display UI all on one MCU platform for Advanced and Innovative HMI

Value Proposition

Turnkey Solution to enable Intellectual HMI with **ML Vision**, **Voice** and **Graphics UI** implemented on **One** NXP Crossover MCU to simplify system design.

Cross-platform Framework under **dual core** architecture, rich middleware, complete AI algorithm and NXP one-stop-shop support, empower customer capability and flexibility to customize and focus on products design



Key Features

• Graphics Display User Interface

- 5.5-inch MIPI LCD display(1280*720)
- 2D graphics accelerator supported by LVGL
- GUI Demo for Coffee Machine, Elevator and Smart Home Panel

• Machine Vision

- 720P RGB and VGA IR image sensor
- User identification through face recognition
- Gesture control through palm shape recognition

• Voice Control

- 2 digital microphones on board and another 2 more through expansion
- VoiceSeeker to support acoustic echo cancellation, noise reduction, beamforming and barge-in
- VIT for wake word and local voice command (English, Mandarin)
- Cyberon for more languages' wake word and local voice command through 3rd Party

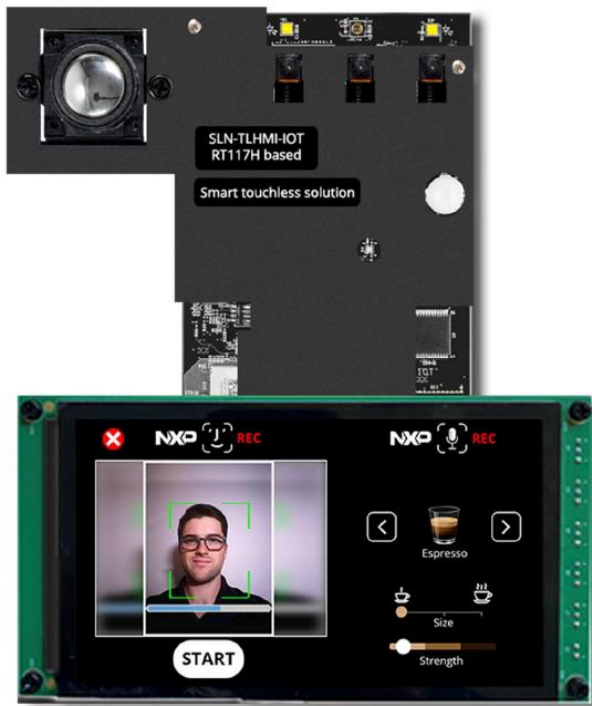
• Wireless Connectivity

- Dual band Wi-Fi 4+BLE combo: IW416
- Cloud based device management, user data management, OTA, etc.

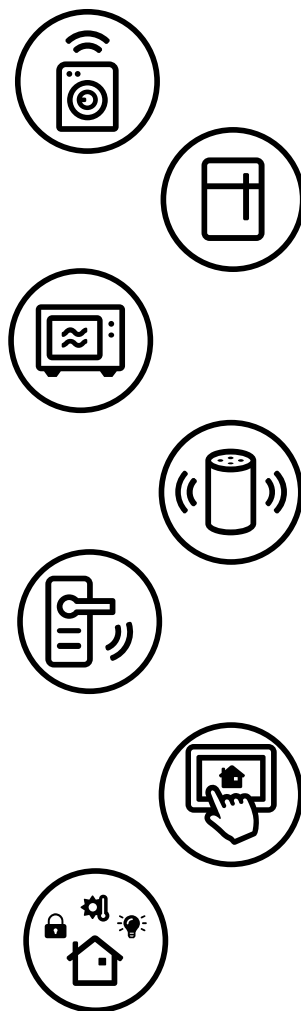
• Others

- 32MB Flash, 32MB SDRAM, 2W louder speaker
- MikroE Click™ Expansion Header, PIR sensor

NXP RT117H MCU-BASED 一站式解决方案-智能非接触式HMI



开发板
SLN-TLHMI-IOT



提供

MCU RT117H

- 1 GHz Cortex-M7+ 400MHz Cortex-M4, 2MB SRAM

开发板 SLN-TLHMI-IOT -\$299 MSRP (orderable from NXP website)

- Coffee Machine, Elevator, Smart Home Panel App
- All hardware design files, schematics, BOM, layout

软件 (Source, binaries, production-ready ML algorithm)

- Software release in SDK and regular GitHub update
- Code link on GitHub https://github.com/NXP/sln_tlhmi_iot

文档

- Getting Start Guide, User Guide, Hardware Development Guide, Software Development Guide, Application Notes, etc.

目标应用

智能家电

智能家居

智慧楼宇, 智能工业

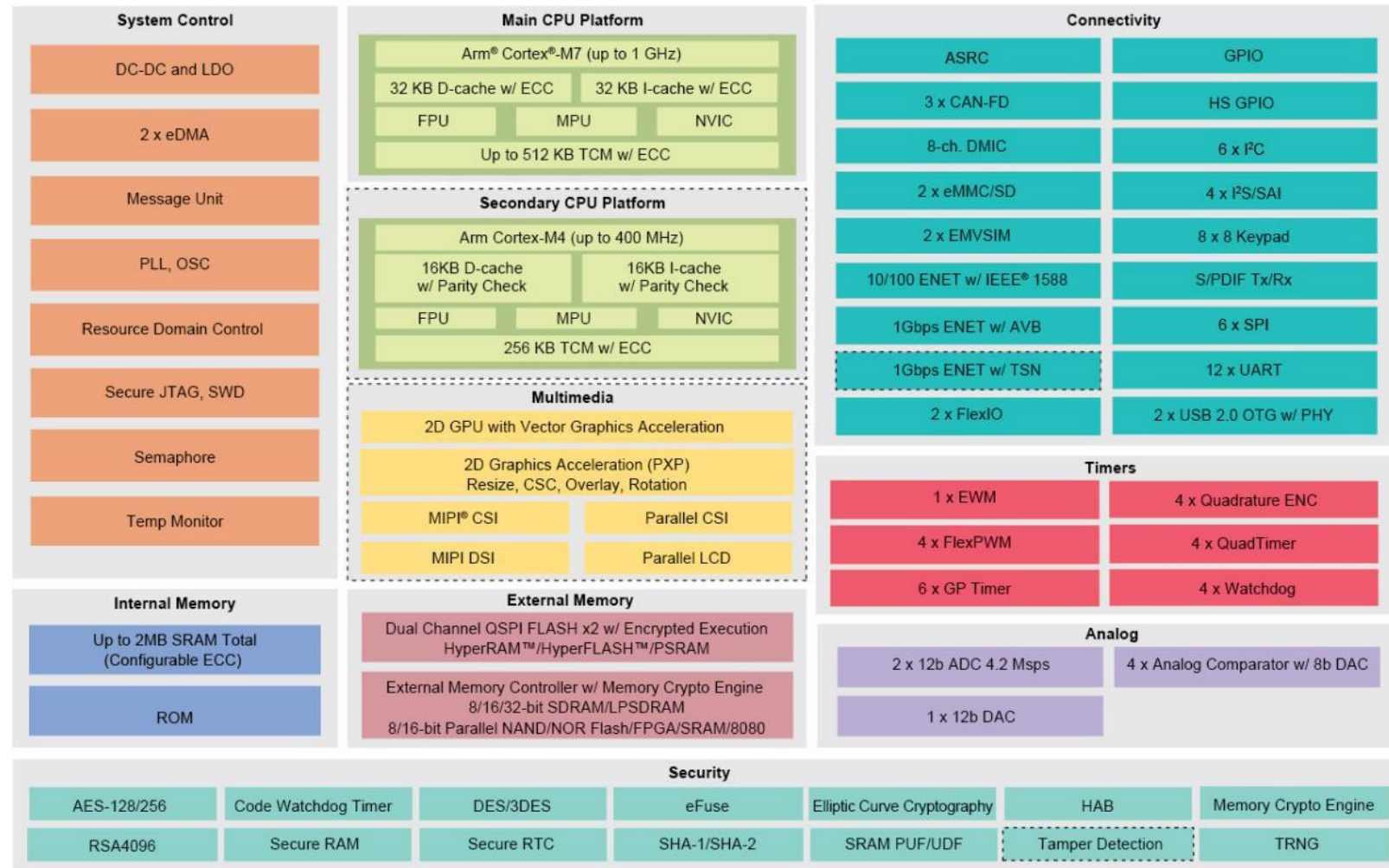
智慧运输

其他

i.MX RT1170 CROSSOVER MCUS

• Key Features

- Arm Cortex-M7 CPU (1 GHz)
 - 32KB/32KB L1 Cache, 512KB TCM
- Arm Cortex-M4 CPU (400MHz) (optional)
 - 16KB/16KB L1 Cache, 256KB TCM
- 2MB on-chip SRAM (including TCM for CPU core)
- Parallel LCD Display
 - Up to WXGA (1280x800) @60fps
- 8/16/24-bit Parallel Camera Sensor Interface
- 2-lane MIPI CSI and 2-lane MIPI DSI
- 2D GPU & Graphics Accelerator
- 8/16/32-bit SDRAM controller up to 200MHz
- 8/16-bit Parallel SRAM / FLASH (NOR or NAND)
- 2x Dual-channel FlexSPI with on-the-fly decryption
 - Serial NOR, serial NAND, HyperBUS devices
- 2x eMMC 5.0/SD 3.0/SDIO Port
- 2x USB 2.0 OTG, HS/FS, Device or Host with PHY
- Audio:
 - 4x I²S/SAI
 - 1x S/PDIF Tx/Rx
 - ASRC
 - 8-ch digital microphone input
- 3x ENET:
 - 1Gbps ENET w/ AVB
 - 10/100 ENET w/ IEEE 1588
 - 1Gbps ENET w/ TSN
- 2x 12-bit ADC, 4.2 Msps, up to 20 channels total
- 4x Analog comparator,
- 12-bit DAC
- Full PMU Integration – DC-DC + LDOs



 Available on certain products within the family

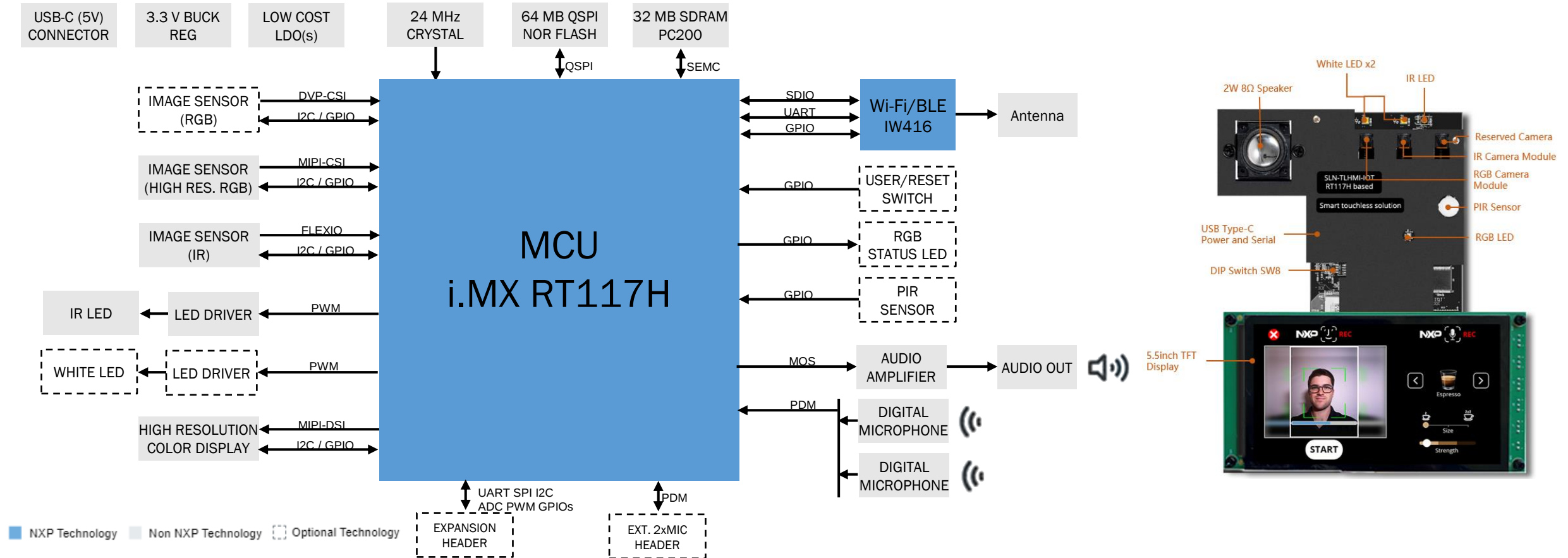
i.MX RT1170 MCU CONFIGURATIONS

	i.MX RT1171	i.MX RT1172	i.MX RT117F	i.MX RT1173	i.MX RT1175	i.MX RT1176	i.MX RT117H
Cortex-M7	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**	800 MHz**	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**
Cortex-M4	-	-	-	400 MHz	400 MHz	400 MHz	400 MHz
MIPI CSI / DSI	-	Y	Y	Y	-	Y	Y
OpenVG 1.1	-	Y	Y	Y	-	Y	Y
CSI / LCDIF / PXP	-	Y	Y	Y	-	Y	Y
Ethernet	Y	Y	Y	Y	Y	Y	Y
TSN	-	-	-	-	-	Y	Y
Tamper Protection	-	-	-	Y	-	-	-
HAB / AES / DES	Y	Y	Y	Y	Y	Y	Y
Face recognition	-	-	Y	-	-	-	Y
Local voice control	-	-	-	-	-	-	Y
Package	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA
Qualification (Temperature)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Industrial (-40-105°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)
Part Numbers (10k resale price)	MIMXRT1171DVMMAA (\$5.82) MIMXRT1171CVM8A (\$6.22) MIMXRT1171AVM8A (Auto)	MIMXRT1172DVMMAA (\$6.22) MIMXRT1172CVM8A (\$6.72) MIMXRT1172AVM8A (Auto)	MIMXRT117FDVMAA (\$7.02) MIMXRT117FCVM8A (\$7.52) MIMXRT117FAVM8A (Auto)	MIMXRT1173CVM8A -\$7.42	MIMXRT1175DVMMAA (\$6.47) MIMXRT1175CVM8A (\$6.97) MIMXRT1175AVM8A (Auto)	MIMXRT1176DVMMAA (\$6.97) MIMXRT1176CVM8A (\$7.57) MIMXRT1176AVM8A (Auto)	MIMXRT117HDVMAA (\$7.96) MIMXRT117HCVM8A (\$8.77) MIMXRT117HAVM8A (Auto)

* Speed of consumer qualified device.

** Speed listed is for industrial and automotive/extended industrial qualified devices.

SMART TOUCHLESS HMI SOLUTION DEVELOPMENT KIT (SLN-TLHMI-IOT) HARDWARE BLOCK DIAGRAM



SLN-TLHMI-IOT Contains

- i.MX RT117H TLHMI solution development Kit
- USB Type-C cable

Out-Of-Box

- Coffee Machine, Elevator, Smart Home Panel APP
- User switches to load different APP when booting and reset

SLN-TLHMI-IOT HARDWARE SPECIFICATIONS

MAIN

Application MCU **NXP i.MX RT117H**
Dual core ARM® Cortex®-M7 @1GHz+ Cortex®-M4 @440MHZ
2 MB on chip SRAM

Memory **Winbond W25Q512JVEIQ**
64MB QSPI NOR Flash at 133MHz

Memory **Winbond W9825G6KH-5**
32MB SDRAM x16 at 200MHz

VIDEO

RGB Camera **JSX-Vision GC20-0SLN-F0** with **Galaxy GC2145**
1280 X 720 MIPI interface

IR Camera **JSX-Vision GC03-0SLN-F0** with **Galaxy GC0308**
VGA with FlexIO

IR and White LEDs **OSRAM** with **MPS MP2410AGJ** LED driver

AUDIO

Audio Amplifier **Diodes Inc. PAM8013** with i.MX RT MQS
mono, class-D, up to 2W at 8Ω

Speaker **PUI Audio ASE02808MR-LW150-R**
28mm Enclosed Speaker, 2W cont. 3W max. with 8Ω impedance

RADIO

WIFI/BLE Combo module **Azurewave AW-AM510** with **NXP IW416**
Dual band 1x1 WIFI 4+ BLE 5.2

DISPLAY

MIPI Display **Rocktech RK055AHD091A0-CTG**
5.5-inch TFT 1280*720 Pixels with LED backlight

POWER

Power supply
USB Type-C
Selectable Source to wake-up RT117F from Low Power Mode
Switch, PIR, WIFI, BLE, External signal.

Separate Power circuitry during RT117H Low Power mode
only power necessary components

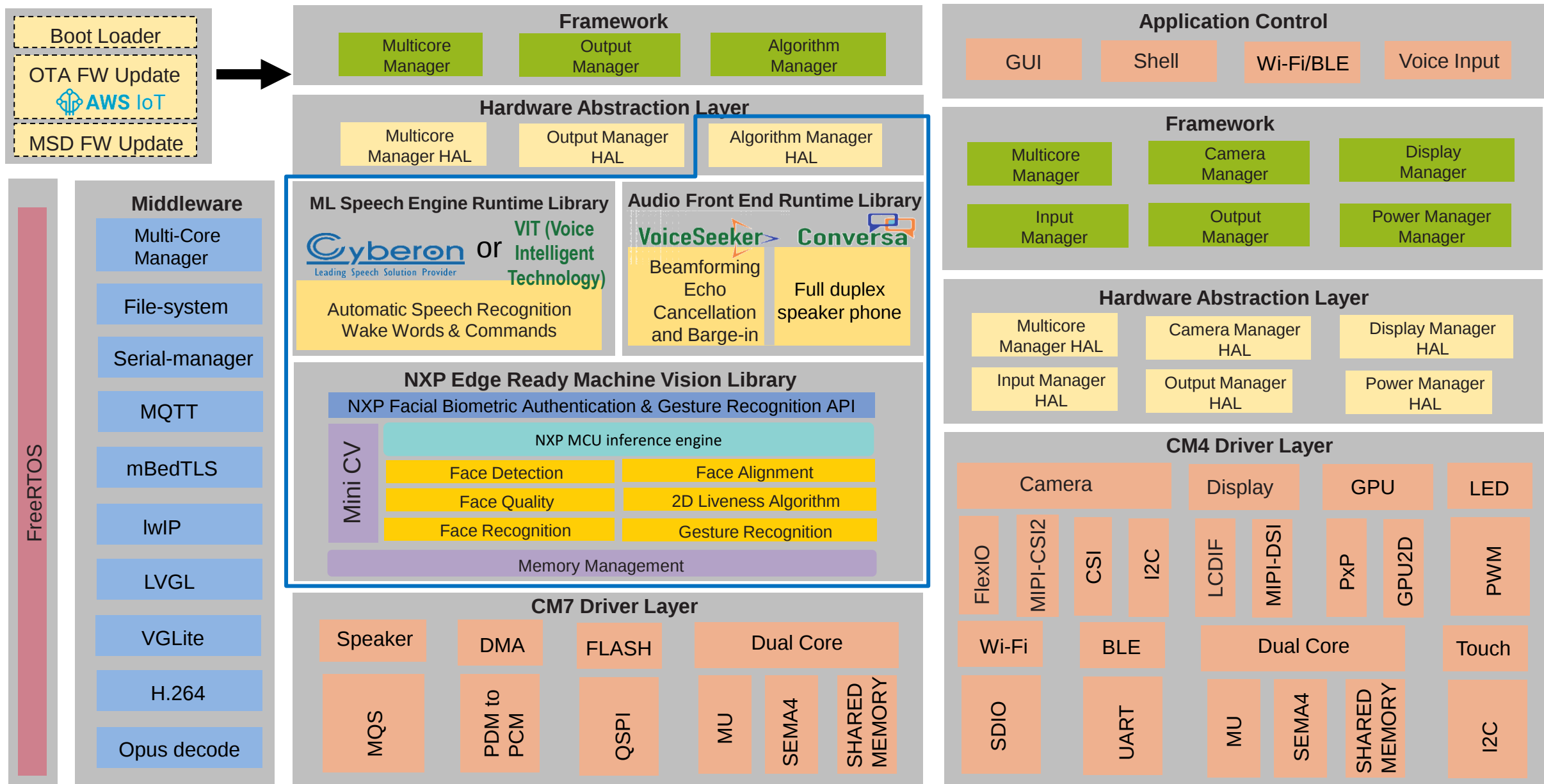
OTHER

User-switches for low power mode wakeup(SW0), load different
application when booting(SW1,2,3) and reset(SW4)

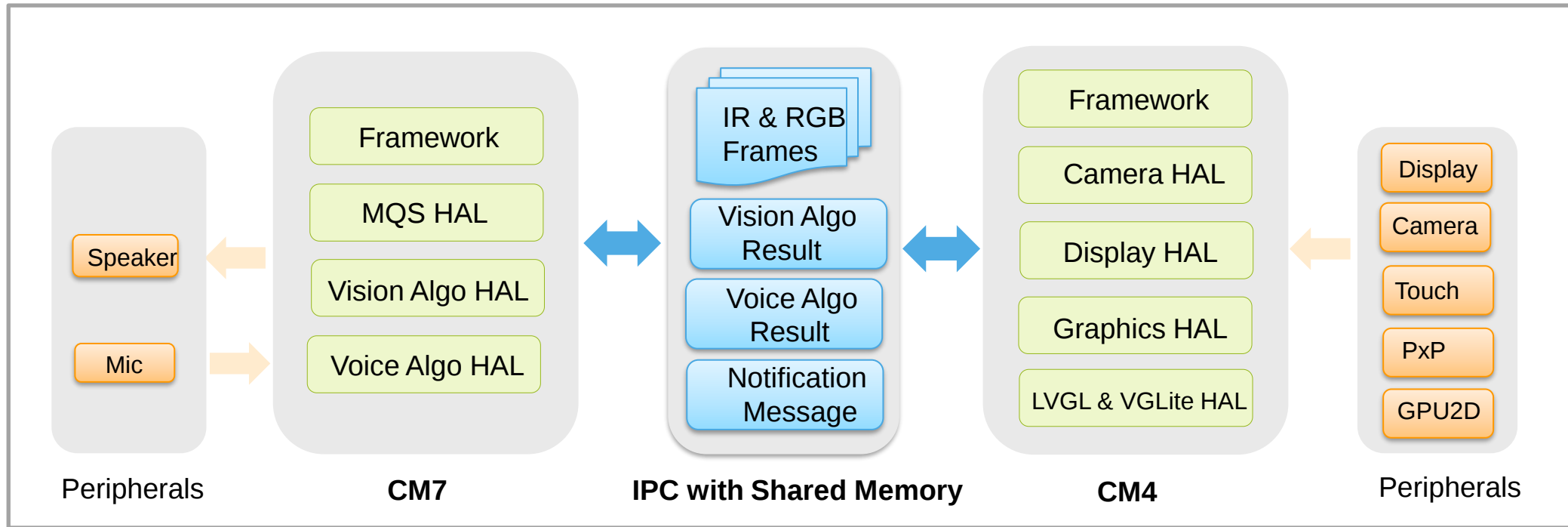
RGB and Status LEDs, PIR, MICX2

MikroE Click™ expansion header(debug/programming)
General Purpose Header
External Microphones

SLN-TLHMI-IOT (I.MX RT117H) EDGEREADY SOLUTION SOFTWARE BLOCK DIAGRAM



SLN-TLHMI-IOT (I.MX RT117H) EDGEREADY SOLUTION SOFTWARE ARCHITECTURE



CM7 (Vision & Voice algorithm accelerator):

- Framework
- Vision algorithm with VGA input frames
- Voice algorithm (AFE + ASR) with mic input
- MQS audio playback
- IPC communication with shared memory

CM4 (UI & System control unit):

- Framework
- CSI/MIPI Camera preview @VGA
- LVGL GUI @720p with VGLite 2D GPU acceleration
- Vision algorithm input frames color space conversion with PxP
- Touch panel input
- IPC communication with shared memory

OUT-OF-BOX **COFFEE MACHINE** (FACTORY) DEMO (BASIC EXPERIENCE)



Connect one end of the USB-C cable to the board and the other end to your computer's USB port



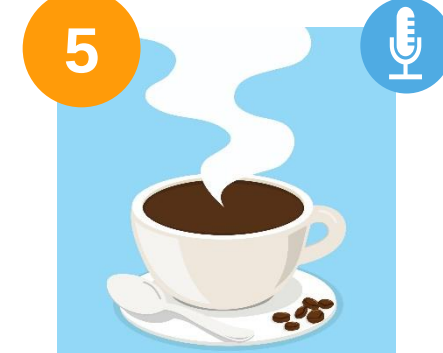
Screen will display a brief standby screen before entering a low power sleep mode



Use the "Hey NXP" wake word (or touch the screen) to reawaken the kit



Align your face with the camera until it is detected by the board and the bounding box turns from blue to red



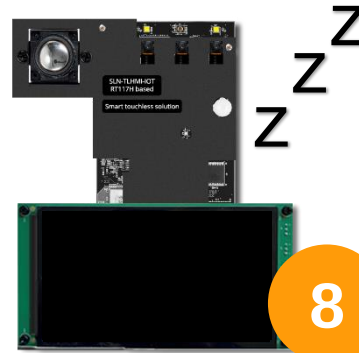
Select your coffee preferences (type, size, and strength) using the hands-free voice commands + touchscreen UI controls



Use the "Start" voice command to begin the "brewing" animation



Save your coffee selection for next time by answering "Confirm" to the "Register your coffee selection?" prompt



Board will return to standby mode; wake again using the "Hey NXP" wake word or by touching the display



Align your face with the camera until your face is recognized by the board and the bounding box turns from blue to green



Rather than using your saved order, "Cancel" and modify your selection instead, changing the type, size, and strength of the coffee

OUT-OF-BOX COFFEE MACHINE (FACTORY) DEMO

10



Start brewing your new coffee selection

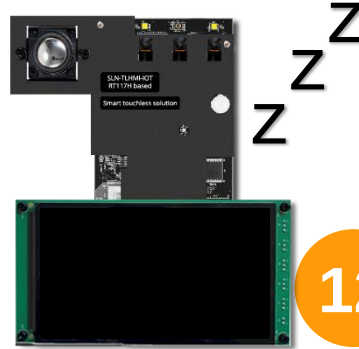
11

Register your coffee selection?



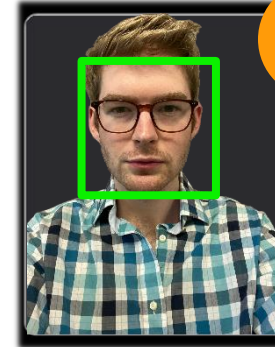
The TLHMI will ask if you want to update your saved selection because you ordered something different. Respond using "Confirm" to update

12



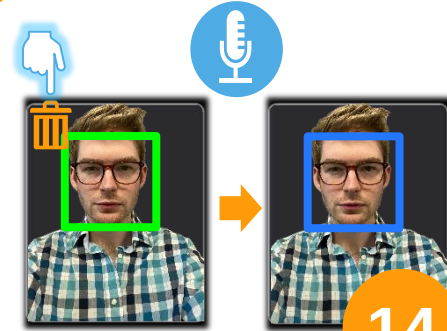
Wake the board up a final time, again using either the "Hey NXP" wake word or by touching the display

13



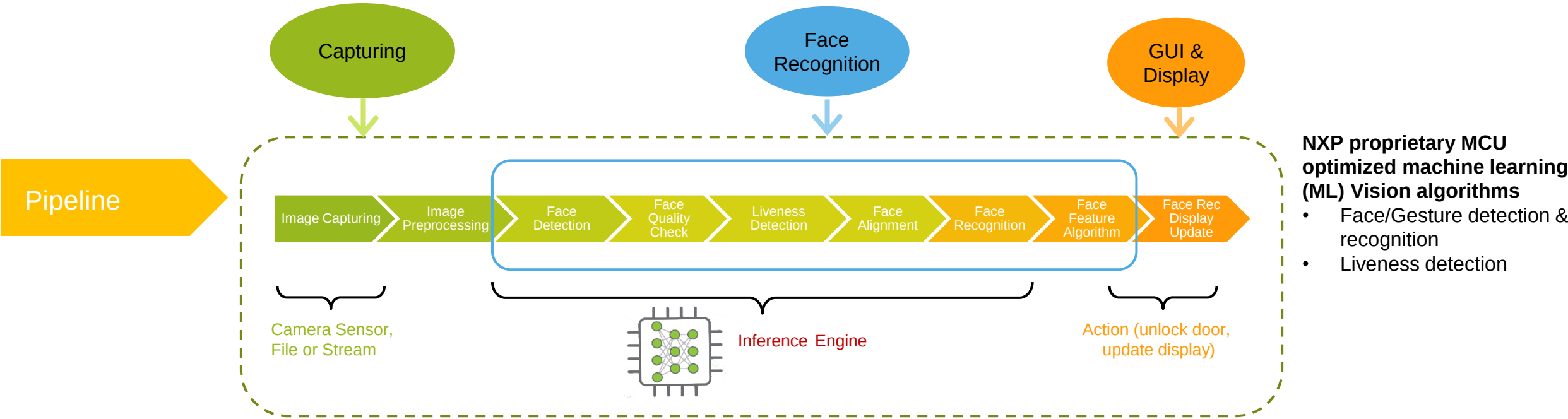
Align your face with the camera until your face is recognized by the board and the bounding box turns from blue to green

14



Use the "deregister" voice command or onscreen deregister button to remove your face from the local face database

FACE RECOGNITION

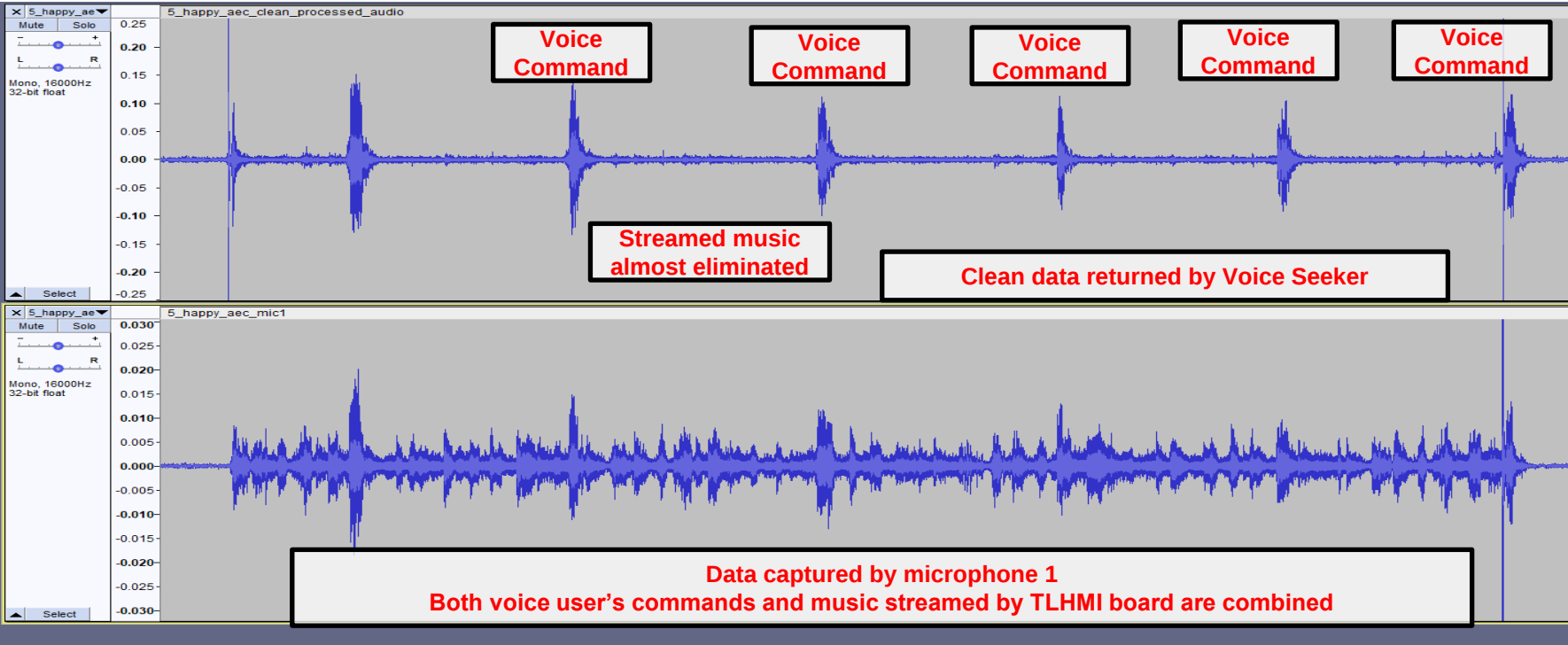


Performance

Metric	Performance*	Comments
Accuracy	99.73%	Based on the official LFW. bin which has 3000 positive pairs and 3000 negative pairs
TAR @ FAR=1.00E-7	94.44%	Based on the randomly generated 100,000 positive pairs and 10,000,000 negative pairs from LFW dataset
Face detection/recognition distance	0.3-1.0m	
FOV	90 degree	
Face recognition time	900 ms	Will be optimized in FW V1.1

*Notes: Above performance will be updated based on FW V1.1 to have enhancement when launch

VOICE PERFORMANCE



AFE

- Acoustic echo cancellation
- Noise Reduction
- Beamforming
- Barge-in
- Full duplex for speaker phone(Conversa)

ASR

- Wake word
- Voice command
- Audio playback

Features in default demo

- Multi-language wake word in parallel
- Skip wake word to active voice command
- 4 languages (English, Chinese, French, Germany)

Support language: English* Background	Far-filed (2.7m, 90°)		Near-field (0.9m, 90°)		Support language: Chinese* Background	Far-filed (2.7m, 90°)		Near-field (0.9m, 90°)	
	FRR	RAR	FRR	RAR		FRR	RAR	FRR	RAR
Silence	1.79%	91.07%	0%	92.86%	Silence	2.50%	73.53%	0%	98.53%
Microwave	3.57%	88.69%	0%	87.50%	Microwave	36.76%	69.44%	0%	98.53%
Music	17.86%	88.69%	12.50%	95.94%	Music	11.76%	94.36%	2.94%	100%

***Notes:**

- Tests setup is almost the same with Alexa AQT testing
- Above performance will be updated based on FW V1.1 to have enhancement when launch.

Coffee Machine Demo – CM7

- AEC enabled – Barge-in enabled

Notes:

- Streaming – AFE uses more CPU for AEC (Audio Echo Cancellation)
- Streaming – System is vulnerable to Self Wake Ups
- Waiting for Wake Word in 4 languages (EN, CN, DE, FR)
- Waiting for Voice Commands in the language of the previously detected Wake Word.

IDLE state

Waiting for WW in 4 languages
Vision recognition disabled

Interaction / Recognition state

Waiting for VC in 1 language
Vision recognition running

Interaction state

Waiting for VC in 1 language
Vision recognition stopped

IDLE state

Waiting for WW in 4 languages
Vision recognition disabled

“Hey NXP”

VIZN = 50%

Face detected
Face not registered

“Start”

Register your coffee selection?

ASR = 48%
4 languages (EN, CN, DE, FR)
12% per language

AFE = 3%

ASR = 15%
1 language of detected WW

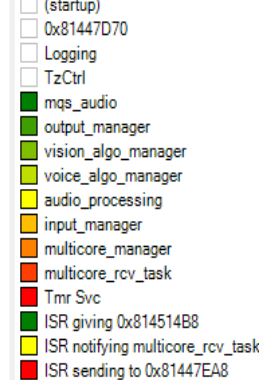
AFE = 4%

ASR = 15%
Streaming audio

AFE = 17%
Streaming audio

ASR = 48%

AFE = 3%



Coffee Machine Demo – CM4

- AEC disabled – Barge-in disabled
- ASR turned off during streaming

Notes:

- Streaming – ASR disabled for Self Wake Up prevention
- Waiting for Wake Word in 4 languages (EN, CN, DE, FR)
- Waiting for Voice Commands in the language of the previously detected Wake Word.

IDLE state

Waiting for WW in 4 languages
Vision recognition disabled

Interaction / Recognition state

Waiting for VC in 1 language
Vision recognition running

Interaction state

Waiting for VC in 1 language
Vision recognition stopped

IDLE state

Waiting for WW in 4 languages
Vision recognition disabled

“Hey NXP”

Face detected
Face not registered

“Start”

Register your
coffee
selection?

Camera Manager = 5%

Camera Manager = 3%

LVGL = 7%

LVGL = 20%

queue = 7%

LVGL = 70%

Camera Manager = 3%

LVGL = 7%

1:40.000.000 (m.s.ms.µs)

- (startup)
- Logging
- TzCtrl
- camera_manager
- display_manager
- input_manager
- LVGL
- multicore_manager
- multicore_rcv_task
- output_manager
- queue_task
- Tmr Svc
- ISR giving 0x80AF6140
- ISR giving 0x80AF5ED8
- ISR giving 0x80AF5C80
- ISR giving 0x80AF5240
- ISR notifying multicore_rcv_task
- ISR sending to 0x80AFBEC8
- ISR sending to 0x80AF9678
- ISR sending to 0x80AF6E28

NXP EDGEREADY Touchless HMI SOLUTIONS – ADVANTAGES SUMMARY

High-Integration &Low cost

- Enables ML Vision(face/gesture recognition), far-field voice control, 2D graphics UI with one NXP high performance crossover MCU which results in simple system design and low cost
- Not an add-on solution - allows developer to replace host MCU with i.MX RT
 - Available MHz & memory, and ability to trade off inference time vs. CPU load

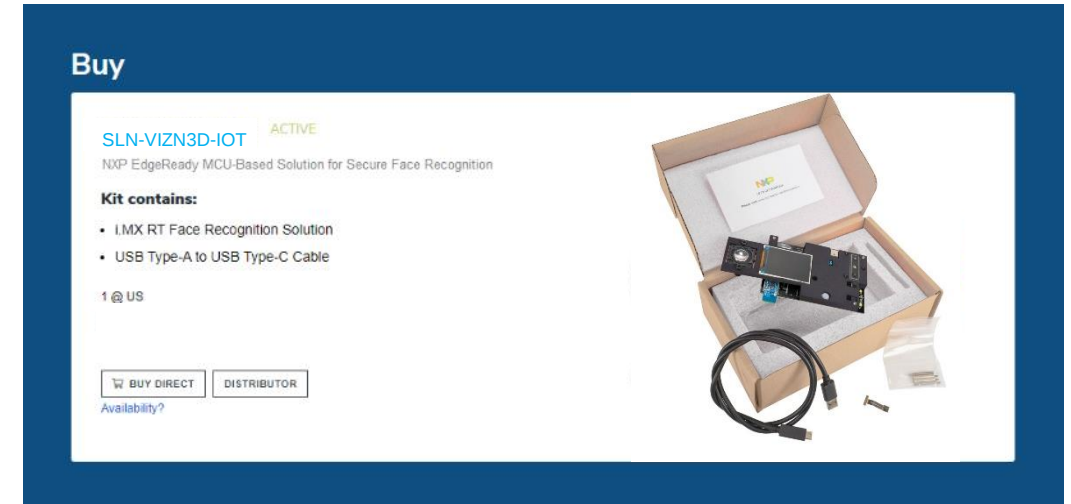
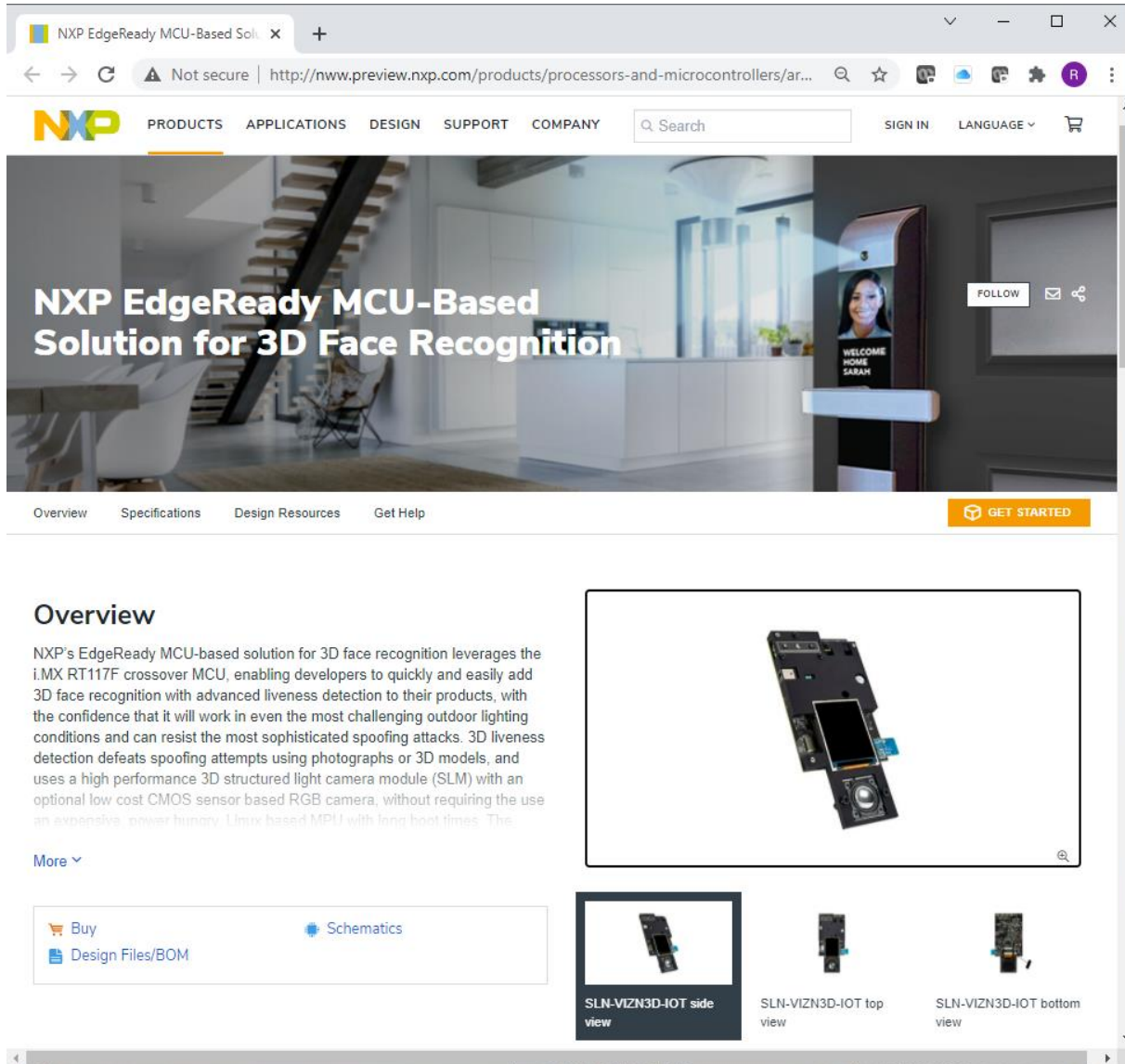
Fast & easy to-use

- Turnkey solution – EdgeReady examples of concept to production in only four months
- No face/gesture recognition, local voice control or ML/AI expertise necessary
- One stop shop support from NXP
- Cross-platform Framework under dual core architecture with rich middleware and production ready AI algorithms, enables customer capability and flexibility to customize product design and fast time to market.
- Plug and play out-of-box-experience
- Easy to use development tools (MCUXpresso IDE, SDK, configuration & provisioning)
- Familiar RTOS based environment for IoT developers
- Worldwide distribution network for sales and support

Flexible

- Offer intuitive and customizable off/on-line device interactions.
- Offline implementation eliminates latency while preserving privacy
- Choose between face recognition or gesture recognition and different model types to adapt to different user cases
- Enables Cloud based device management, user data management, OTA, etc.
- Flexibility to change external components

FOR MORE INFORMATION... www.nxp.com/mcu-vision3D GOES LIVE NOVEMBER 3



- **Download**
 - Design Files: Schematics, BOM, layout
 - Software via MCUXpresso SDK
 - Source, binaries, documentation
- **View** getting started pages & videos
- **Buy** SLN-VIZN3D-IOT kits (\$299)

软件架构和设计



SECURE CONNECTIONS
FOR A SMARTER WORLD

PUBLIC

NXP, THE NXP LOGO AND NXP SECURE CONNECTIONS FOR A SMARTER WORLD ARE TRADEMARKS OF NXP B.V.
ALL OTHER PRODUCT OR SERVICE NAMES ARE THE PROPERTY OF THEIR RESPECTIVE OWNERS. © 2022 NXP B.V.



软件架构和设计

传统的开发流程

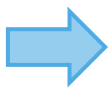
- 从SDK 导入基础应用
 - CPU/Memory/Clock
- 集成SDK 相关外设的单个示例代码
 - Display, Camera, GPU, USB/I2C/UART/GPIO
- 集成AI算法
- 增加应用层UI/Logic
 - 例如注册流程，识别流程等

- SDK 单一的功能示例
- 底层硬件平台BSP和上层应用逻辑的耦合
- 算法和应用层逻辑和UI 的耦合
- 多种MCU的推理引擎
- Global parameter and cross function calls
-

面临多个维度的挑战

- 硬件平台
- 不同算法、应用场景
- 外设
- SDK的升级更新

Code was tightly coupled->Made changing code difficult



增加软件开发的负担



需要更多的技术支持



Flexibility



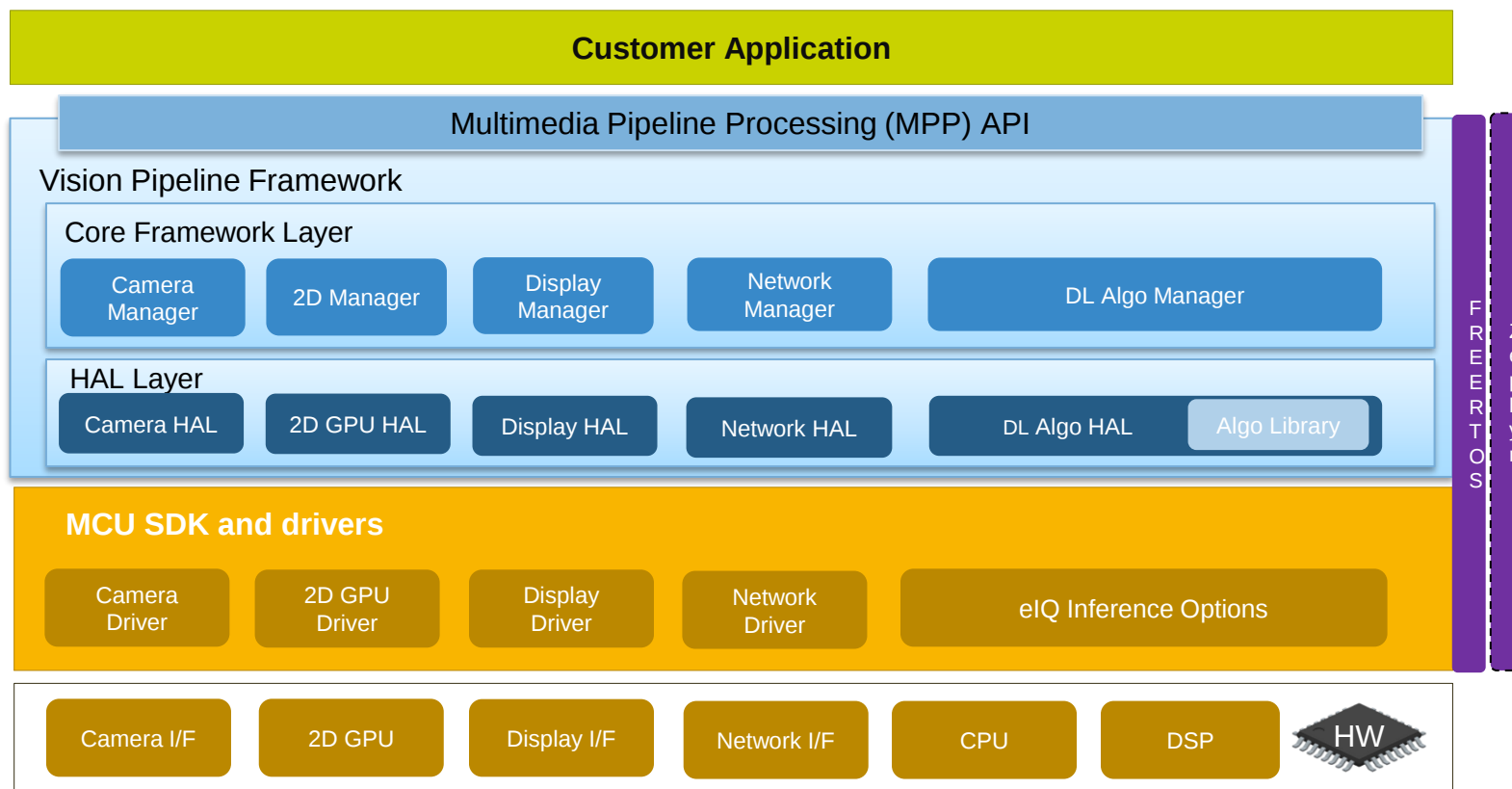
Ease-of-Use



Efficiency (Minimal Overhead)

模块化
可重用
可扩展

一个统一的FRAMEWORK架构



Made up of 3 core components

- Hardware Abstraction Layer(HAL) devices
- Device Managers
- Message/Events
- **Device** provides unified attributes and operators (executor)
- **Manager** handles the logic (decision maker)
- Device asks manager to take action through **callback** with unified events
- Multiple devices with runtime **registration**

A UNIFIED FRAMEWORK: ABSTRACT THE FUNDAMENTAL ELEMENTS

Message Queue

Unified *fwk_message_t* Structure

```
typedef struct {  
    fwk_message_id_t id;  
    unsigned char  
    freeAfterConsumed;  
    union {  
        frame_msg_payload_t frame;  
        raw_msg_payload_t raw;  
        framework_request_t request;  
    };  
} fwk_message_t;
```

Unified APIs

Message_RegisterQueue

Message_Put

Message_Get

Message_PutFromISR

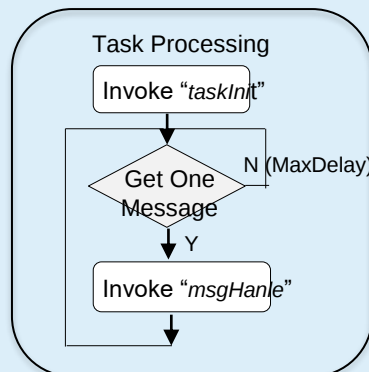
Task

Unified *fwk_task_t* Structure

```
typedef struct  
{  
    QueueHandle_t  
    queueHandle;  
    fwk_task_id_t taskId;  
    int delayMs;  
    void (*msgHandle)(...);  
    int (*taskInit)(fwk_task_data_t  
    *);  
} fwk_task_t;
```

Unified APIs

Task_Start



Timer

Unified *sln_timer_t* Structure

```
typedef struct  
{  
    TimerHandle_t handle;  
    sln_timer_callback_t function;  
    SemaphoreHandle_t lock;  
    char  
    name[TIMER_NAME_LENGTH];  
    void *arg;  
    int autoReload;  
} sln_timer_t;
```

Unified APIs

Timer_Start

Timer_Reset

Timer_Stop

Timer_GetRemainingTime

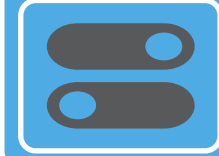
Key objects

- Unified structure

- Unified APIs

ANATOMY OF A HAL DEVICE

- Analogous to abstract classes in object-oriented languages
 - Provide device type-specific list of methods which must be implemented
 - Ex. start, stop, init, etc.
 - Defines device type-specific attributes
 - Ex. Camera has resolution, height, width attributes



Input

- Ex. Push Buttons, Shell, etc.



Output

- Speaker, LEDs, etc.



Camera

- RGB, IR, 3D



Display

- Touch Displays, Non-touch

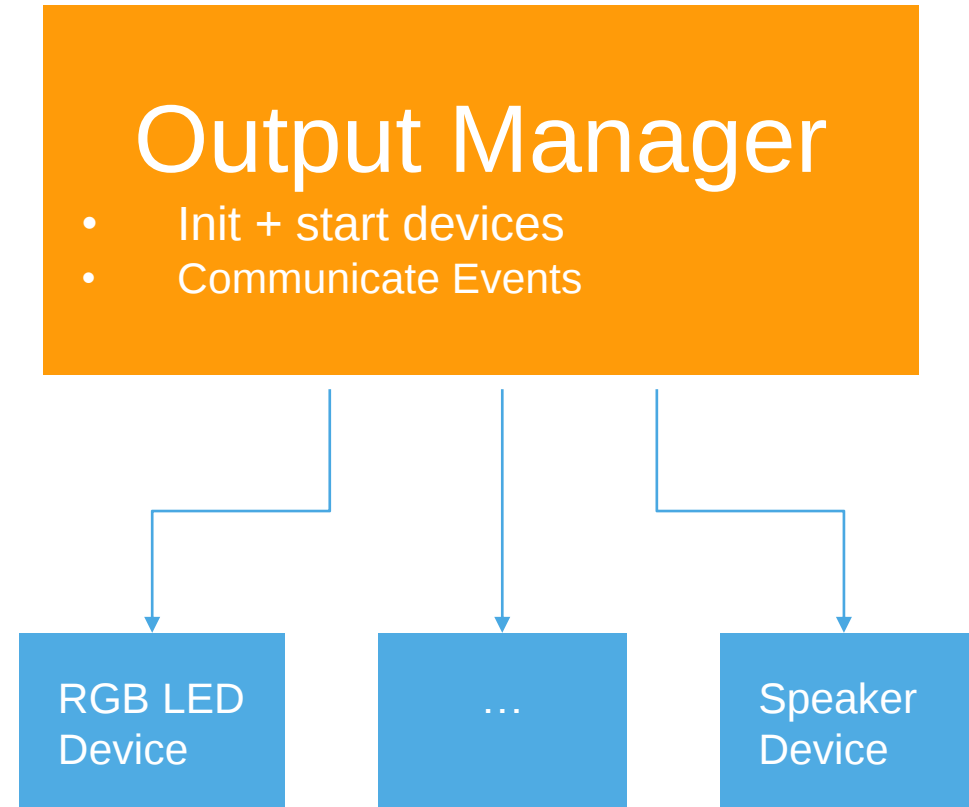


etc.

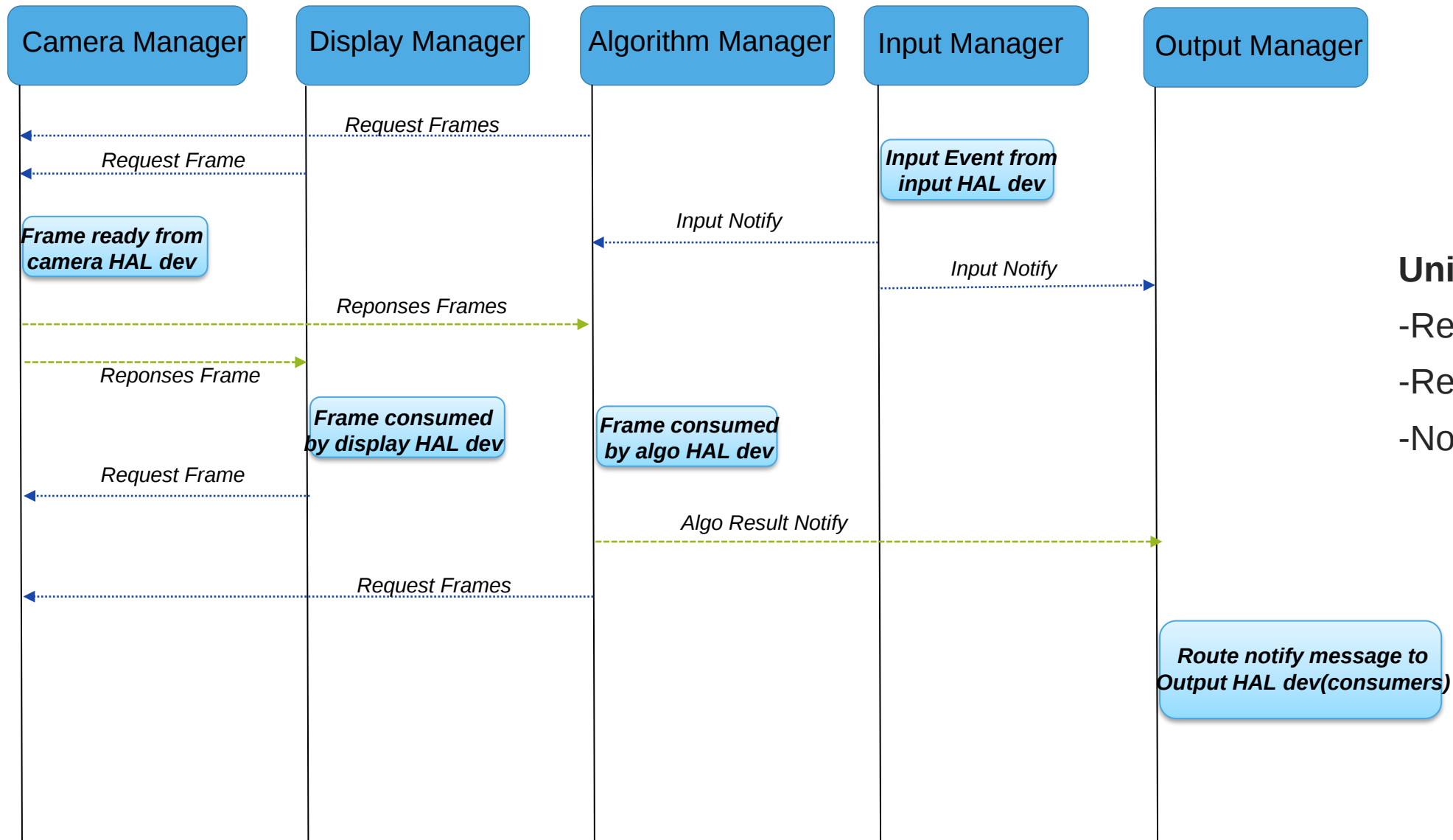
支持多种不同的设备类型

DEVICE MANAGERS

- **“Manages” devices**
 - Responsible for initializing, starting, stopping, etc. all registered HAL devices
 - Manager for each type of device
- **Communicates data between devices**
 - Reduces tight code coupling
- **Provided to customer as library binary and header files**
 - Underlying details of message passing not important for customer project development
 - Focuses attention on HAL devices rather than optimizing message passing



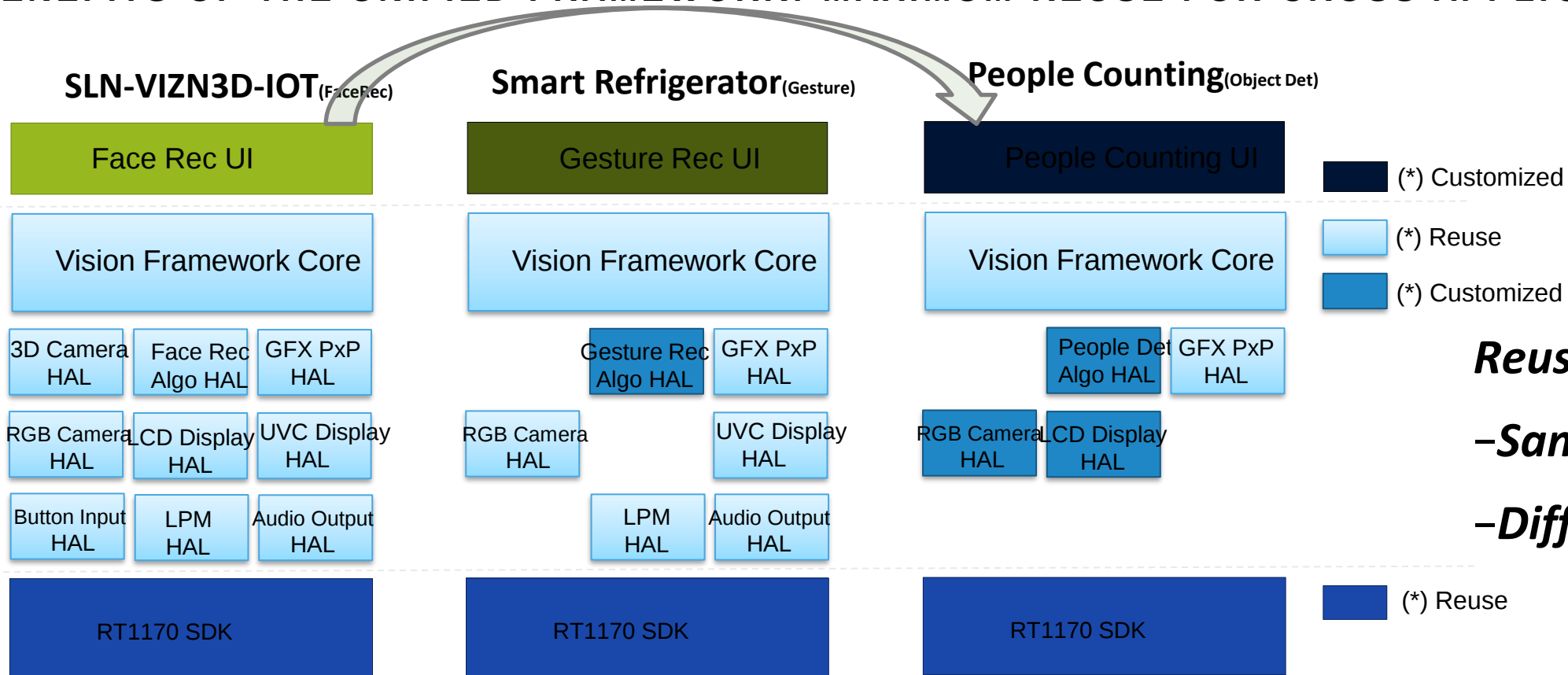
UNIFY THE PRODUCER/CONSUMER PATTERN WITH MESSAGING



Unified Messaging

- Request
- Response
- Notification

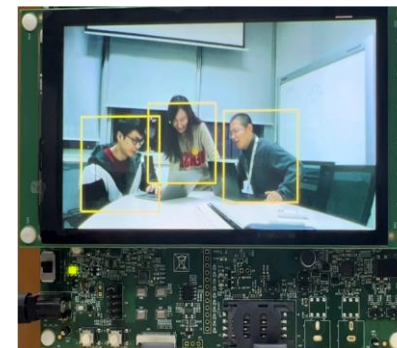
BENEFITS OF THE UNIFIED FRAMEWORK: MAXIMUM REUSE FOR CROSS APPLICATIONS



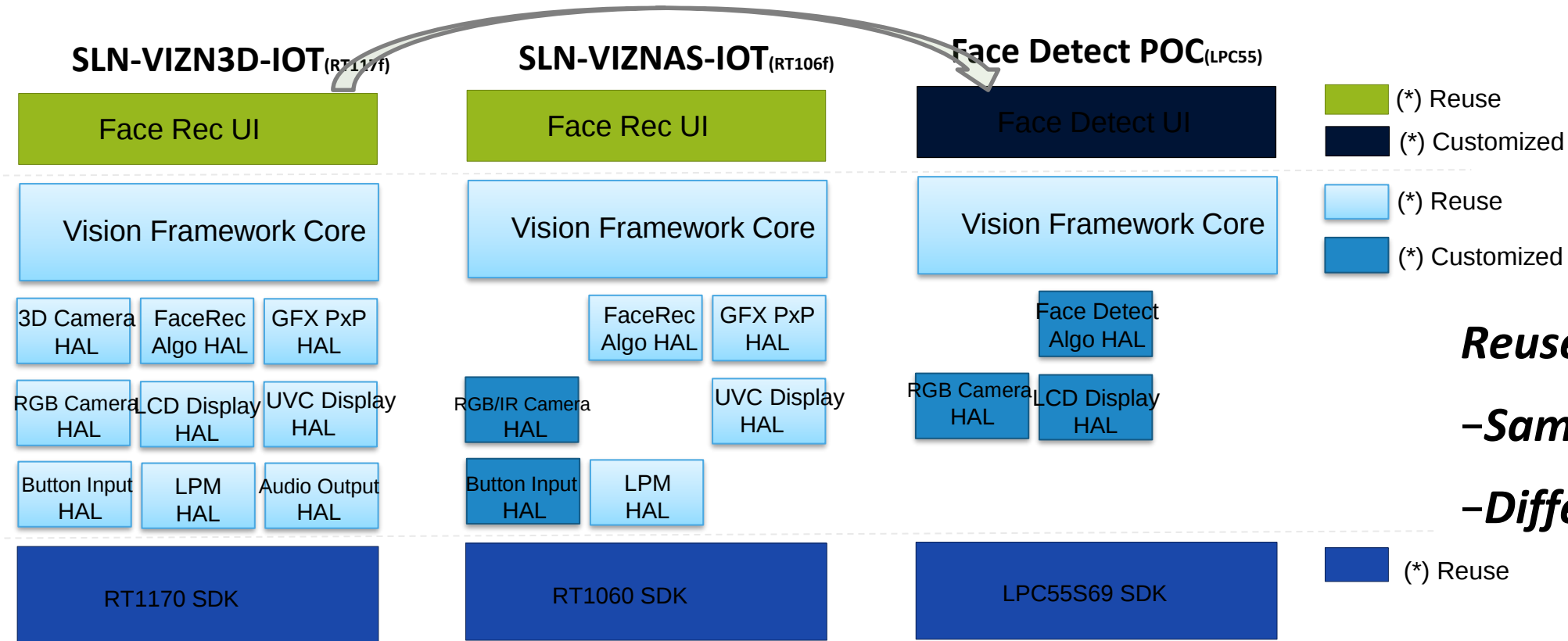
Reuse

-Same platform

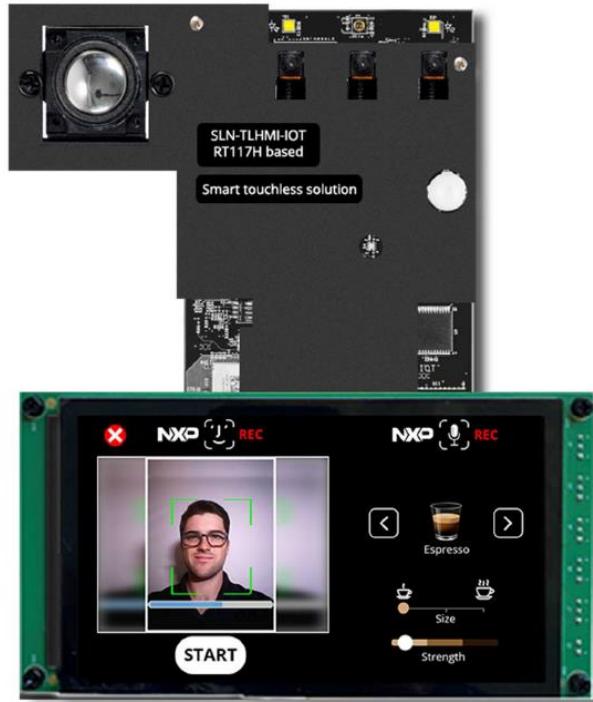
-Different use cases



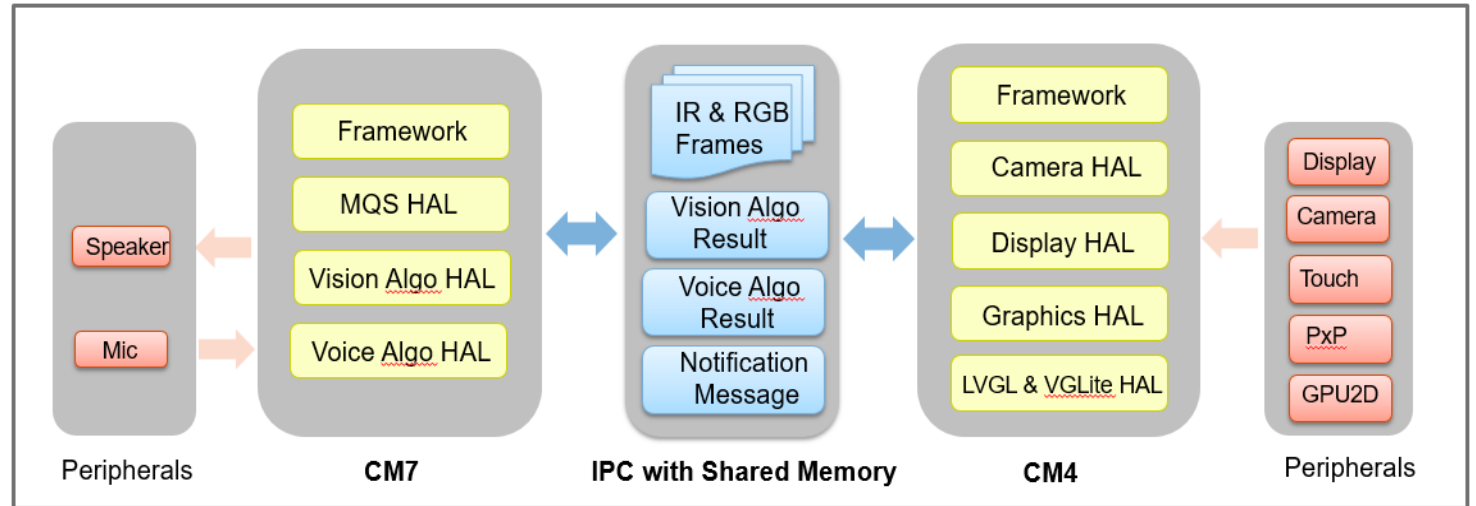
BENEFITS OF THE UNIFIED FRAMEWORK: MAXIMUM REUSE FOR CROSS PLATFORMS



BENEFITS OF THE UNIFIED FRAMEWORK: FLEXIBLE TO EXTEND TO SUPPORT DUAL CORE/LVGL/VOICE



SLN-TLHMI-IOT(RT117H)



-FLEXIBILITY

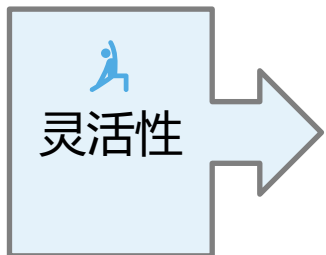
▪ DUAL CORE

- Add the IPC HAL
- Run separate configured framework and HAL on cm7 and cm4

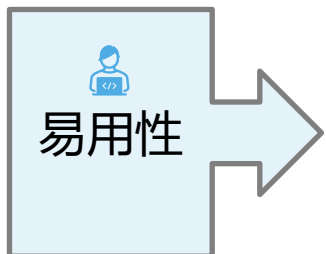
▪ LVGL And VOICE

- Add the LVGL HAL dev for display/output
- Add the voice algorithm HAL dev

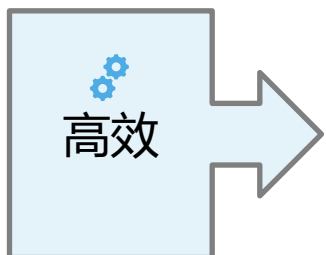
软件架构和设计



更换外设
硬件平台移植
不同的算法



Binary Library
完备的AI算法



只需关注应用层
From concept to product in 4 months

Face Recognition Solutions



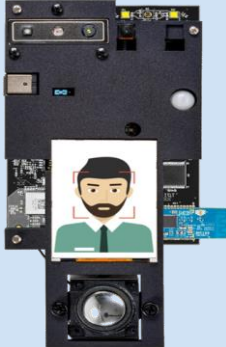
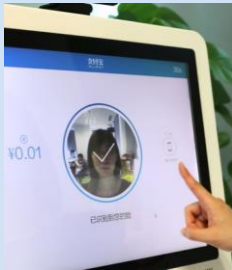
SECURE CONNECTIONS
FOR A SMARTER WORLD

PUBLIC

NXP, THE NXP LOGO AND NXP SECURE CONNECTIONS FOR A SMARTER WORLD ARE TRADEMARKS OF NXP B.V.
ALL OTHER PRODUCT OR SERVICE NAMES ARE THE PROPERTY OF THEIR RESPECTIVE OWNERS. © 2022 NXP B.V.



NXP 人脸识别可选平台

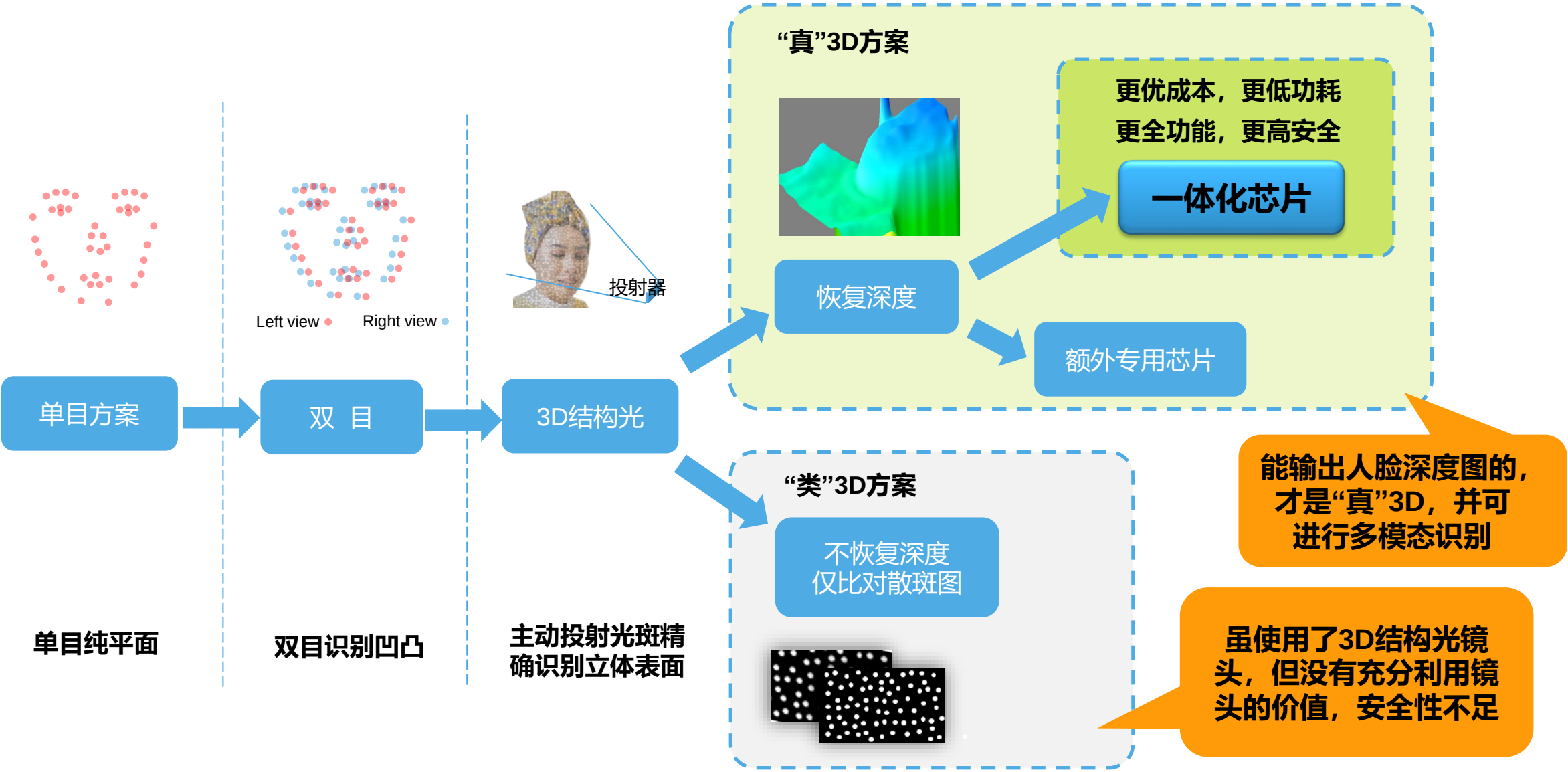
平台	i.MX RT106F	RT117F	i.MX 8M mini
镜头	2D (IR+RGB)	3D (2IR, 3D结构光)	3D (NIR +结构光)/ToF
算法	NXP	NXP/3 rd partner	Alibaba/Tencent
目标市场	门锁,门禁,考勤	门锁, 门禁, 猫眼	人脸支付
推广方式	NXP Solution/Module	NXP Solution/Module	Reference design
			

MPU VS. NEW MCU

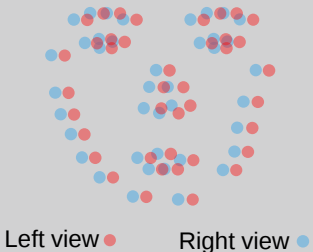


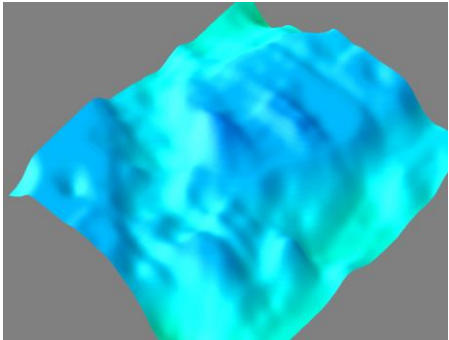
	MPU (Application Processor)	MCU (Embedded Processor)
Applications	Smart phones & tablets, Smart screens, Routers/gateways, Robo-cleaners, etc.	Switches, Appliances, Power tools, Toys, etc.
Graphics	Complex UI	None, or basic bit mapped
Operating System	Linux, Android, iOS, Windows, ...	FreeRTOS, MicroC/OS, Mbed OS, ...
Virtual Memory Support	Memory Management Unit	No
Storage	Giga Bytes (NAND Flash)	Mega Bytes (NOR Flash – often on chip)
Memory	Giga Bytes (SDRAM)	Mega Byte (SRAM – usually all on chip)
CPU	Arm Cortex-A Intel Core i7	Arm Cortex-M Intel 8051
Number of cores	1, 2, 4, 8, ...	1 (or 2)
NXP Example Family	i.MX 8M	i.MX RT1060

人脸识别技术演进路线

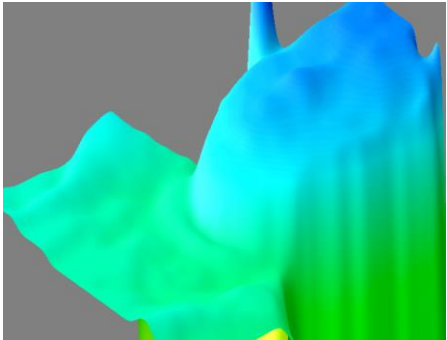


人脸识别方案：3D结构光 V.S. 双目红外

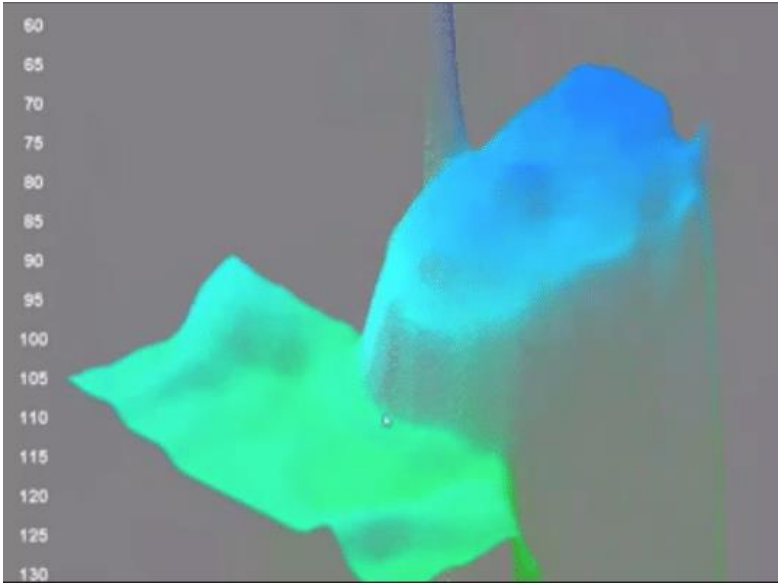
	双目红外	3D结构光
原理示意图		
波段	850nm	940nm
采样点获取方式	被动提取	主动投射
抗环境光干扰	一般	优秀
视野内采样点数目	约1000个点	约30000个点
人脸测量垂直精度	± 20 mm	± 2 mm
瞬时功耗	1 W	3 W
活体判别算法	仅识别凹凸特征	精确匹配面部特征
能否完成立体重构	不能	能
抵御特殊照片攻击	弱	强
能否用于金融级别	不能	能
应用场景	考勤，闸机 中低端门锁	高端手机，金融支付， 中高端门锁



双目红外立体重构



3D 结构光立体重构

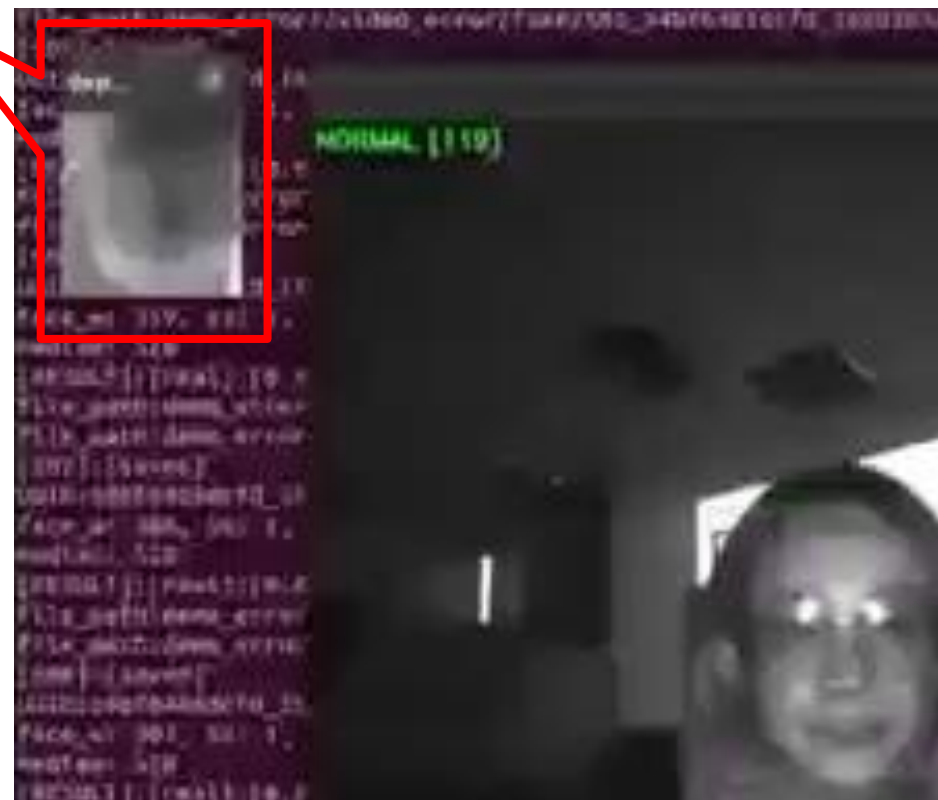


3D 结构光立体重构 (动态展示)

恩智浦 “一体化芯片”，提供“真3D”解决方案

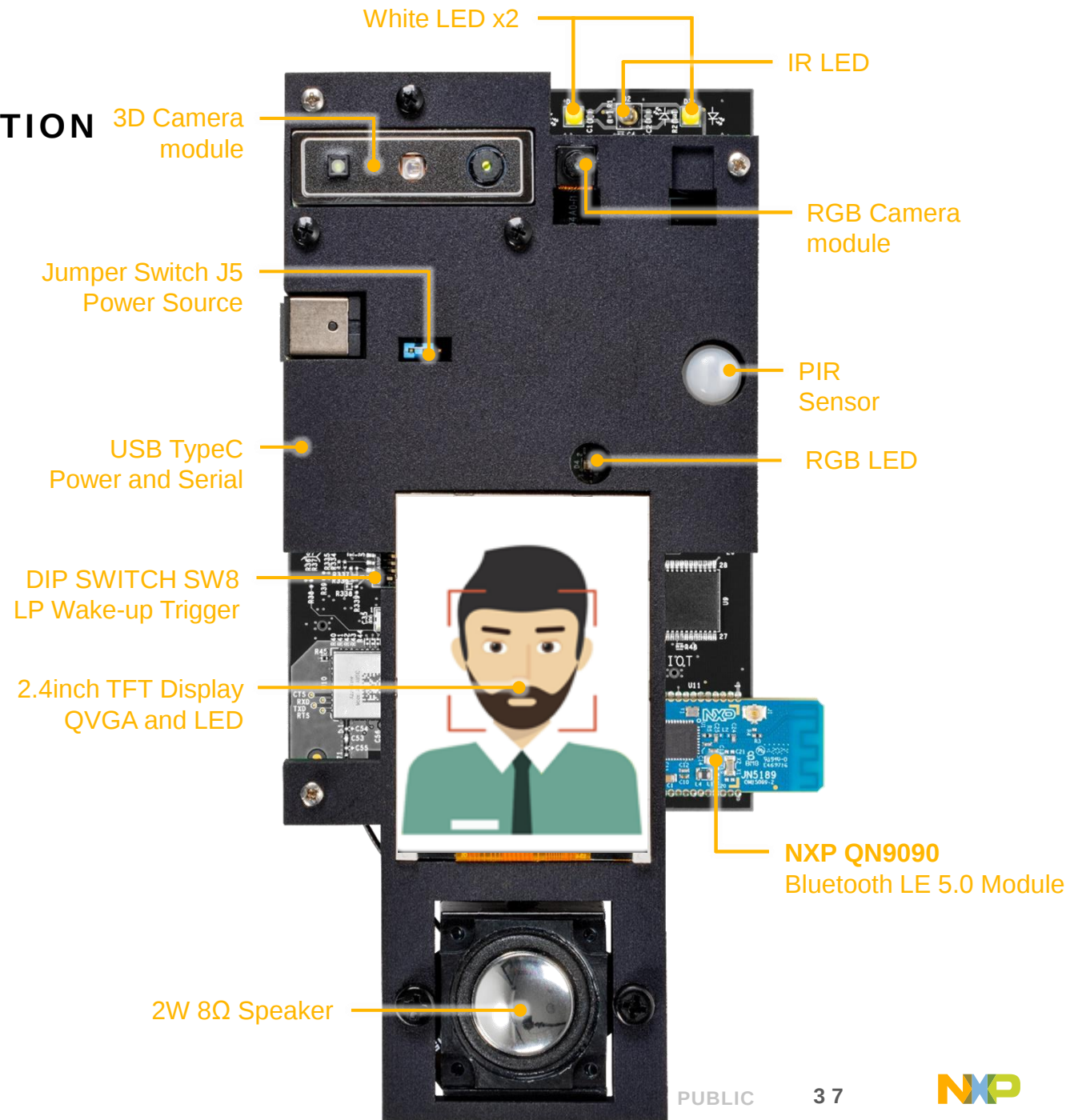
- 完整恢复人脸深度信息
- 抵御攻击能力强，安全性高
- 可以留存深度信息，用于多模态识别

实时计算
深度信息



NXP EDGEREADY i.MX RT117F MCU BASED 3D FACE RECOGNITION SMART LOCK SOLUTION

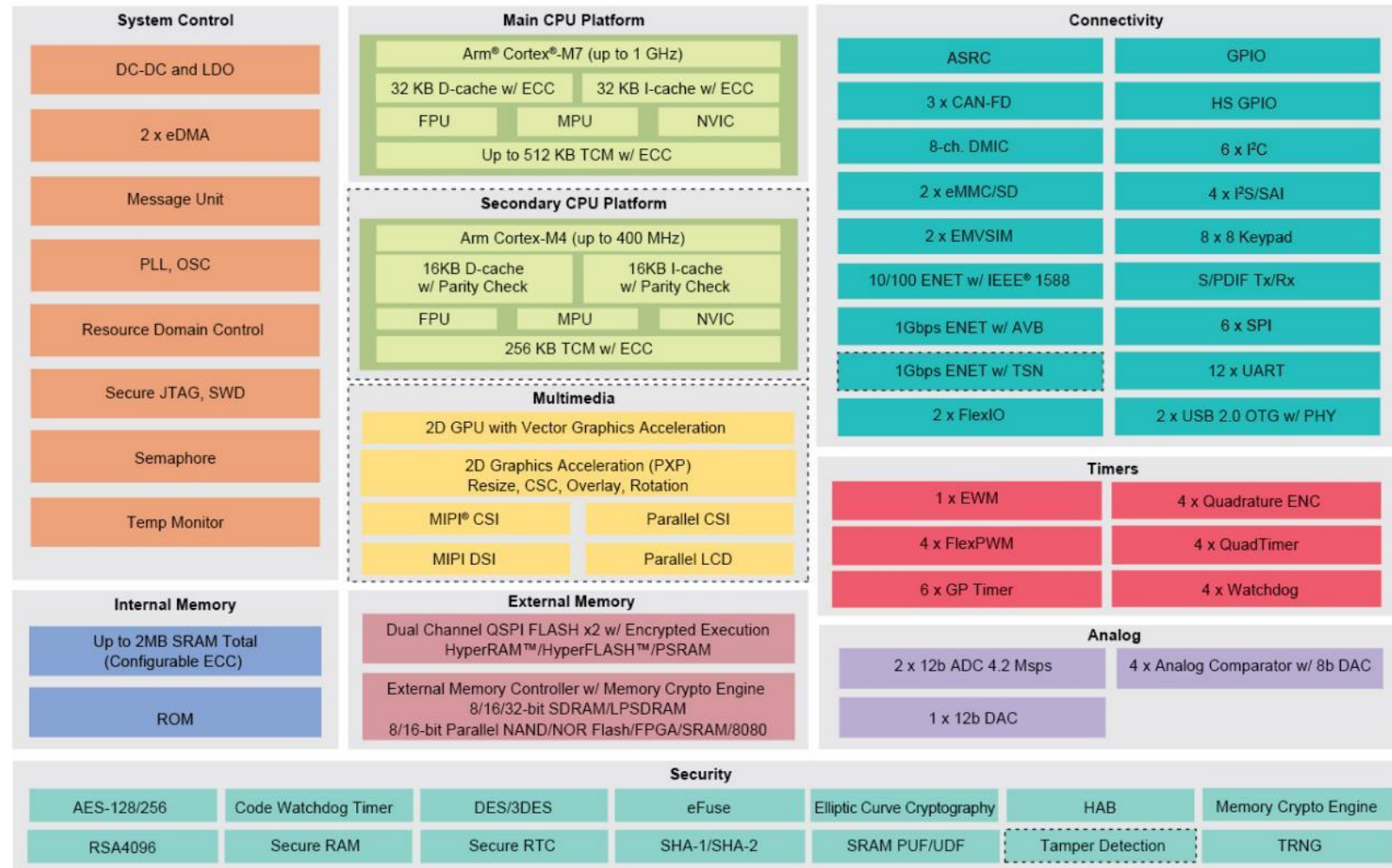
- Development kit SLN-VIZN3D-IOT
 - Available Now – \$299 from NXP distributors
- MCU
 - i.MX RT117F (1 GHz Cortex-M7 Core, 2 MB SRAM)
- Camera(s)
 - 3D SLM Camera (IR) + RGB CMOS Sensor (optional)
- Connectivity
 - NXP QN9090 Bluetooth LE 5.0
- Display (optional)
 - 2.4" LCD (240 x 320)
- Audio playback (optional)
 - Speaker + analog amplifier (DAC integrated on MCU)
- Low power mode
 - SNVS with wake on PIR, BLE, button



i.MX RT1170 CROSSOVER MCUS

• Key Features

- Arm Cortex-M7 CPU (1 GHz)
 - 32KB/32KB L1 Cache, 512KB TCM
- Arm Cortex-M4 CPU (400MHz) (optional)
 - 16KB/16KB L1 Cache, 256KB TCM
- 2MB on-chip SRAM (including TCM for CPU core)
- Parallel LCD Display
 - Up to WXGA (1280x800) @60fps
- 8/16/24-bit Parallel Camera Sensor Interface
- 2-lane MIPI CSI and 2-lane MIPI DSI
- 2D GPU & Graphics Accelerator
- 8/16/32-bit SDRAM controller up to 200MHz
- 8/16-bit Parallel SRAM / FLASH (NOR or NAND)
- 2x Dual-channel FlexSPI with on-the-fly decryption
 - Serial NOR, serial NAND, HyperBUS devices
- 2x eMMC 5.0/SD 3.0/SDIO Port
- 2x USB 2.0 OTG, HS/FS, Device or Host with PHY
- Audio:
 - 4x I²S/SAI
 - 1x S/PDIF Tx/Rx
 - ASRC
 - 8-ch digital microphone input
- 3x ENET:
 - 1Gbps ENET w/ AVB
 - 10/100 ENET w/ IEEE 1588
 - 1Gbps ENET w/ TSN
- 2x 12-bit ADC, 4.2 Msps, up to 20 channels total
- 4x Analog comparator,
- 12-bit DAC
- Full PMU Integration – DC-DC + LDOs



Available on certain products within the family

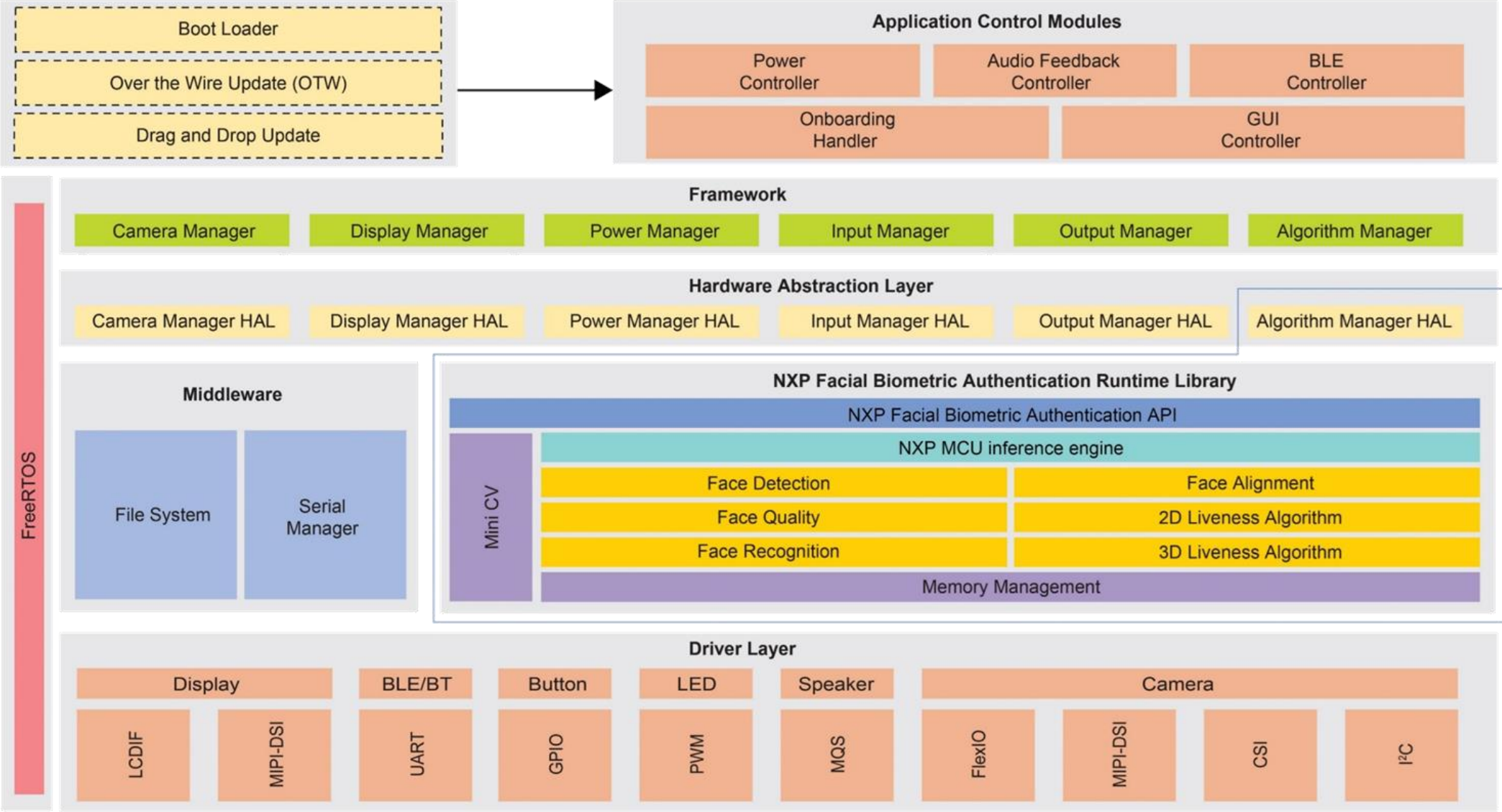
i.MX RT1170 MCU CONFIGURATIONS

	i.MX RT1171	i.MX RT1172	i.MX RT117F	i.MX RT1173	i.MX RT1175	i.MX RT1176	i.MX RT117H
Cortex-M7	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**	800 MHz**	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**	1 GHz* / 800 MHz**
Cortex-M4	-	-	-	400 MHz	400 MHz	400 MHz	400 MHz
MIPI CSI / DSI	-	Y	Y	Y	-	Y	Y
OpenVG 1.1	-	Y	Y	Y	-	Y	Y
CSI / LCDIF / PXP	-	Y	Y	Y	-	Y	Y
Ethernet	Y	Y	Y	Y	Y	Y	Y
TSN	-	-	-	-	-	Y	Y
Tamper Protection	-	-	-	Y	-	-	-
HAB / AES / DES	Y	Y	Y	Y	Y	Y	Y
Face recognition	-	-	Y	-	-	-	Y
Local voice control	-	-	-	-	-	-	Y
Package	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA
Qualification (Temperature)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Industrial (-40-105°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)	Consumer (0-95°C) Industrial (-40-105°C) Automotive (-40-125°C)
Part Numbers (10k resale price)	MIMXRT1171DVMMAA (\$5.82) MIMXRT1171CVM8A (\$6.22) MIMXRT1171AVM8A (Auto)	MIMXRT1172DVMMAA (\$6.22) MIMXRT1172CVM8A (\$6.72) MIMXRT1172AVM8A (Auto)	MIMXRT117FDVMAA (\$7.02) MIMXRT117FCVM8A (\$7.52) MIMXRT117FAVM8A (Auto)	MIMXRT1173CVM8A -\$7.42	MIMXRT1175DVMMAA (\$6.47) MIMXRT1175CVM8A (\$6.97) MIMXRT1175AVM8A (Auto)	MIMXRT1176DVMMAA (\$6.97) MIMXRT1176CVM8A (\$7.57) MIMXRT1176AVM8A (Auto)	MIMXRT117HDVMAA (\$7.96) MIMXRT117HCVM8A (\$8.77) MIMXRT117HAVM8A (Auto)

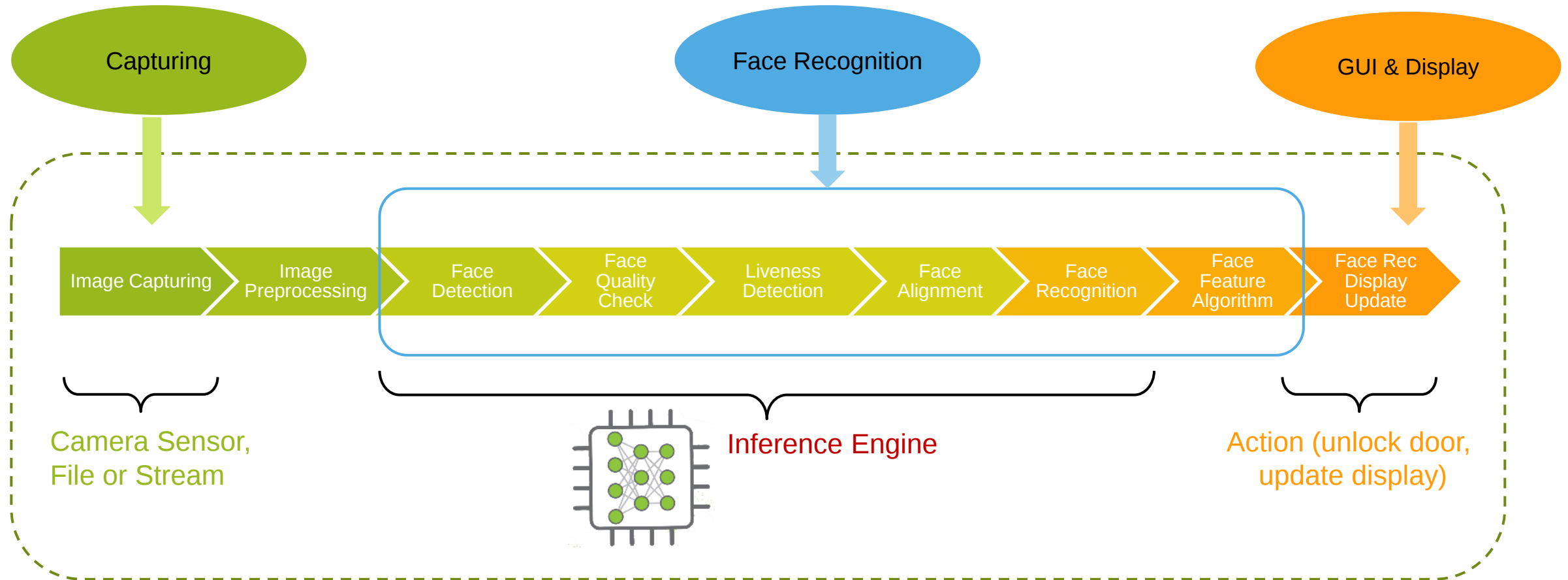
* Speed of consumer qualified device.

** Speed listed is for industrial and automotive/extended industrial qualified devices.

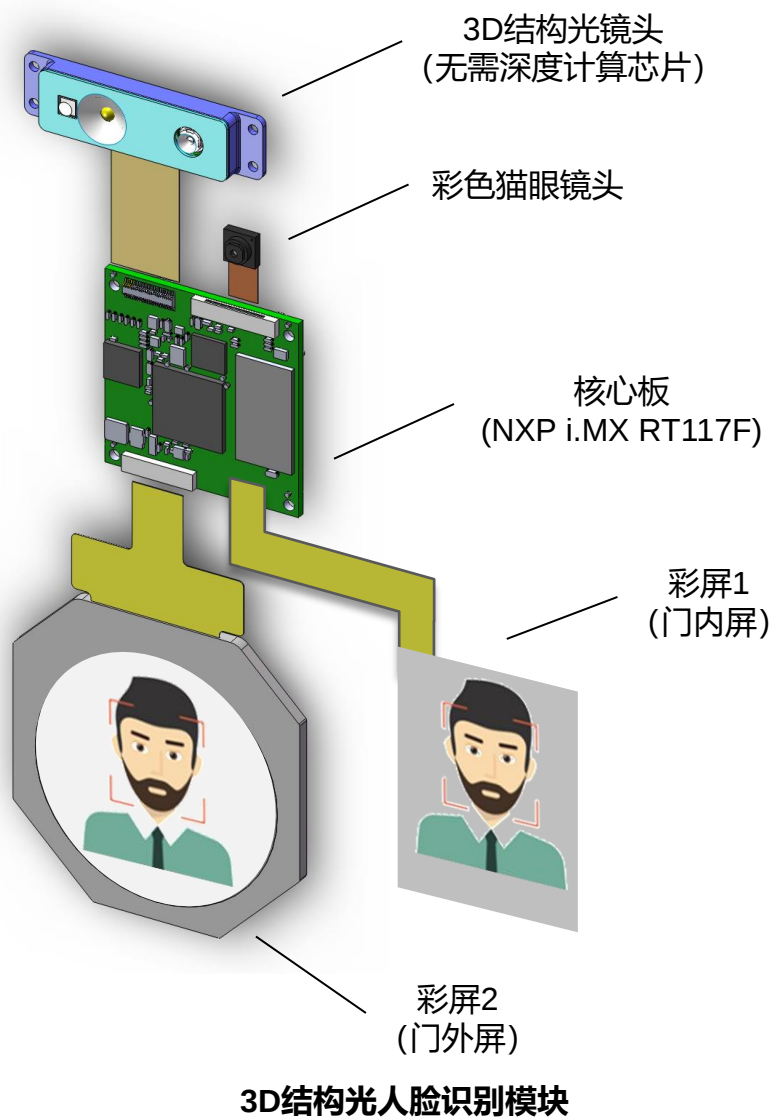
SLN-VIZN3D-IOT SOFTWARE DEVELOPMENT KIT BLOCK DIAGRAM



FACIAL BIOMETRIC AUTHENTICATION SOFTWARE PIPELINE



恩智浦“一体化芯片”，提供“真3D”解决方案

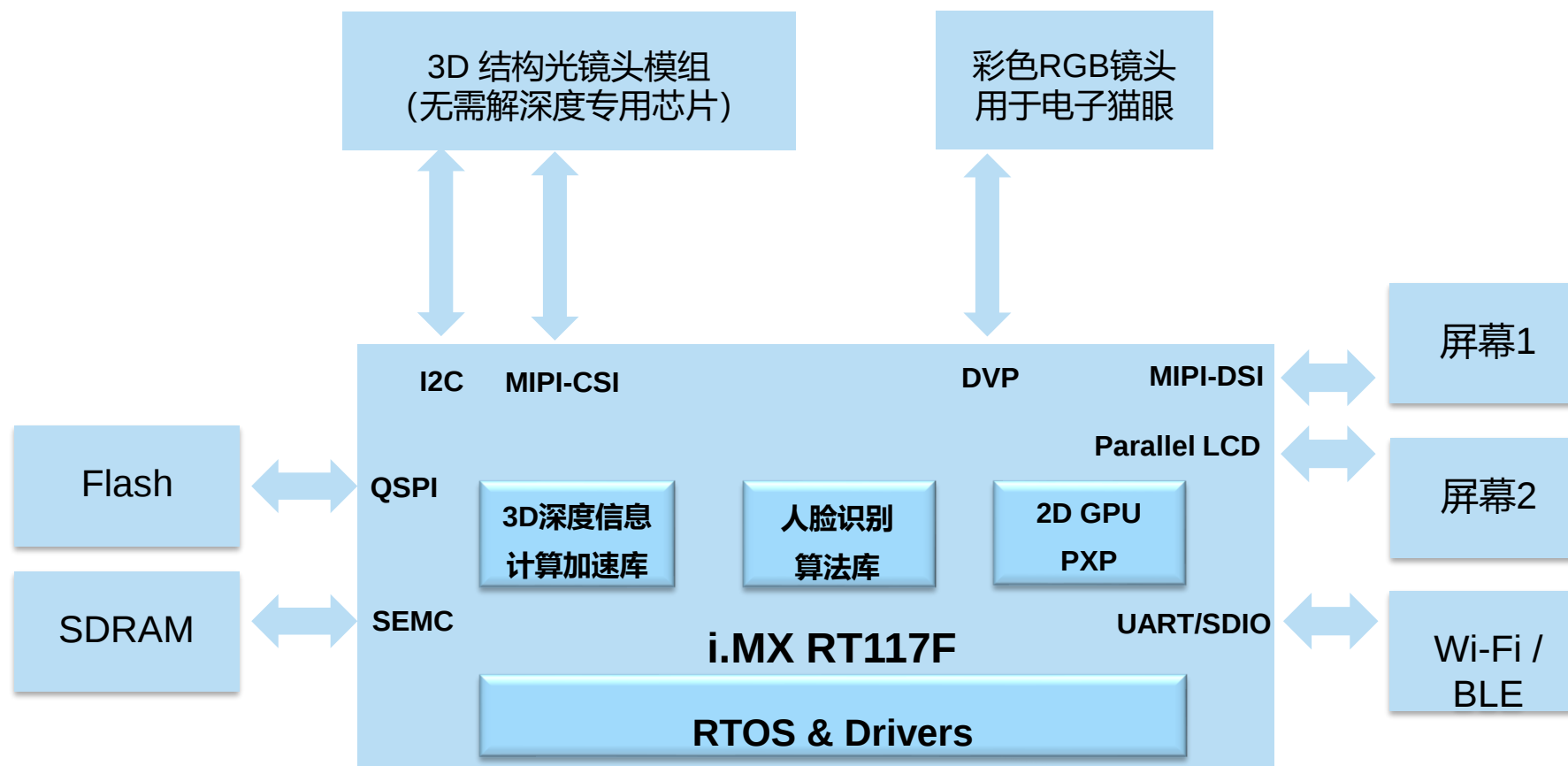


- 核心芯片采用恩智浦高性能MCU⁽¹⁾
 - 具有快速启动及低功耗特性, 具有成熟的软件生态和量产经验
 - 能够计算人脸完整3D特性, 无需镜头内置专用深度计算芯片, 具有更好的成本优势⁽²⁾
- 采用940nm波长, 相比于850nm波长, 能够更好的抵抗环境光, 太阳光的干扰
- 经恩智浦eIQ软件工具优化的人工智能算法
- 算法执行在本地, 数据安全可控, 保护用户隐私
- 支持无线连接, 可以通过手机APP进行操作管理
- 低功耗, 模块高低温适应性强

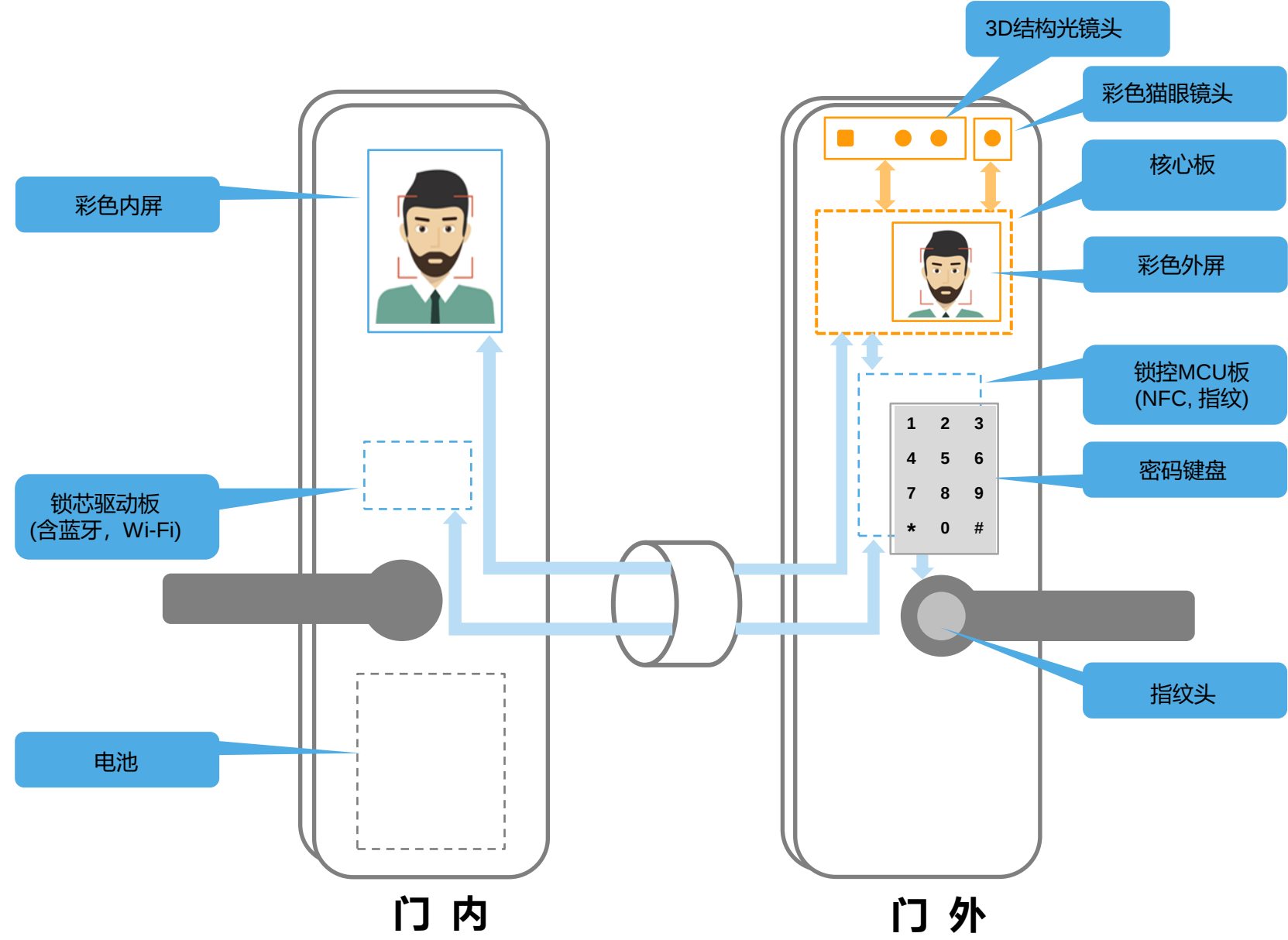
(1) 采用 NXP i.MX RT117F 主控芯片

(2) 与内置专用深度计算芯片的镜头模组相比

恩智浦 “一体化芯片”，提供“真3D”解决方案



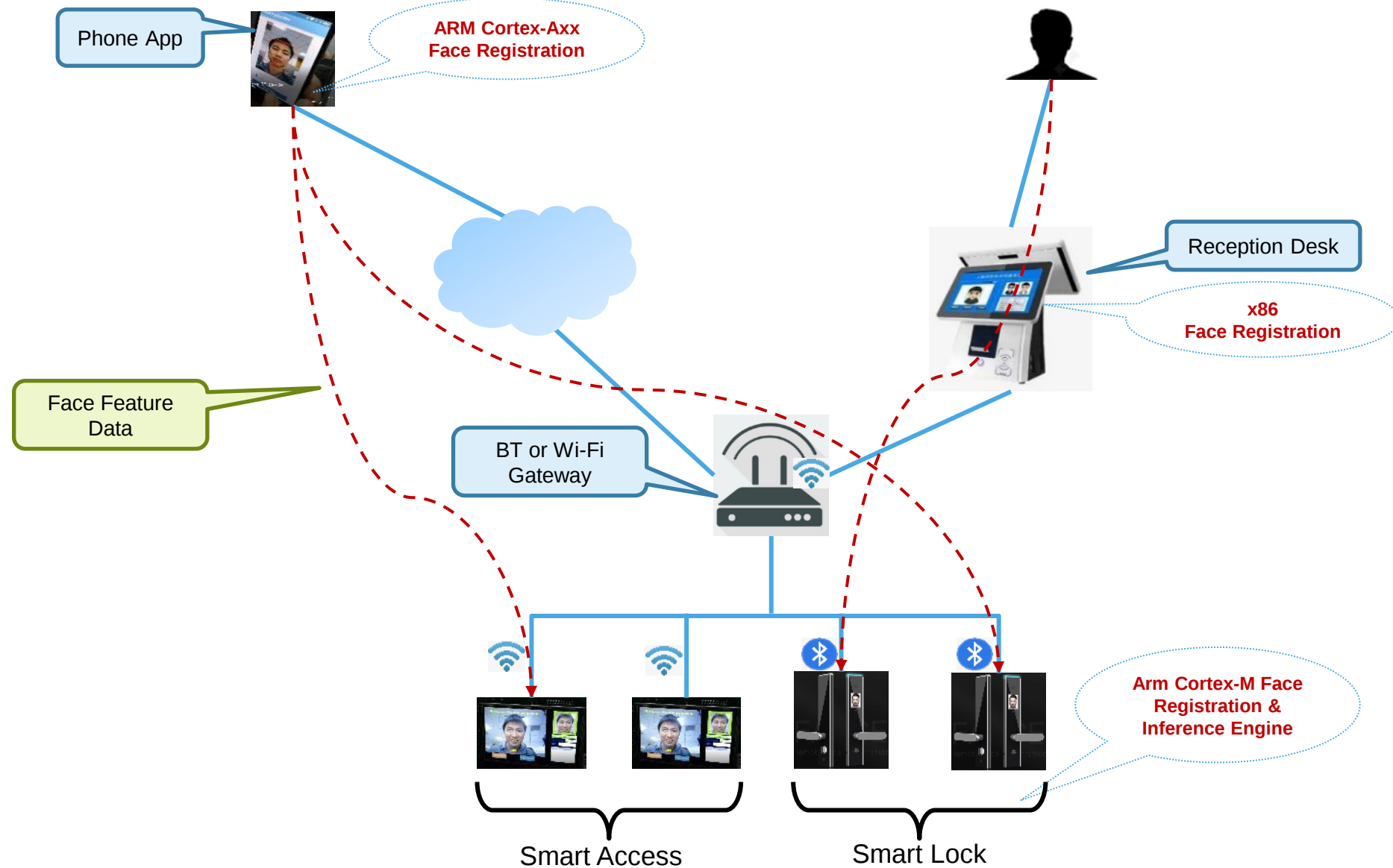
NXP i.MX RT117F 3D结构光人脸识别门锁方案



单芯片支持:

- 3D结构光人脸识别
- 彩色猫眼功能
- 支持门内外双彩屏

REMOTE REGISTRATION CAPABILITY

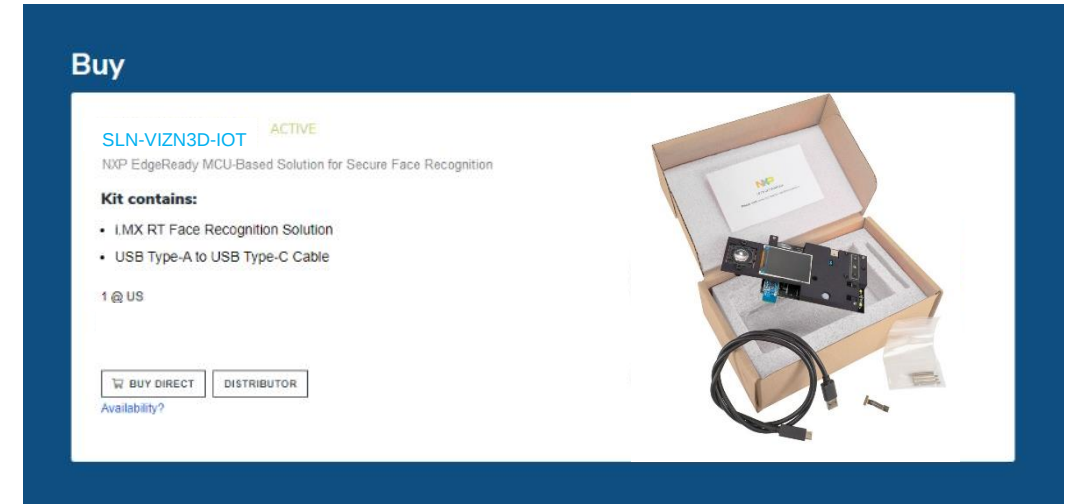
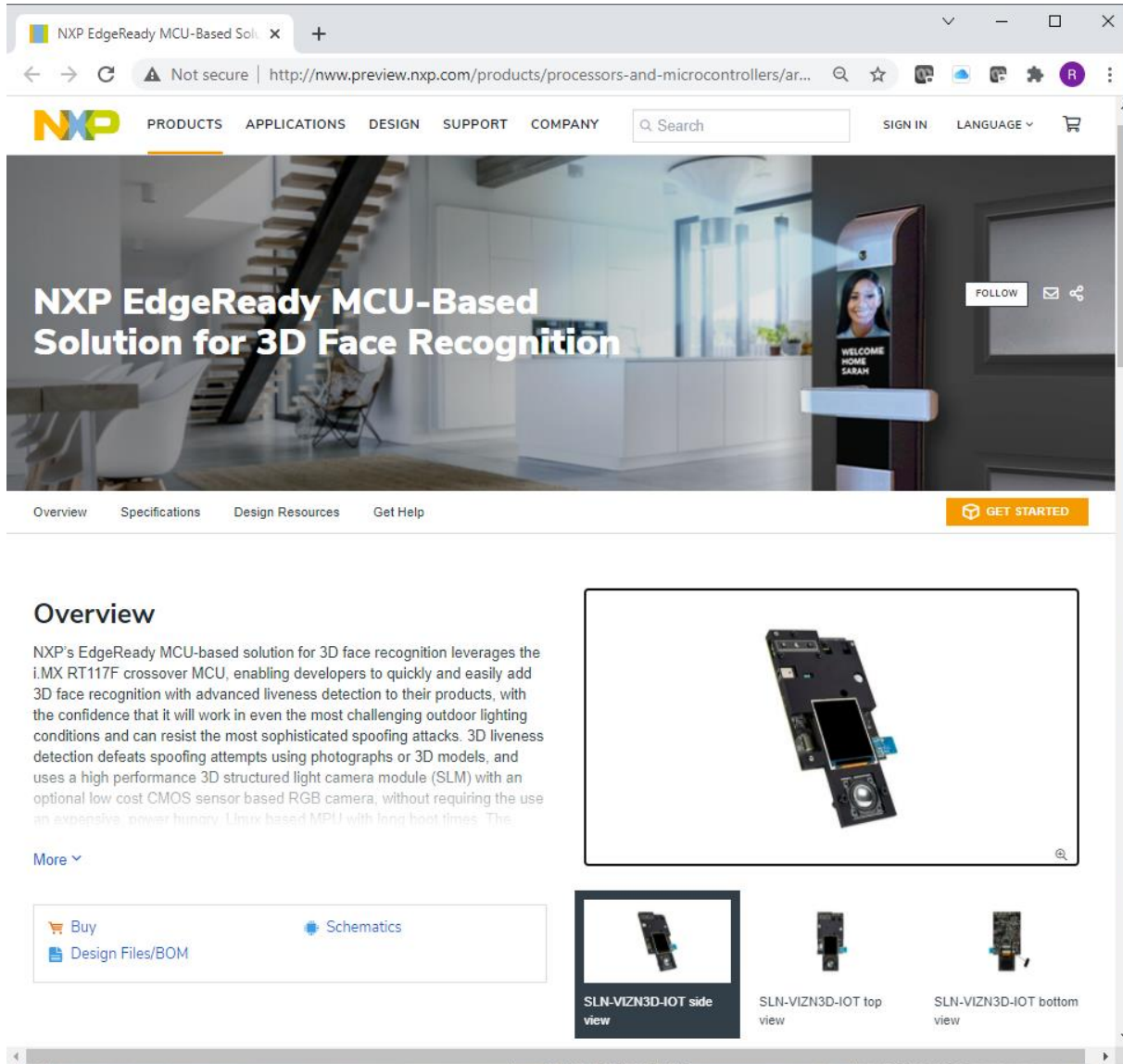


FACE RECOGNITION APP TYPE AND MODEL TYPE CONFIGURATIONS AND CAPABILITIES

App Type Definitions
Smart Lock Targets battery powered smart lock applications
Smart Access For line powered access control panels
User Identify (1:1) HMI user identification applications that used for identify if the card match with the user.

App Type	Maximum # of faces	Liveness Detection
Smart Lock	50	Yes (2D & 3D)
Smart Access	3000	Yes (2D & 3D)
User Identify	No limit	2D No liveness

FOR MORE INFORMATION... www.nxp.com/mcu-vision3D GOES LIVE NOVEMBER 3



- **Download**
 - Design Files: Schematics, BOM, layout
 - Software via MCUXpresso SDK
 - Source, binaries, documentation
- **View** getting started pages & videos
- **Buy** SLN-VIZN3D-IOT kits (\$299)



TECHNOLOGY SHOWROOM

JOURNEYS BY DESIRED ENGAGEMENT

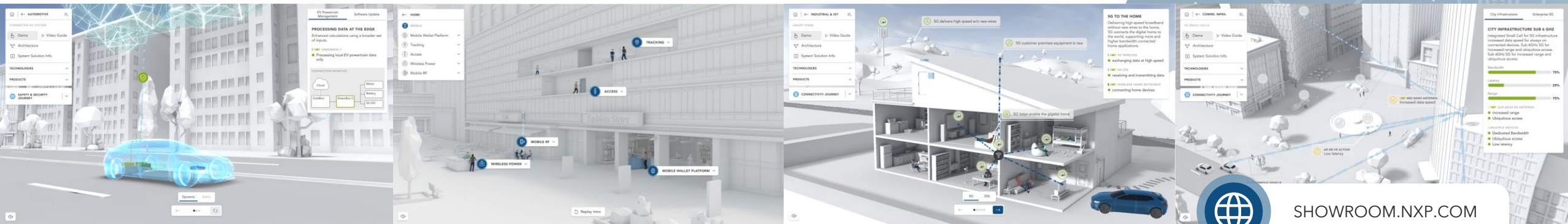
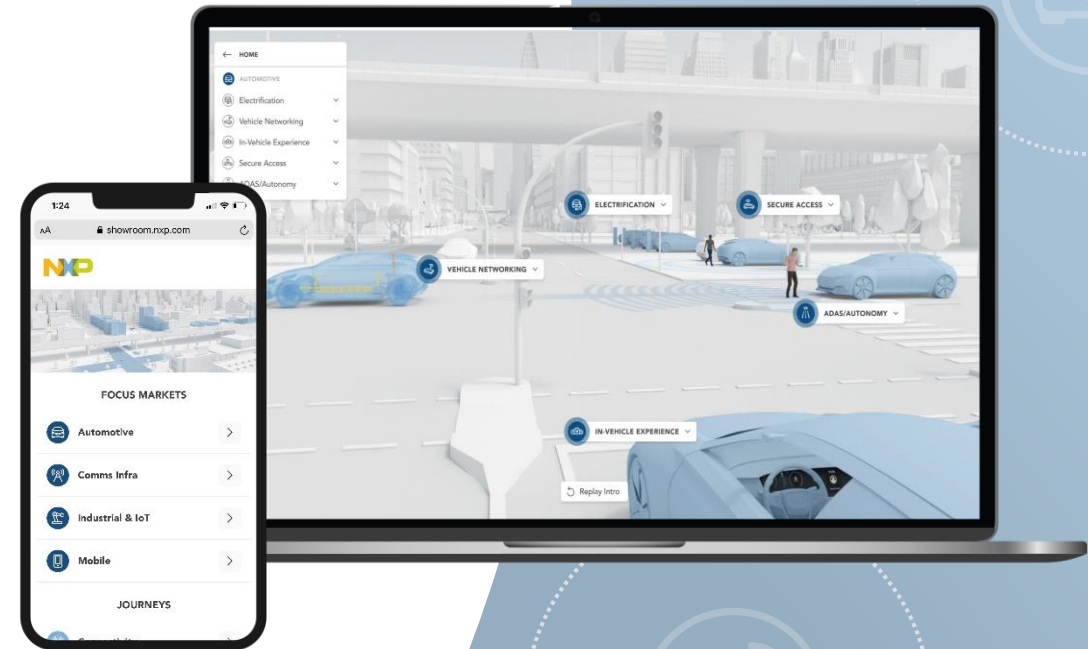
- Self-guided tour
- Live-streaming at set times
- Guided tours

JOURNEYS BY DESIRED FOCUS

- Low Power Innovations
- Advanced Analog
- Connectivity
- Edge & AI/ML
- Safety & Security

60+ VIRTUAL DEMOS

- Focus on system solutions
- Set up along NXP verticals



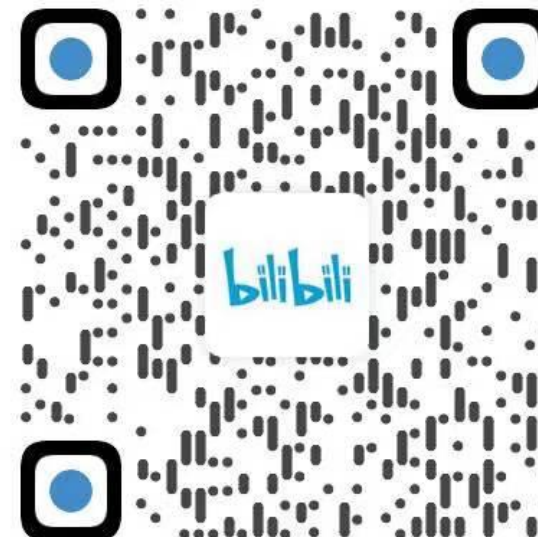
WELCOME TO FOLLOW NXP AT SOCIAL PLATFORMS



欢迎您关注「恩智浦微招聘」公众号
及时获取恩智浦“芯”职位及员工
活动相关资讯



关注NXP客栈公众号，查看恩
智浦最新官方资讯及技术材料



关注恩智浦B站官方账号，观
看恩智浦最新技术视频

Q&A





SECURE CONNECTIONS
FOR A SMARTER WORLD



[SHOWROOM.NXP.COM](https://showroom.nxp.com)