Leveraging Face Recognition for Friction-Free Interfaces

Chris Rivera

IoT Security and Solutions

Machine Vision System Integrator

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SECURE CONNECTIONS
FOR A SMARTER WORLD

Agenda

- NXP IoT Solutions Model

- MPU-Based Secure-ID Solution

    – 8MM-AMI Demos

- MCU-Based Facial Recognition

    – RT-Vision Demos

- Q&A and Wrap-up

Our Purpose

Our Vision

Simplifying complex IoT integration challenges; focused on voice, vision and anomaly detection

Our Mission

Enabling customers to focus on their application differentiation & get their products to market faster

Our Value

Proving & Productizing relevant & optimized integrated solutions for out customers

Combining Horizontal Capabilities to Build Vertical Solutions

Vision
Face and Object Recognition

Voice Control
Local and Cloud Commands, Near and Far Field Support

Anomaly Detection
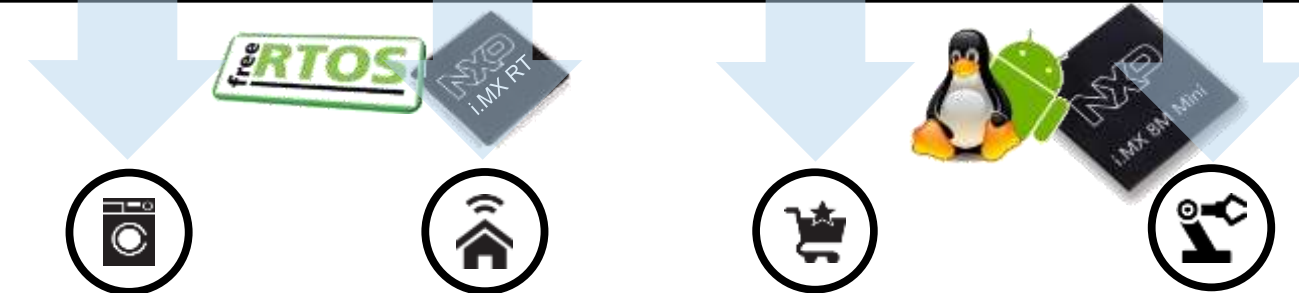Monitoring/Tracking: Vibration, Acoustic, and Pressure

Secure IoT Capabilities
- Manufacturing
- Boot
- Provisioning
- Onboarding
- OTA
- Decommissioning

Connectivity
Wi-Fi | Bluetooth | Zigbee

Processor and OS Platform
freeRTOS | i.MX RT | Linux/Android | i.MX 8M Mini

Smart Appliance   Smart Home   Smart Retail   Smart Industry

Production Grade, Certified IoT System Solutions

- Implemented with best in class silicon, software and IP from NXP and 3rd parties

- Near production ready hardware
  - Cost and form factor optimized

- Pre-integrated production ready software,
  fully tested & certified

- NXP provides a single point of contact for support, licensing and procurement

- Use case dependent solutions:
  - Turnkey – for well defined use cases
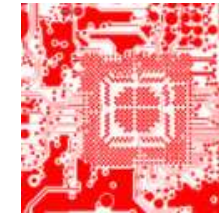 - Customizable – can be modified, tuned and trained for specific use cases

OOB HW/SW

Software Source
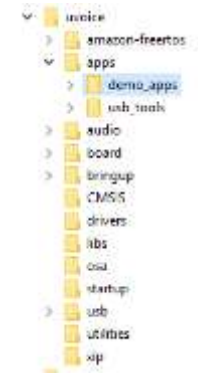
Schematics

Layouts

Certifications

BOMs

U1	MIMXRT1052DVL6B	I.MXRT1050 Cross Processor
U3	W9812G6JB-6I	128Mbit SDRAM 3V 166MHz
U4	IS26KL256S-DABLI00	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 10XQFI
U10	XCL214B333DR	DC/DC CONVERTER 3.3V 5W

Documentation

MPU-Based Secure-ID Solution

Adaptive Machine Interface – Target Applications

- **Anywhere you would like to embed**
  - Secure authentication and access
  - User identification and personalization
  - Voice control with display
  - Video & voice communication

- **Target applications include**
  - Smart access and alarm panels
  - Fleet management / Rideshare / Dashcams
  - Smart appliances
  - Smart thermostats
  - Smart screens
    - Displays / monitors / mirrors

NXP Adaptive Machine Interface Differentiating Features

- Secure, robust, facial recognition with <200ms inference time

- Larger display options (initially 5" & 7"), more later

- Day/night vision camera capability

  – IR sensitive camera sensor for low-light & no-light operation

- Dual speakers for stereo sound

- Secure element

  – Root of trust for OOB device-to-cloud security (including AWS)

    ▪ Enables secure manufacturing capability

- 6-axis accelerometer/magnetometer

  – Vibration anomaly detection for smart appliances, etc.

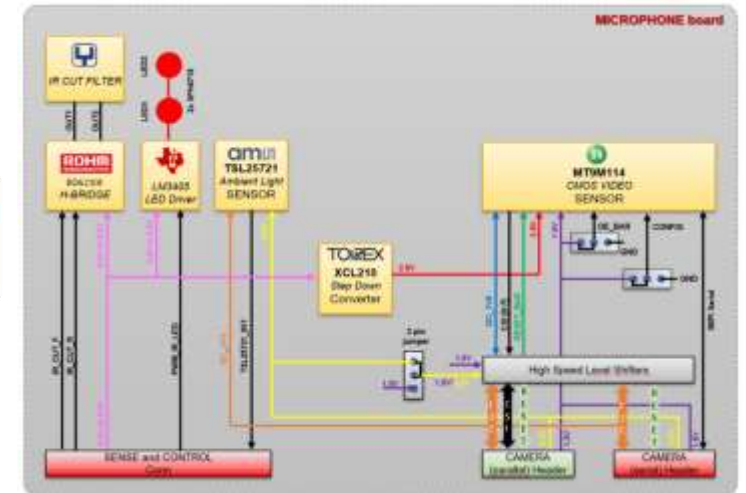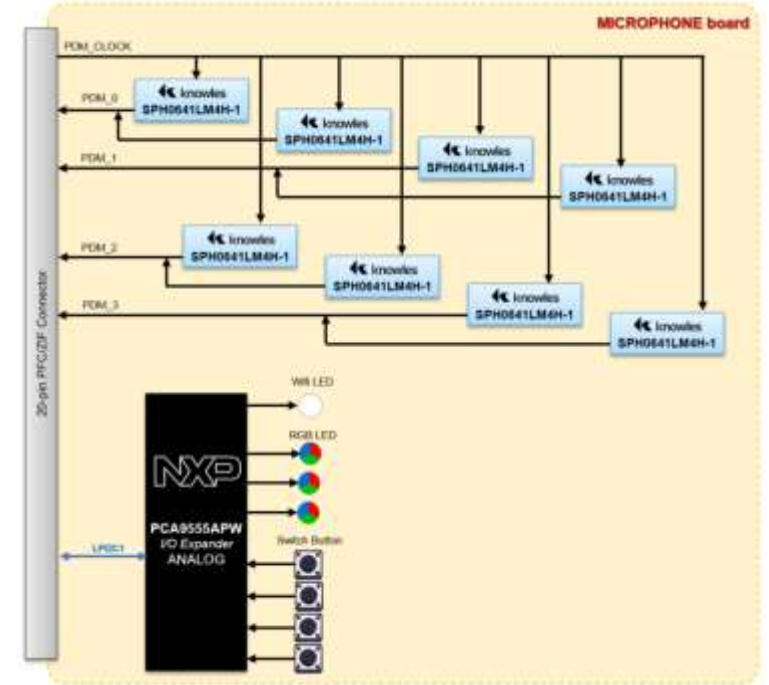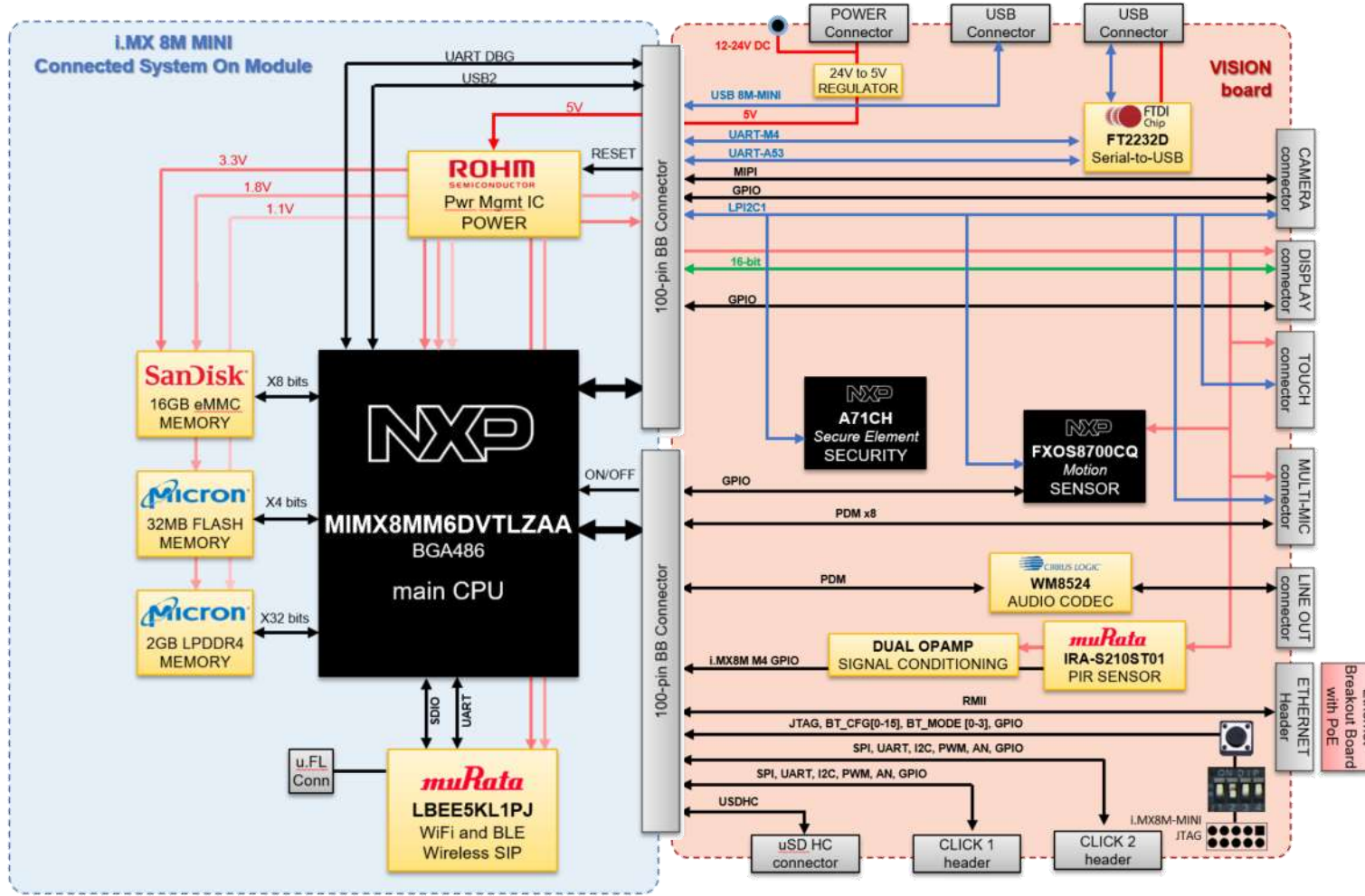- Sold through NXP's extensive channel network, w/o NDA

Feature Comparison – NXP AMI Kit

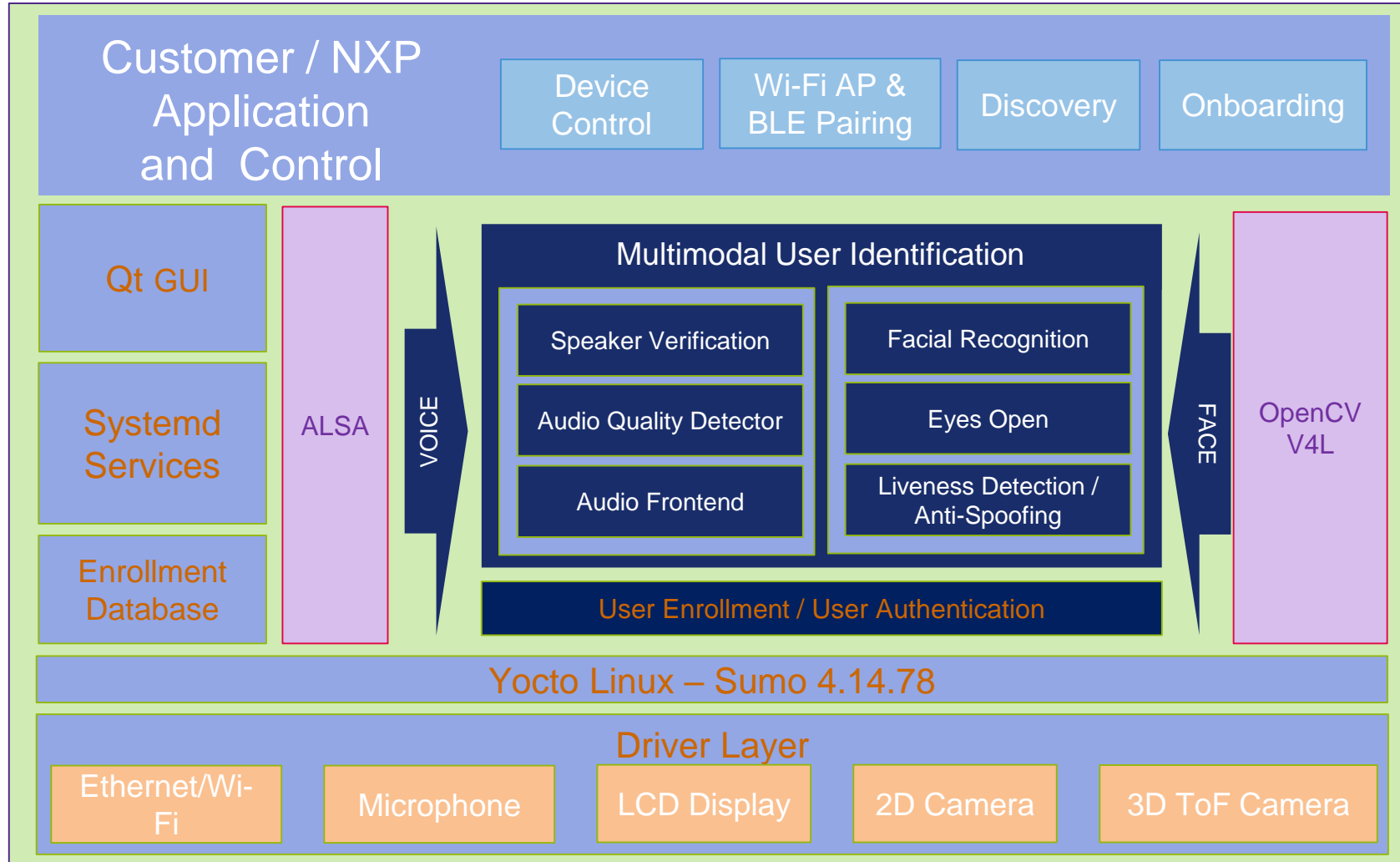| Feature	NXP AMI Kit
Screen size & type	5" or 7" TFT cap touch
Screen resolution	1280 x 720p
Camera	Visible light & IR for night vision
Microphones	3 (population options up to 8
Processor	NXP i.MX 8M Mini - Quad Arm Cortex-A53 (1.8 GHz) + Cortex M4
O/S	Linux (Android later)
Speakers	2
SDRAM	2 GB LPDDR4
Flash	16 GB eMMC 5.1
Wi-Fi / Bluetooth	802.11ac 1x1 (2.4 & 5 GHz) / BLE 4.1
Zigbee / Z-Wave	Optional via Click module
Secure Element	✓
Vibration/motion anomaly detection	✓
OTA	✓
Secure Facial Recognition	✓
Planned availability	For sale through distribution (no NDA)

NXP Adaptive Machine Interface Kit

NXP AMI – HW Block Diagram

NXP AMI SecureID – Software Block Diagram

Customer / NXP Application and Control

Device Control | Wi-Fi AP & BLE Pairing | Discovery | Onboarding

Qt GUI

Systemd Services

Enrollment Database

ALSA

VOICE

Multimodal User Identification

Speaker Verification

Audio Quality Detector

Audio Frontend

Facial Recognition

Eyes Open

Liveness Detection / Anti-Spoofing

User Enrollment / User Authentication

FACE

OpenCV V4L

Yocto Linux – Sumo 4.14.78

Driver Layer

Ethernet/Wi-Fi | Microphone | LCD Display | 2D Camera | 3D ToF Camera

NXP AMI: SecureID Key Specs and Next Steps

Specs:

- Provides production grade Facial Recognition and Speaker Verification in the form of a certified development solution.

- Facial Recognition
  - Access control level accuracy of upto 1/1,000,000 FAR and 1% FRR
  - Built on arm64 gcc4/5 libs
  - Application install sizes ~22MB, and user enrollment sizes of 240KB per user
  - Liveness detection included to prevent spoofing attacks
  - Support for 3D ToF Camera a 3D Facerec
- Speaker Verification
  - Fully language independent
  - Supports fixed and user-defined pass phrases
  - Access control level accuracy of upto 1/1,000,000 FAR and 1% FRR
- Support for Convenience mode where either face or voice, or both are needed for system access

Live Demo Link:
https://youtu.be/ceZLn0bTBqg

Next Steps and Call to Action

- Sampling limited number of prototype AMI development kits now for customers interested in ramping in 2019
- General AMI kit availability through NXP channels planned for 4Q19

Need Roadmap Slide
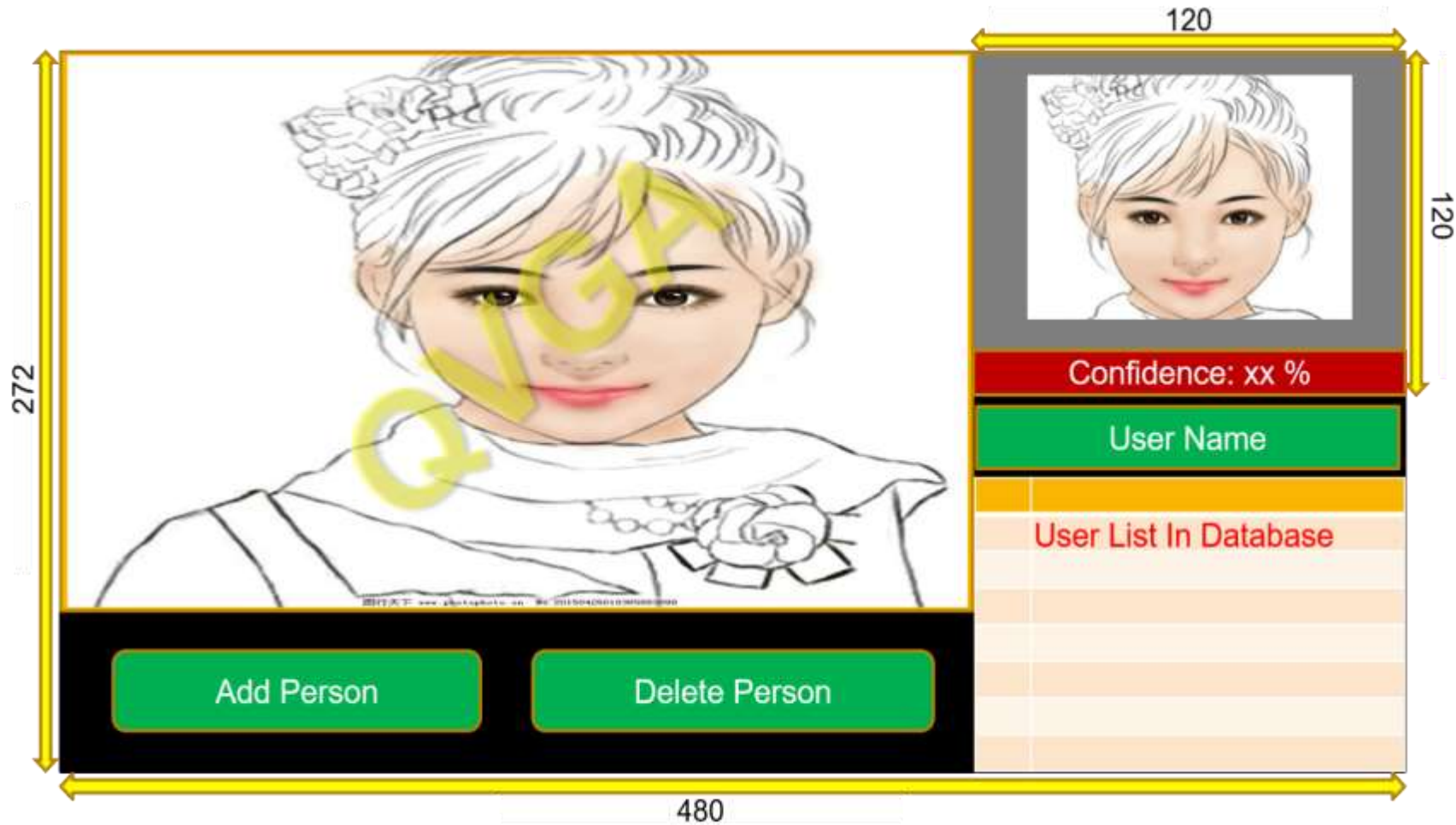
MCU-Based Facial Recognition
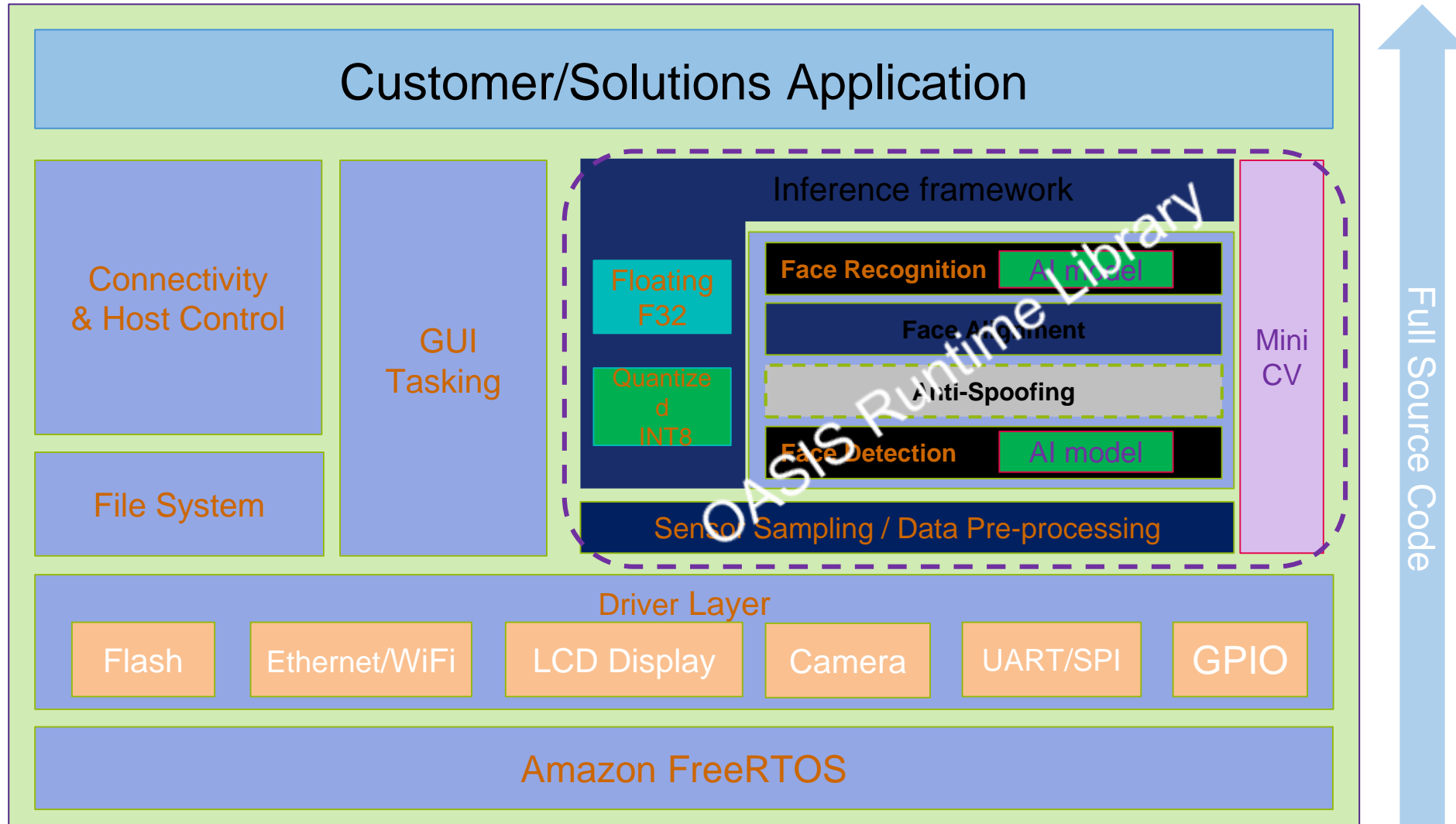
i.MX RT Vision for MCU Demonstration

- Built on i.MX RT106x MCU

- Machine Learning powered by NXP OASIS

- Facial registration performed via mobile app

- Face classifier transferred to RT106x via WIFI/BLE connection

- RT1060 running OASIS inferencing engine, MobileNet model, and SVM face classifier

- RT1060 recognizes users using parallel-IF 720P camera (400x200 px processed)
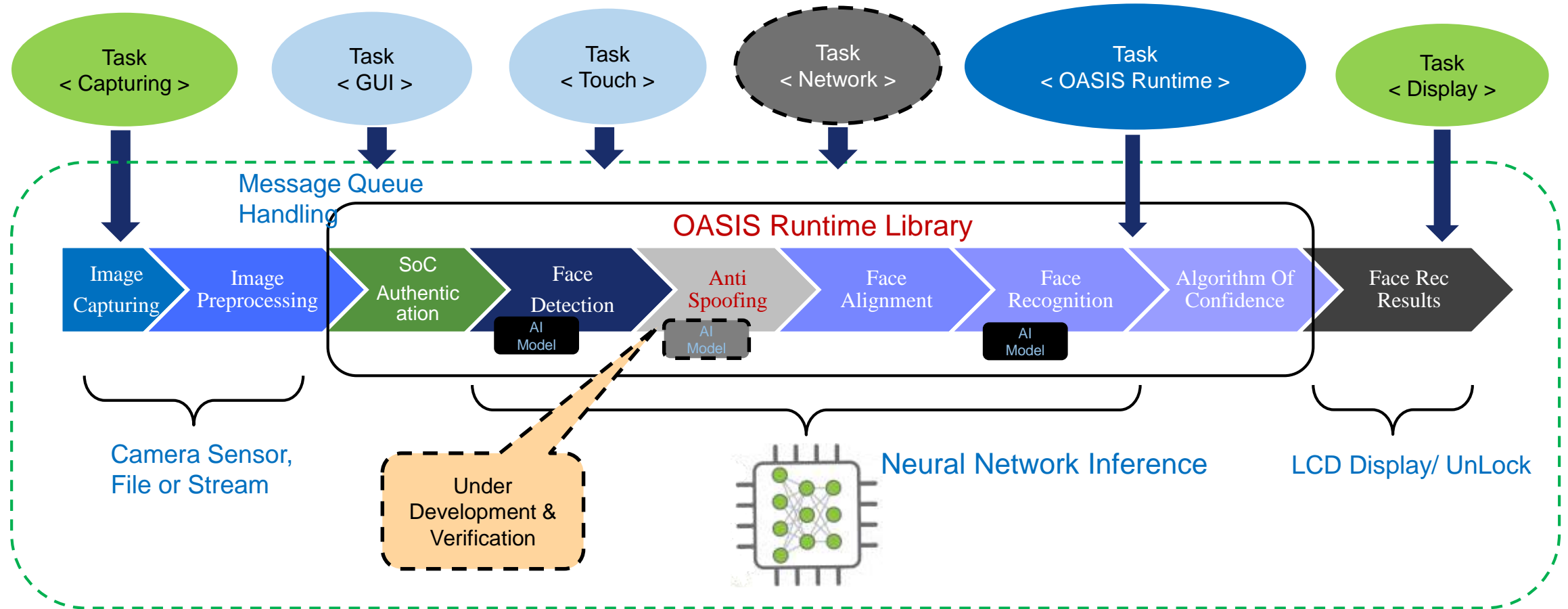
iMX-RT106x Facial Recognition GUI Design

i.MX RT106x MCU Facial Recognition Solution SW

i.MX RT Facial Recognition Pipeline

NXP MCU Face Recognition Framework

Task < Capturing >

Task < GUI >

Task < Touch >

Task < Network >

Task < OASIS Runtime >

Task < Display >

Message Queue Handling

OASIS Runtime Library

Image Capturing

Image Preprocessing

SoC Authentication

Face Detection — AI Model

Anti Spoofing — AI Model

Face Alignment

Face Recognition — AI Model

Algorithm Of Confidence

Face Rec Results

Camera Sensor, File or Stream

Under Development & Verification

Neural Network Inference

LCD Display/ UnLock

NXP MCU Facial Recognition Demo
Performance & Benchmark Summary

Benchmark Items	NXP solution
Model Framework	Caffe
Model Network	Mobilenet_nxp (an evolution based on Mobilenet V2 with nxp optimization)
Model Size	0.99 MB (quantized to INT8, 0.99M parameters)
Model Data Input	160 X 160 ROI (resize M X N for inference)
Camera Pixels Processed	240 X 320 (matters for preview only, ROI size is more important
Model optimize	Quantized and some algorithm optimized for model layers combined
Heap Size	8 MB
Face detection	YES
Face recognition inference time	603 ms
Anti-spoofing feature	NO (To Be Implemented)
Face recognition accuracy	Excellent (threshold = 80) for face recognized. (Model Accuracy ~ 99 %)
Face DB storage	Local file system storage support (done)
GUI multitasking support	Good GUI support with multitasking / message handling.

M7 Core Speed	Face Detection (mS)	Face Recognition (mS)	Total Inferrence Time (mS)	SoC Power (mW)
600Mhz	131	472	603	353.7
528Mhz	141	500	641	269.2
396Mhz	190	635	825	239.7
264Mhz	221	737	958	195.4
132Mhz	458	1500	1958	95.1
24Mhz	1941	6238	8179	7.6

Live Demo Link: https://youtu.be/lILhTNcOEpg

Detection Time: the time required to find a face in the frame and crop the ROI
Recognition Time: the time is takes to run the cropped ROI pixels through the CNN and SVM to classify the users face

i.MX RT106x Vision Solution

- **Friendly face recognition (up to 100 faces)**
  - Suitable for user identification
  - Less appropriate for user authentication

- **i.MX RT1060 MCU-based SOM (40 mm x 30 mm)**
  - Arm Cortex-M7 @600MHz
  - 1 MB integrated SRAM (512 kB TCM)

- **600ms recognition time (NXP built IP)**
  - Concurrent w. NW stack, display & OEM application

i.MX RT Vision Solution
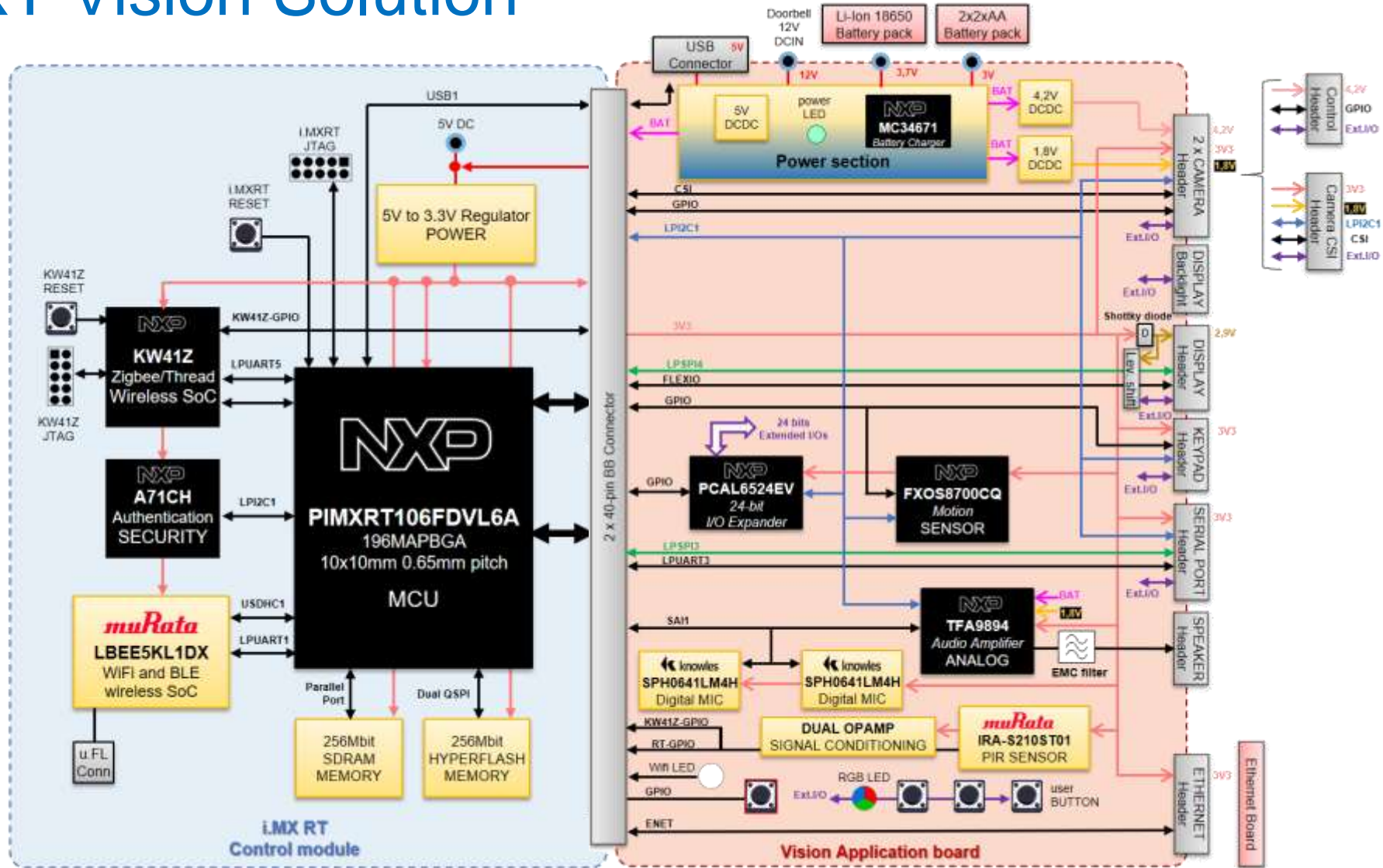
Low Light Camera Module
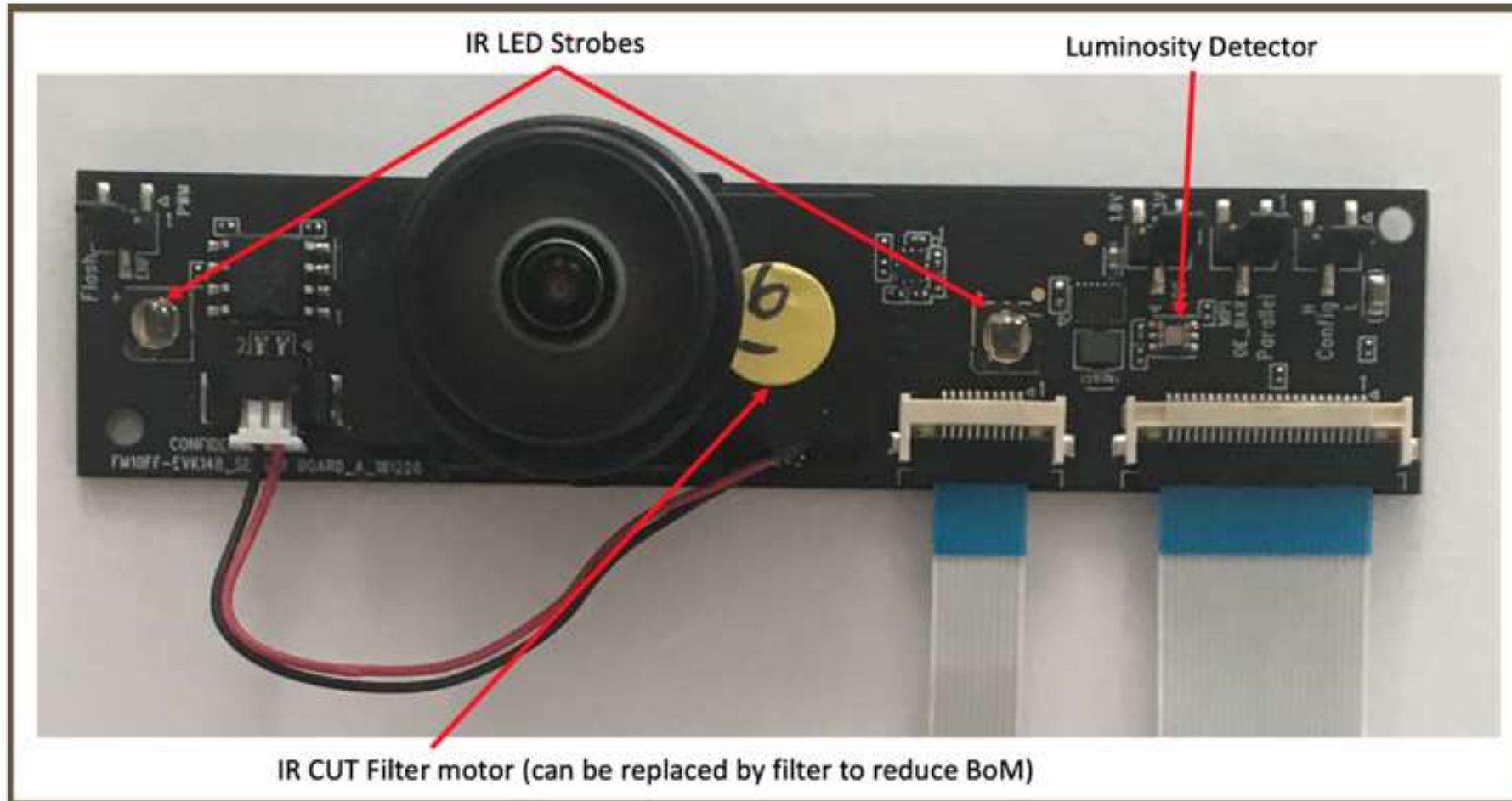
Compatible with both 8MMINI AMI and RT Vision kits

Need Roadmap Slide

Questions?

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