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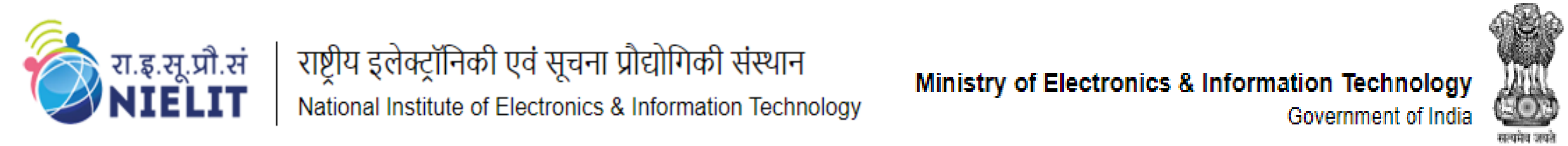
Ministry of Electronics & Information Technology
Government of India



with support from:

Microsoft | रा.इ.सू.प्रौ.सं NIELIT CALICUT

Faculty Workshop 2022

Remote Hardware Lab

Rajesh M.
rajesh.m@nielit.gov.in

Agenda

- About NIELIT Calicut
- Remote Lab Overview
- Demo

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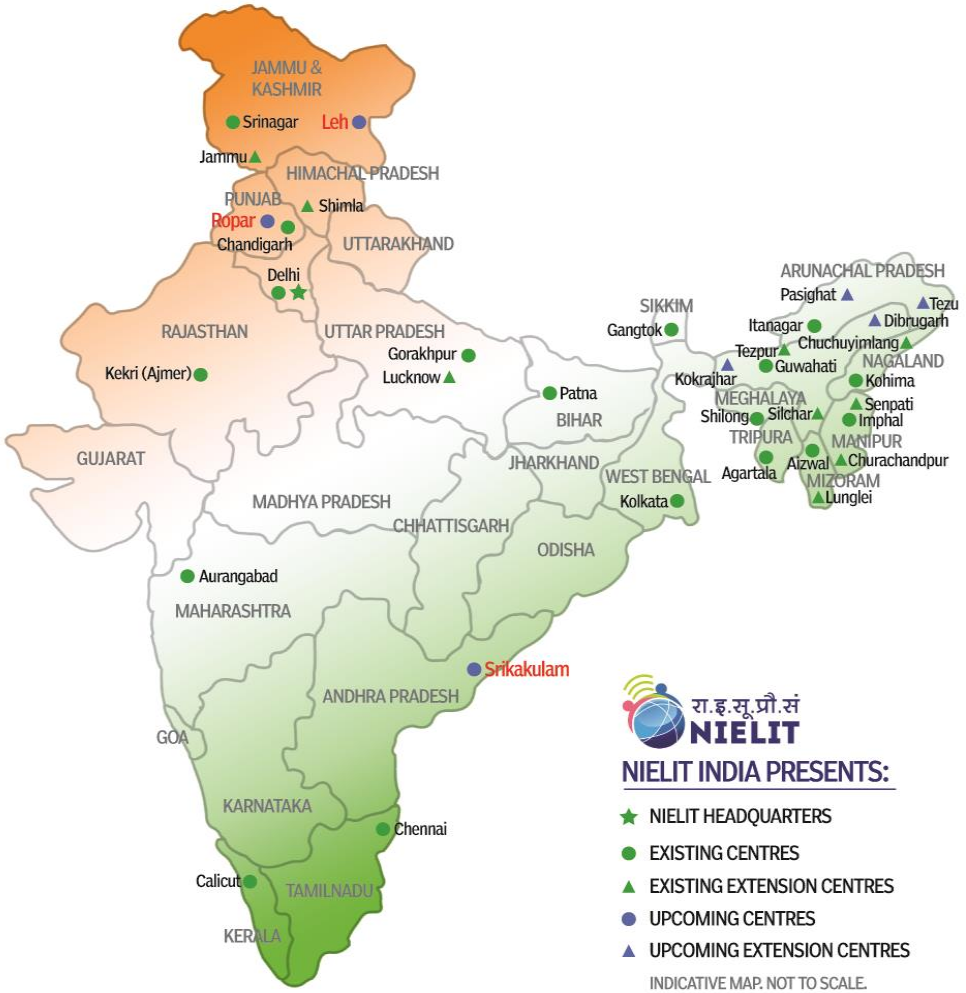

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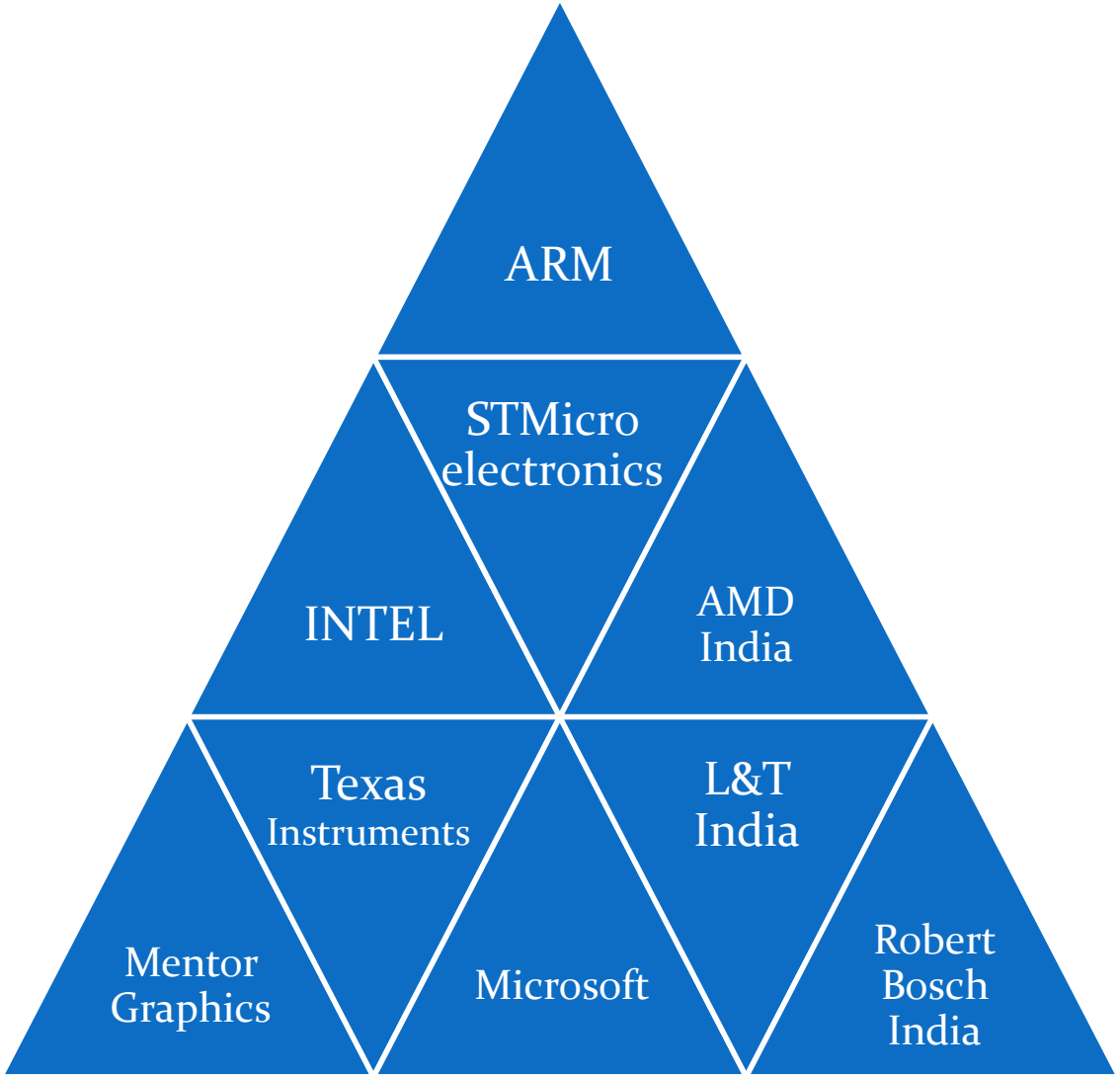
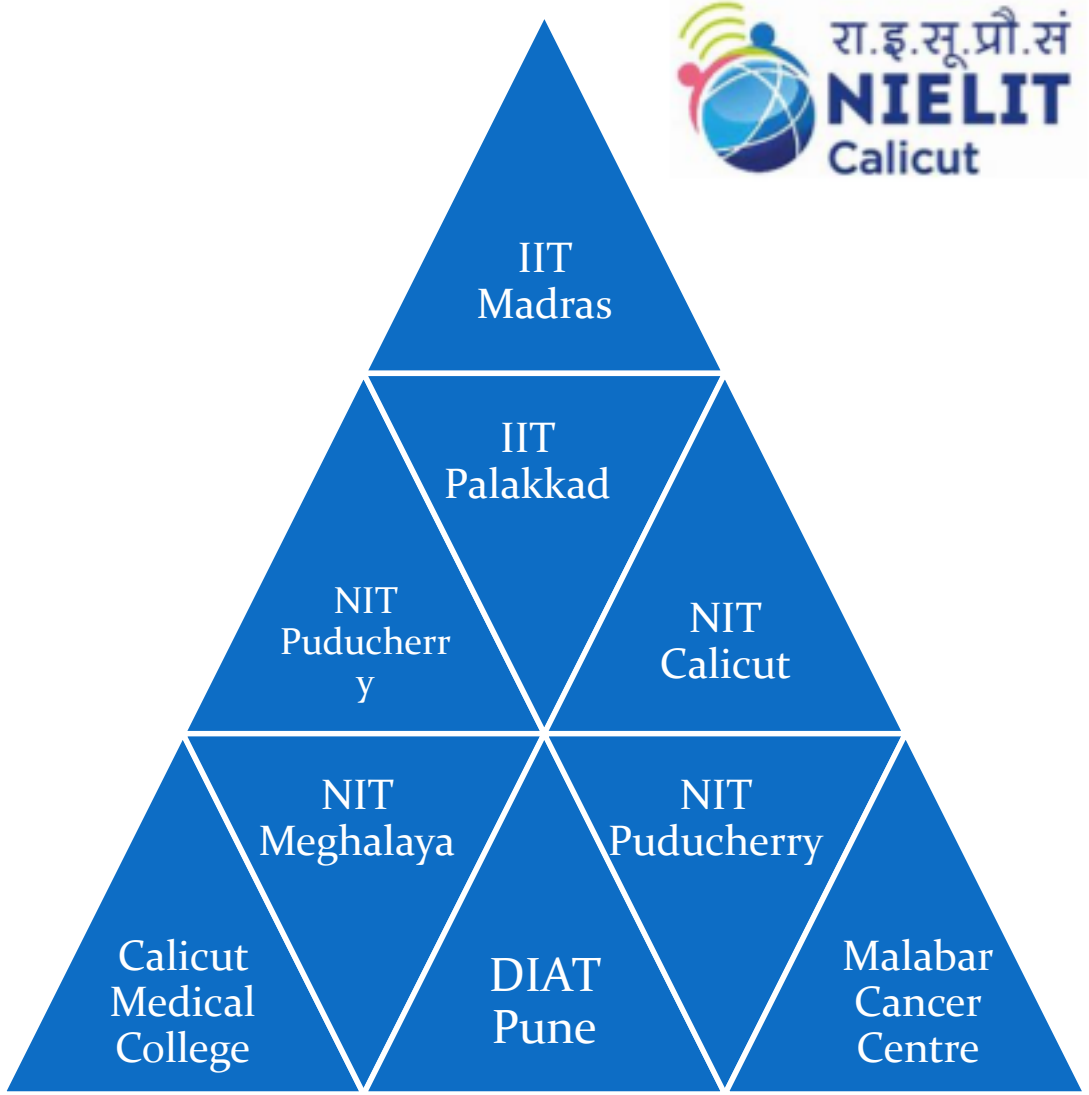
NIELIT INDIA PRESENTS:

- ★ NIELIT HEADQUARTERS
- ● EXISTING CENTRES
- ▲ EXISTING EXTENSION CENTRES
- ● UPCOMING CENTRES
- ▲ UPCOMING EXTENSION CENTRES

INDICATIVE MAP. NOT TO SCALE.

Collaborations with Leading Academia / Industries





Industry Oriented Training Programs

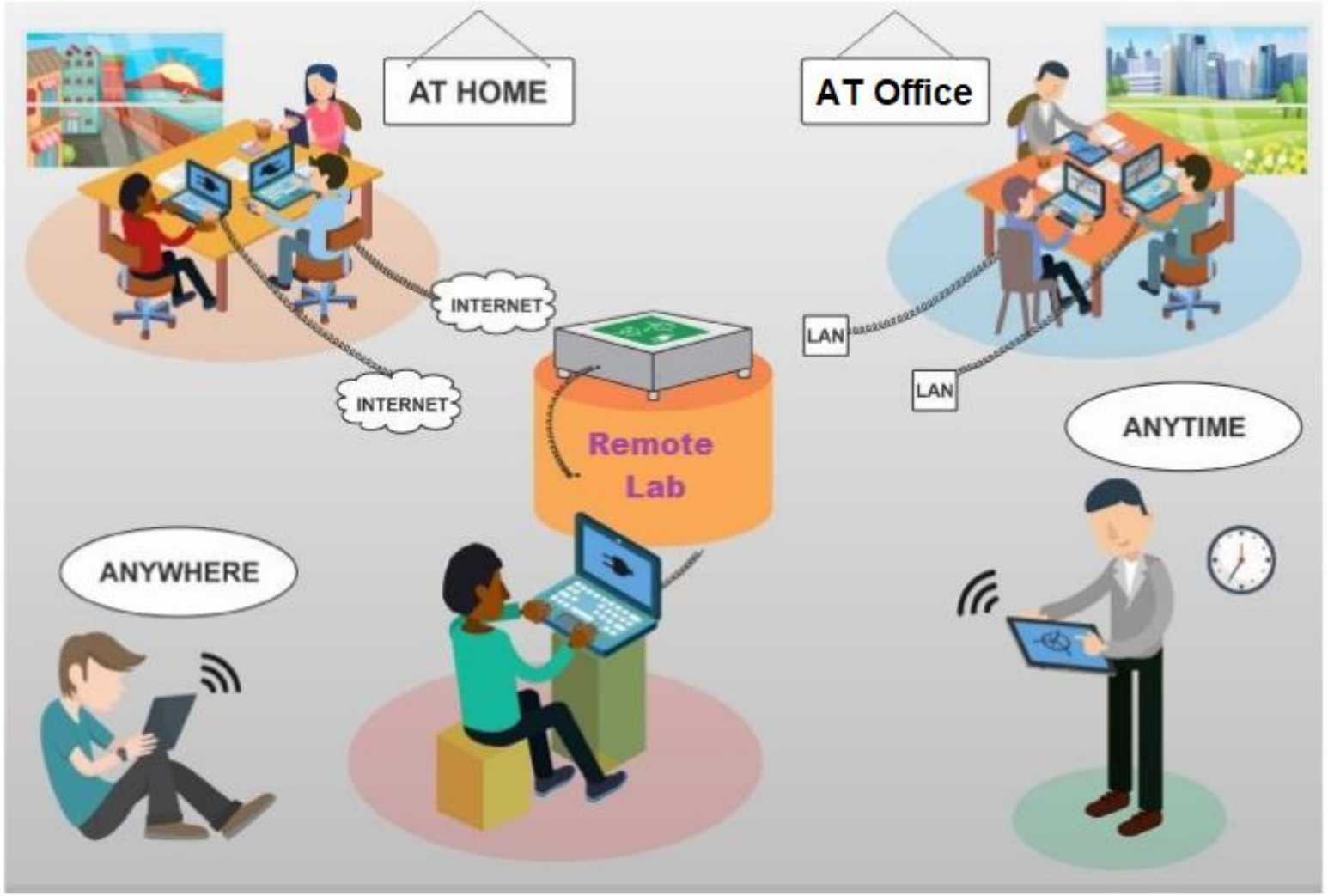
Non- Formal Training Programs

- PG Diploma in Embedded Systems and IoT.
- PG Diploma in VLSI SoC Design and Verification.
- PG Diploma in Industrial Automation

Formal Training Programs

- M.Tech in Embedded Systems
- M.Tech in Electronic Design Technology
- M.Tech in VLSI and Embedded (Joint program with Defence Institute of Advanced Studies (DIAT- Pune), Ministry of Defence, Govt. of India)

Introducing Remote Hardware Labs:
The innovation arm of Remote Hardware Access



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NIELIT
Calicut

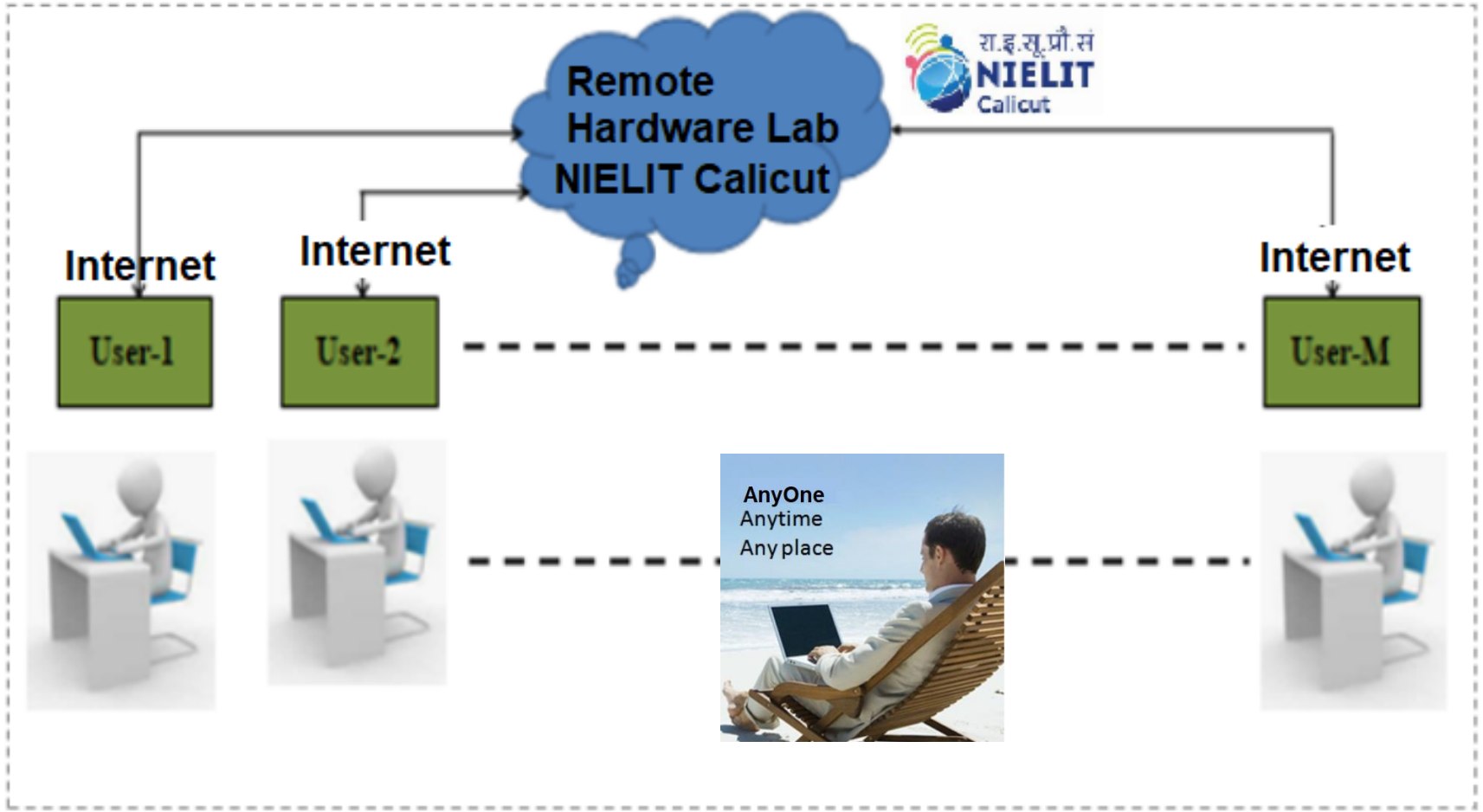
AnyOne
AnyTime
AnyWhere

Why Remote Lab?

- **A paradigm shift from offline to online instruction mode was resulted due to COVID-19**
  - **Software courses were suiting to the online mode**
  - **Hardware courses needed access to physical devices and was a challenge to provide online.**
    - **Centralized positioning**
    - **Affordability**
    - **Long procurement lead time**

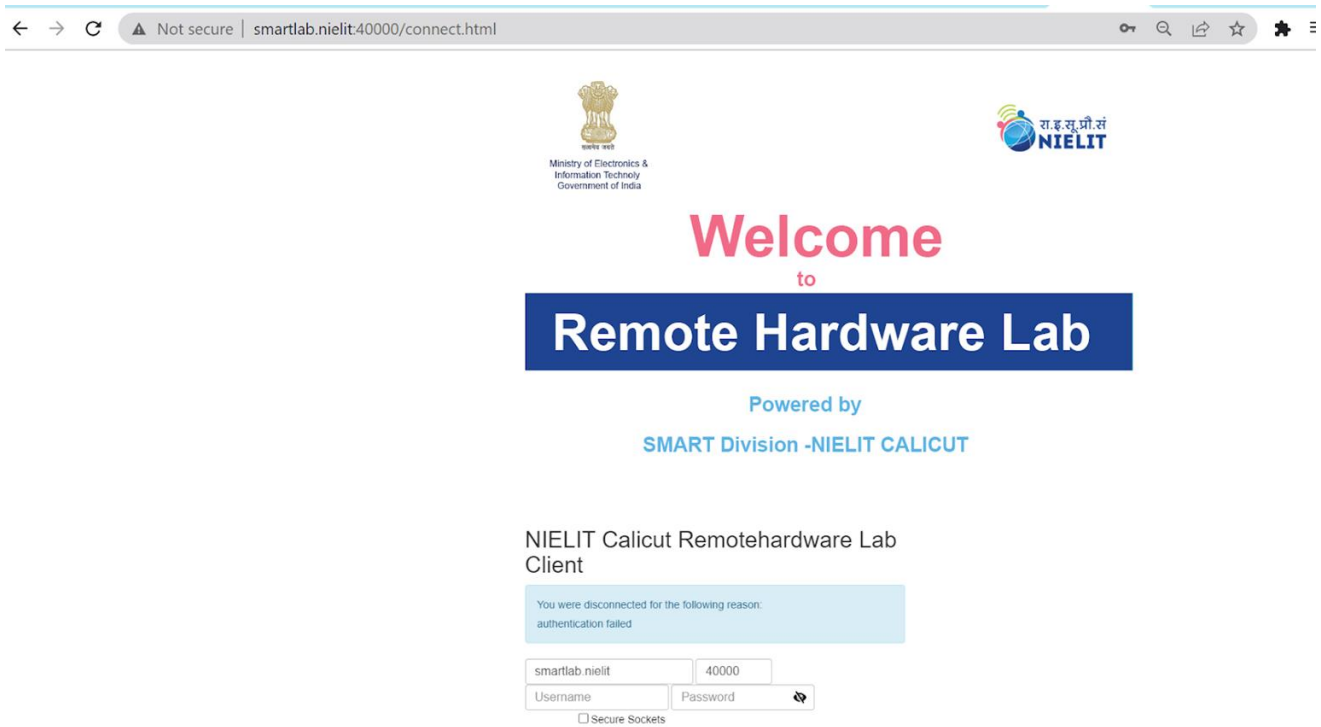
This necessitated looking for innovative solutions to offer lab-based courses efficiently and conveniently to all students regardless of their location and time.

What is a Remote Lab ?

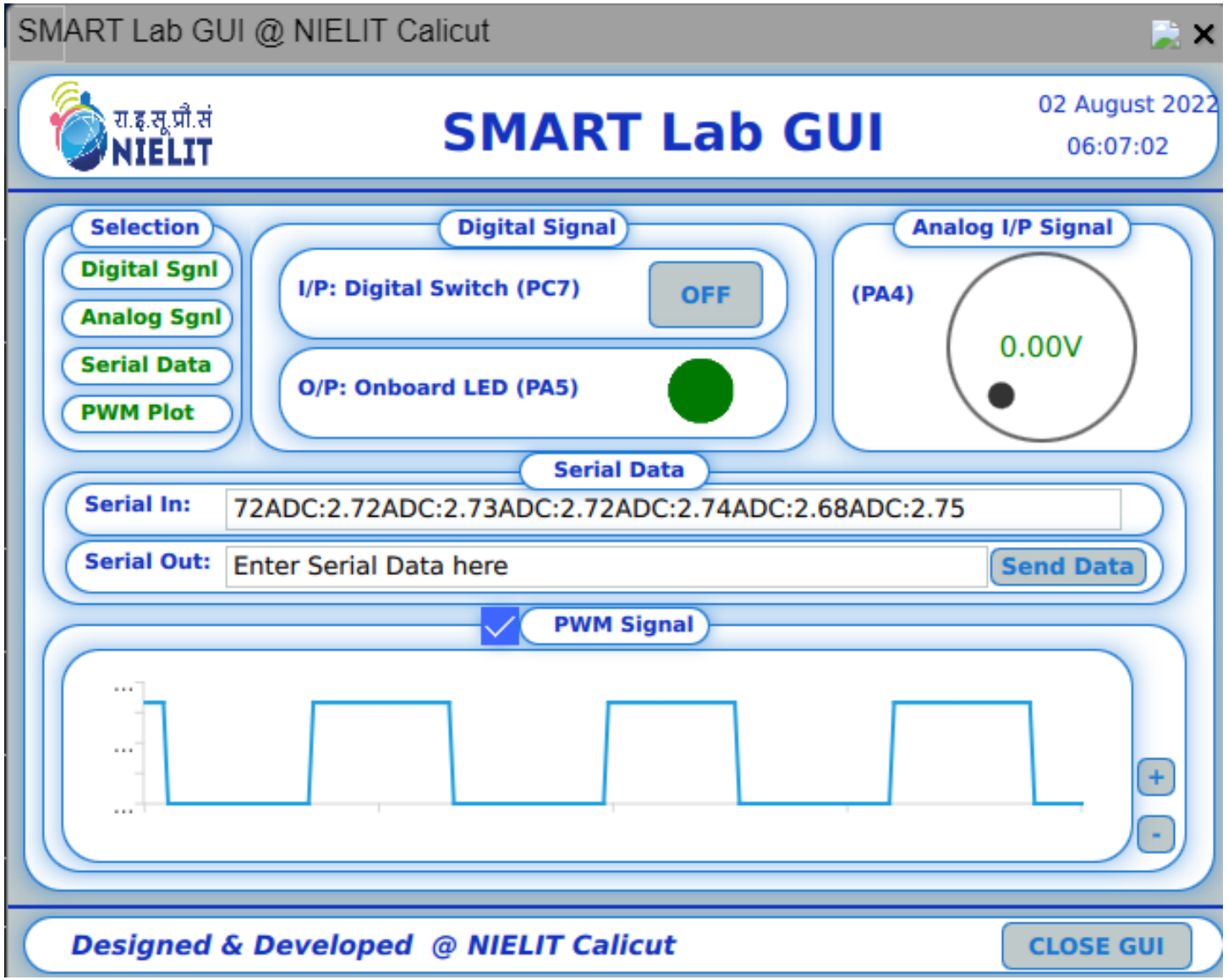


Remote Lab Access requirements

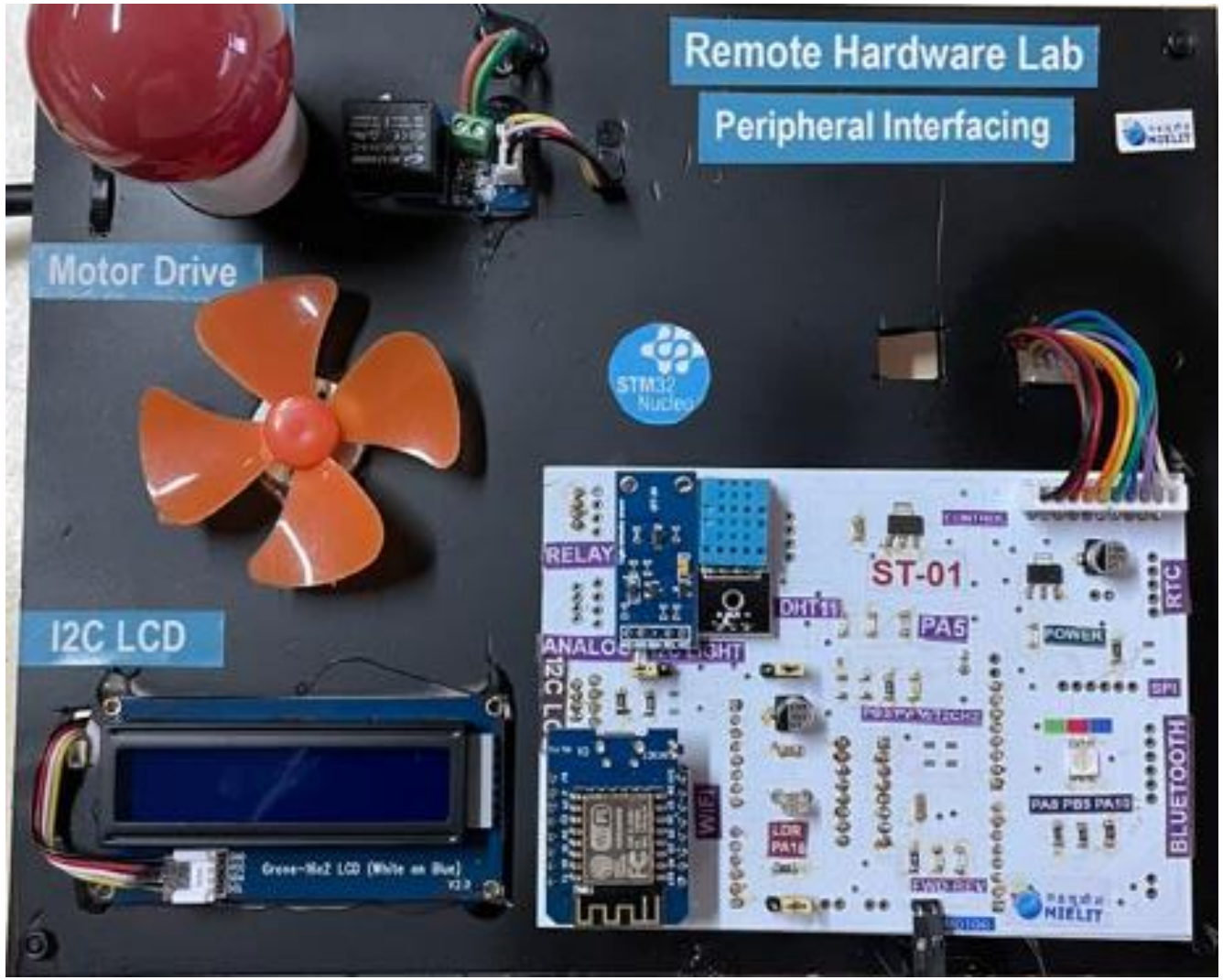
- Laptop/ Desktop/ iPad/ Smart TV/ Smart Phone with any OS
- Login Credentials
- Any web browser

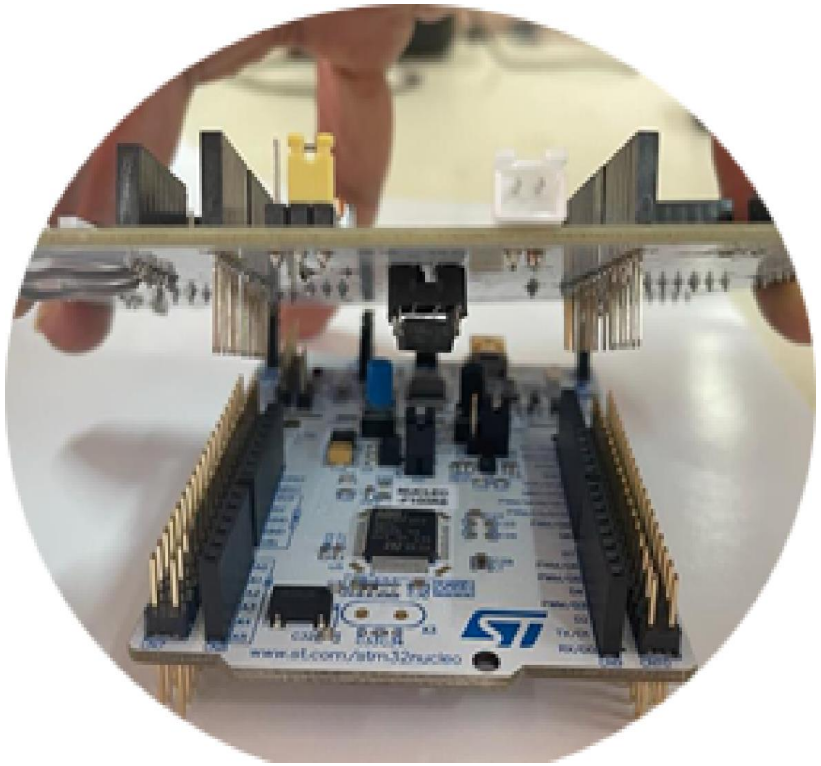


User Inputs via GUI



Live view of Hardware Targets





Beneficiaries

- Engineering College students
- Faculty
- R&D scholars
- Industry professionals
- Startup Companies

Remote Lab outcomes

- NIELIT Calicut offers various online training programs targeting students/Faculties/startup companies and provide hardware access through the remote lab infrastructure

- **Benefits for the students**
  - Enhances their skills and inculcates a Practical oriented approach in them
  - Enables them to **earn Credits** through practical oriented training
  - Exposed to the latest Industry standard design practices and tools
  - Gets a practical exposure of the various subjects of industry relevance which increases placement chances
  - Can attend these workshops according to the student's convenience as well as enhance the knowledge and skills
  - Can result in better ideas and better projects

- **Benefits for the Industry & startups**
  - Embedded/ IoT/ VLSI companies can get skilled students which reduces their training expenditure
  - There will be profound impact on the product turnaround time.

Remote Lab Target areas

- Embedded Systems
  - Embedded Microcontrollers
  - Embedded Software development
    - Embedded Firmware development, Embedded Linux
    - Embedded Linux Device Driver Development
    - Embedded OS & RTOS
- Internet of Things
- VLSI
  - RTL Design & Verification
  - VLSI Physical Design
  - Circuit Design & Characterisation
  - RTL to GDS Design Flow
  - FPGA based SoC Design
  - Scripting Language for Electronic Design Automation
- Cyber Physical Systems
- Industrial IoT
- Robotics

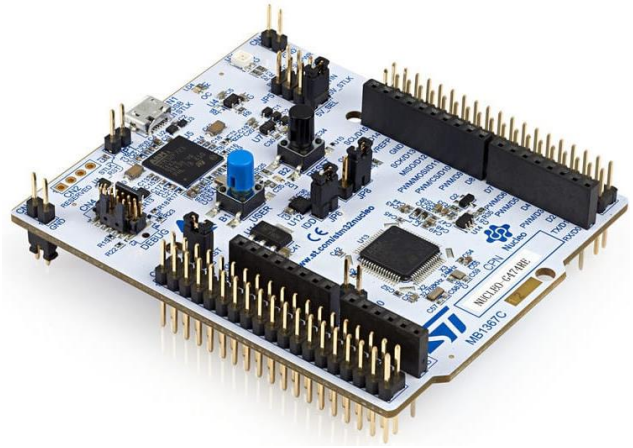
Past Remote Lab based Trainings

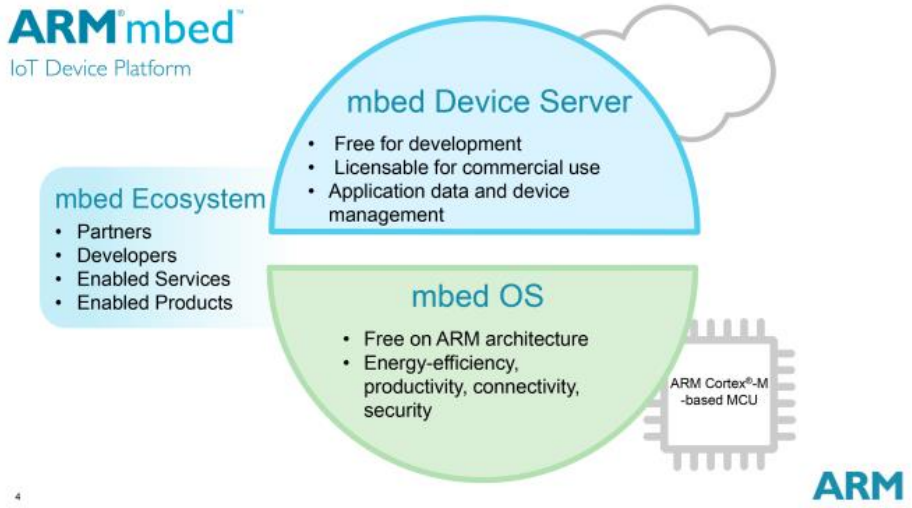
- Conducted Remote Lab based Courses
  - **Online Lab Workshops Jointly with ARM and NPTEL**
  - Embedded Training Program - IEPs sponsored by MeitY, Govt. of India, jointly with IIT Madras & CDAC Trivandrum.
  - Joint Training programs with IITM & IITM.
  - VLSI & Embedded training
    - NIT Meghalaya
    - VIT
  - Online hardware access trainings supported by industries.
  - More than 1350 people utilized this training within 1 year

User Experiences

Embedded Microcontroller Lab Access

- All Microcontrollers with access to following peripherals to users
  - GPIO
  - ADC
  - PWM
  - DAC
  - Timer
  - Serialport
  - USB



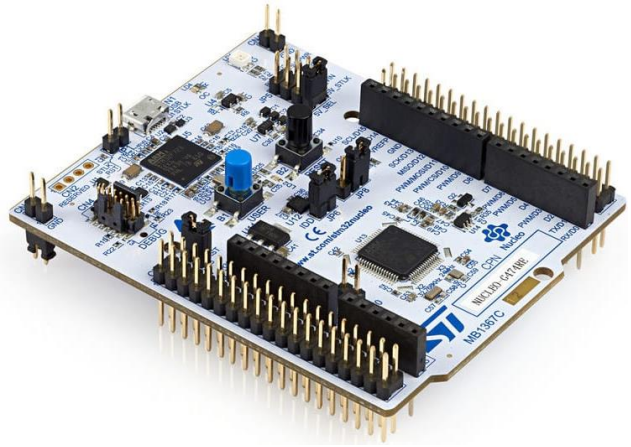


Source:

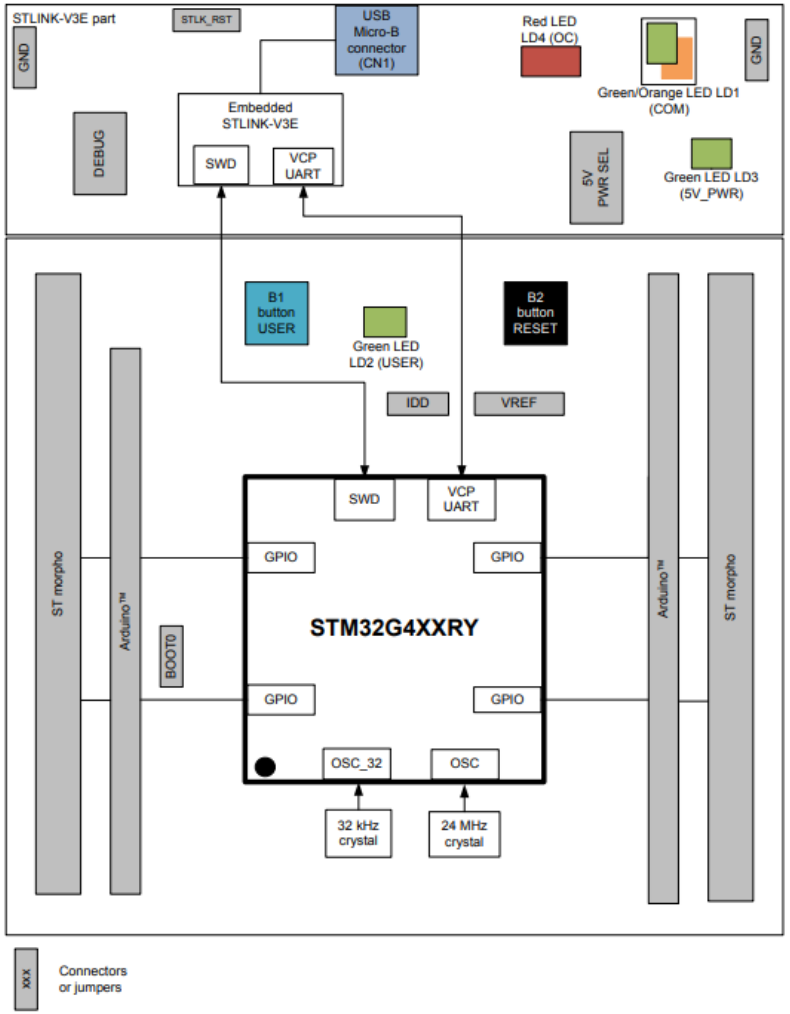
1. *https://www.st.com/en/microcontrollers-microprocessors/stm32g474re.html*
2. *https://os.mbed.com*

Embedded ARM Cortex Microcontroller Lab Demo

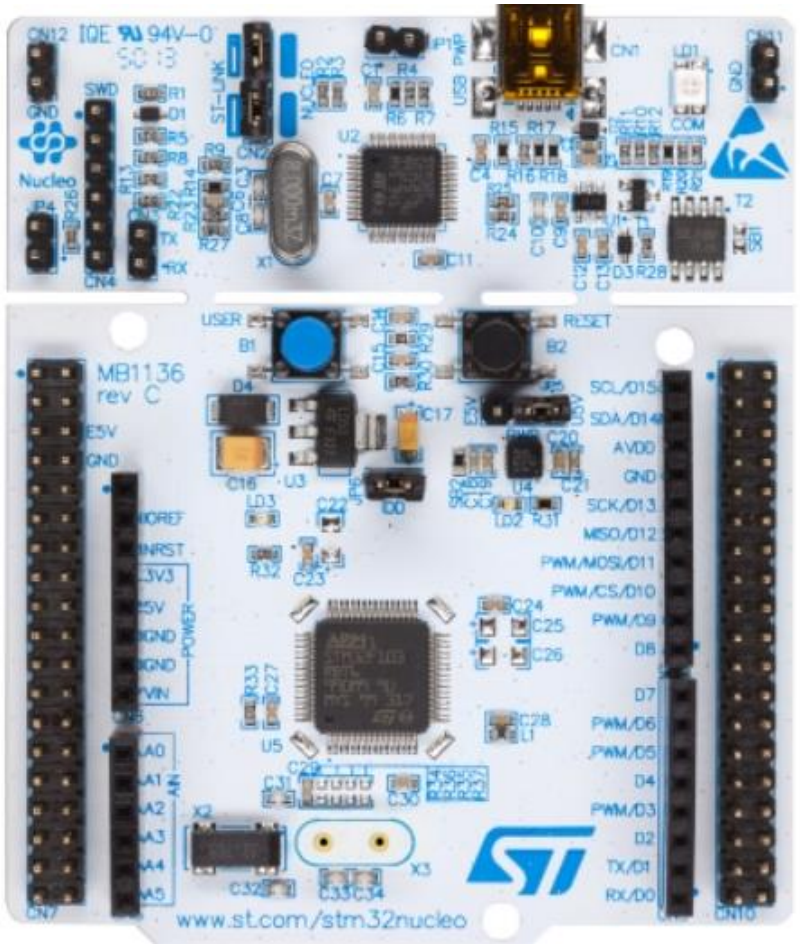
NUCLEO-G474RE

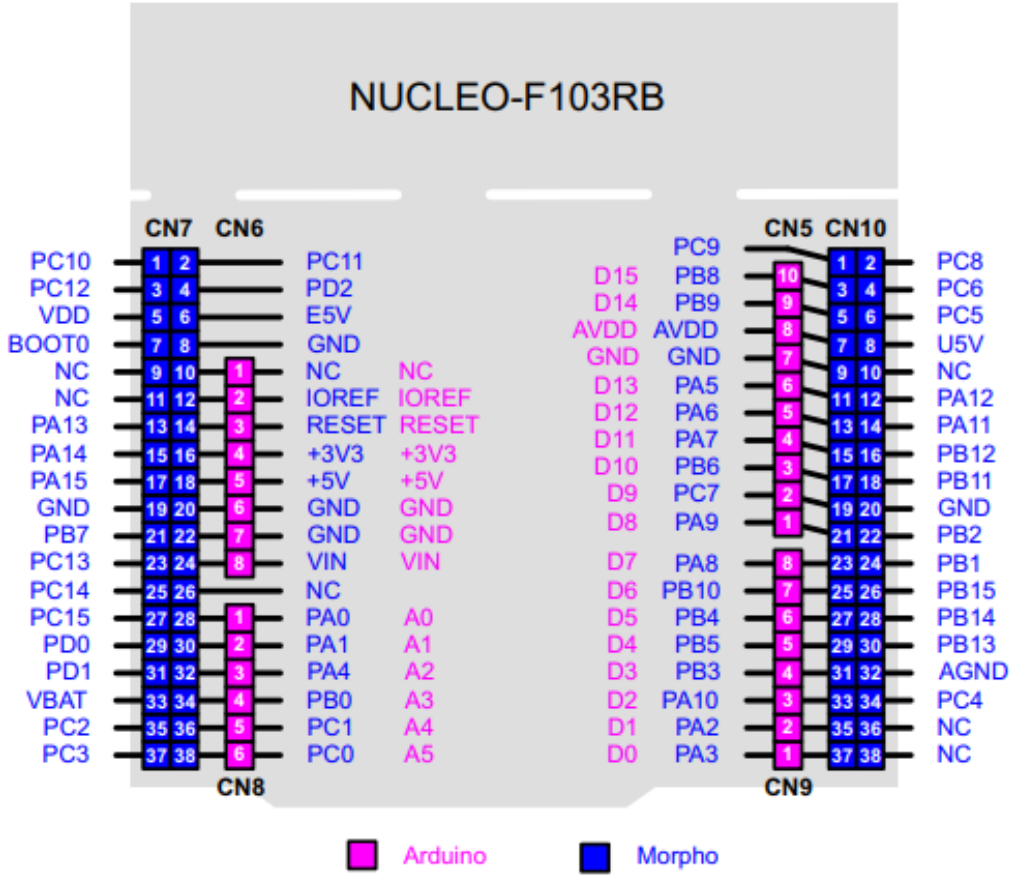


STM32 CubeIDE

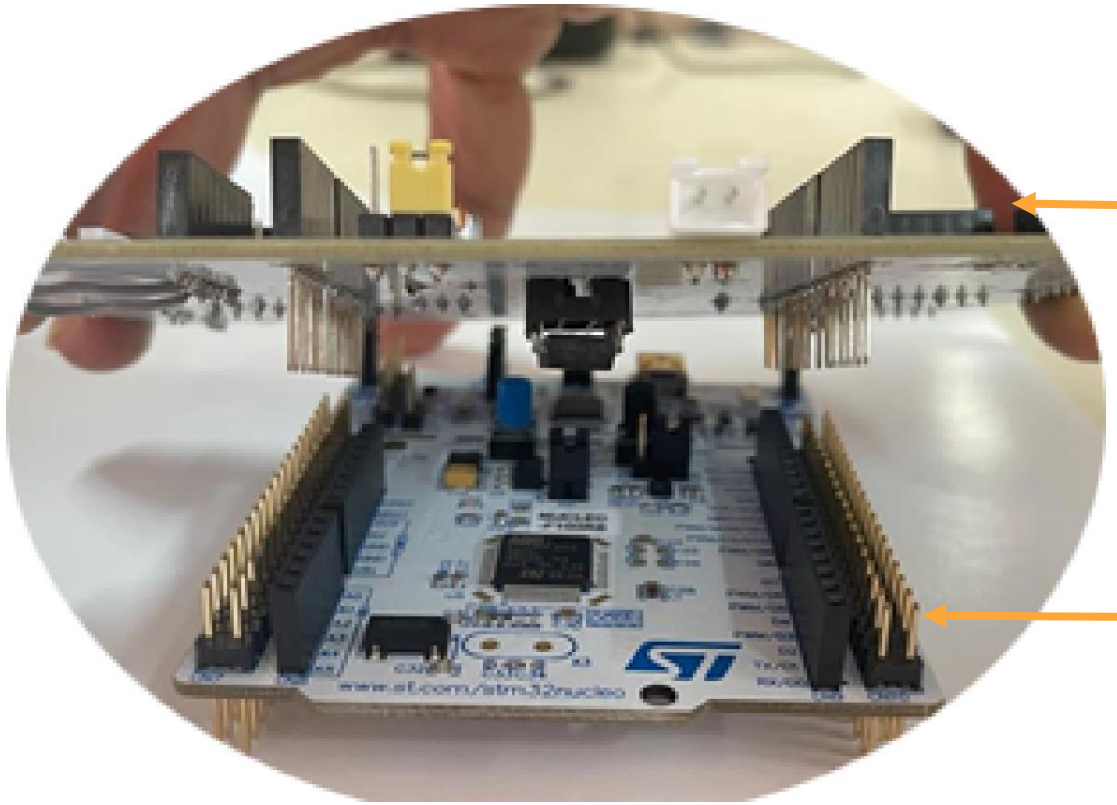


Embedded ARM Cortex Microcontroller Peripheral Lab

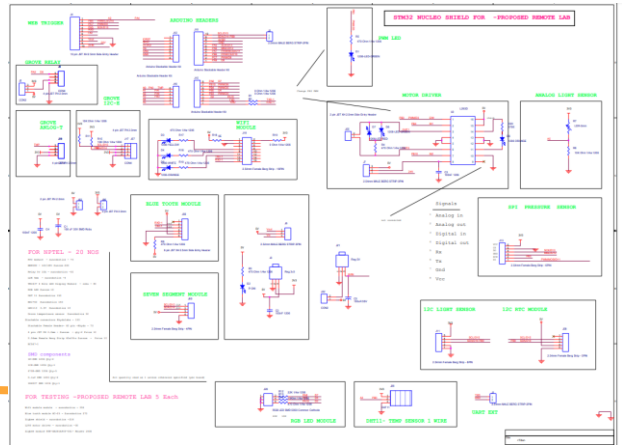




STM32 NUCLEO SHIELD - Developed by NIELIT Calicut



Nucleo Shield



Schematic

ST Nucleo Board

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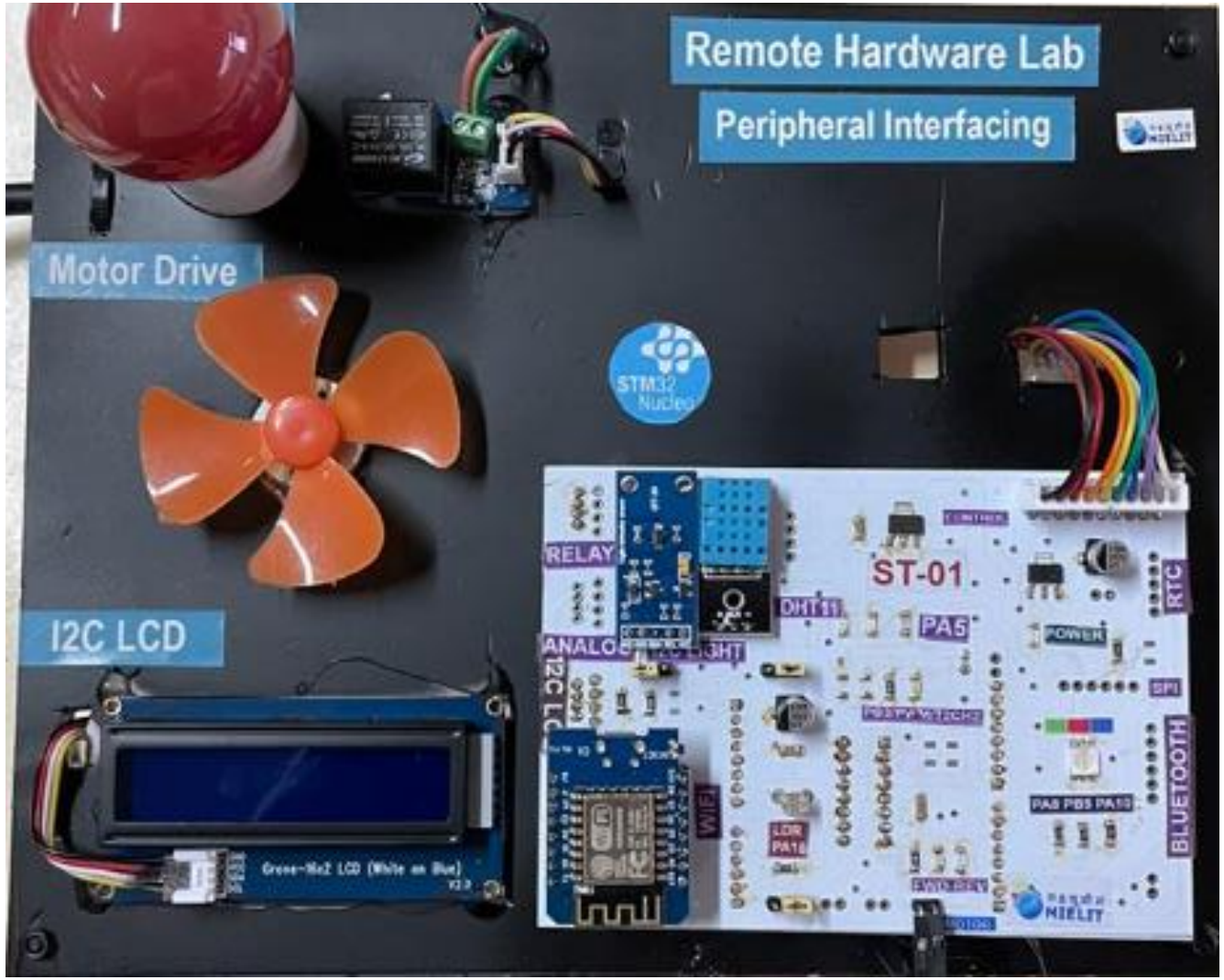
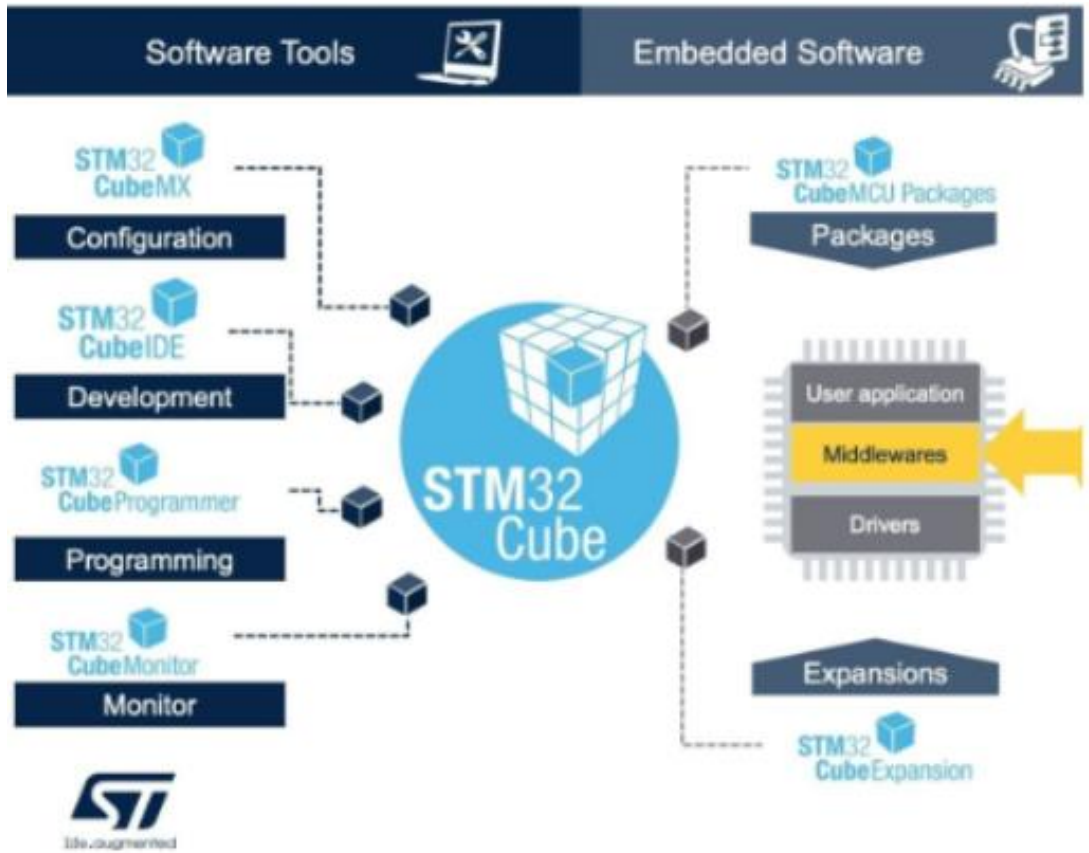
Interfacing Sensors and Actuators



- GPIO
  - Onboard LED - PA5
  - Relay - PA9
  - RGB - LEDs - PA8, PA10, PB5
- UART
  - WiFi Module
  - Bluetooth
- I2C
  - LCD
  - RTC
  - Light Sensor
- Analog
  - Light Sensor
  - Temperature - PB0
  - Humidity - PB0
- PWM
  - Brightness Control - PB3
  - Motor Speed Control - PB3
    - Direction - PB4, PB10
- SPI
  - Pressure Sensor

Real-Time OS (RTOS) Lab access

- Keil RTX Real-Time OS
- FreeRTOS
- ChibiOS/RT
- Real-Time Linux



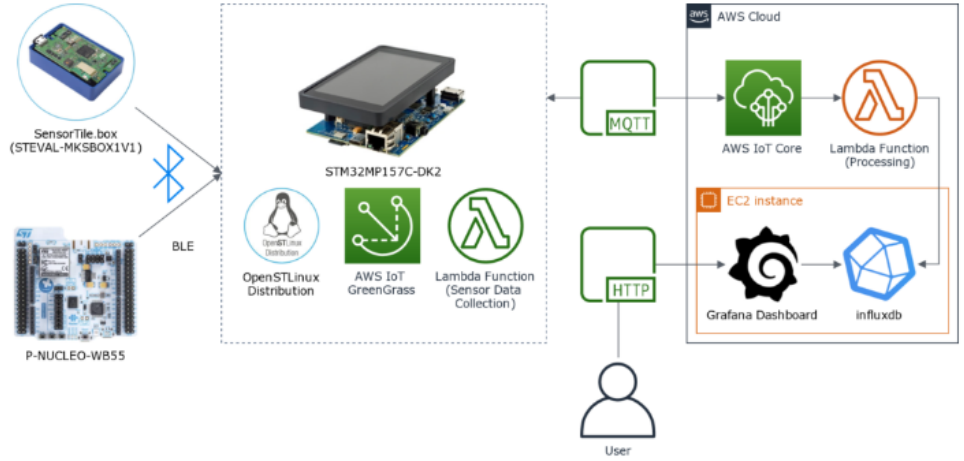
RTX5 RTOS
CMSIS
COMPLIANT
ARM® Cortex™ Microcontroller Software Interface Standard

freeRTOS

ChibiOS/RT
A compact and fast real-time operating system

IoT Lab Access

- IoT Node setup
- Interfacing with sensors and actuators
- IoT Gateway setup
- Cloud connectivity
- IoT dashboard & user access



ARM® mbed™

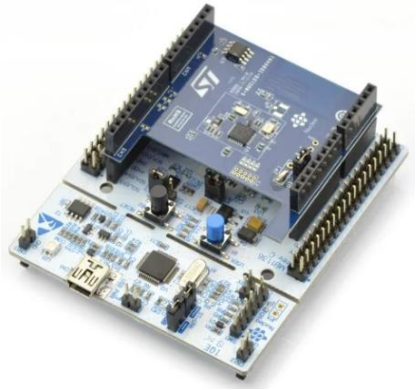
IoT Device Platform

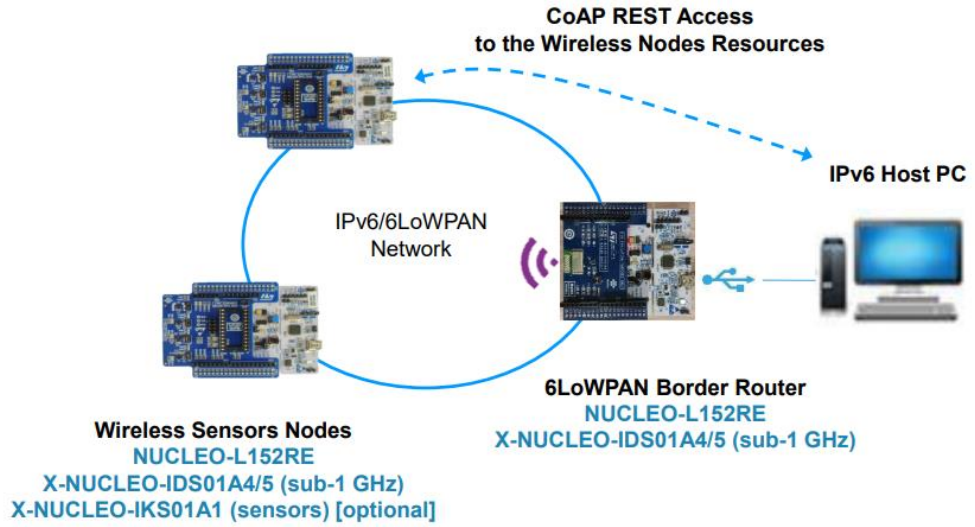
Productivity Security Connectivity Management Efficiency

The end-to-end **software ecosystem** for the Internet of Things

Wireless Communication Lab Access

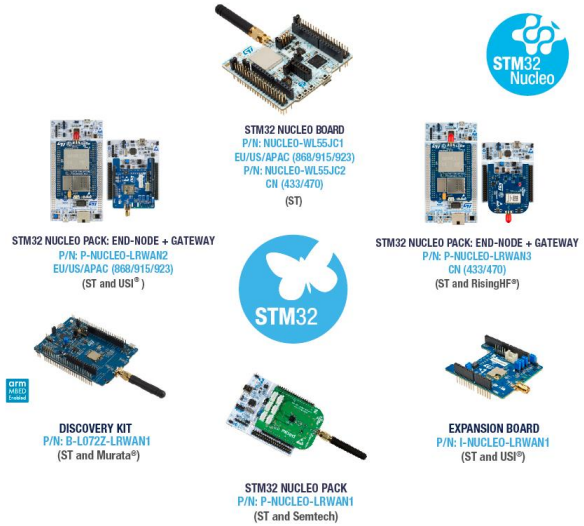
- Wireless PAN
- WSN setup
- Contiki OS
- Wireless Modem based Labs
  - GSM
  - Bluetooth
  - BLE
  - Zigbee/ Zwave
  - Sub1GHz





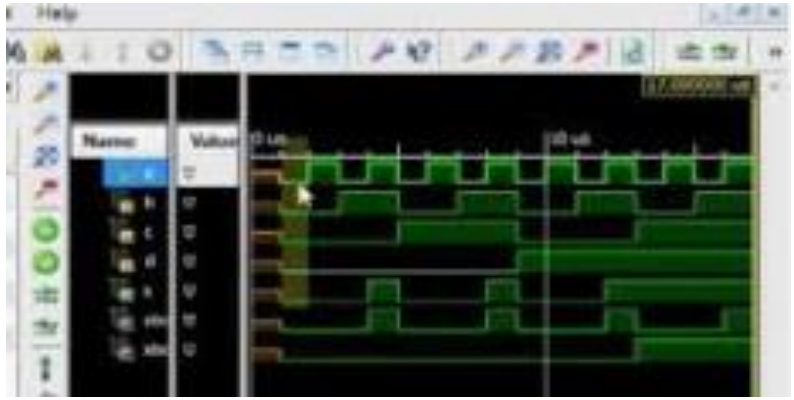
LoRaWAN & Industrial IoT Lab Access

- LoRaWAN node setup
- LoRaWAN Gateway setup
- LoRaWAN cloud based solutions
- Industrial IoT Nodes
- Industrial IoT Gateway



VLSI Lab Access

- VLSI
  - RTL Design
  - RTL Verification
  - VLSi Physical Design
  - Circuit Design & Characterisation
  - RTL to GDS Design Flow
  - FPGA based SoC Design
  - Scripting Language for Electronic Design Automation



Embedded Linux Lab Access

- Linux internal programming
- Linux Kernel Module Programming
- Linux Device Driver Development
- Embedded Linux Customisation and porting to hardware targets
- Real Time Linux

```
ifneq ($(KERNELRELEASE),)
obj-m := foo.o
else
KERNEL_DIR= /lib/modules/$(shell uname -r)/build
PWD := $(shell pwd)
all:
	make -C $(KERNEL_DIR) M=$(PWD) modules
endif
```

Upcoming Trainings through Remote Hardware Lab

Embedded Stream starting from September 2022 onwards

1. Embedded C and ARM Cortex Microcontrollers
2. Embedded Linux
3. Internet of Things
4. Real Time OS
5. Industrial IoT
6. Embedded Product Design

PG Diploma in Embedded Systems and IoT

VLSI Stream next batch starting from September 2022 onwards

1. Embedded C and ARM Cortex Microcontrollers
2. VLSI Fundamentals
3. FPGA Architecture and Programming using Verilog HDL
4. ARM based SoC Design
5. Advanced ARM SoCs and OS Porting
6. ARM based SoC Verification

PG Diploma in VLSI SoC Design and Verification

Remote access for Startup companies

- EMI/EMC test setup
- Logic Analyser
- DSO/MSO
- High-end development boards / Software Tools

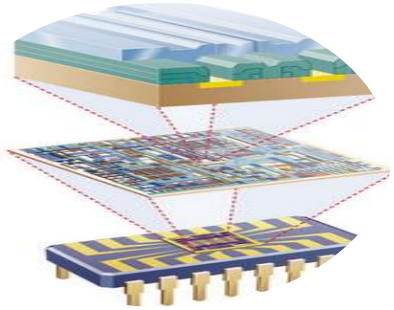
MEITY FUNDED PROJECTS (R & D)

❑ Indigenous Color Doppler Ultrasound Scanner with PNDT Compliance.

- ✓Indigenous design is First time in India
- ✓High Social relevance by making the system PNDT Compliance.
- ✓Huge Money savings for the Nation, by import substitution.
- ✓Plethora of Applications and very few researchers in India.
- ✓Ultrasound research platform, enables high end research ,First time in India.
- ✓High quality manpower development in Electronic Product design, R & D in Medical Imaging etc.

❑ Special manpower Development Program for Chips to System Design (C2SD)

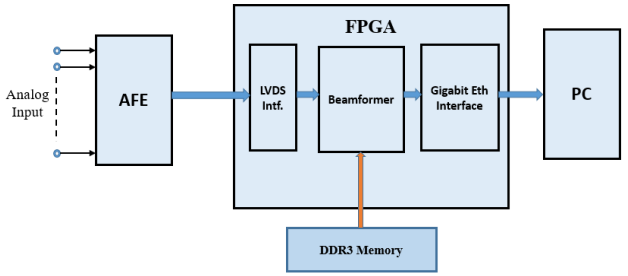
- ✓ Design and Development of Array Signal Processor ASIC (Single chip solution for under water acoustic CAMERA/SONAR and medical imaging)
- ✓ Training of Minimum 180 candidates in VLSI/Electronics System Design and Manufacturing area.
- ✓ Training of candidates at Doctoral level (PhD)
- ✓ To introduce new PG Programme in VLSI Design
- ✓ Capacity building in ASIC Design & Verification , Manufacturing and Chip to System Design.



Array Signal Processor ASIC *For NPOL Cochin*

R&D PROJECTS – DRDO

❑ Study on Analog Frontend (AFE) and design of hardware field beamformer for Imaging Sonar.



- ✓ Supports up to 128 Channels
- ✓ Parallel beam formation up to 28 beams.
- ✓ Field of View up to 90 Degree
- ✓ High Speed SERDES Interface
- ✓ Gigabit Eth Interface
- ✓ Delay Tables in External DDR3 Mem
- ✓ Porting on Custom Designed Board

❑ Development of a new scheduling algorithm for Multi-Core architectures in Real-time Linux platform

- ✓ Development of application specific scheduling algorithm for Embedded Linux Platform for multi-core architecture.
- ✓ Targeted application – Sonar Signal Processing

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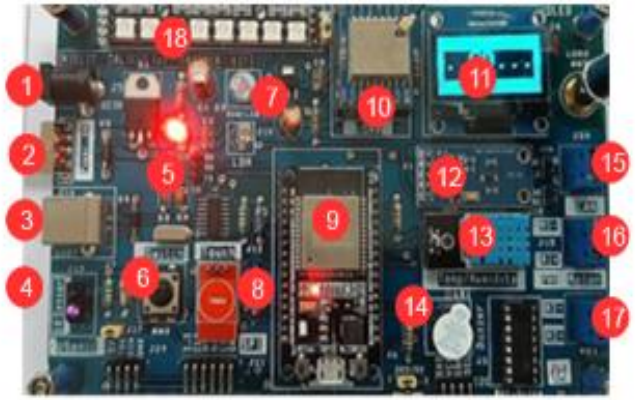
R & D Projects

❑ Indigenous Portable Ventilator-SAMIRA

- ✓ Invasive Closed Loop Ventilator
- ✓ BLDC Blower based Air Source
- ✓ CPAP, BiPAP, CMV and SIMV Modes.
- ✓ FiO2 : 21% - 80%
- ✓ LCD/TFT display and remote access display with IoT connectivity to laptop / Mobile app

❑ IoT Trainer Kit



1. Power supply Socket
2. Power On switch
3. Power on USB/UART2
4. IR Proximity Sensor
5. Power on LED
6. Tactle Switch
7. User LED
8. Touch switch
9. ESP32 module
10. LoRa
11. OLED
12. Digital Light sensor
13. Temperature & humidity
14. Buzzer
15. CAN bus
16. DC motor 1/PWM1
17. DC motor 2/PWM2
18. Neo pixel LED

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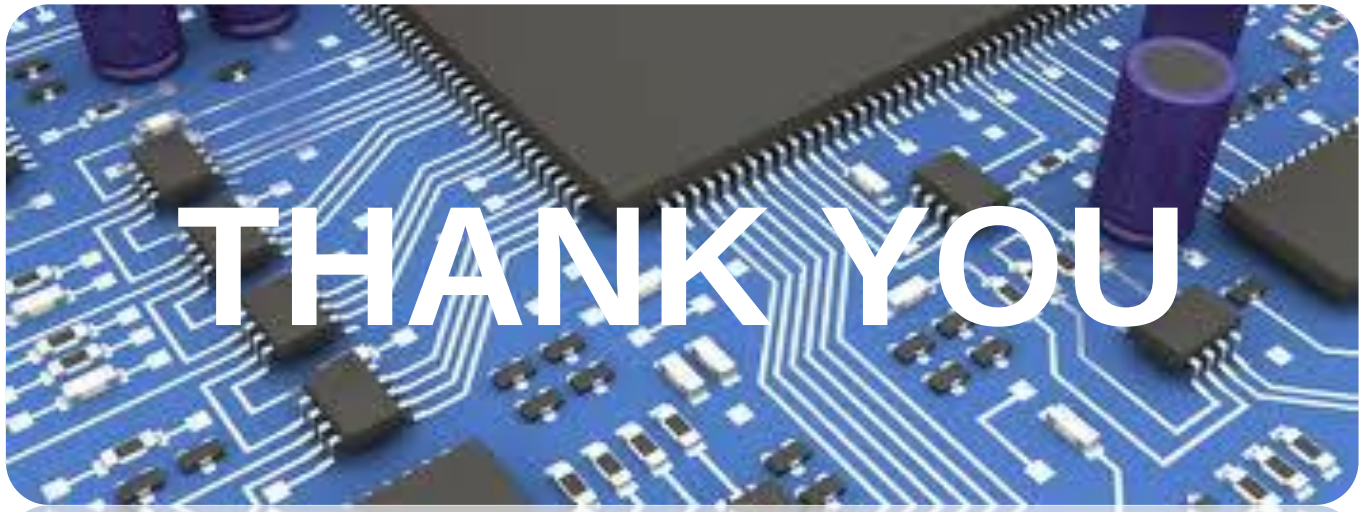

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National Institute of Electronics & Information Technology

www.nielit.gov.in/calicut
rajesh.m@nielit.gov.in