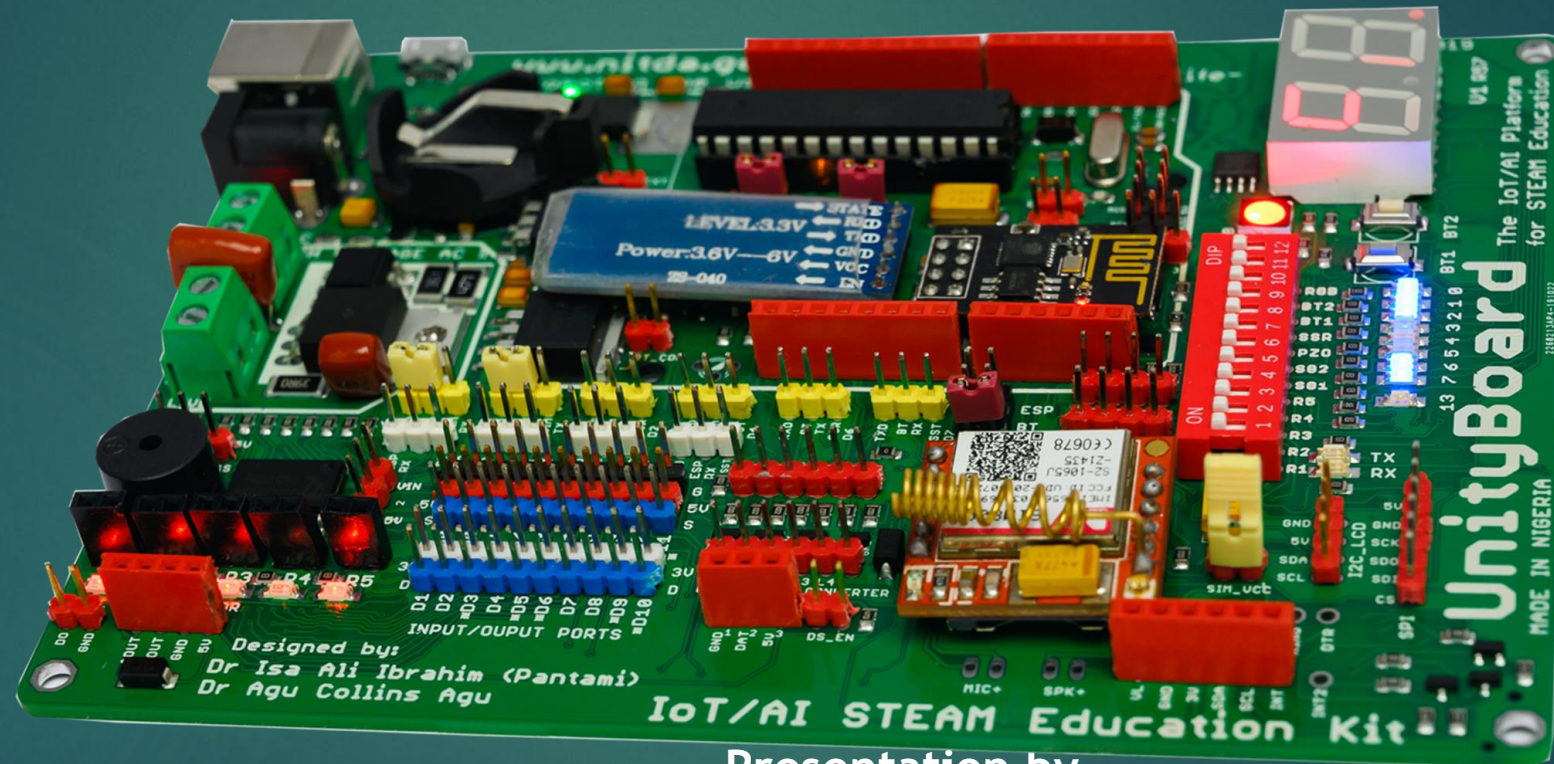


IoT & Its Implications for Africa - 4IR-focused Human Capital Development to drive IoT & Datafication of Africa.



Presentation by

Dr Agu Collins Agu - Director R&D, NITDA (www.nitda.gov.ng)

Co-Designer, Unity Board IoT/AI STEAM Education Kit (www.unityboard.ng)

Founder & Mentor , td4pai IoT Hub, Nigeria. (www.td4pai.org.ng)

25/09/2023

Kindly follow me for updates:

www.linkedin.com/in/AguCollinsAgu/

www.facebook.com/AguCollinsAgu

www.youtube.com/@AguCollinsAgu

AFRICA's Demography - Asset or Liability?

With a combined population of 1.5 billion people and a diverse economy,

Africa is poised for significant growth and development.



Why AFRICA ?



- ▶ The Economic Community of West African States (ECOWAS) is a regional organization that promotes economic integration, political stability, and social progress among its 15 member countries.
- ▶ Despite significant progress over the years, the region still faces numerous challenges such as lack of access to basic infrastructure, poverty and inequality, limited access to education and healthcare, and climate change.
- ▶ However, the emergence of the Internet of Things (IoT) and other emerging technologies provides an opportunity for ECOWAS to overcome some of these challenges and promote socio-economic development in the region.

CASE STUDY

Real-Time Tank
Monitoring System at
td4pai IoT Hub,
Nigeria.



How can IoT and Emerging technologies support sustainable development in AFRICA?

- ▶ **Internet of Things (IoT)** refers to the network of physical devices, vehicles, buildings, and other objects that are embedded with sensors, software, and network connectivity that allows them to collect and exchange data.
- ▶ **Internet of Things (IoT)** and emerging technologies have the potential to play a significant role in promoting sustainable development in the Economic Community of West African States (ECOWAS):
- ▶ **Smart Agriculture:** IoT-enabled sensors and devices can be used to monitor and optimize agricultural processes such as irrigation, fertilization, and pest control. This can lead to more efficient use of resources, higher yields, and lower environmental impact.

- ▶ **Smart Energy Systems:** IoT can be used to monitor and optimize the performance of energy systems to improve energy efficiency.
- ▶ **Smart Waste Management:** IoT-enabled sensors can be used to monitor waste levels in bins and dumpsters, which can help optimize waste collection routes and reduce the amount of waste that ends up in landfills. Additionally, emerging technologies like blockchain can be used to create transparent and efficient supply chains for waste management.

IoT Solar Powered Smart Waste Bin

Courtesy of td4pai IoT Hub, Nigeria

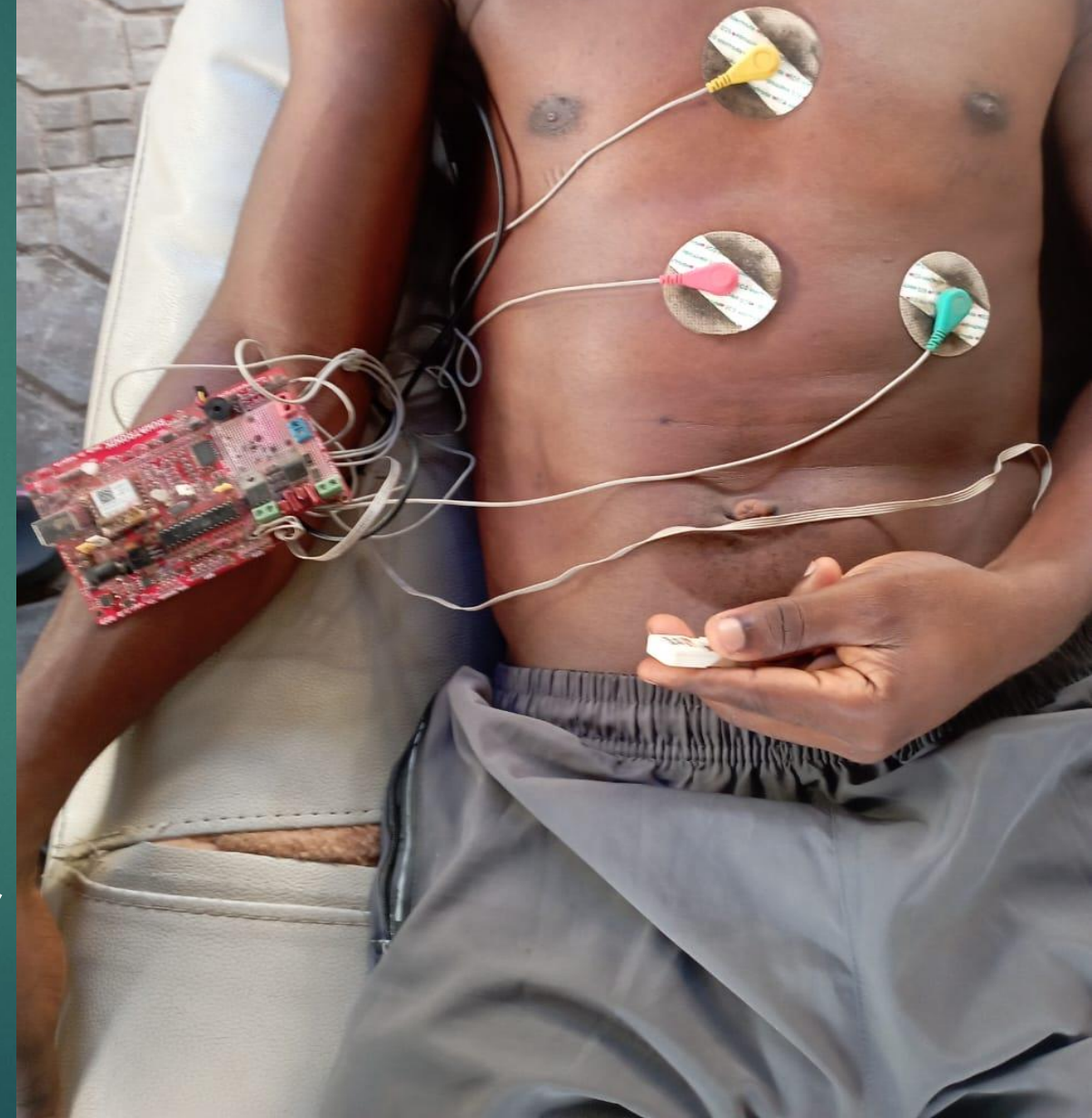


mHealth (Mobile Health) refers to the use of IoT, mobile devices, such as smartphones, tablets, and wearable devices, to address a wide range of healthcare challenges, such as:

- ▶ Improving access to healthcare services, especially in remote or underserved areas, by enabling telemedicine consultations, remote monitoring, diagnostics and mobile clinics.
- ▶ Improving public health surveillance and response by using IoT and mobile technologies for disease surveillance, outbreak management, and health promotion campaigns.

IoT based Remote Patient Monitoring System (IRPMS)

Courtesy of td4pai IoT Hub, Nigeria



Smart Water Management: Access to clean water is a fundamental human right, yet many people in ECOWAS lack access to safe and reliable drinking water.

- ▶ IoT sensors can be used to monitor water utilization in especially remote communities and predict maintenance, which can help to increase access to clean water in areas where fresh water is scarce.
- ▶ IoT enables remote visualization of performance of various remote water schemes thereby aiding Monitoring & Evaluation through Data Acquisition and Analytics



IoT based Smart Mechanical Pump for rural communities
Courtesy of td4pai IoT Hub, Nigeria

Remote Silos, LPG, Oil & Diesel Tank Monitoring System. Many industries are continuously accepting the wonders of IoT technology by installing sensor-based technologies within their entire assets.

Benefits:

- ▶ Alarm management - Immediately detect abnormality. Direct alarms to service personnel via SMS or email.
- ▶ Avoid unnecessary delays & transports – Speed response time to environmental activity.
- ▶ Get reports and statistics - So can predict environment by comparing your historical activities.
- ▶ Detect anomalous activities – In the case of Oil spillage in the environment or abnormal flow.
- ▶ Receive alarm notifications via e-mail, SMS, Direct alarms to service staff or 3rd party systems

IoT based Real-Time Tank Monitoring System.

Courtesy of td4pai IoT Hub, Nigeria



Possible examples of IoT and Emerging Technologies in AFRICA

- ▶ In Ghana, IoT-enabled water sensors are being used to monitor water levels in reservoirs and improve water management
- ▶ In Nigeria, blockchain is being used to improve supply chain management and reduce fraud in the agricultural sector
- ▶ In Senegal, telemedicine is being used to provide healthcare to remote communities
- ▶ In Ivory Coast, smart traffic management systems are being used to reduce traffic congestion and improve road safety

Case Studies of indigenization of Technology in Nigeria

12



Startups



Current Trends and Challenges

- ▶ The fourth industrial revolution characterized by the fusion of the digital, biological and physical worlds is the current and developing environment in which disruptive technologies and trends such as the Internet of Things (IoT), artificial intelligence (AI), robotics, virtual reality (VR), cloud computing and 3D printing etc are changing the way we live and work.
- ▶ Whilst technological advancements are undoubtedly increasing productivity, concerns over job losses due to automation are rife. The World Economic Forum predicts net job growth overall, with as many as four new roles emerging for each role lost.
- ▶ ECOWAS needs to adapt to the rapidly changing global economy

4IR technologies can drive economic growth, job creation, and social progress in the region. However, this requires investment in human capital development



Robotics



3D Printing



Gene Editing

Mobile Technology



Top 10 Emerging Technologies



Artificial Intelligence



Nano Technology



Internet of Things



Virtual Reality



Technology



Solar Technology

IoT and Datafication of Africa

- ▶ IoT and datafication combined refers to the collection, processing, and analysis of vast amounts of data that can provide valuable insights and inform decision-making.
- ▶ **Opportunities of IoT and Datafication in ECOWAS:** IoT and datafication can drive economic growth and job creation, can improve healthcare, education, and infrastructure, can also promote sustainable development.
- ▶ **Challenges of IoT and Datafication in ECOWAS:** Limited infrastructure and connectivity, limited access to education and skills development.
Data privacy and security concerns

Importance of Human Capital Development in IoT and Datafication

- ▶ Human capital development refers to the process of improving skills, knowledge, and abilities of individuals critical for successful adoption and utilization of 4IR technologies.
- ▶ Human capital development is critical for successful adoption and utilization of IoT and datafication technologies toward promotion of job opportunities and economic growth

Strategies for Human Capital Development - Government investment in education and skills development programs, Public-private partnerships to promote skills development and training, Creation of innovation hubs and centers of excellence

- ▶ Strategies such as education and skills development programs, public-private partnerships, and innovation hubs can help to drive human capital development and promote socio-economic development in the ECOWAS region

IoT/emerging technologies landscape and future uses in Africa.

- ▶ **Current Landscape:** IoT is already being used in various applications in the region, including agriculture, healthcare, and transportation.
- ▶ AI is also gaining traction in the region, with applications in finance, healthcare, and education.
- ▶ **Blockchain** is another emerging technology that is being adopted in the region. It is being used to improve transparency and security.

- ▶ **Future Uses:** The potential uses of IoT, AI, and blockchain in ECOWAS are vast.
- ▶ In agriculture, IoT devices can be used to improve irrigation, reduce water waste, and increase crop yields.
- ▶ AI has the potential to transform several industries in the region.
- ▶ Blockchain has the potential to improve transparency and security in several industries in the region.

4IR-focused Human Capital Development to drive IoT & Datafication of ECOWAS

- ▶ The ECOWAS region is home to over 380 million people, representing a diverse group of cultures, languages, and economic systems. With the proliferation of 4IR technologies, there is a need for the region to develop its human capital to drive IoT and datafication.
- ▶ **The Unity Board for Emerging Skills** (UB4ES) program is a proposed initiative that seeks to equip the region with the necessary skills and knowledge to thrive in the 4IR era.
- ▶ The UB4ES program aims to promote 4IR-focused human capital development in the ECOWAS region by providing training and resources to:
 - ▶ Develop a skilled workforce:
 - ▶ Foster innovation:
 - ▶ Improve economic growth:

UB4ES Program Implementation:

- ▶ **The Unity Board for Emerging Skills (UB4ES)** program will be implemented through a variety of channels, including partnerships with educational institutions, government agencies, and private sector organizations.
- ▶ The program will also leverage indigenous digital platforms, such as online courses and virtual training sessions, to reach a wider audience.
- ▶ The UB4ES program has the potential to transform the ECOWAS region by promoting 4IR-focused human capital development.
- ▶ By equipping individuals with the skills and knowledge required to harness the power of 4IR technologies, the program will facilitate the growth of local industries and businesses contributing to the region's digital transformation and drive economic growth.
- ▶ Additionally, the program will foster innovation and encourage the development of new technologies that can address the region's unique challenges.
- ▶ The UB4ES program is a proposed initiative that seeks to promote 4IR-focused human capital development in the ECOWAS region

Skills Development

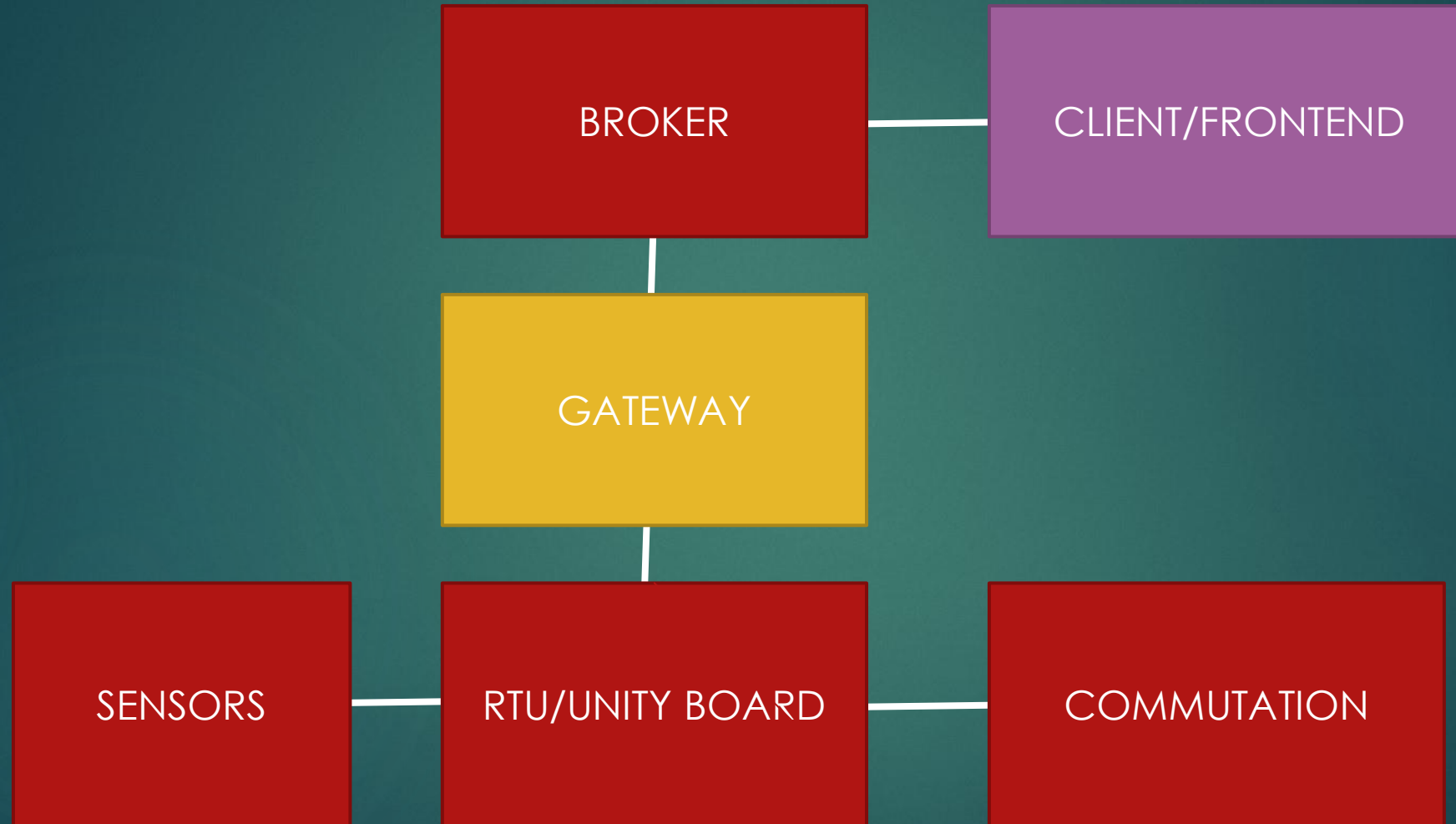


The 4C's of IoT

- ▶ Computation – Firmware/Software
- ▶ Control – Hardware/Sensors/Actuations
- ▶ Connectivity - Networking
- ▶ Cloud - Database



Generic IoT Architecture – My Perspective



IoT is one of the foundation stones of Industry 4.0

- ▶ The Internet of Things (IoT) is a technological revolution that enables pervasive interaction between objects, people and environments. Data will be gathered by embedded sensors and actuators, which are then sent to specialised applications to create actionable information
- ▶ By embedding sensors in objects and integrating cloud computing, augmented reality, wearable technologies and big data in this platform, different parameters of the educational environment can be measured and analysed to provide useful information

Hardware Challenges /Constraints in existing boards – Arduino, Raspberry Pi etc

addressed by Unity Board

- ▶ High Cost /Non-Availability of shields
- ▶ Absence of Direct Switching of heavy loads – 220VAC
- ▶ Inherent Voltage interfacing issues – 3V3/5V
- ▶ Memory deficiency – limited data storage capability for data logging etc
- ▶ Inaccessibility of unutilized pins
- ▶ Limited Communications Channels – GSM/GPRS ; WIFI, BLUETOOTH etc
- ▶ No onboard RTC – For Time Stamp
- ▶ Low current capability – less than 1A
- ▶ Absence of IMU Capability - ACCEL/GYROS
- ▶ No Remote Programmability – OTA/DEMO Purpose
- ▶ No piezo/speaker – for sounds, tunes etc

Existing Solutions

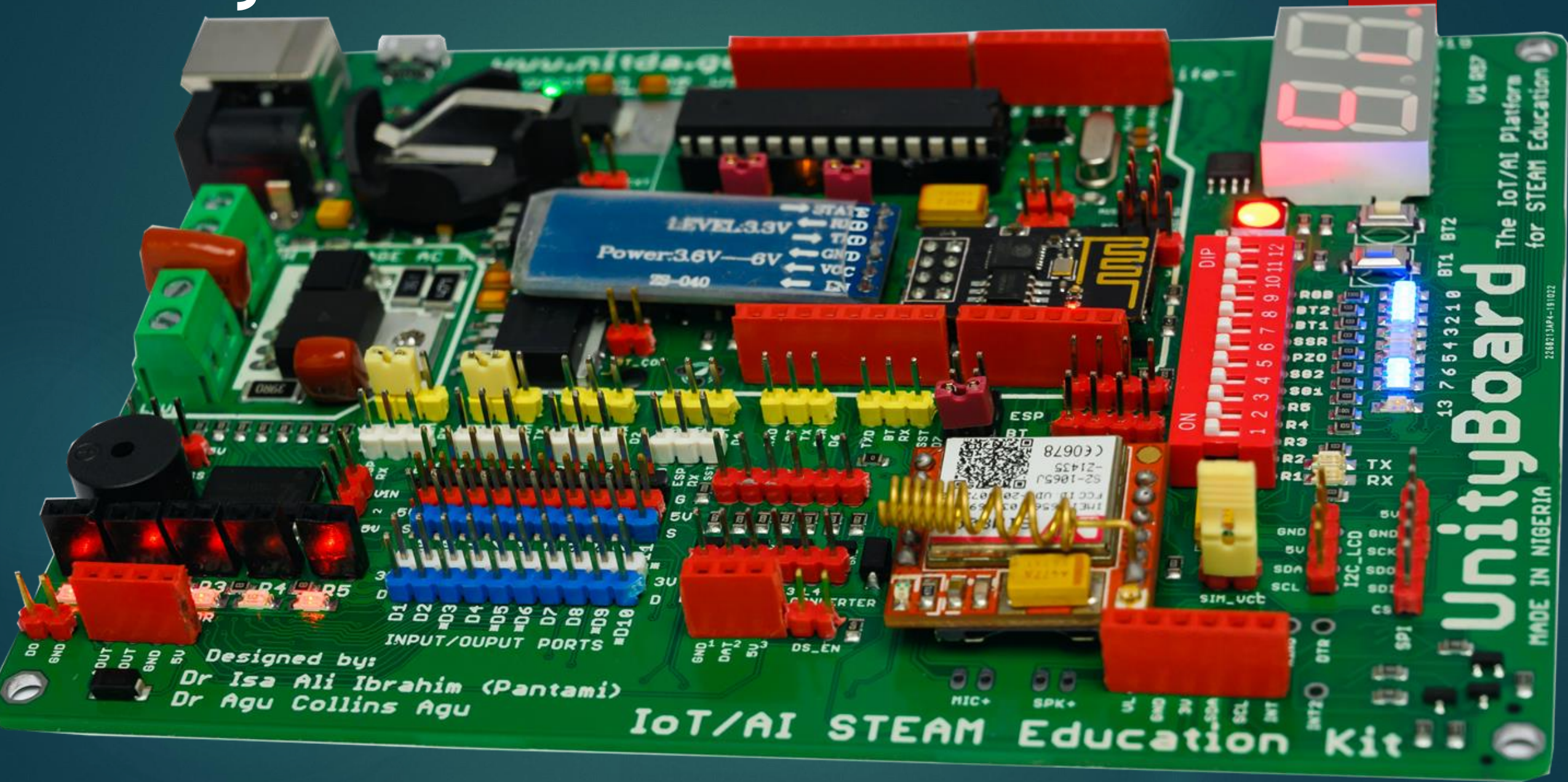


ARDUINO UNO

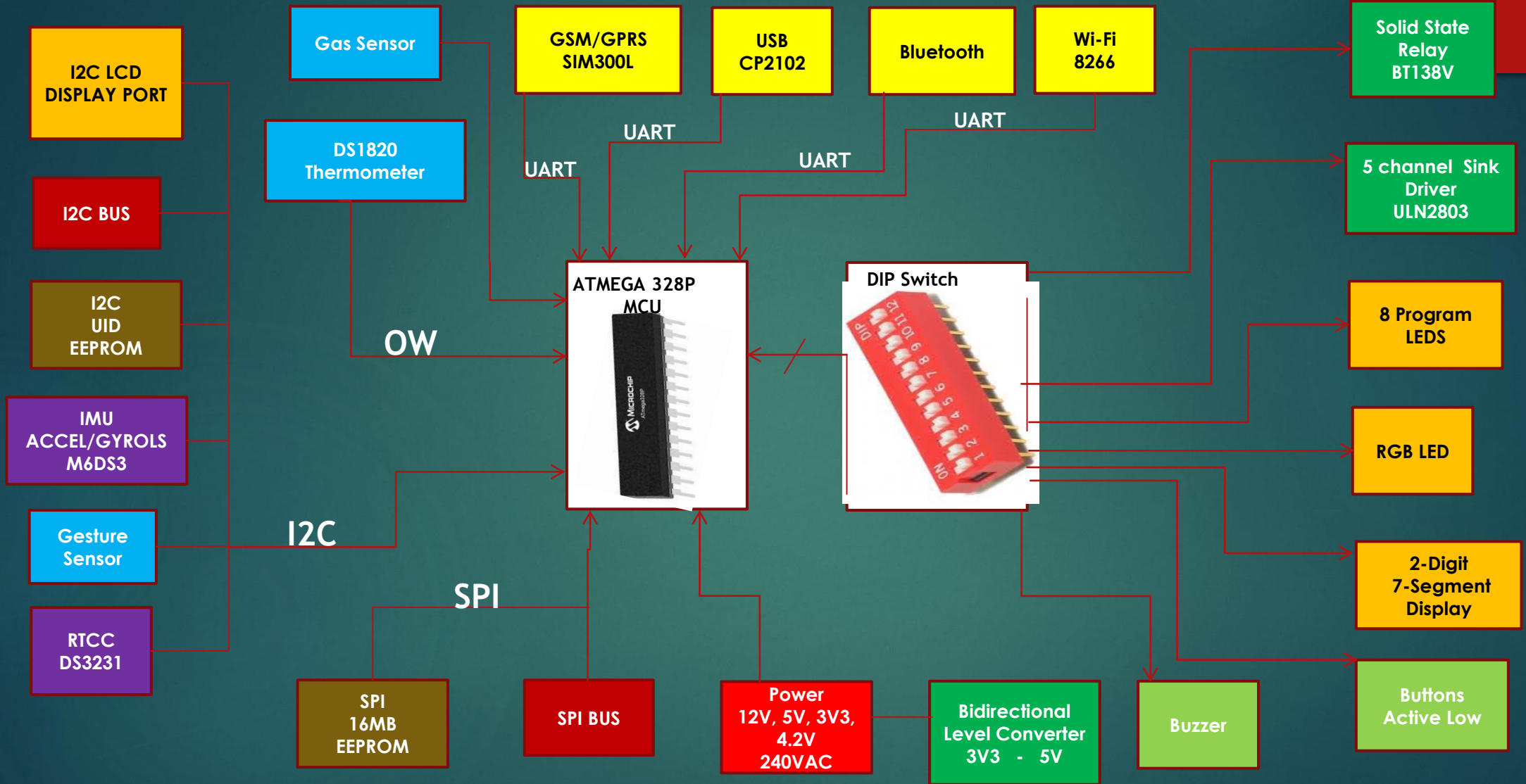


RASPBERRY PI 3

Unity Board® - IoT / AI STEAM Education Kit

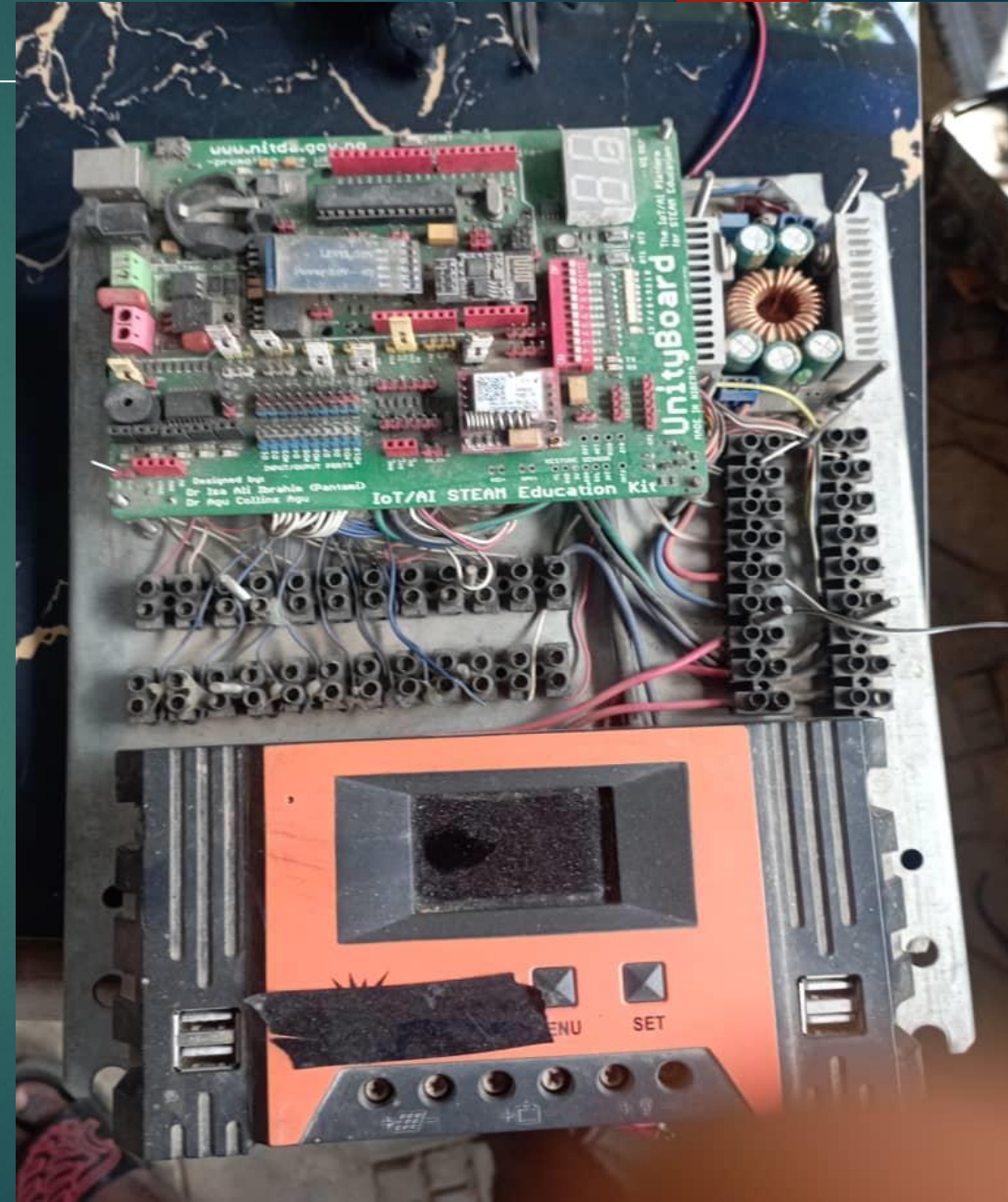


BLOCK DIAGRAM OF UNITY BOARD



Affordable Cloud-Connectable Kit from Nigeria.

- ▶ Unity Board Puts More Features On-Board for Fast and Flexible IoT-Device Development giving
- ▶ unrivalled flexibility for developers while integrating a complete collection of motion, gesture, and environmental sensors, unavailable on other kits in the market.



Teaching **STEAM** - Science, Technology, Engineering, Math by **ART**

Unity Board is a creative medium for advancing teaching and learning, designed specifically as hands-on learning tools to help today's students build skills for the creative and digital economy through critical thinking, collaboration, communication, curiosity, problem solving and invention.

It teaches Physical Computing combining hardware and software by focusing on teaching of computer science and computational thinking creating a perfect way to introduce schools to physical computing that opens up a world of opportunities in the fields of AI, Robotics, Internet of Things (IoT) etc.

Aims to embed problem solving capability through creative thinking and problem-based learning methods, especially at the early age.

Unity Board is a complete solution for education purposes on Internet of Things. It provides all the required elements to setup a local IoT environment for academic or research purposes.

Early Spark Program - CATHY

Unity Board is a complete Internet of Things development kit, that integrates WiFi, GSM/GPRS, Bluetooth, USB connectivities along with a set of powerful sensors to provide environmental and motion sensing. This way, it is possible to create several connected projects easily.

Kids can easily use hardware for learning IoT, that can be programmed over a user-friendly environment such as **Scratch**. Moreover, this solution is more cost-effective than most solutions.

It can be used like an Arduino in terms of programming, debugging, serial port, etc.,

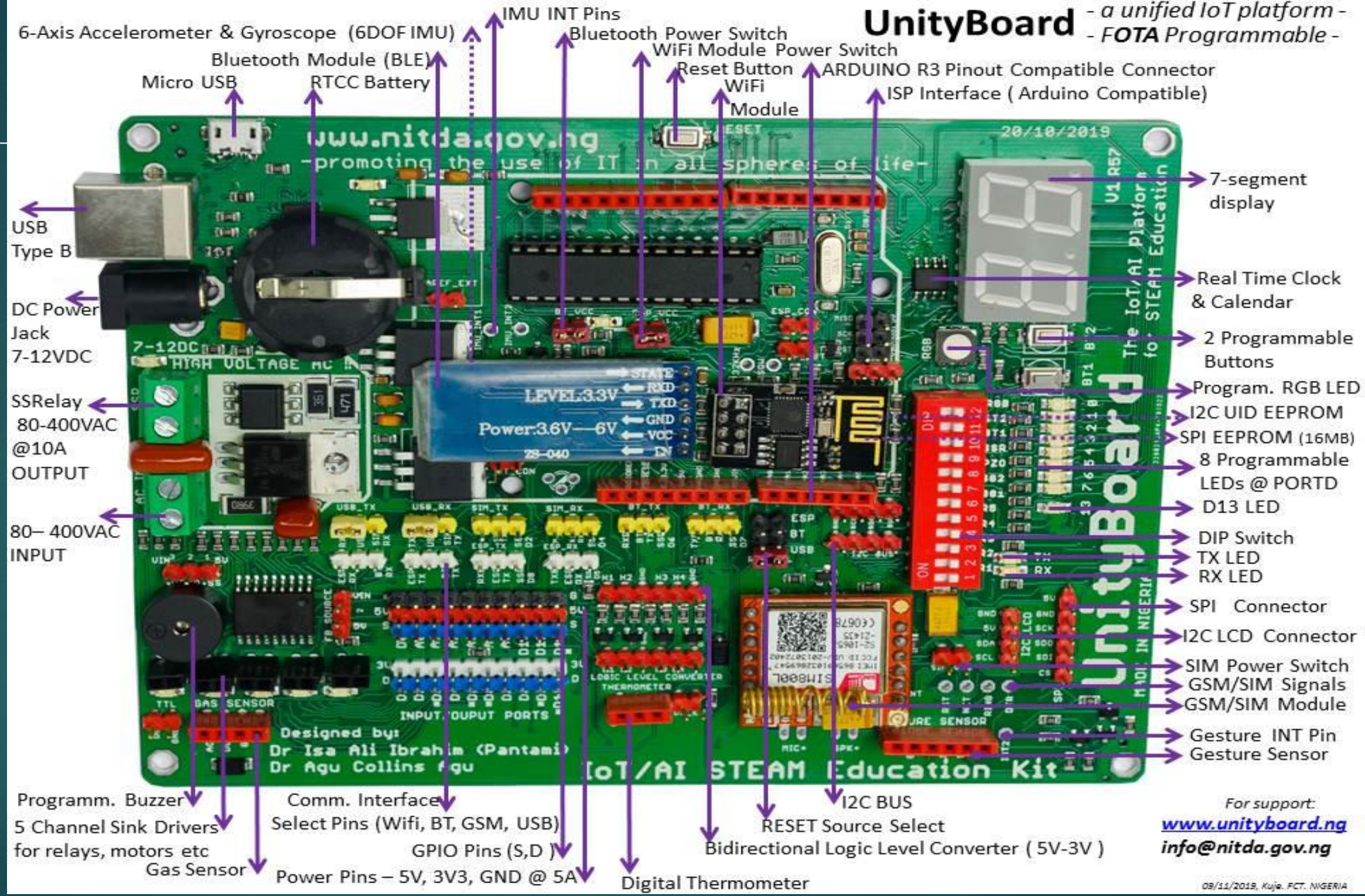
SAGE, MAITAMA PARK, ABUJA. NIGERIA



Some Specifications and Unique Features of Unity Board:

- ▶ Microcontroller: ATmega 328@16MHz; Flash Memory 32 KB; SRAM 2 KB; EEPROM 1KB
- ▶ Storage: 2MBit I2C Serial EEPROM;
- ▶ Storage: 128MBit SPI Serial EEPROM;
- ▶ On-board Modules: Real Time Clock & Calendar (RTCC) with battery backup - DS3231
- ▶ 6-Degree-of-Freedom Inertia Measurement Unit (3-Axis Accelerometer, 3-Axis Gyroscope);
- ▶ Bidirectional 3V3 to 5V level converter;
- ▶ Arduino Compatible pins
- ▶ Communication Interface: USB; GSM/GPRS Module; WiFi (ESP8266); BlueTooth; I2C Bus; SPI; UART
- ▶ Audio-Visual: Piezo buzzer; RGB LED; Programmable 8 LEDs; I2C LCD Display; 2-Digit 7-Segment Display; Microphone; Speaker; Programmable Push Buttons.
- ▶ Input Voltage: 5VDC (via USB), 7-12VDC (via adapter); 110-400VAC
- ▶ Output Voltages: 3.3VDC, 5VDC, 110-400VAC
- ▶ Commutation/Switching: On-board 4KW@380VAC-Solid State Relay with Opto-coupler & Snubber;
- ▶ 5-Port Sink Driver I/O @50Vmax for Servo, Stepper Motors, External Relays; Solenoids etc
- ▶ Gas & Gesture Sensors
- ▶ Digital thermometer

Board Layout



Unity Board will spark the spirit of innovation in learners, and ignite great things.

- ▶ *When students are free to invent and create, they begin to see technology as a means for solving real-world problems and taking their learning to the next level.*
- ▶ By introducing the Internet of Things (IoT) in education via Unity Board and allowing Internet based communications to happen between physical objects, sensors and controllers, will change educational institutions massively.



Field Applications:

It is maker friendly and fully compatible with Arduino and peripheral modules making it programmable via Arduino IDE and compatible with all the example codes and libraries for Arduino. It is also compatible with Graphical Programming Environment such as XOD, ArduBlock, Scratch for Arduino (S4A), Minibloq, Modkit, Visuino, Embrio, GraspIO etc

Further Applications:

Learning embedded programming, developing and testing firmware

Smart Technology

Tracking Systems & Fleet Management

Data Acquisition Systems

Grid/Infrastructure Monitoring, Environment Monitoring, etc)

Unity Board Application Videos

<https://www.youtube.com/watch?v=CNofLYH1Gfc>

<https://www.youtube.com/watch?v=xTc6Nq0ozmQ&list=PLWtmW6LmNv1mVTQfJzfw-aZZVNMw09M0t>

COMPETITIVE MATRIX

	FEATURES	UnityBoard		Libelium WASPMOTE	FlyportPRO	Ublox C027	ARDUINO YUN	Arduino Pi
1	Microcontroller	Atmel ATmega328P @16MHz		ATmega1281	PIC 24FJ256GB206	ARM Cortex M3	ATmega32u4	BROADCOM SoC
2	SPI EEPROM 32MB	YES		TBD	TBD	TBD	NO	NO
3	I2C UID EEPROM	YES		YES	YES	YES	NO	NO
4	Realtime Clock & Calendar (RTCC)	YES		YES	YES	NO	NO	NO
5	6-Axis Accelerometer & Gyroscope 6-DOF Inertia measurement Unit (IMU)	YES		NO	NO	NO	NO	NO
6	Bi-directional 3V3 to 5V Logic Level Converter	YES		NO	NO	NO	NO	NO
7	Arduino Compatible pins (R3 Shield Compatible)	YES		NO	NO	YES	YES	NO
8	integrated GSM/GPRS Module;	YES		NO	NO	YES	NO	NO
9	integrated WiFi (ESP8266);	YES		NO	YES	YES	NO	YES
10	integrated BlueTooth LE	YES		NO	NO	NO	NO	NO
11	I2C Bus;	YES		NO	NO	NO	NO	NO
12	USB Type B Connector	YES		NO	NO	NO	YES	NO
13	Programmable Buzzer;	YES		NO	NO	NO	NO	NO
14	Programmable RGB LED;	YES		NO	NO	NO	NO	NO
15	Programmable 8x LEDs	YES		NO	NO	NO	NO	NO
16	I2C LCD	YES		NO	NO	NO	NO	NO

Adoption Strategy for ECOWAS

- i) Utilization of the education technology platform (Unity Board) as the basis for preparing the ECOWAS Region towards the 4IR through capacity development in emerging technologies
- ii) collaboration with ECOWAS Member states and various Innovation Hub, Ministry of Education, Private Sector , Makers community towards the adoption and deployment of the Unity Board nationwide with pervasive benefits from its use
- iii) Development of curriculum, establishment and promotion of train-the-trainer programs with subsequent relevant certifications across ECOWAS
- iv) Creation of mentorship programs and localization of the manufacturing of the Unity Board in Nigeria in collaboration with ECOWAS to drive technology transfer and entrepreneurship.
- v) Creation of a Technical Working Group with a program/mandate

AWARDS

▶ Endorsement and Award of Honour to NITDA by Federal Ministry of Education. The National Information Technology Development Agency (NITDA) won the Education Technology Development Agency of 2020 award for supporting the development of the Unity Board, an Indigenous Education Technology Platform for STEAM Education at EdTech Summit organised by the Federal Ministry of Education in collaboration with AFRITEX on March, 2020 at the International Conference Centre in Abuja. Nigeria.



Approval of Unity Board for use

- ▶ The Approval (NCCDE 2019(07)/58) for the Adoption of Unity Board as Education Technology Platform for Human Capital Development in Emerging Technologies was given by the National Council on Communications and Digital Economy - 2019.
- ▶ <https://www.commtech.gov.ng/resources/download-centre.html>
- ▶ “THE REPORT OF 7TH REGULAR MEETING OF THE NATIONAL COUNCIL ON COMMUNICATION TECHNOLOGY (NCCT-07) HELD AT THE BANQUET HALL, GOVERNMENT HOUSE, GOMBE STATE FROM 2ND - 6TH DECEMBER, 2019”.
- ▶ See: S/N 56 - Pages 73 -74

Reference Materials and Links

- ▶ **UNITY BOARD INTRODUCTION:** https://drive.google.com/file/d/1InNNnvvY1kuhAU_qPbOJPUnV8iDvii0y/view?usp=sharing
- ▶ **UNITY BOARD USER MANUAL:** <https://drive.google.com/file/d/1aUX3and9CqKQL2SpRR-MTI0Jg4VBn05w/view?usp=sharing>
- ▶ **UNITY BOARD TRADE MARK REGISTRATION:** <https://drive.google.com/file/d/1wts-o7pUdk2ETFMijFyCMY4HXrQxMB2w/view?usp=sharing>
- ▶ **UNITY BOARD COUNCIL APPROVAL:** <https://drive.google.com/file/d/1MR81iITHxV4iO-i4btXWCD24HgA7Envv/view?usp=sharing>

Conclusion:

- ▶ UB4ES Program, a 4IR-focused human capital development is critical to driving the adoption of IoT technology in the ECOWAS region.
- ▶ By promoting digital literacy, skill development, innovation, and entrepreneurship, individuals can become more familiar with IoT technology, contributing to its development and adoption in ECOWAS Region.
- ▶ However, promoting 4IR-focused human capital development requires addressing various challenges and opportunities, including limited access to education and training opportunities, inadequate infrastructure, and limited access to technology.
- ▶ By working together, stakeholders in the ECOWAS region can promote 4IR-focused human capital development and drive the adoption of IoT technology, contributing to sustainable economic and social development.

DEMO, Q & A

Daalu

www.linkedin.com/in/AguCollinsAgu/

www.facebook.com/AguCollinsAgu

www.youtube.com/@AguCollinsAgu