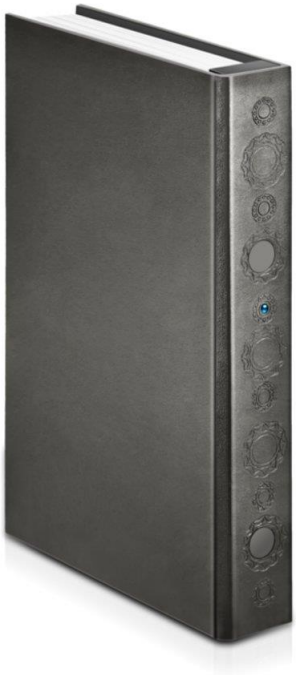
HAN AEA - Embedded Vision & Machine Learning

EVD1 – period 2 Introduction

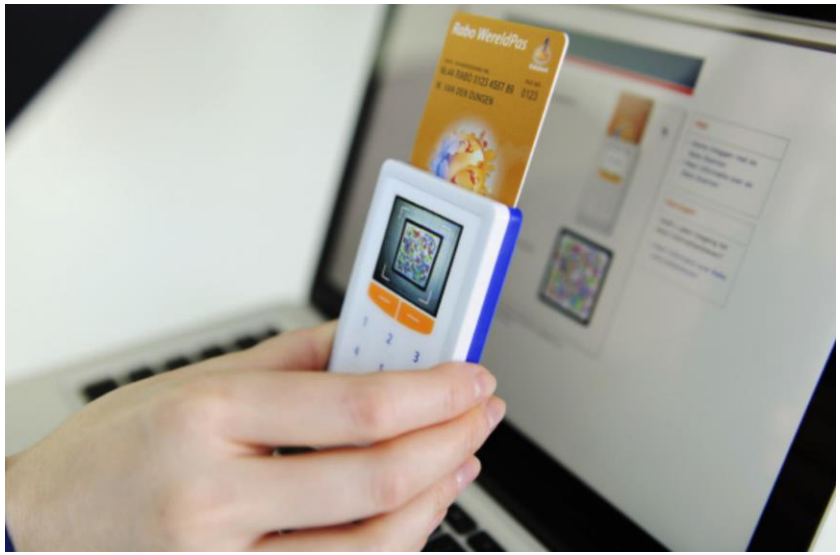
By Hugo Arends

EVD1 – Purpose

Learn how to use computer vision on microcontroller-based products



https://www.bol.com



https://www.rabobank.nl

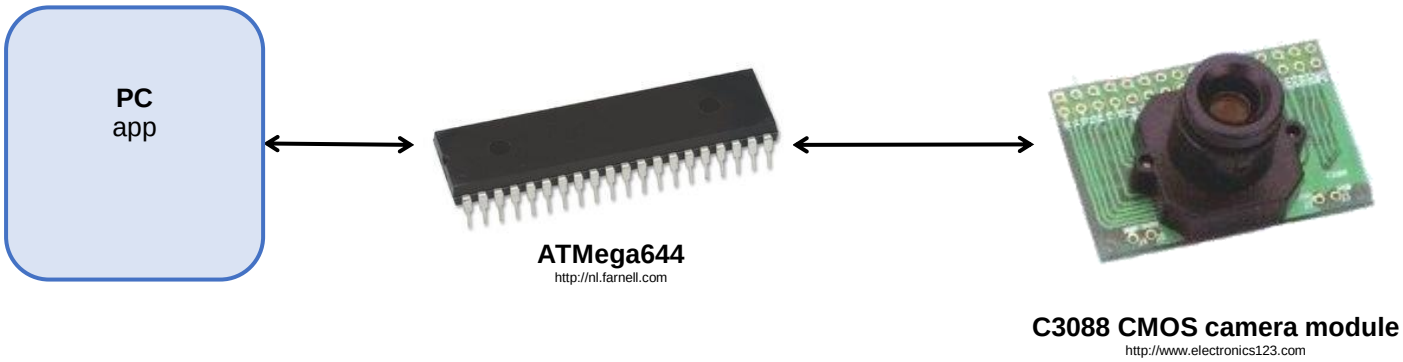
EVD1 – History

Requirements: Offer a development environment for image processing operators that can be …

- … used on both PC and embedded hardware
- … used for benchmarking purposes
- … easily debugged
- … worked with at home
- … used to realize challenging assignments for EVD project

EVD1 – History

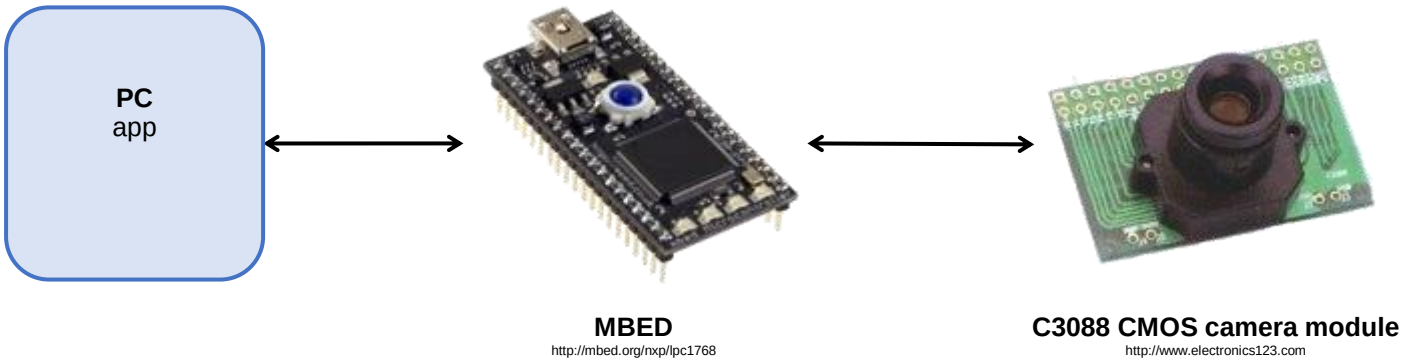
EVD1 2009-2010



Features:
- ~ 1 frame per minute data transfer
- vision operators ‘on-the-fly’
- 4 kB RAM (picture 50x50 pixels)

EVD1 – History

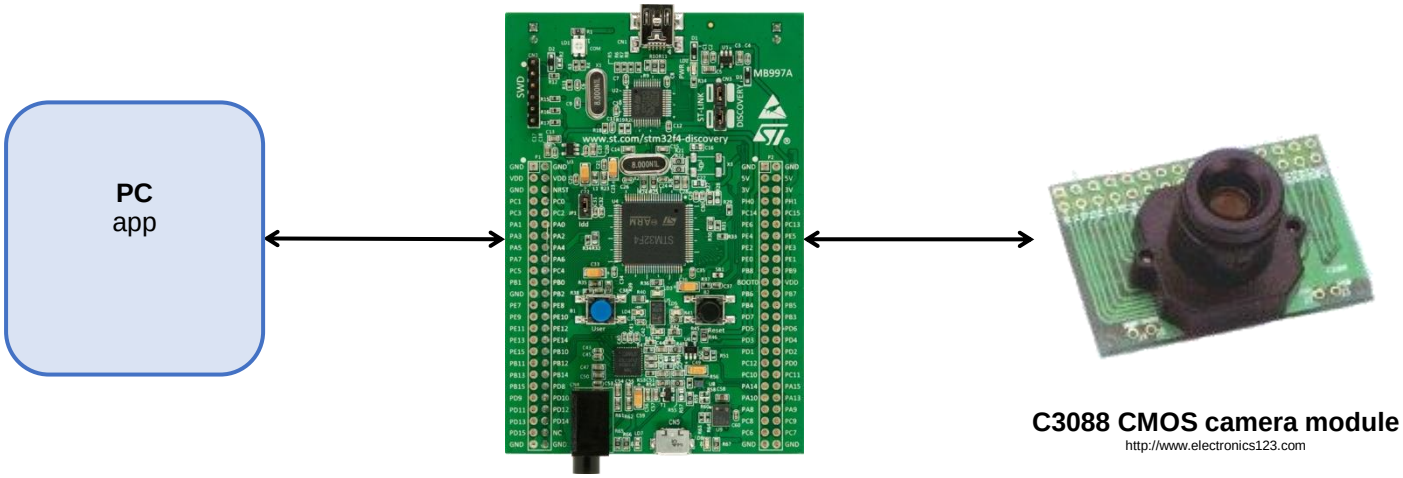
EVD1 2010-2011



Features:
- ~ 1 fps data transfer
- ~ 3 fps (standalone, incl. vision operators)
- 32 kB RAM (picture 176x144 pixels)

EVD1 – History

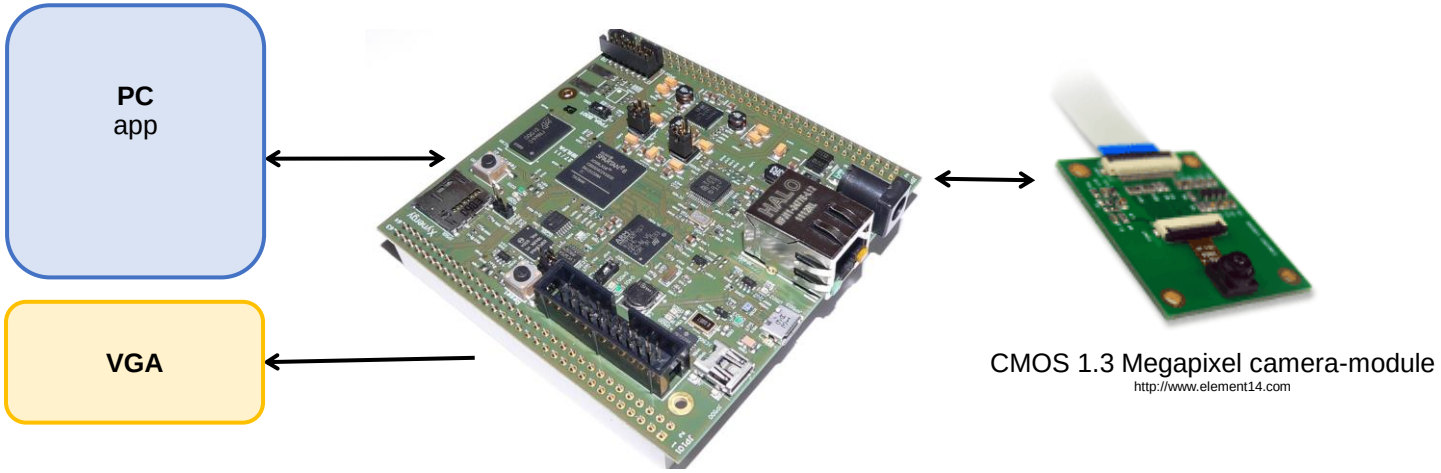
EVD1 2011-2012



Features:
- 30 fps data transfer
- 7 fps (standalone, incl. vision operators)
- 192 kB RAM (multiple pics. 176x144 pixels)

EVD1 – History

EVD1 2013-2014



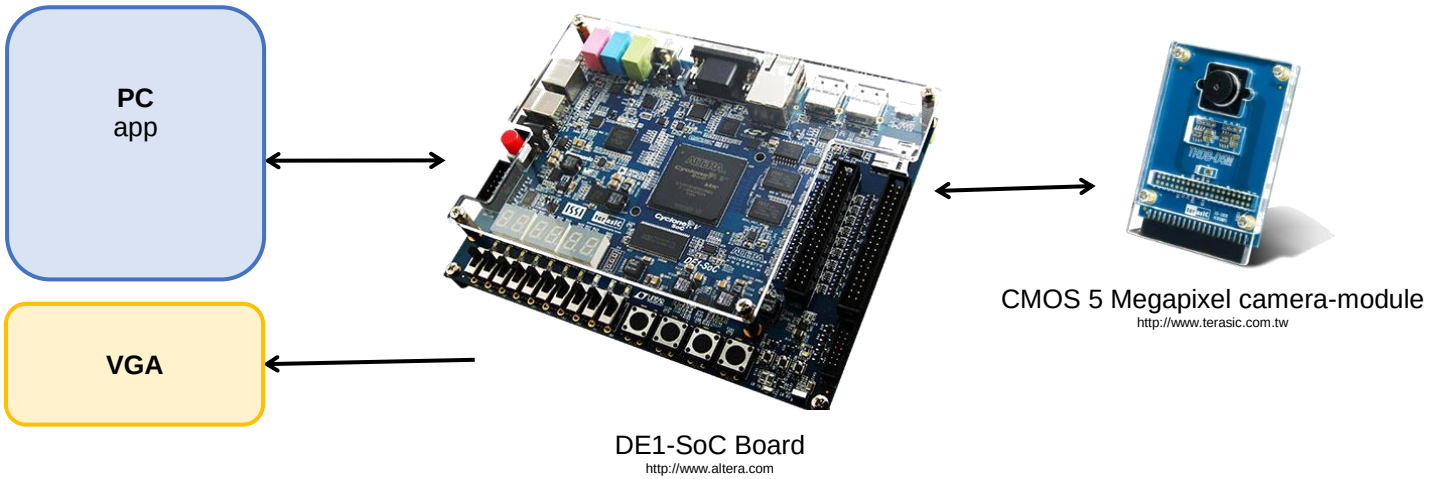
Silica Xynergy-M4
http://www.silica.com

CMOS 1.3 Megapixel camera-module
http://www.element14.com

Features:
- ? fps data transfer
- ? fps (standalone, incl. vision operators)
- 64 M x 16 bit RAM

EVD1 – History

EVD1 2014-2015



Features:
- ? fps data transfer
- ? fps (standalone, incl. vision operators)
- Altera's Cyclone® V FPGA
- Dual-core ARM Cortex-A9 (HPS)
- 1GB DDR3 SDRAM (FPGA), 64 MB SDRAM (HPS)

EVD1 – History

2017-2018

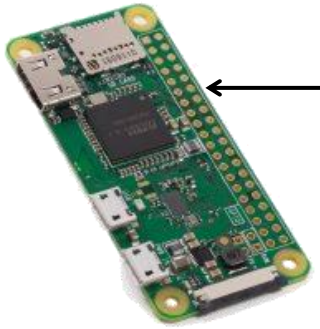
Webcam
http://www.logitech.com

PC
app

STM32F4Discovery
http://www.st.com

C3088 CMOS camera module
http://www.electronics123.com

Features:
- 12 Mbit per second via USB
- 30 fps (standalone, incl. vision operators)
- 192 kB RAM (multiple pics. 176x144 pixels)

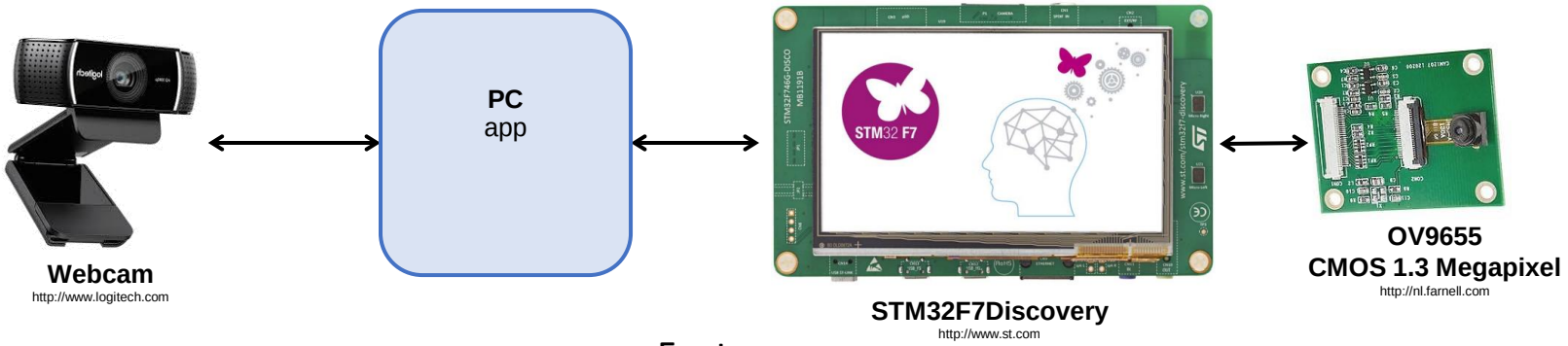


RPi zero W
http://www.raspberry.org

Features:
- ? fps data transfer via TCP
- ? fps (standalone, incl. vision operators)
- 512 MB RAM
- Color image processing

EVD1 – History

2020-2021

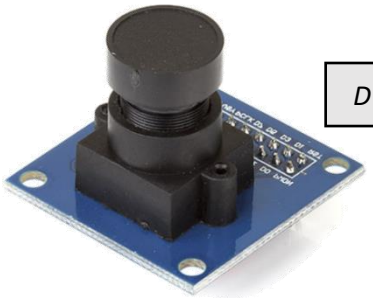


Features:

- Greyscale and color image processing (RGB565)
- Two image sizes: QVGA and QQVGA
- LCD
- 12 Mbit per second via USB
- 15 fps (standalone, QQVGA, incl. vision operators)
- 340 kbyte internal RAM and 4 Mbyte external SDRAM

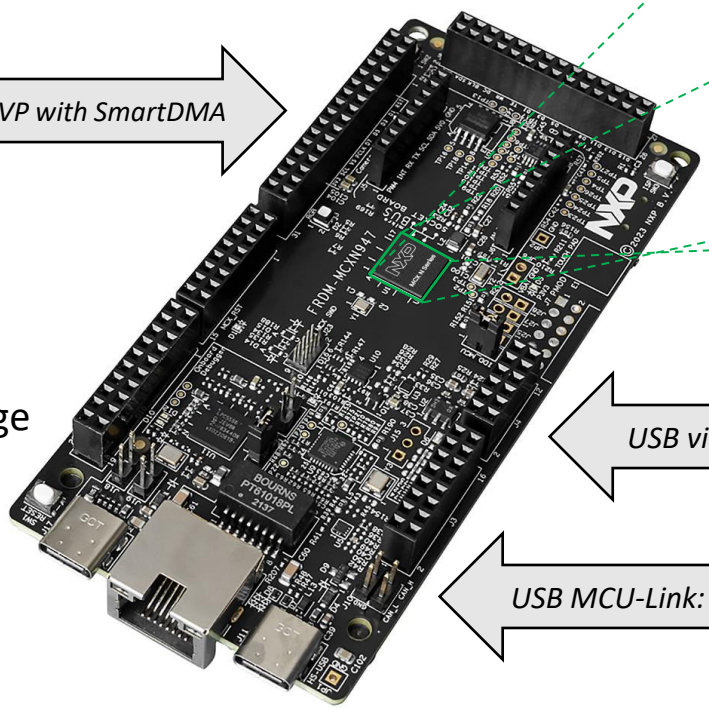
EVD1 – History

2024-2025



OV7670

DVP with SmartDMA



MCXN947VDF

Image processing
QQVGA: 160x120
YUV, RGB888, uint8, int16, int32, float

USB video class device

USB MCU-Link: SWD and VCOM

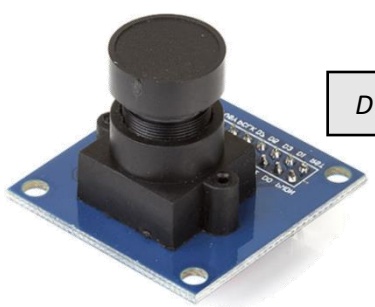
Laptop / PC

Features:

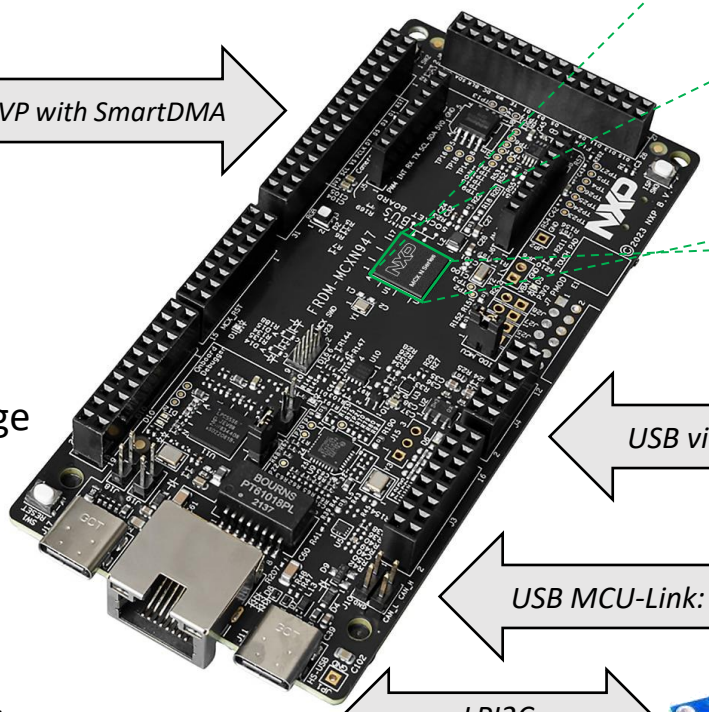
- Greyscale and color image processing (RGB565)
- QQVGA (160x120)
- USB-HS interface
- UVC
- 30 fps
- 512 kByte internal SRAM

EVD1 – Present: EVDK5

2025-2026



DVP with SmartDMA



MCXN947VDF

Image processing
QQVGA: 160x120
YUV, RGB888, uint8, int16, int32, float

USB video class device

USB MCU-Link: SWD and VCOM

LPI2C

Laptop / PC

Features:

- Greyscale and color image processing (RGB565)
- QQVGA (160x120)
- USB-HS interface
- UVC
- 30 fps
- 512 kByte internal SRAM
- VS Code instead of Qt
- OLED for (image) visualisation

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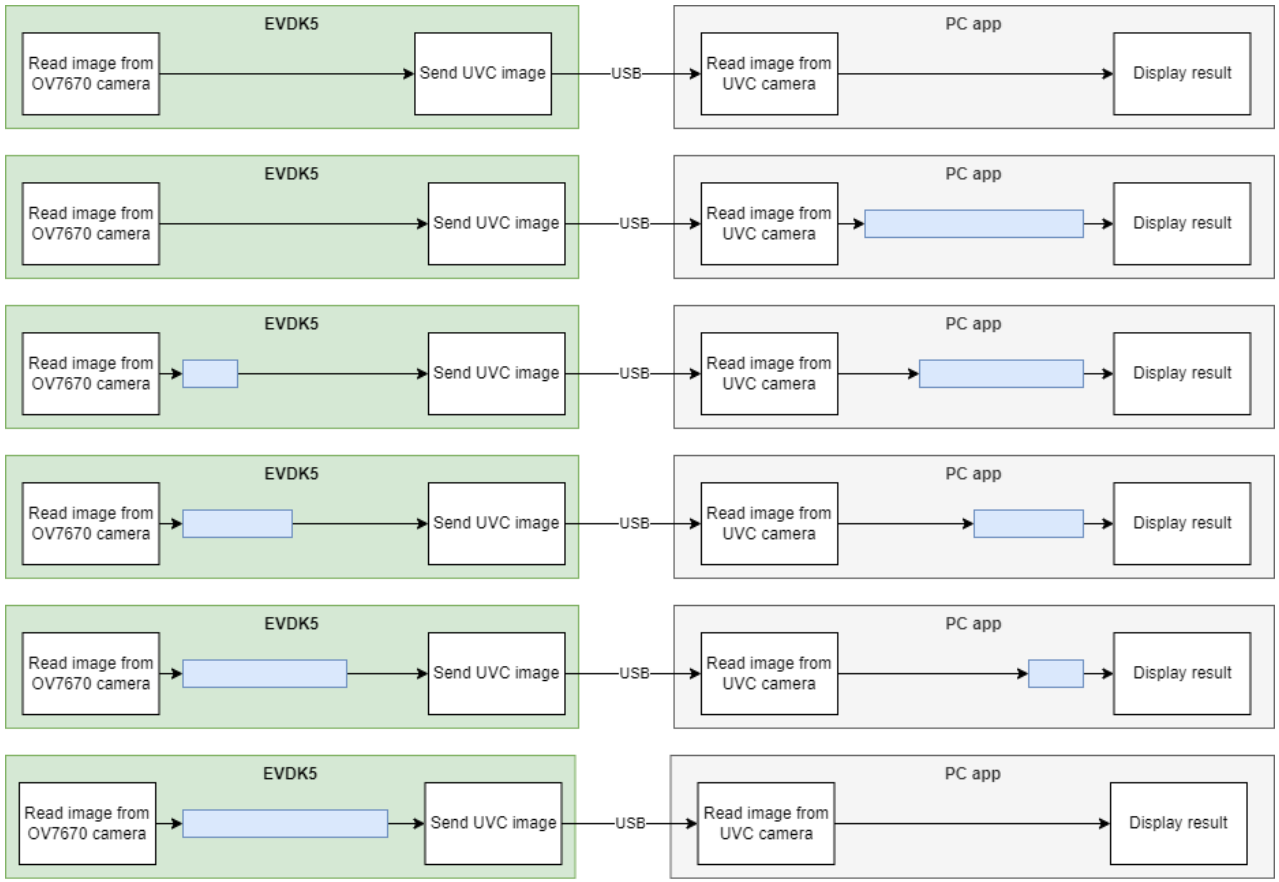
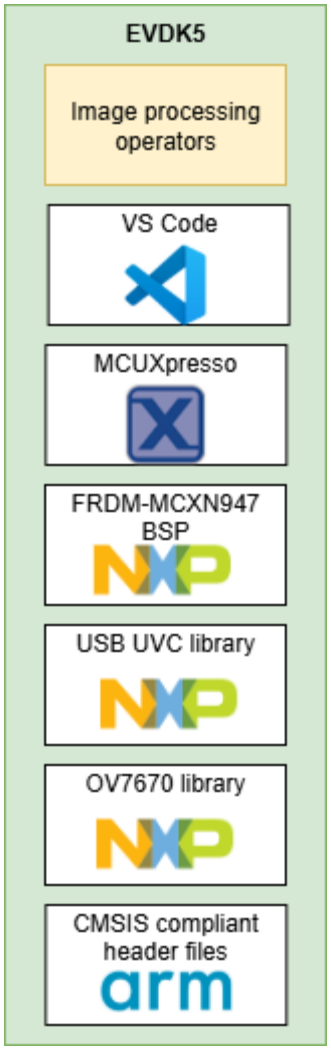
EVD1 – Workflow



EVD1 – Tools and software



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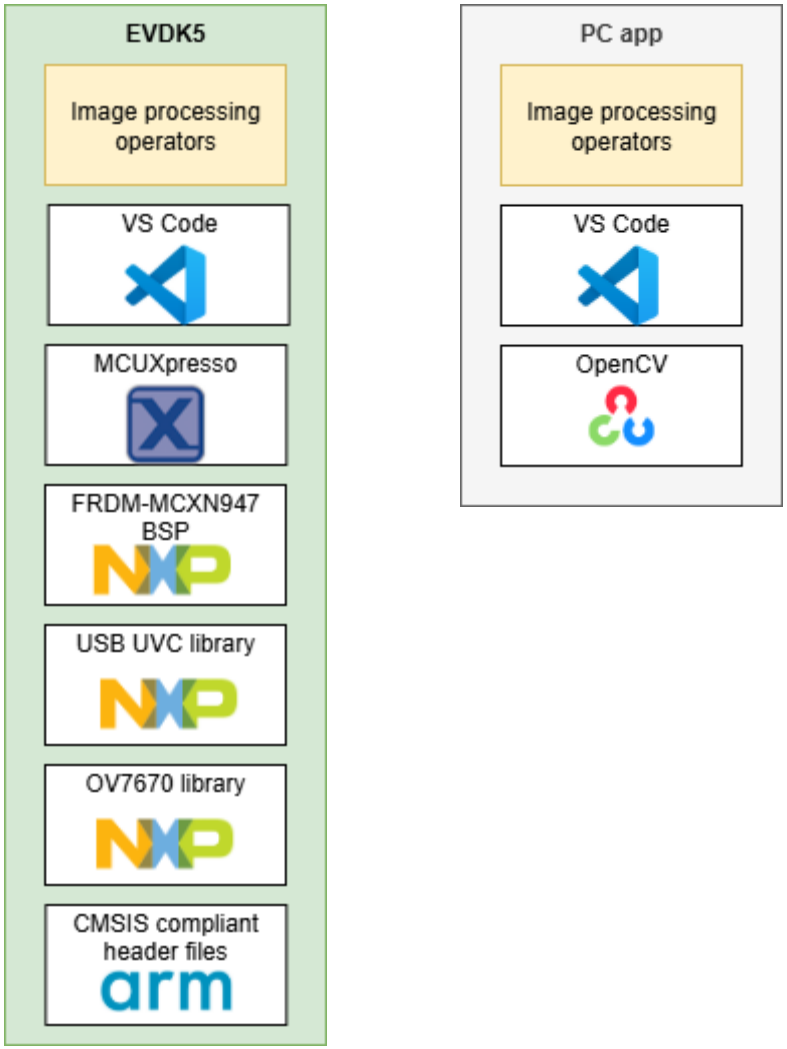
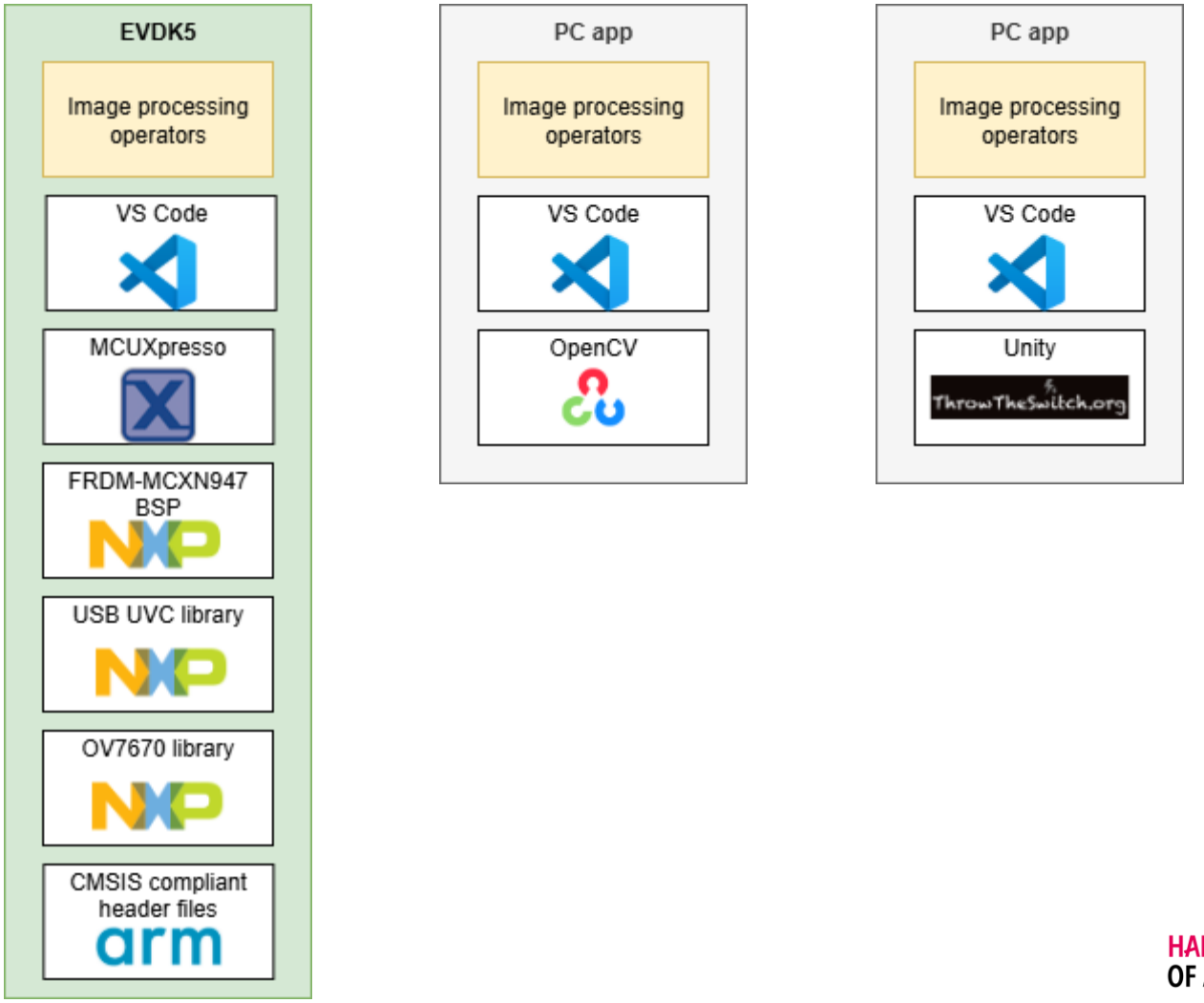
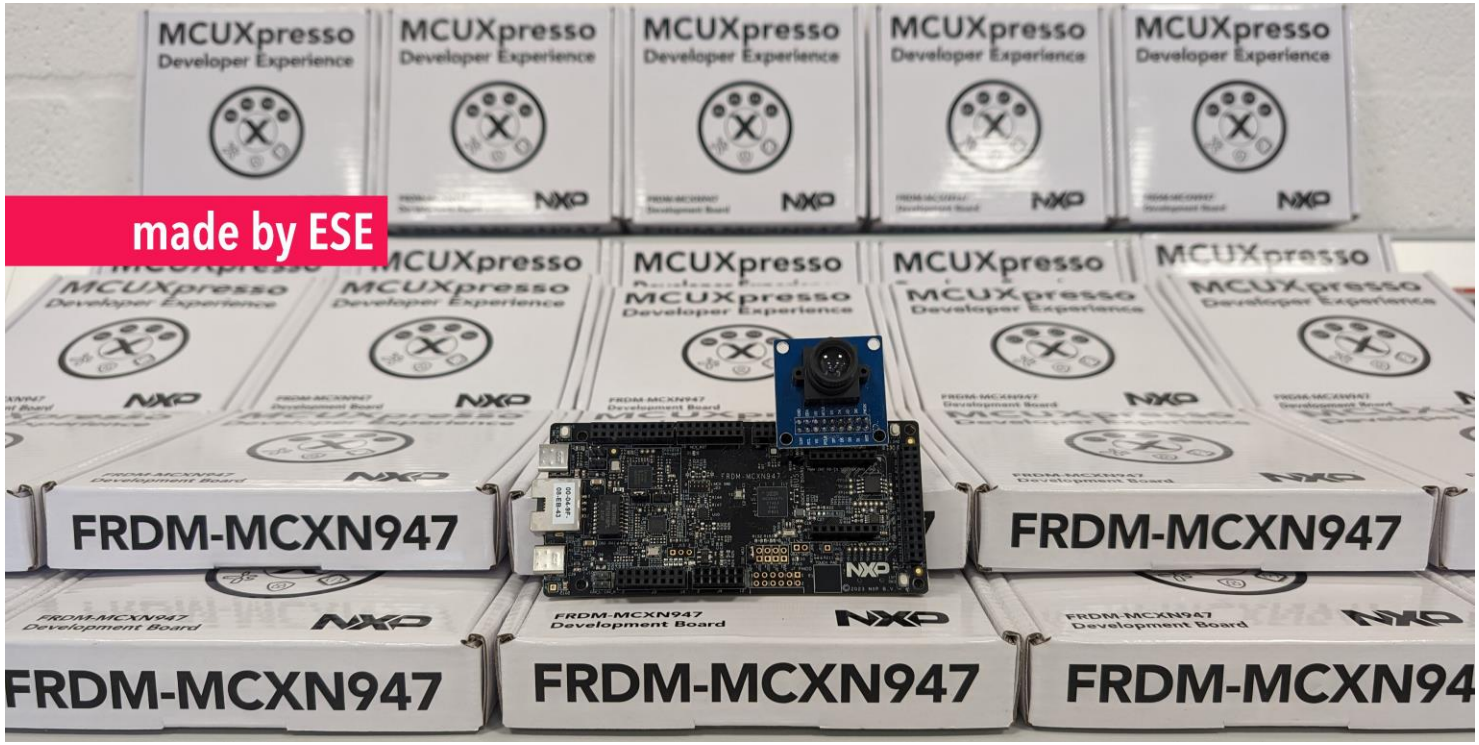


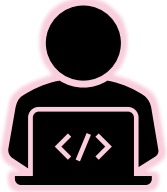
EVD1 – Tools and software



EVD1 – Demo


made by ESE
MCUXpresso
Developer Experience
FRDM-MCXN947
FRDM-MCXN947
FRDM-MCXN947
FRDM-MCXN947
FRDM-MCXN94

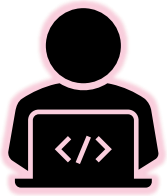
EVD1 – Assignment



Study guide

Final Assignment

EVD1 – Assignment



Study guide

Week 1

1 SDE setup

2 FRDM-MCXN947 changes

3 Hello Webcam!

EVD1 – Assignment

- Working together is allowed, copying is not!!
- Unique operator selection starts in the coming weeks