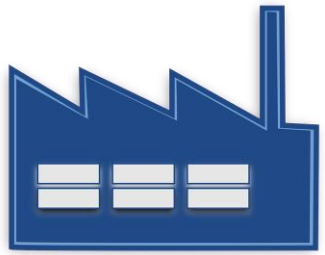

# DAVE EMBEDDED SYSTEMS

Your partner in embedded technology solutions

DAVe
Embedded Systems

# AGENDA

Any time!!!



**Part I – The company**

- Introduction
- Applications
- Products and services (servitization, *asS)
- Technologies and skills
- Organization
- Manufacturing

**Part II – DAVE's Academy**

- Internships: examples and proposals

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# PART I – THE COMPANY

Your partner in embedded technology solutions

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# HEADQUARTER AND SUBSIDIARIES

DAVE Embedded Systems' headquarter
Via Talponedo, 29/A
33080 Porcia (PN), Italy

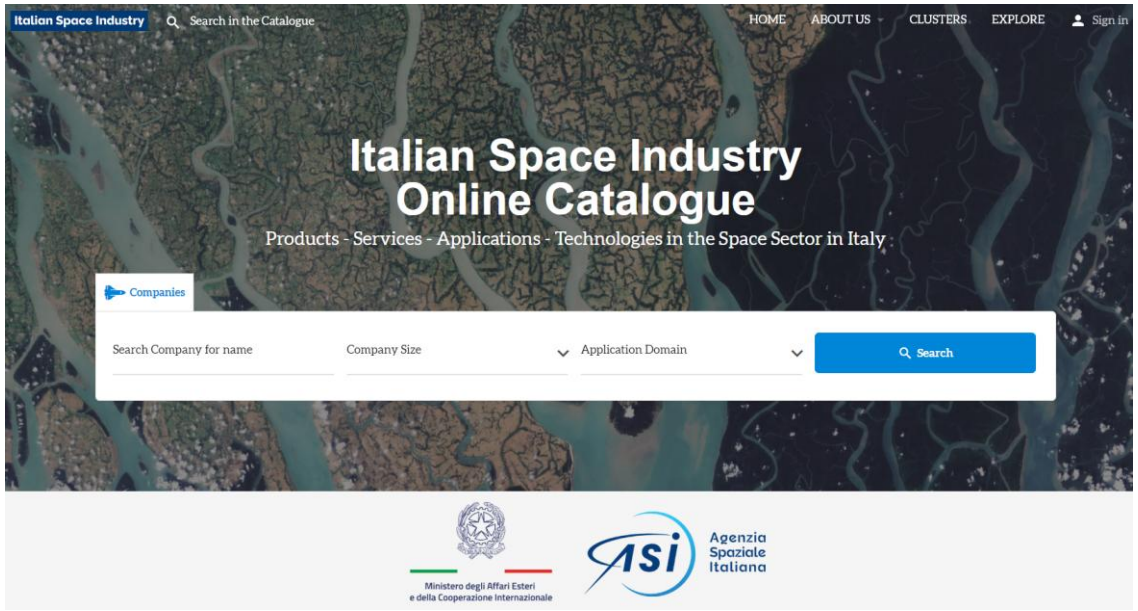
DAVE Embedded Systems' branch office
Maximilianstrasse, 13
80539 München, Germany

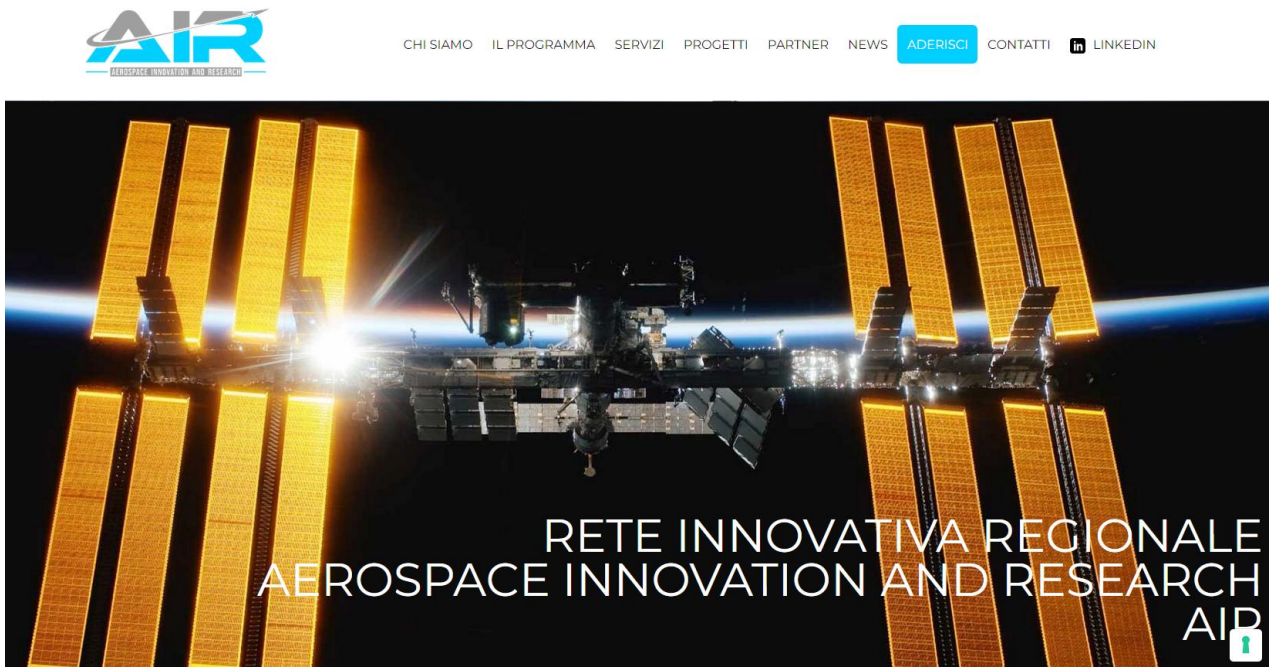
# PARTNERSHIPS

- Università degli Studi di Udine
- Università degli Studi di Padova
- Università degli Studi di Trieste
- Università degli Studi di Trento
- Istituto IMAMOTER CNR di Ferrara
- I.T.S.T. J.F. Kennedy – Pordenone
- Istituto Tecnico Superiore Alto Adriatico – Pordenone
- Associazione Cultura Informatica (AsCI) – Udine
- Texas Instruments
- NXP/Freescale
- ST Microelectronics
- AMD Xilinx

# PARTNERSHIPS (NEW SPACE ECONOMY-FOCUSED)

- Italian Space Industry (https://italianspaceindustry.it/listing/dave-embedded-systems/)
- AIR Aerospace Innovation and Research (https://rir-air.it/)

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# WHAT WE HAVE DONE ...

DAVE Embedded Systems deals with design, manufacturing, and testing of embedded systems and IIoT solutions since 1998. Our products are used by customers in different markets such as automation, telecommunication, biomedical, computer vision, image/video processing, transportation etc.

**What is an embedded system?**

*An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer, is designed to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today.*

**What is the Internet of Things (IoT)?**

*The Internet of things (IoT) describes devices with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks. "Internet of things" has been considered a misnomer because devices do not need to be connected to the public internet; they only need to be connected to a network and be individually addressable.*

source: Wikipedia

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# . . . AND WHAT WE ARE GOING TO DO

*Service economy can refer to one or both of two recent economic developments:*

*…*

*The relative importance of service in a product offering. The service economy in developing countries is mostly concentrated in financial services, hospitality, retail, health, human services, information technology and education. Products today have a higher service component than in previous decades. In the management literature this is referred to as the servitization of products or a product-service system. Virtually every product today has a service component to it.*

Source: https://en.wikipedia.org/wiki/Service_economy

DAVE Embedded Systems aims to provide value added services bound to its traditional products. These services will be accessed via an extensible, secure cloud platform called ToloMEO and will be included but will not be limited to:

- IoT core functions (data upload, fleet managements, etc.)
- Remote assistance
- Data analytics and Machine Learning related tools (AI at the edge, federated/distributed learning, etc.)
- Blockchain-based services such as notarization and Digital Product Passports (DPP)

ToloMEO IIoT ecosystem
www.tolomeo.io
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# APPLICATIONS

Examples of applications designed by our customers to which we have provided any combination of the following:

- Hardware
- Software
- Firmware
- Engineering consultancy
- Technical support

NB: We address **industrial** markets only, i.e. (almost) everything but consumer.

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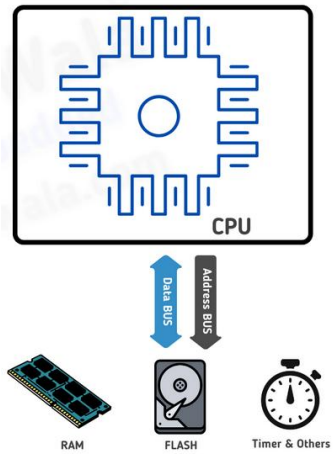
# APPLICATIONS (NOTATION)

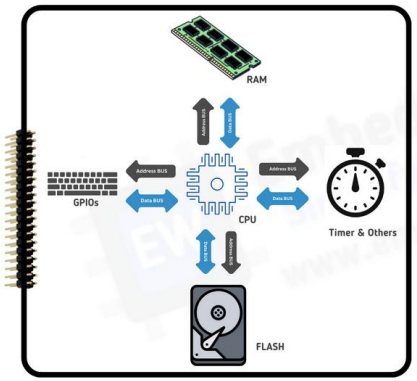
Microprocessor




aka SoC (System-on-Chip)

| Difference Basis | Microprocessor | Microcontroller |
|---|---|---|
| Core | It has only CPU Embedded into it | It has CPU, RAM, FLASH and other peripherals embedded into it |
| Application | Widely used in the computer systems | Widely used in the embedded system |
| Scale | Large scale processing | Small scale processing |
| Usage | PC, Mobile Phone, Rasberry pi etc. | Arduino, STM32 and MSP432 etc |

Microcontroller




https://embeddedwala.com/Blogs/embeddedsystem/microcontroller-vs-microprocessor

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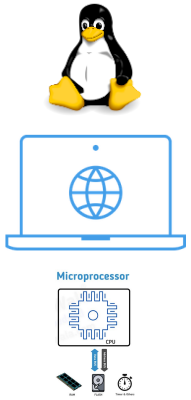
# APPLICATIONS/EDGE DEVICES

Display-based man-machine interface (Qt, Android, web interface ...)

Professional oven

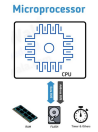


Parking control system


Portable electrocardiograph



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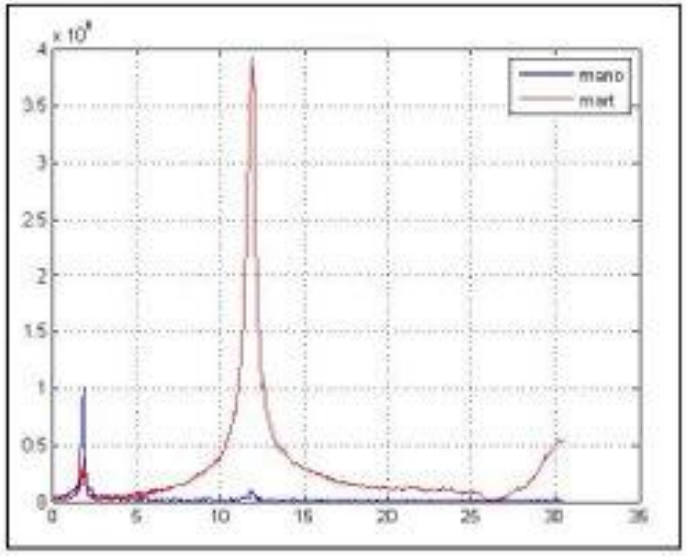
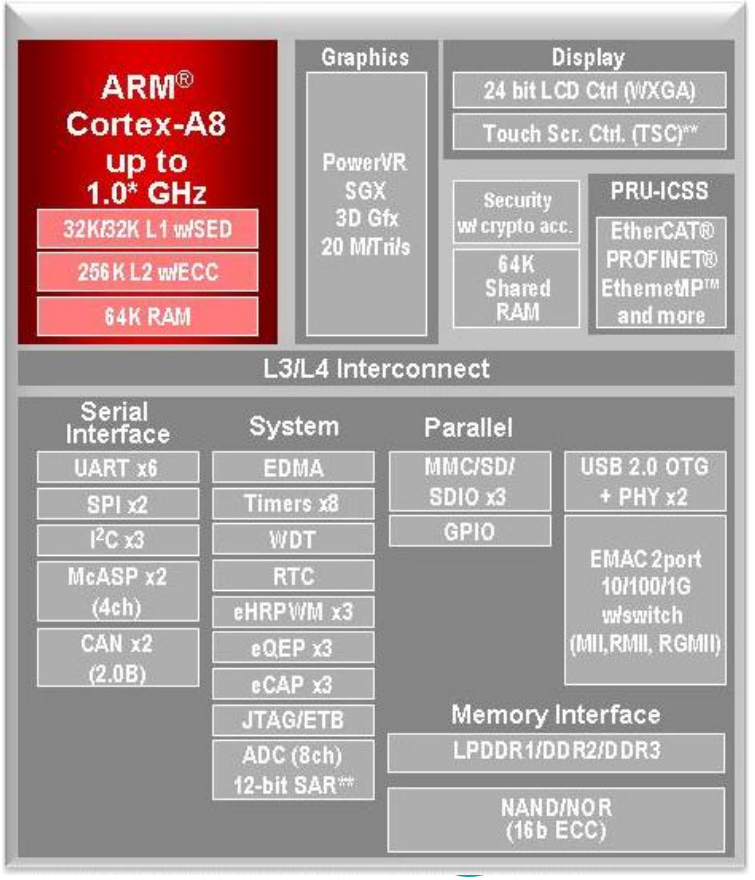
# APPLICATIONS/EDGE DEVICES

## Wooden poles integrity analyzer

- Battery powered
- Portable
- Real-time data acquisition via programmable real-time unit (PRU)
- Wireless connectivity (WiFi, Bluetooth)

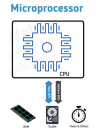


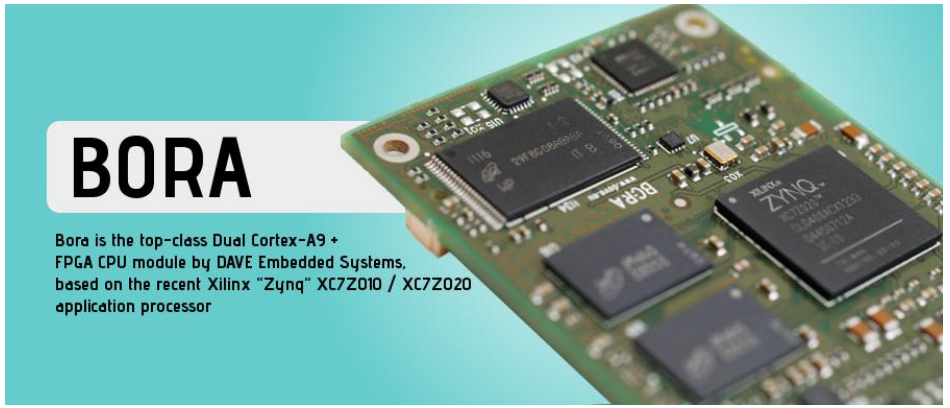



# APPLICATIONS/EDGE DEVICES

## Directed Infrared Countermeasure system

- System-on-chip integrating CPU and FPGA
- Certified real-time operating system (VxWorks*)

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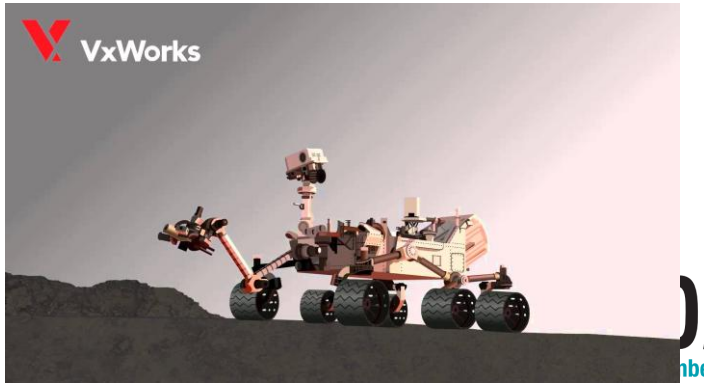
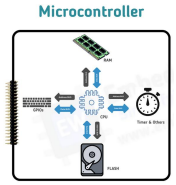
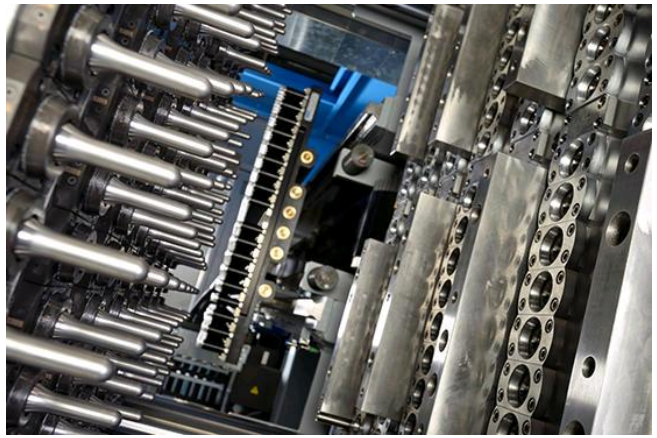


# APPLICATIONS/EDGE DEVICES



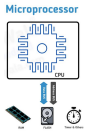

## Smart cycle counter/product ID/logger for industrial press

- Microcontroller-based
- Bluetooth and NFC connectivity
- Bare metal firmware

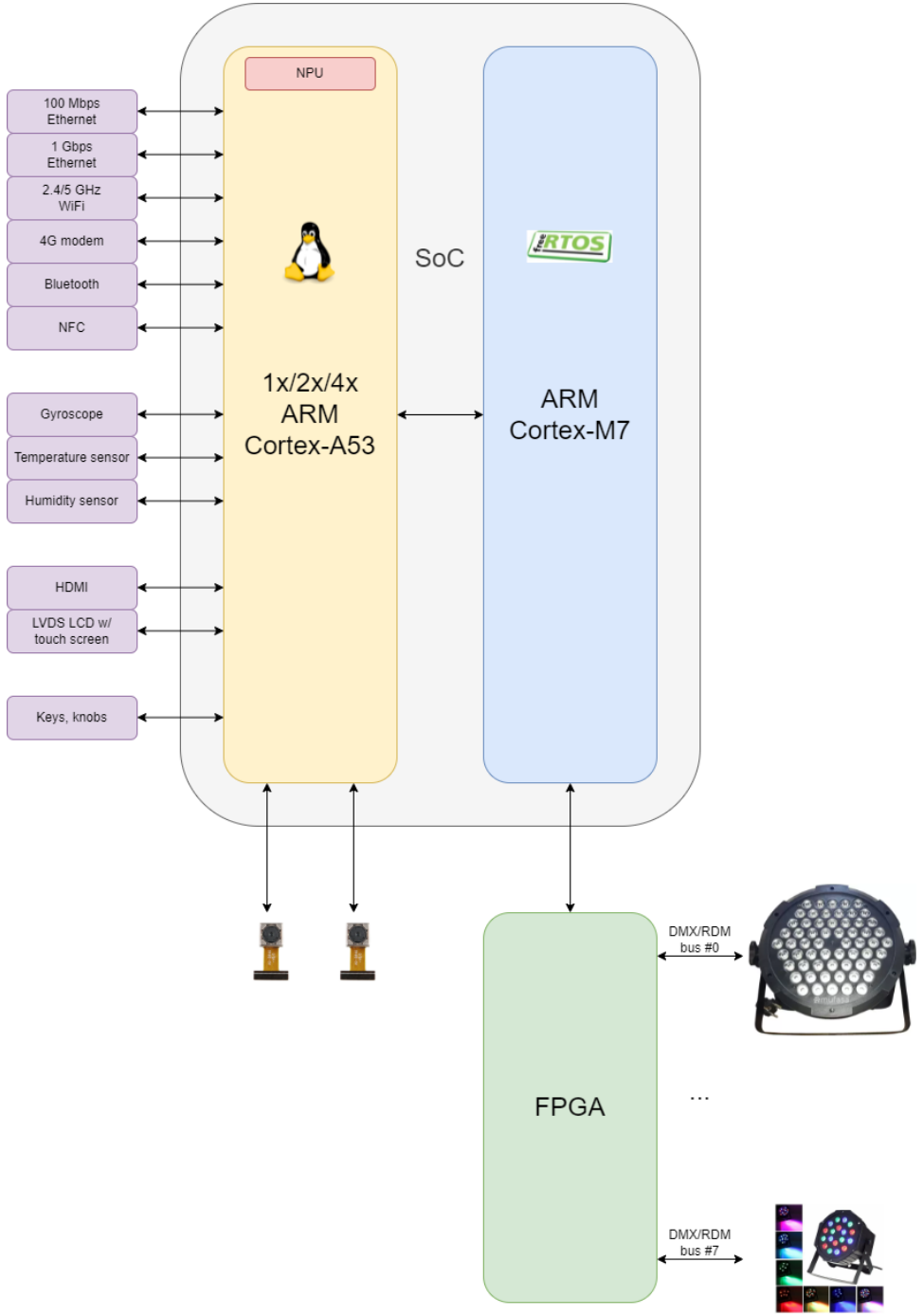


# APPLICATIONS/EDGE DEVICES

## Professional lighting controller



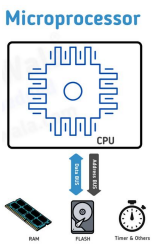

- AMP configuration (Linux + FreeRTOS)
- Hard real-time requirements
- Rich connectivity options (wired and wireless)
- AI-ready
- Technical Note

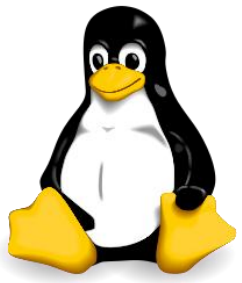


# APPLICATIONS/EDGE DEVICES

## Rehabilitation device

- Migration of existing, legacy software application
- Typical requirement in industrial applications: support for legacy code (in this case, SDL library)



SDL
Simple Directmedia Layer

# APPLICATIONS/EDGE DEVICES

## Software defined radio (SDR) for satellite links (*)

New space economy approach

- No rad-hard components
- No rad-tolerant components
- Industrial components only

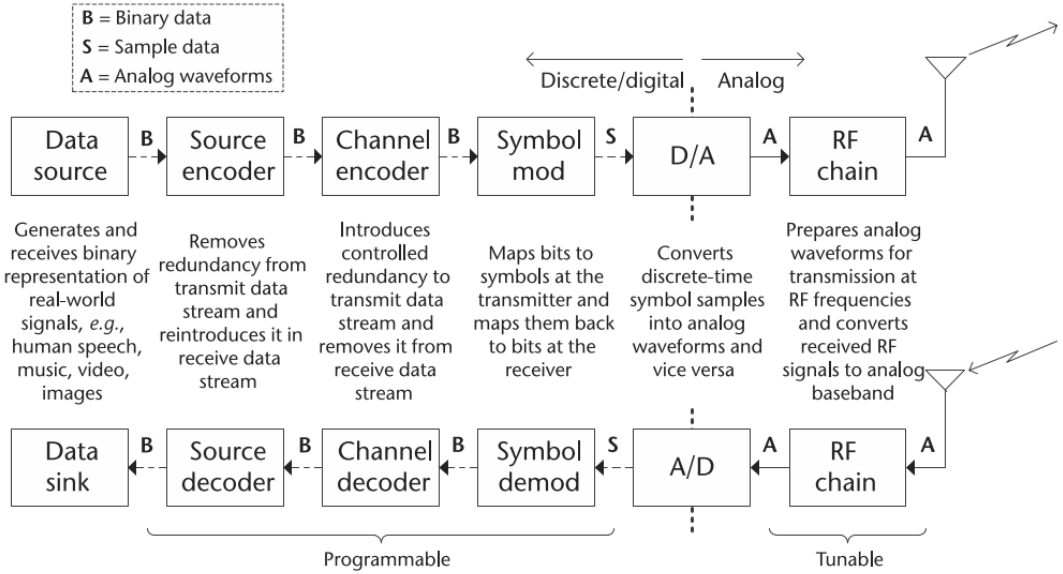
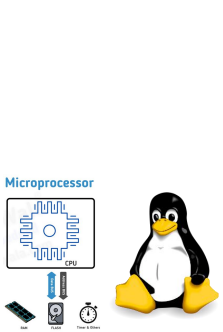
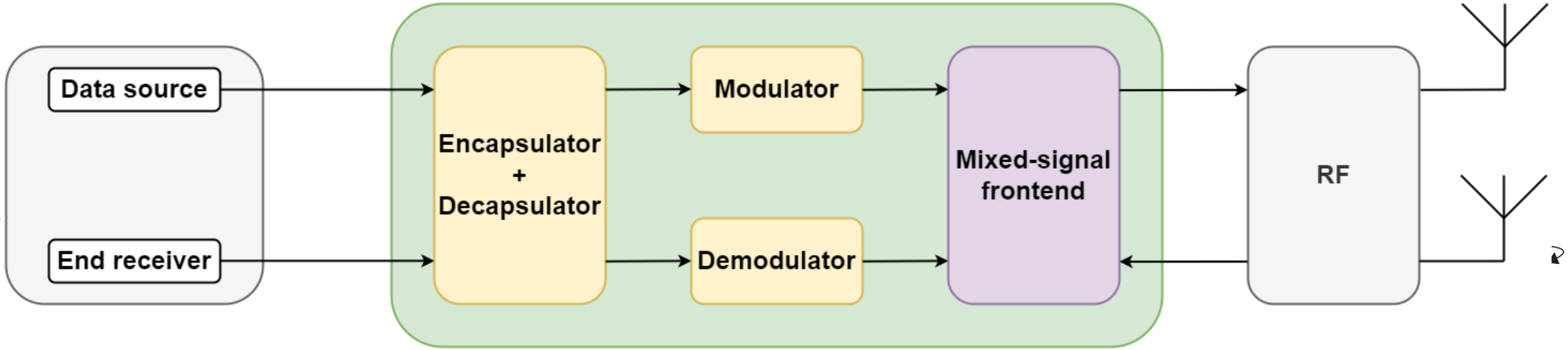



**Figure 1.3** An illustration describing some of the important components that constitute a modern digital communications system. Note that for a SDR-based implementation, those components indicated as programmable can be realized in either programmable logic or software.

(*) Software-Defined Radio for Engineers, by Travis F. Collins, Robin Getz, Di Pu, and Alexander M. Wyglinski, 2018, ISBN-13: 978-1-63081-457-1



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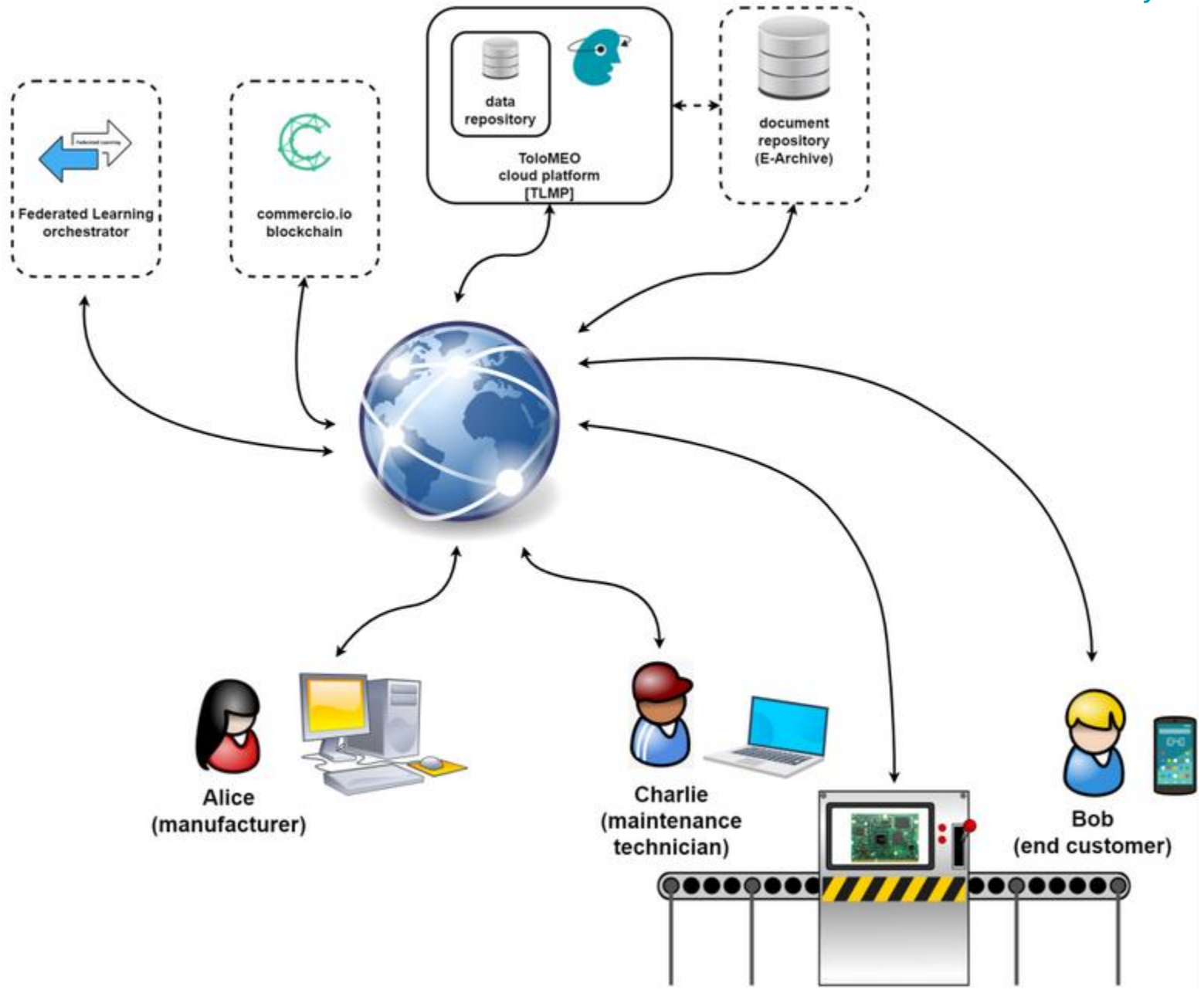
# APPLICATIONS: CLOUD + EDGE COMPUTING

https://tolomeo.io/docs

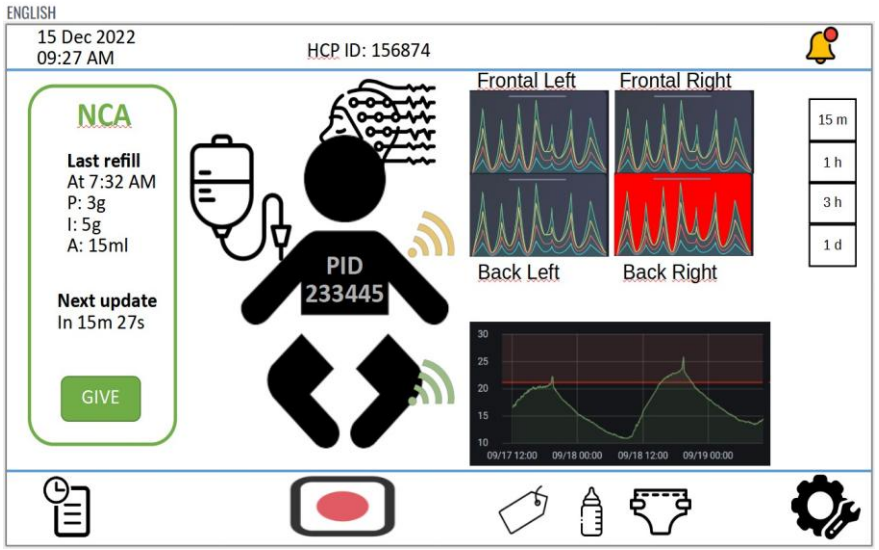
ToloMEO IIoT ecosystem

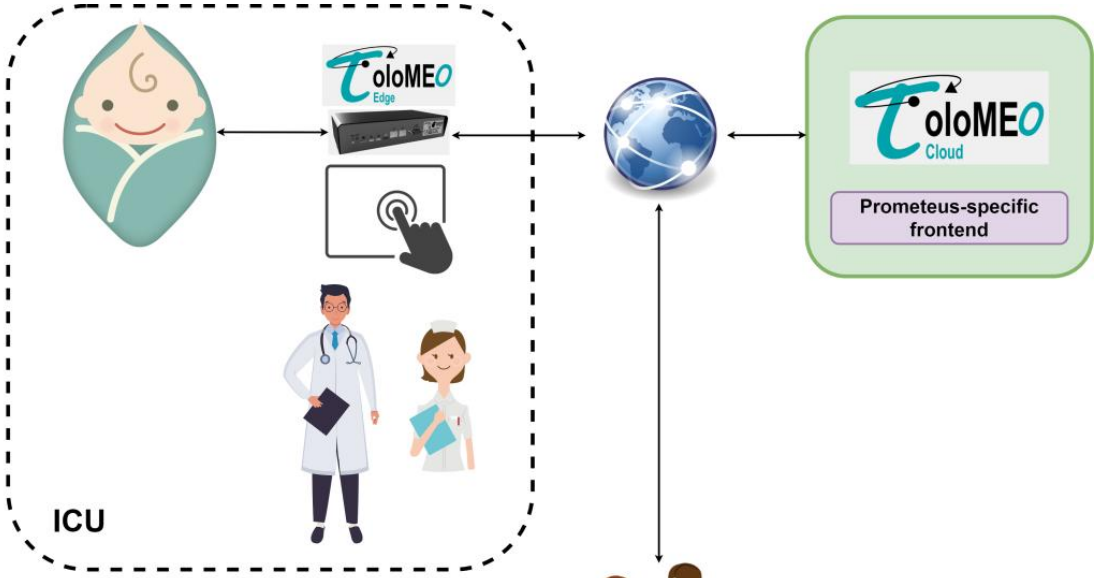
- Complete ecosystem for building Industrial IoT applications (sensor to cloud)
- Security (mTLS connections, etc.)
- Remote fleet management and monitoring
- AI-related services (anomaly detection, time series forecasting, predictive maintenance, AI at he edge, federated learning, etc.)
- Advanced services such as blockchain-based notarization of field data
- …



# APPLICATIONS: CLOUD + EDGE COMPUTING

## Prometeus project




- ToloMEO ecosystem verticalized for Prometeus
- Data treatment to comply with data protection regulations (i.e. GDPR)
- Data collected by tailored-made sensors and industrial gateways
- https://www.unipd.it/news/4-million-euros-awarded-international-unipd-project-premature-babies

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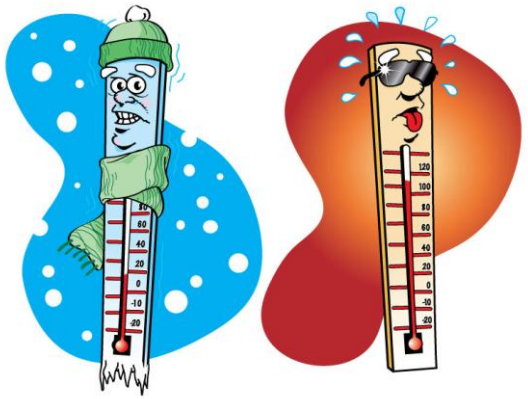
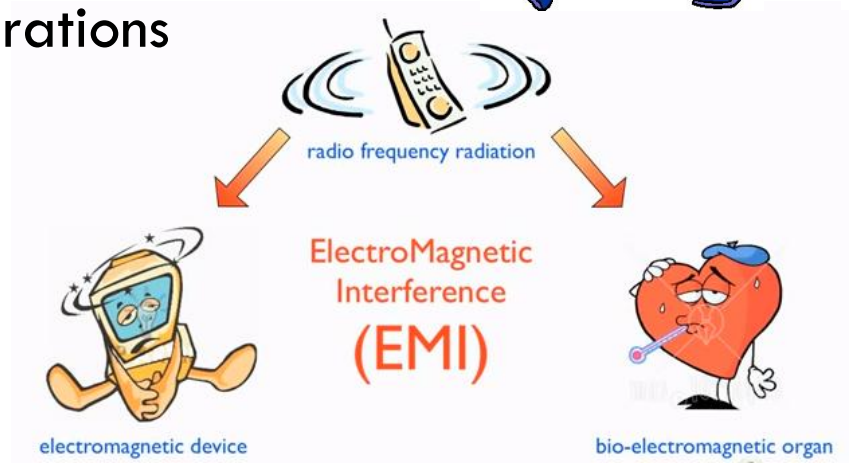
# HARDWARE PRODUCTS

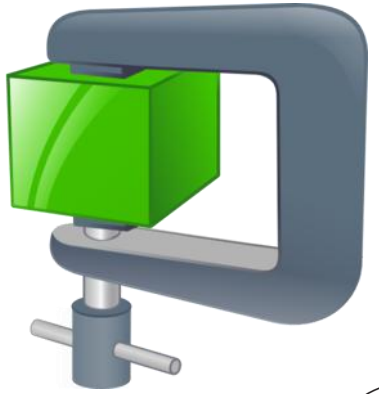
## ELECTRONICS FOR EDGE COMPUTING SOLUTIONS

Common characteristics

- Longevity
- Harsh environments
  - Temperature range
  - Humidity
  - Mechanical vibrations
- EM immunity
- Miniaturization





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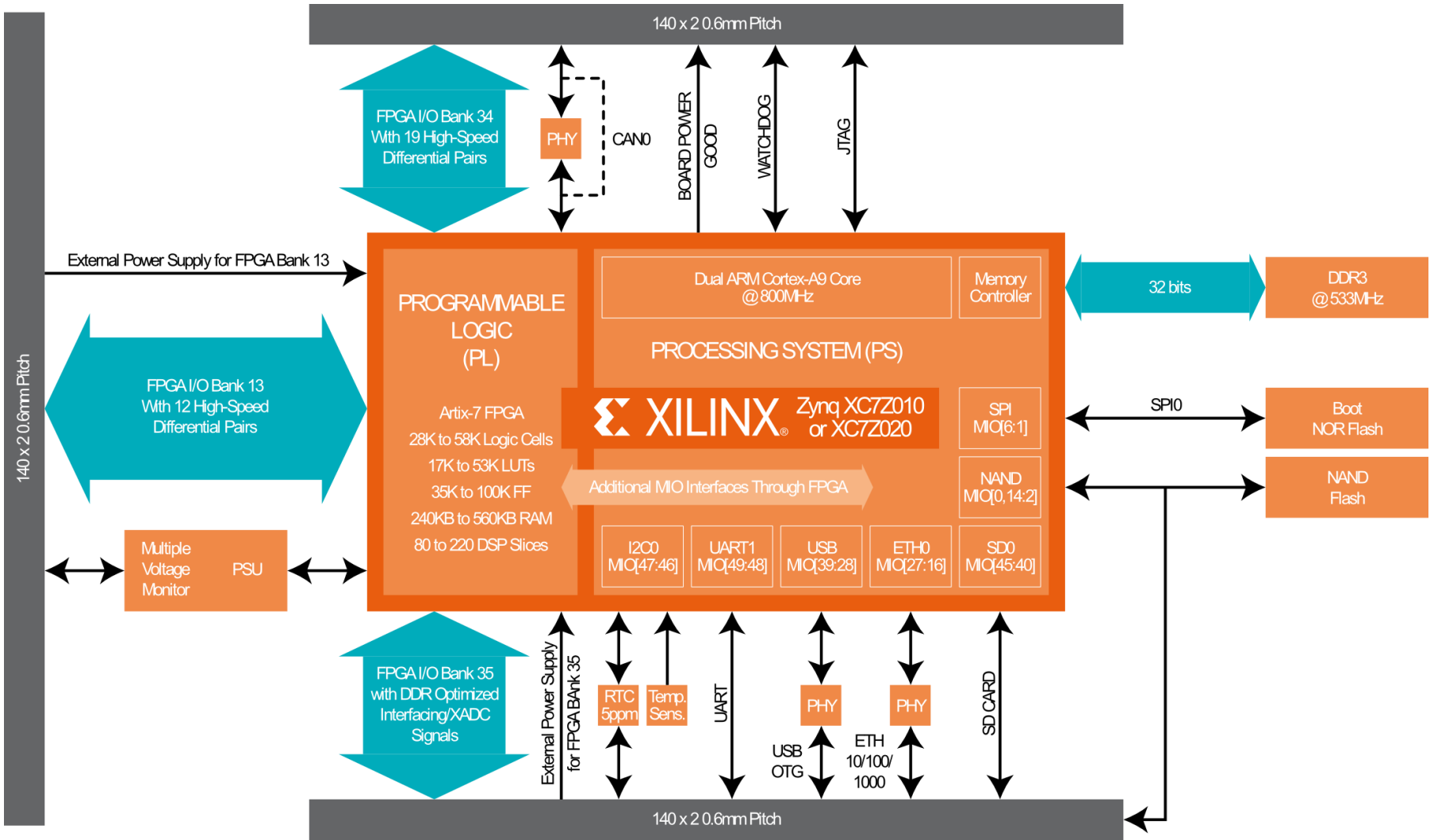
# EXAMPLE OF SYSTEM-ON-MODULE (SOM)

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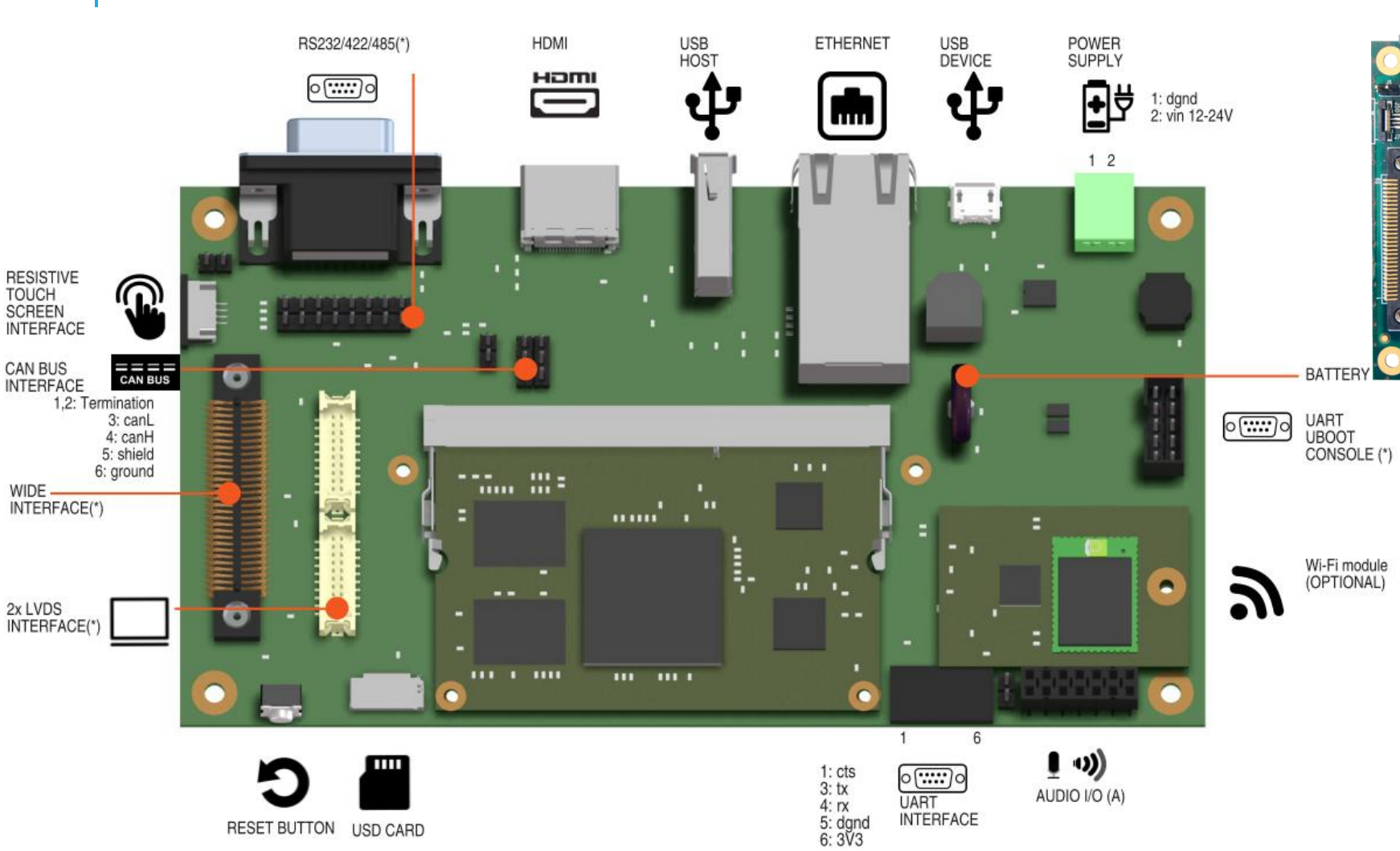
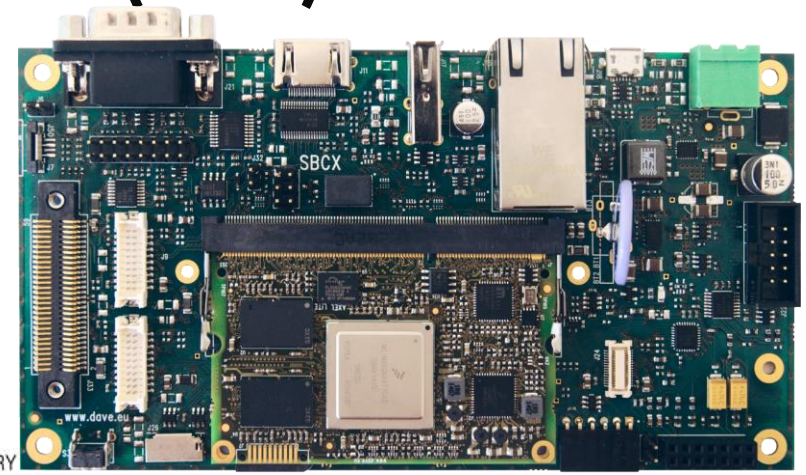
# EXAMPLE OF SINGLE BOARD COMPUTER (SBC)

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# TECHNOLOGIES, TRENDS, AND SKILLS

- Hardware design
- Software development (from hardware to application level)
- Field-programmable gate array (FPGA)
- System integration
- Product certification (Electromagnetic compatibility)
- Manufacturing and Testing Engineering
- Machine Learning
- Cloud engineering
- Devops
- Backend development
- Frontend development

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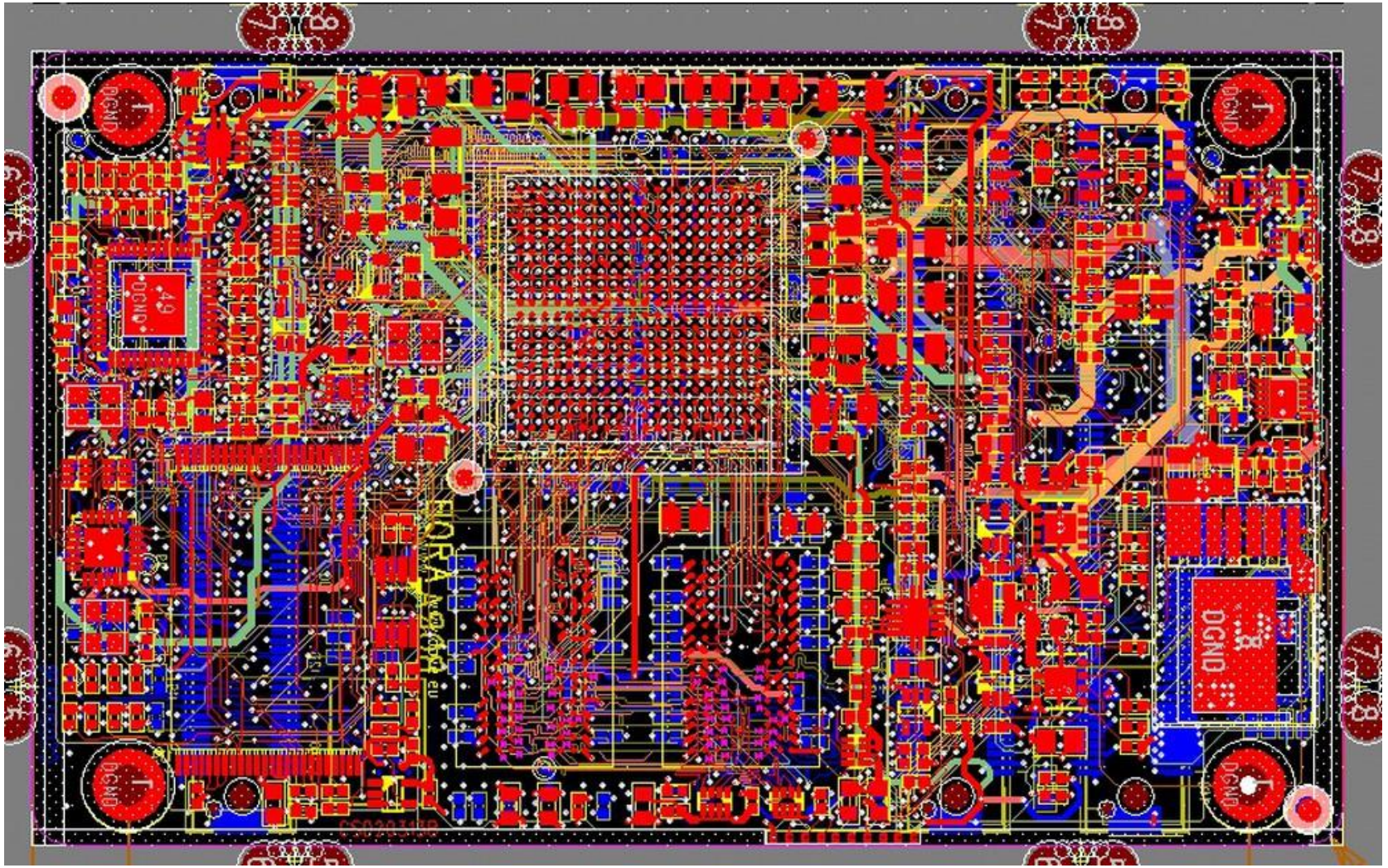
# HARDWARE DESIGN



Altium Designer

AUTODESK® FUSION 360™

HIGH SPEED DESIGN AND ANALYSIS
HyperLynx

Ansys
ELECTRONICS DESKTOP

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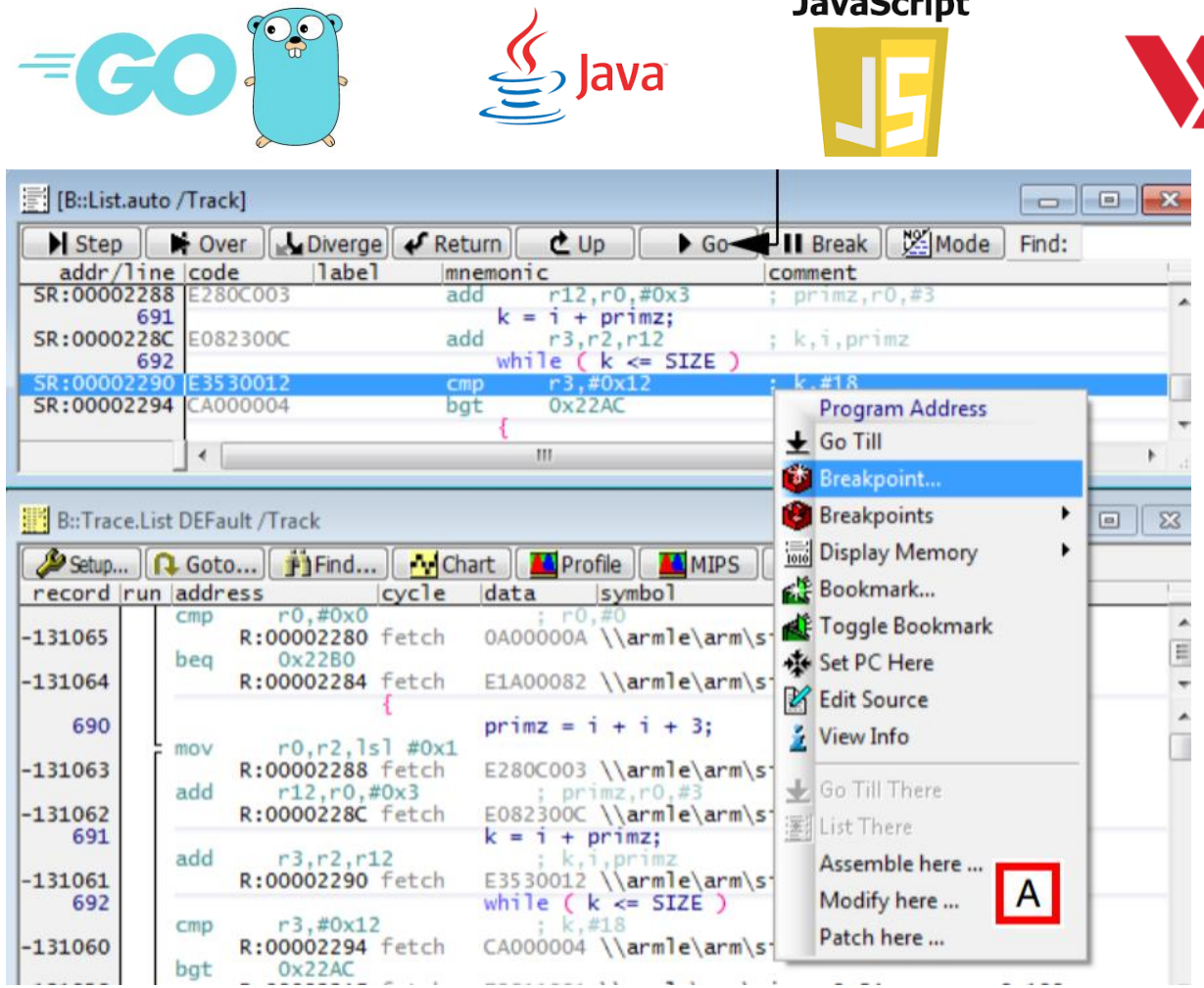
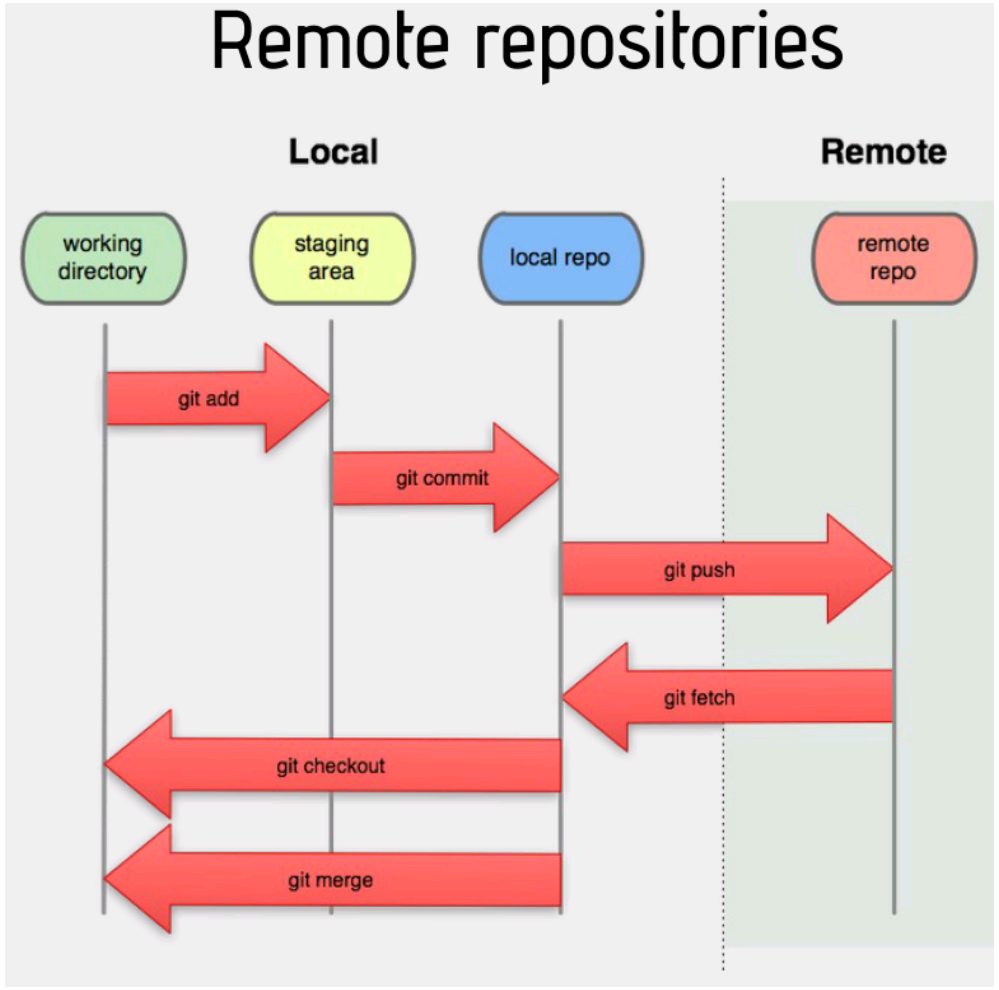
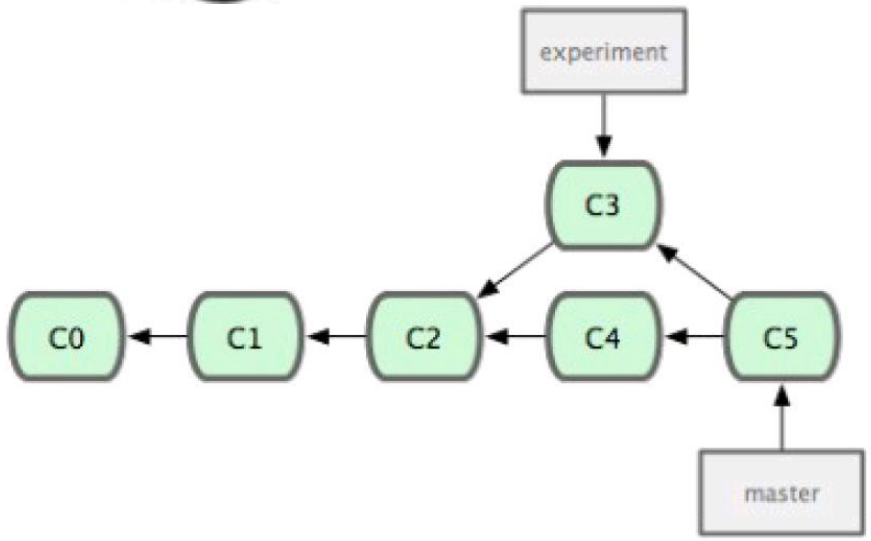
# (EMBEDDED) SOFTWARE DEVELOPMENT



# (EMBEDDED) SOFTWARE DEVELOPMENT



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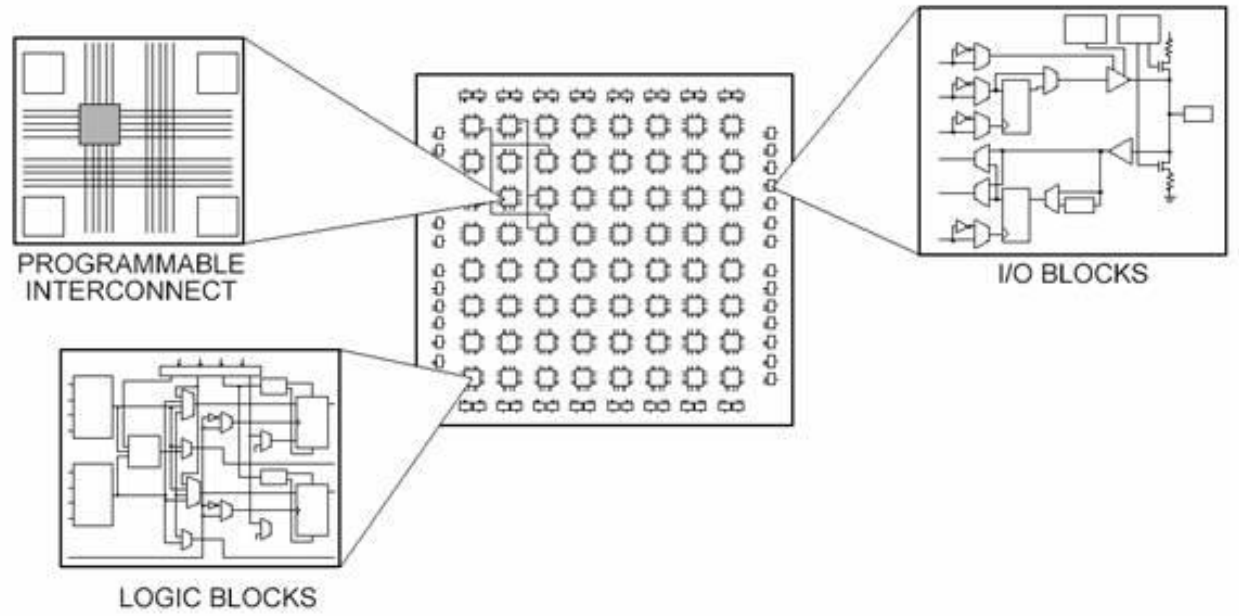
# FPGA




A field-programmable gate array (FPGA) is an integrated circuit designed to be configured by a customer or a designer after manufacturing – hence "field-programmable". The FPGA configuration is generally specified using a hardware description language (HDL), similar to that used for an application-specific integrated circuit (ASIC). (Circuit diagrams were previously used to specify the configuration, as they were for ASICs, but this is increasingly rare.)

FPGAs contain an array of programmable logic blocks, and a hierarchy of reconfigurable interconnects that allow the blocks to be "wired together", like many logic gates that can be inter-wired in different configurations. Logic blocks can be configured to perform complex combinational functions, or merely simple logic gates like AND and XOR. In most FPGAs, logic blocks also include memory elements, which may be simple flip-flops or more complete blocks of memory.

source: https://en.wikipedia.org/wiki/Field-programmable_gate_array

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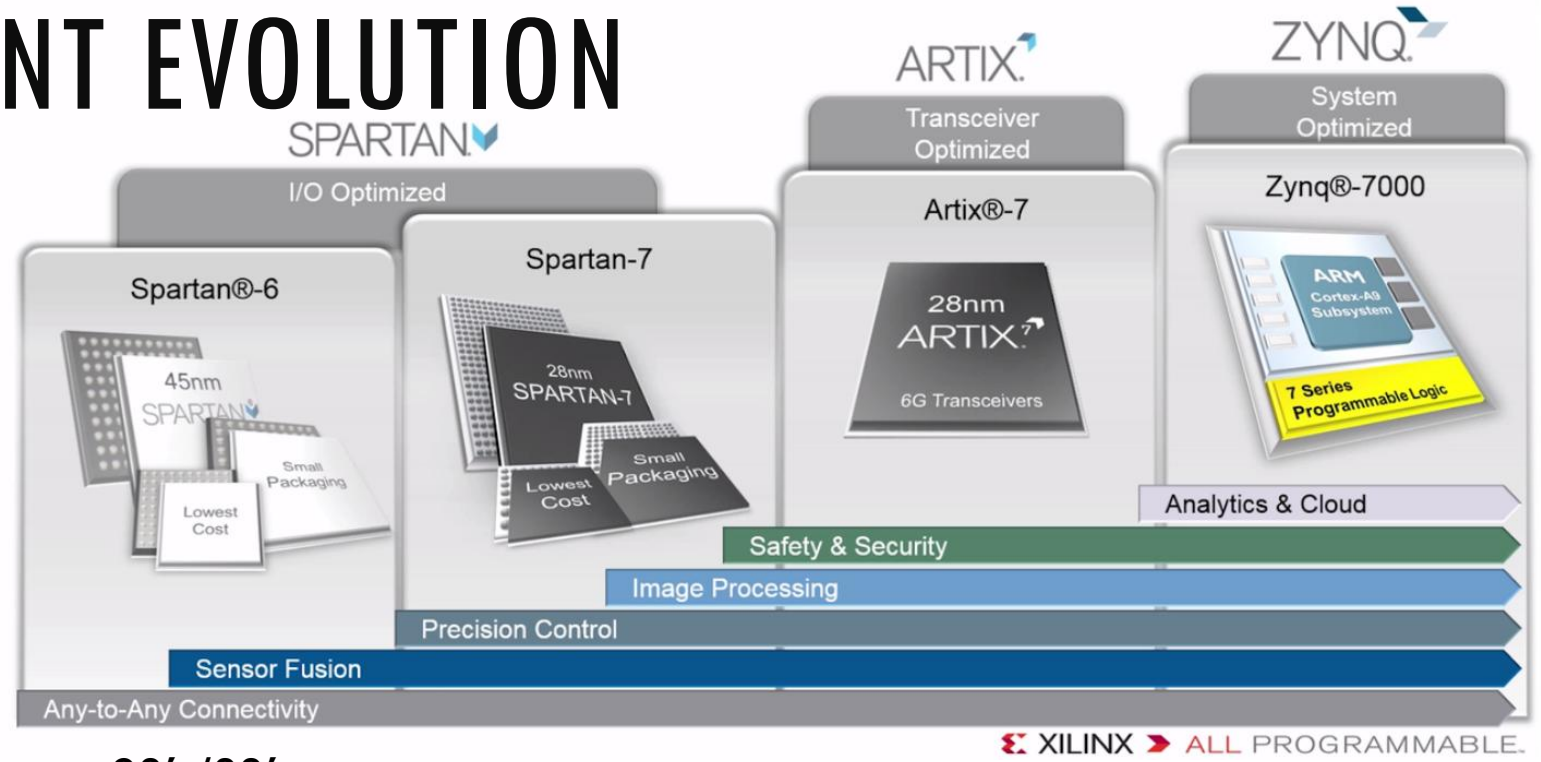
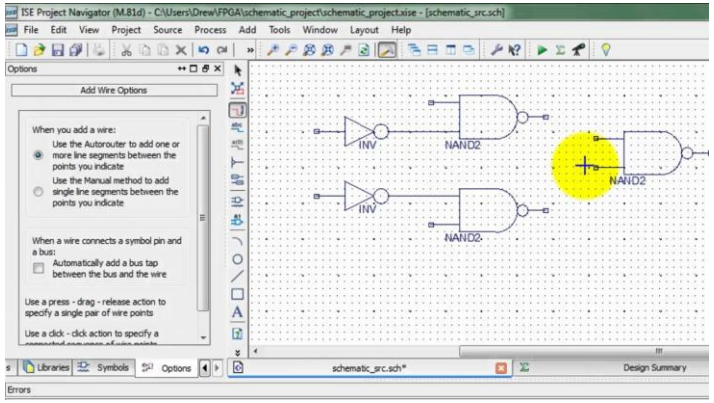
# FPGA DEVELOPMENT EVOLUTION

Silicon: from FPGA to SOC ->




80's/90's




90's/00's

```
always @(posedge op_clk) begin
    case (State)
        UARTTX_STATE_IDLE:
            if (~f0_blk_stat) State <= UARTTX_STATE_START;
        UARTTX_STATE_START: State <= UARTTX_STATE_BIT0;
        UARTTX_STATE_BIT0: State <= UARTTX_STATE_BIT1;
        UARTTX_STATE_BIT1: State <= UARTTX_STATE_BIT2;
        UARTTX_STATE_BIT2: State <= UARTTX_STATE_BIT3;
        UARTTX_STATE_BIT3: State <= UARTTX_STATE_BIT4;
        UARTTX_STATE_BIT4: State <= UARTTX_STATE_BIT5;
        UARTTX_STATE_BIT5: State <= UARTTX_STATE_BIT6;
        UARTTX_STATE_BIT6: State <= UARTTX_STATE_BIT7;
        UARTTX_STATE_BIT7: State <= UARTTX_STATE_STOP;
        UARTTX_STATE_STOP:
        begin
            if (~f0_blk_stat) State <= UARTTX_STATE_START;
            else State <= UARTTX_STATE_IDLE;
        end
        default: State <= UARTTX_STATE_IDLE;
    endcase
end
```

10's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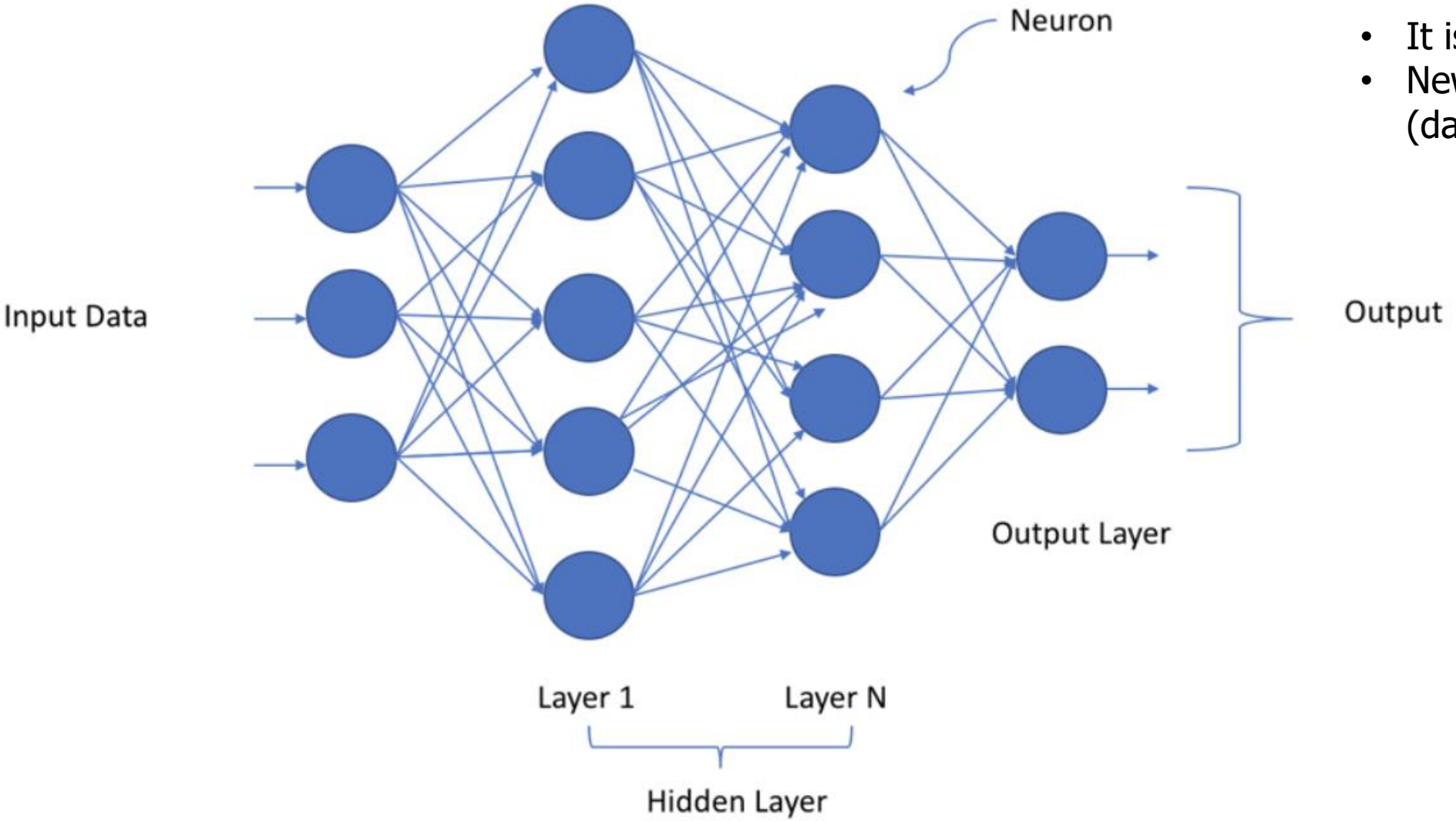
# MACHINE LEARNING (AI)




- It is here to stay!
- New programming paradigm (data programming)

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# CONTINUING EDUCATION

- On-site courses
- In-house training sessions
- Self-taught
- University single course units (for instance, see https://www.unipd.it/en/single-course-units)

Task list 6 | Kanban View (7) | Filters default | Options

| | Parent project | Project | Subject | Priority | Status | Assignee | Start date | Due date | Tags |
|---|---|---|---|---|---|---|---|---|---|
| Total: | | | | | | | | | |
| | R&D | [Formazione] | Training interno su Git/GitLab | Normal | In progress | | 03 Mar 2020 | 03 Mar 2020 | |
| | R&D | [Formazione] | Robot UR5 - Formazione di Base interna | Normal | New | | 18 Feb 2020 | 30 Mar 2020 | |
| | R&D | [Formazione] | Machine Learning | Low | New | | 11 Feb 2020 | --- | |
| | R&D | [Formazione] | IoT Security | Low | New | | 11 Feb 2020 | | |

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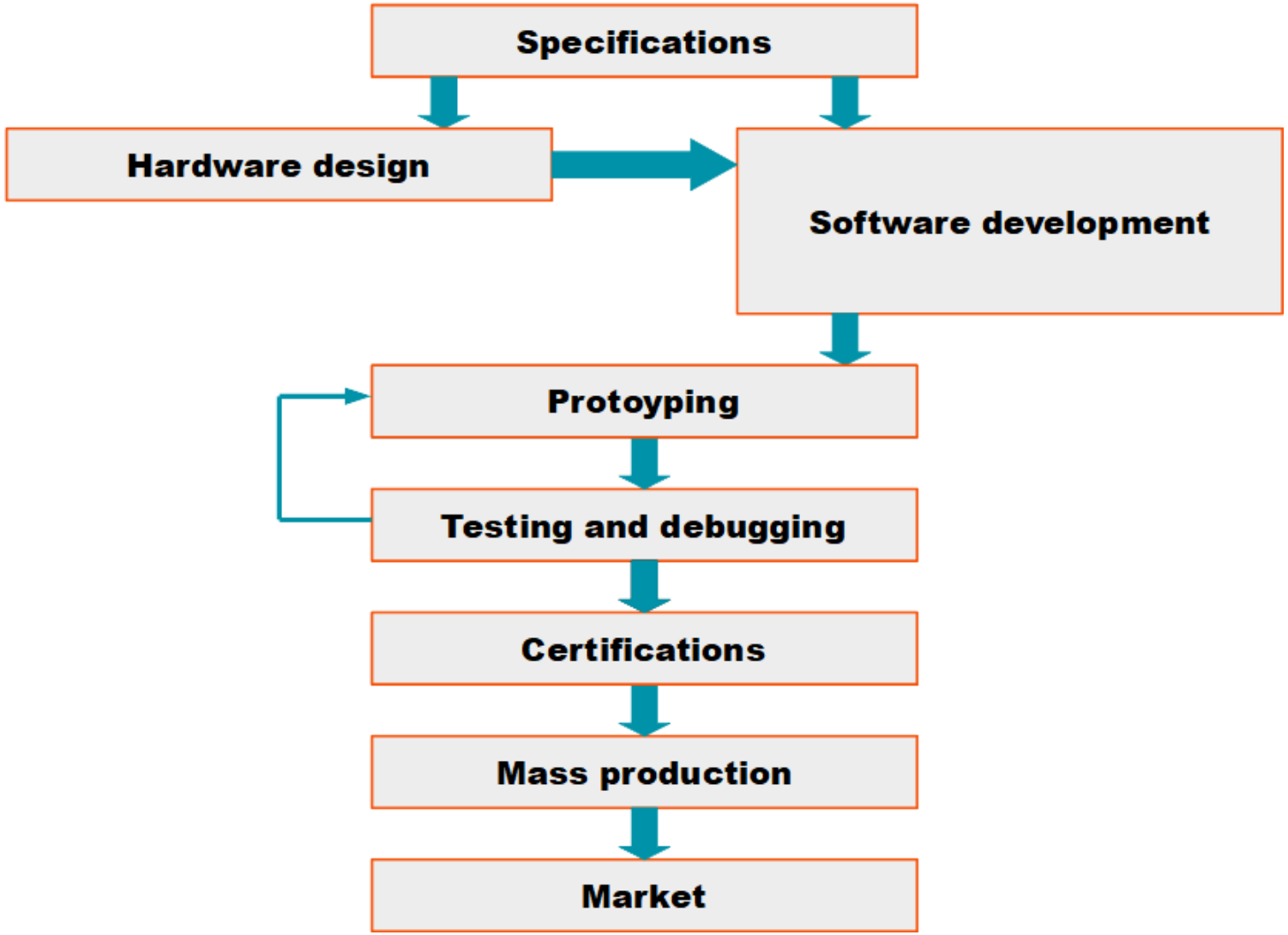
# MANUFACTURING

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# MANUFACTURING

PCB

components

Solder Paste Printing

Pick&Place

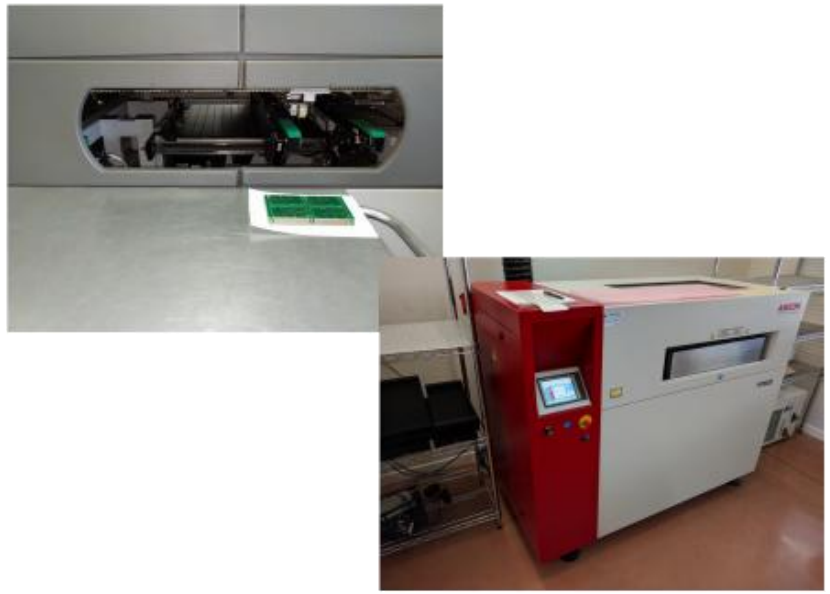
Soldering

Off-line testing

Functional testing

Warehouse / Shipment


https://youtu.be/OoNiKgJXq00?t=403




# PART II – DAVE'S ACADEMY

https://www.dave.eu/dave-academy

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# GENERAL NOTES

- Internship proposals are suitable for either 3-year or 5-year courses
- Proposals can be adjusted according to intern's needs (exams, lessons, interests, etc.)
- Internships are **not** employment relationships
  - No mandatory deadlines/achievements to be matched
  - Students should feel « free to make mistakes »
- Instead, internships should be
  - An outstanding opportunity for students for
    - Putting into practice what they learnt in university courses
    - Learning new things
    - Working on a project in a work-like environment
  - For the company, an opportunity for
    - Getting in touch with soon-to-be graduating students who may become collaborators in the future
    - Experimenting new tools and technologies

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# GENERAL NOTES

- Internships are designed to be as flexible as possible in terms of scheduling, overall duration, etc.
- Internships can be in presence or hybrid (partially in presence, partially remote)
- Free company canteen
- Reimbursement for travel expenses
- In any case, interested applicants are **strongly encouraged** to write to stages@dave.eu to:
  - Discuss in detail the proposal(s) they are interested in
  - Arrange a visit to the company if they are curious to see with their own eyes what has been presented today
  - Talk about any internship-related issues they might have

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# INTERNSHIPS: SOME EXAMPLES ...

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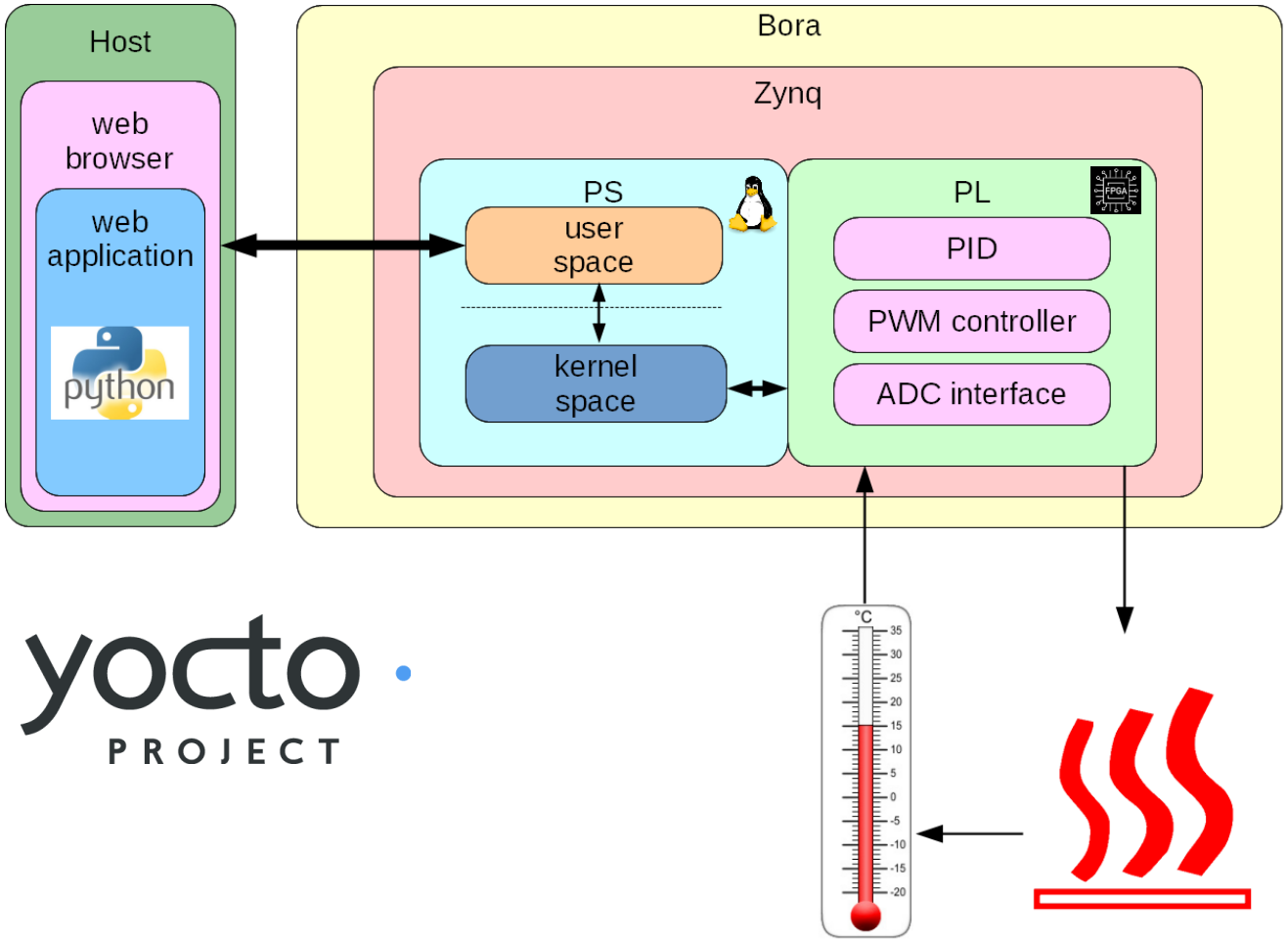
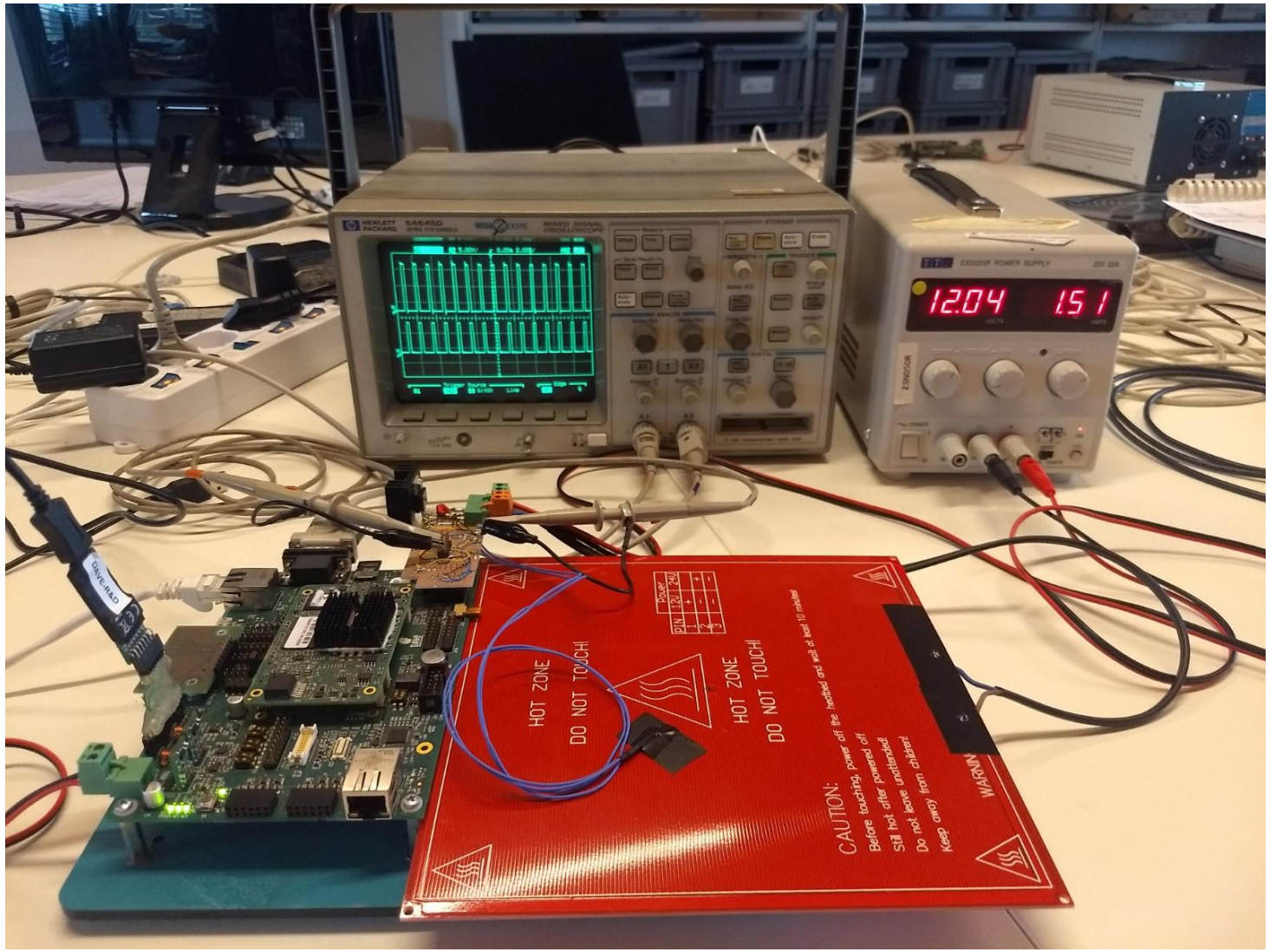
# HARDWARE-ACCELERATED TEMPERATURE CONTROL SYSTEM (2018)




- Bachelor degree thesis
- Creating an embedded Linux distribution suitable for a platform integrating a traditional dual-core processor and an FPGA
- Developing a hardware-accelerated control algorithm
- Using modern tools such as PYNQ for testing

See also
https://wiki.dave.eu/index.php/BELK-TN-005:_Running_PYNQ_on_Bora

# HARDWARE-ACCELERATED TEMPERATURE CONTROL SYSTEM (2018)

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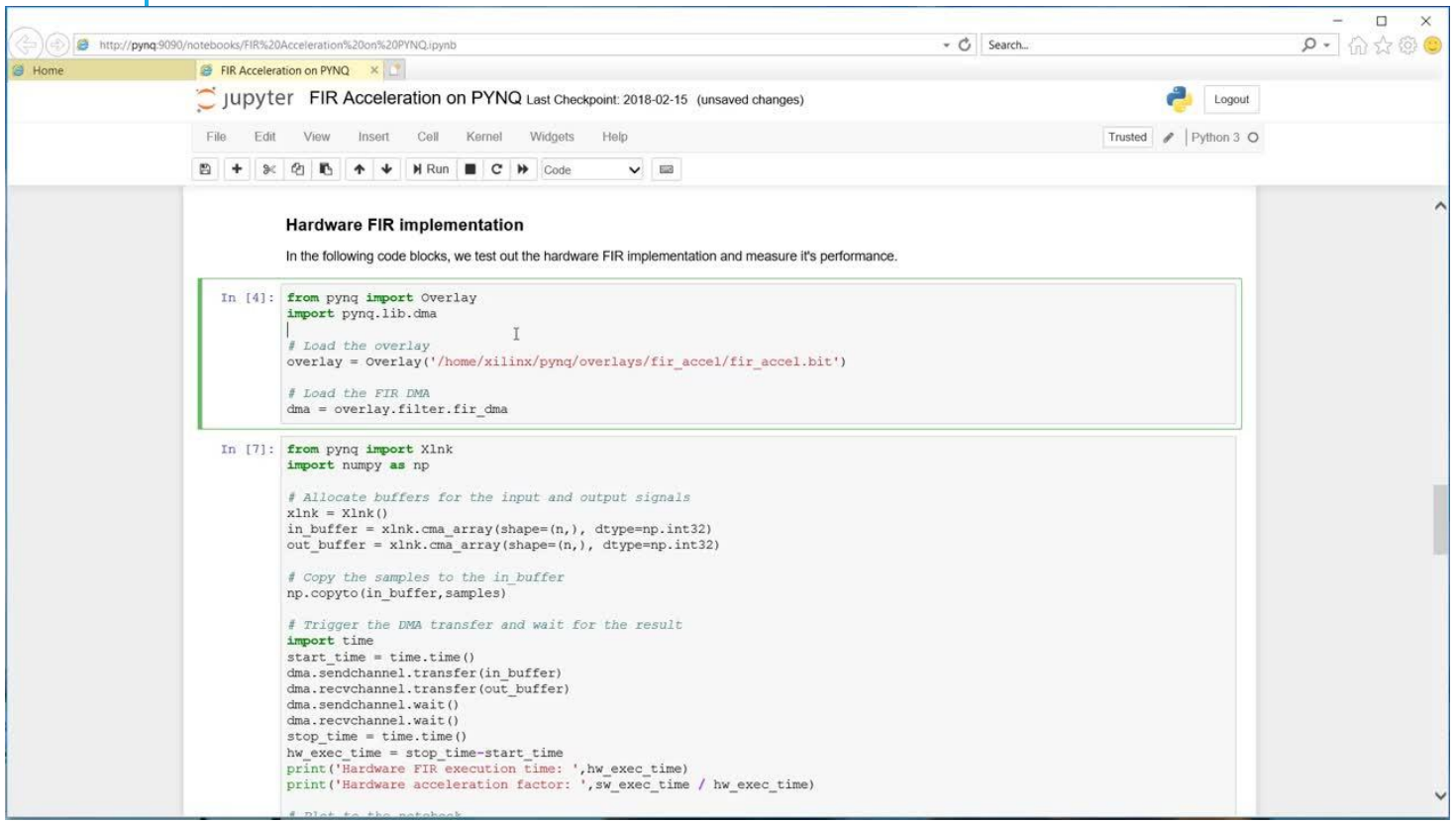
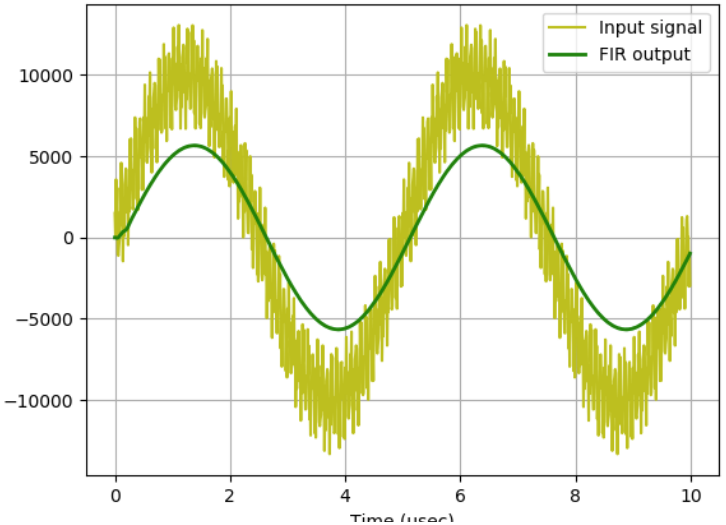
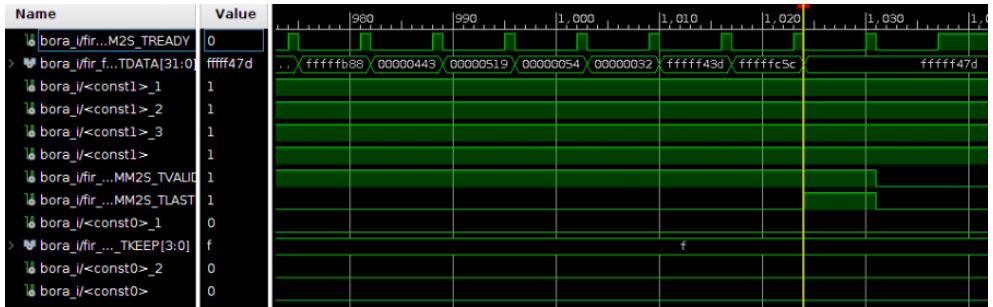
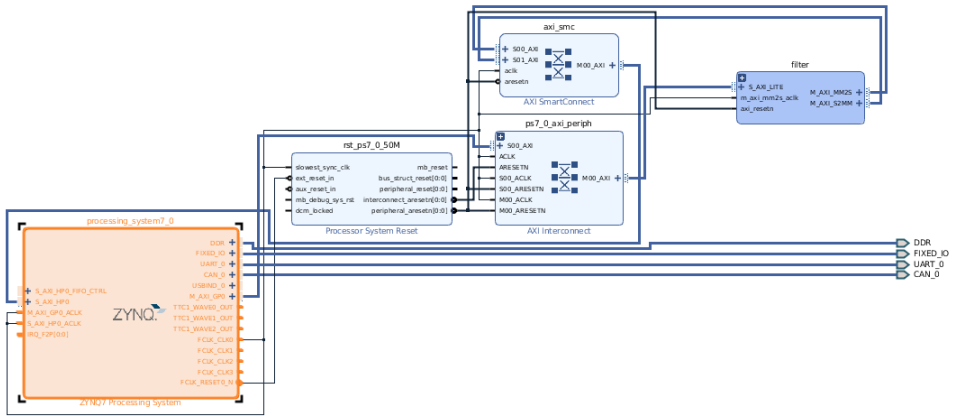
# HARDWARE-ACCELERATED TEMPERATURE CONTROL SYSTEM (2018)




```
Software FIR execution time:  0.08394455909729004
Hardware FIR execution time:  0.04098176956176758
Hardware acceleration factor:  2.0483390540461923
```

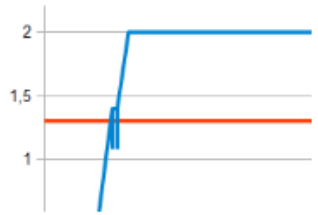


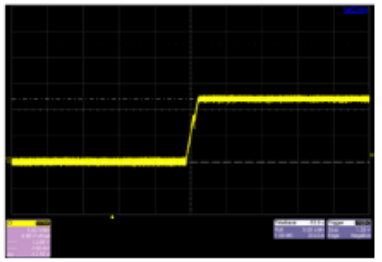



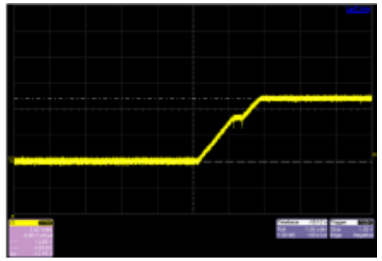



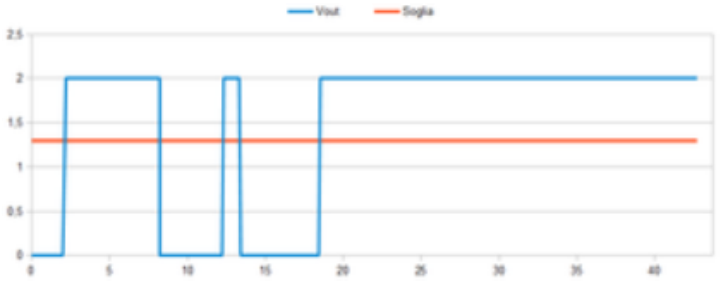
# PROGRAMMABLE BENCH POWER SUPPLY UNIT (2023)

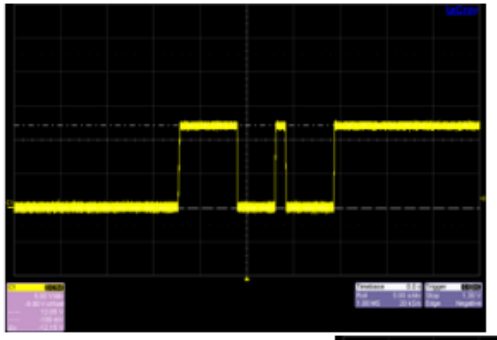
- Used for internal qualification tests of new products
- The goal is to verify the resilience of DUTs against “weird” supply voltage

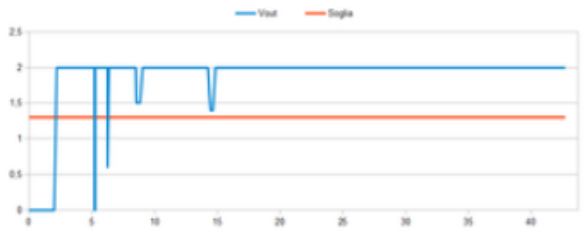


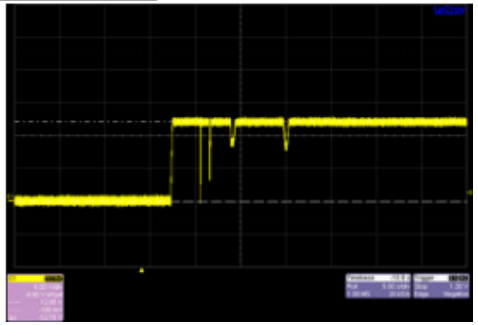





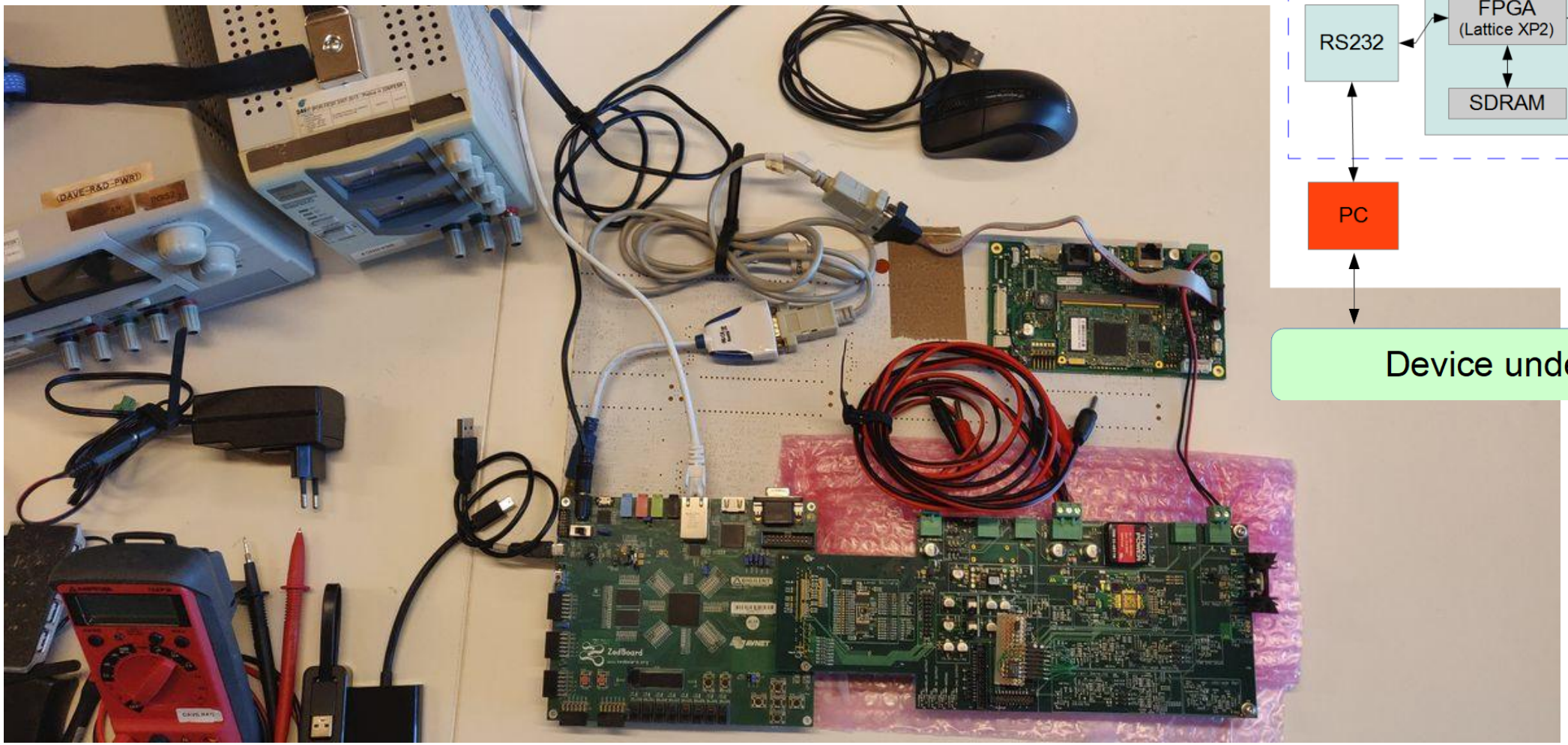


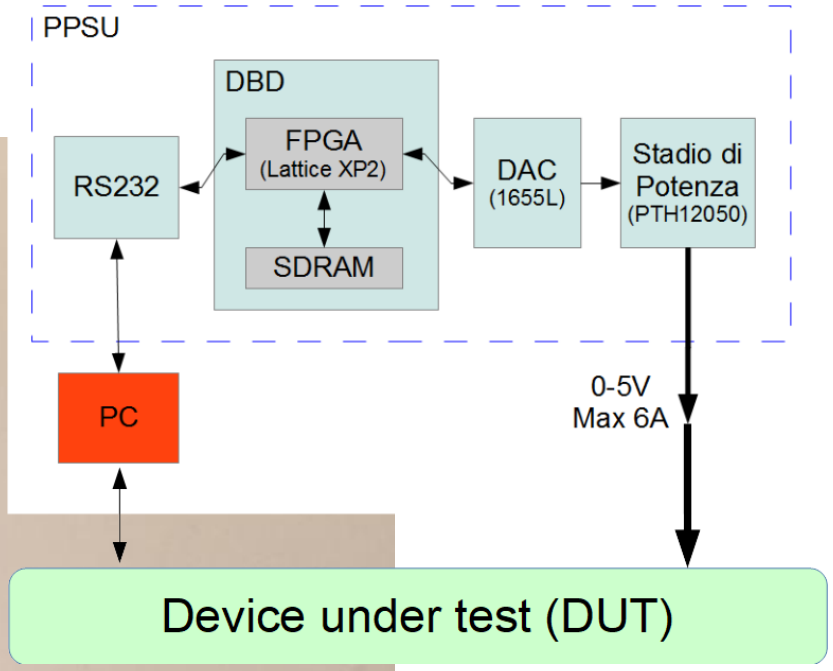





# PROGRAMMABLE BENCH POWER SUPPLY UNIT (2023)



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# ML-BASED ENDOSCOPES FEATURING FEDERATED LEARNING (2025)


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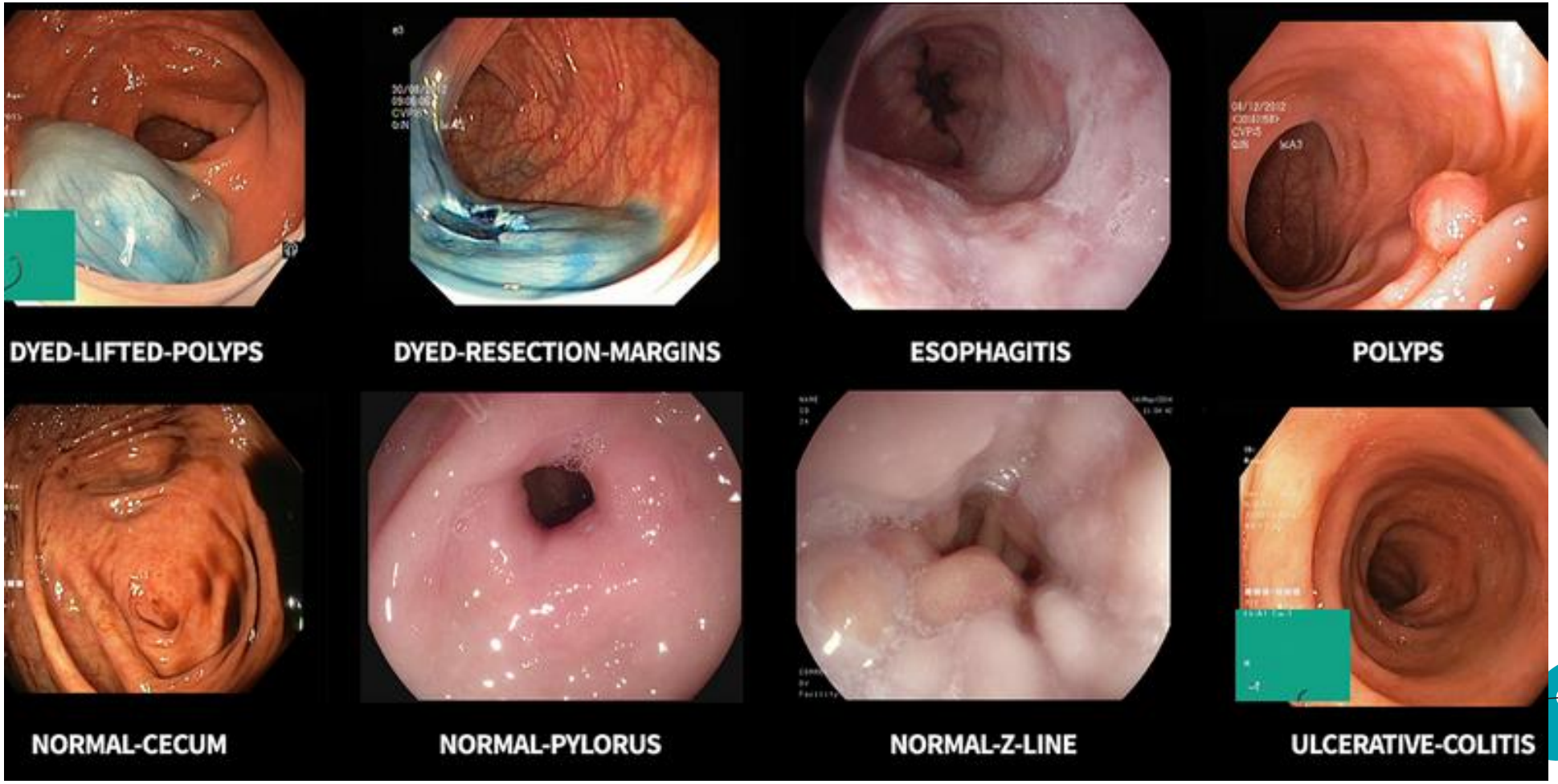
# ML-BASED ENDOSCOPES FEATURING FEDERATED LEARNING (2025)

- Model development trained with open datasets

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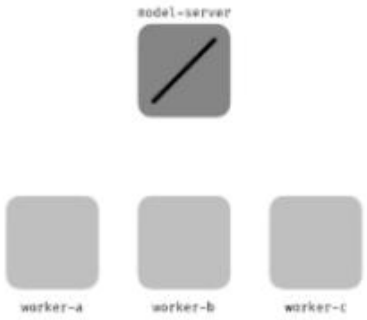
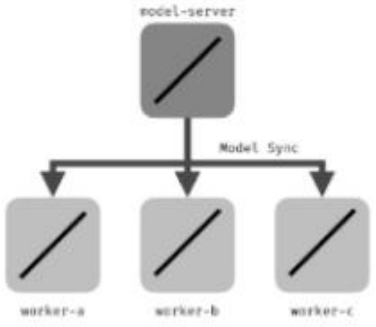
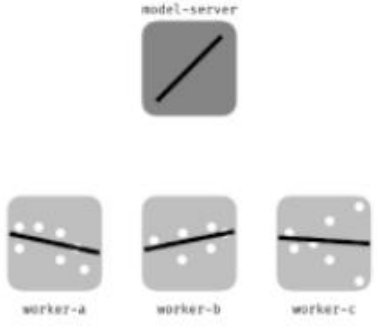
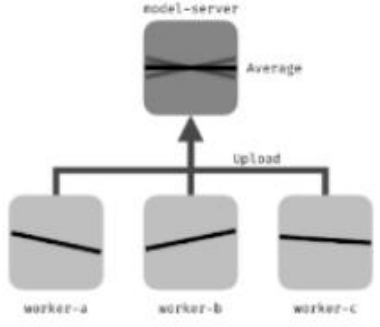
# ML-BASED ENDOSCOPES FEATURING FEDERATED LEARNING (2025)

- Selecting an open-source Federated Learning frameworks
- https://wiki.dave.eu/index.php/ML-TN-007_%E2%80%94_AI_at_the_edge:_exploring_Federated_Learning_solutions

| Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|
|  |  |  |  |
| Central server chooses a statistical model to be trained | Central server transmits the initial model to several nodes | Nodes train the model locally with their own data | Central server pools model results and generate one global mode without accessing any data |



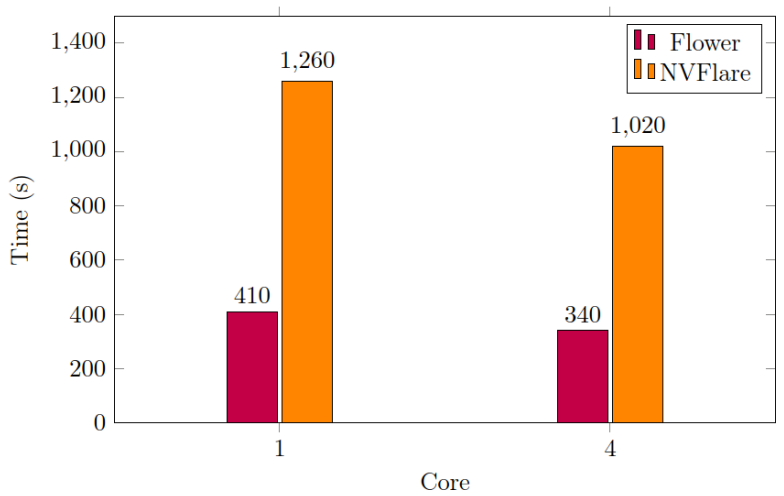



Figure 4.30: Total frameworks execution time

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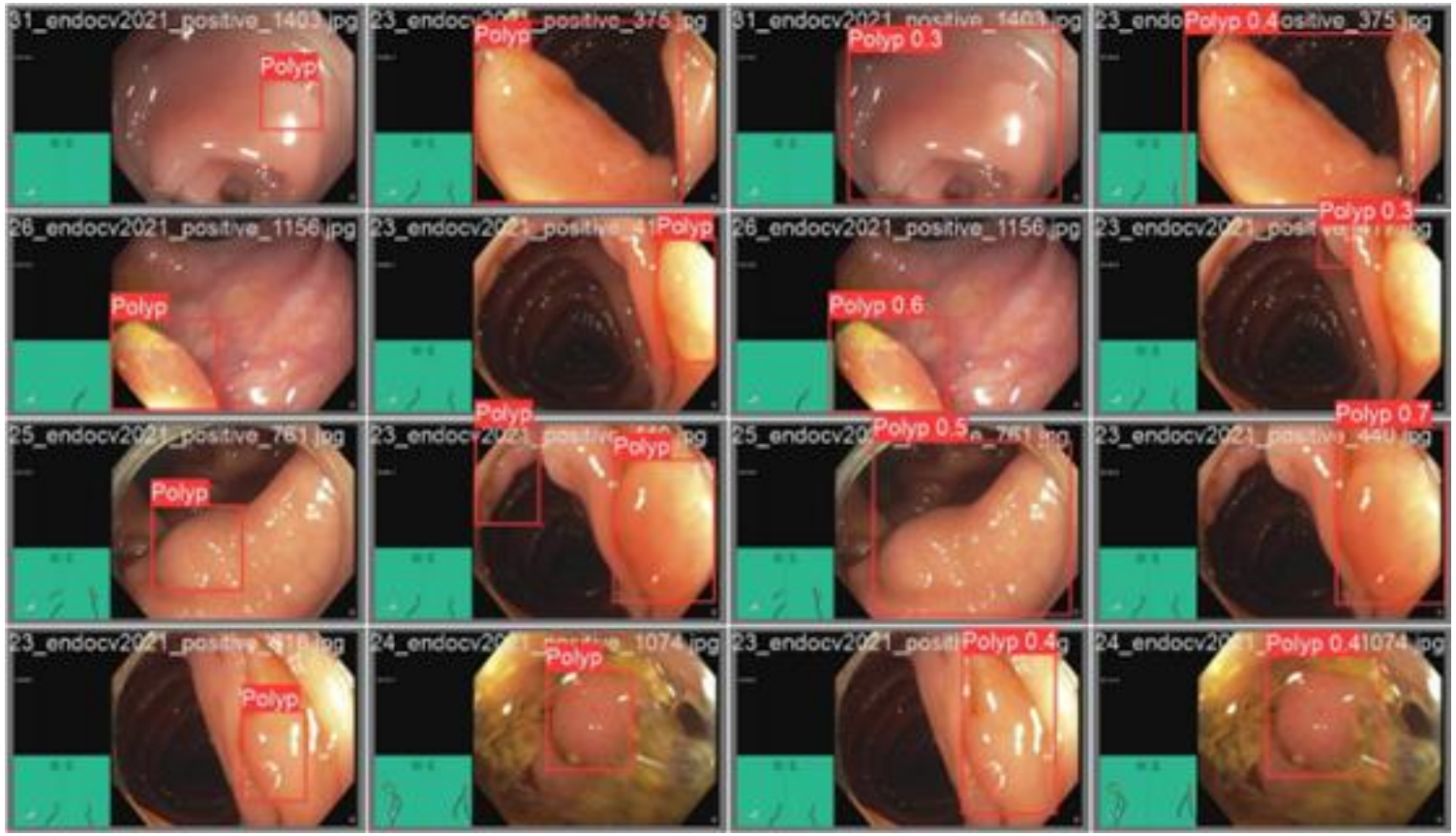
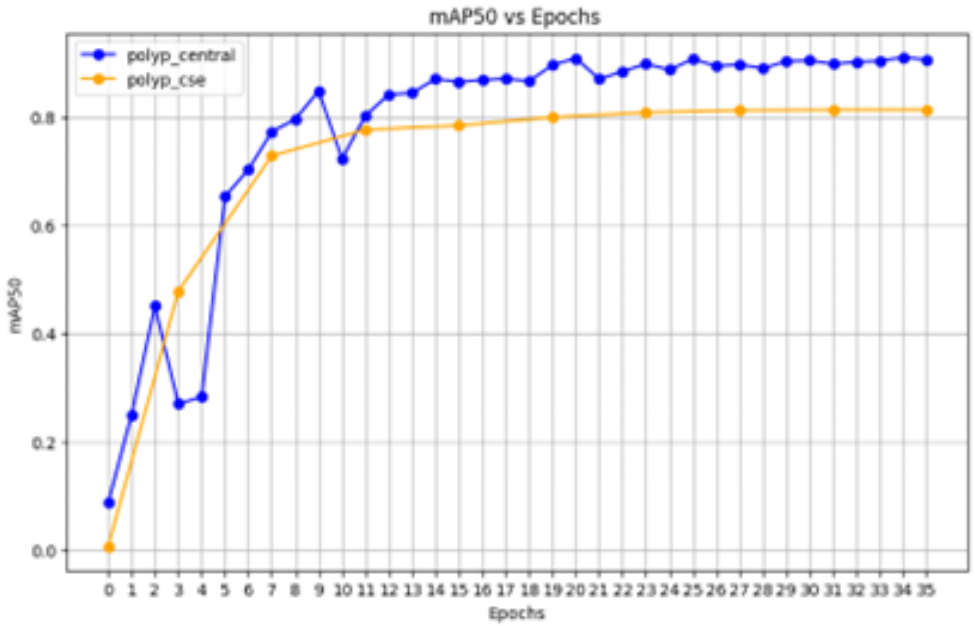
# ML-BASED ENDOSCOPES FEATURING FEDERATED LEARNING (2025)

- Putting it all together
- https://wiki.dave.eu/index.php/ML-TN-009_%E2%80%94_AI_at_the_edge:_IoT_real-time_endoscopes_and_Federated_Learning

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# INTERNSHIPS: SOME PROPOSALS ...

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# PROPOSALS #1


ToloMEO
IIoT ecosystem

- Extending the fleet of smart endoscopes with other prototypes based on newer, advanced system-on-chips featuring more powerful hardware AI accelerators
- Migrating the fleet to ToloMEO to take advantage of the services provided by an industrial IoT ecosystem; for instance
  - Automated provisioning of new endoscopes during installation
  - Cybersecurity: automatic, continuous monitoring of CVEs (Common Vulnerabilities and Exposures)
  - Notarization of the inference predictions performed by the edge devices

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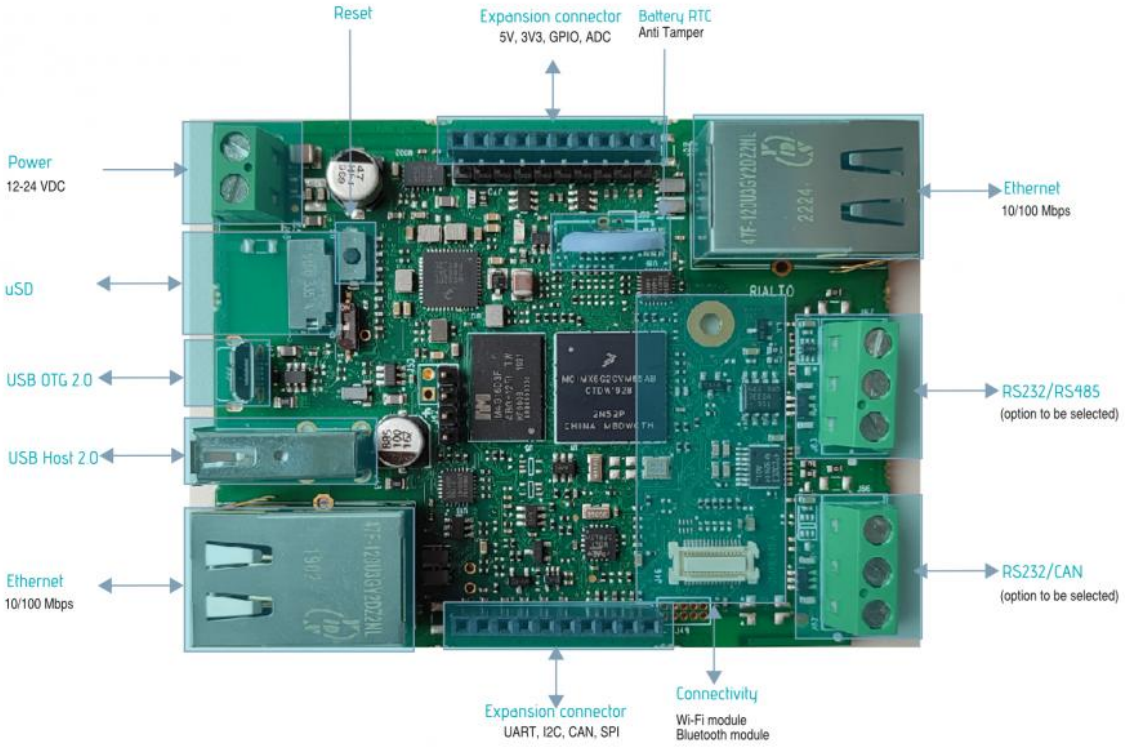
# PROPOSALS #2



## EU Cyber Resilience Act compliance

Global Platform™ SESIP




- Exploring cyber security in terms of
  - Cyber Resilience Act (CRA)
  - SESIP certification as a good practice for achieving CRA compliance
- How to CRA certify real products such as RIALTO Industrial gateway?
  - On-paper analysis
  - Actual implementation of some of the remedies (secure boot, firmware encryption, etc.)

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stages@dave.eu

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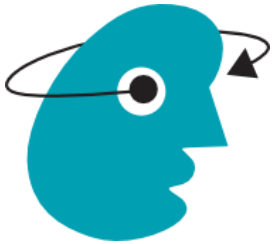

https://www.dave.eu

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# Q&A

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