Training Course on IoT Device Development and Connectivity

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Introduction

This intensive training course provides a comprehensive exploration of IoT device development and connectivity, equipping participants with the essential skills to design, build, and deploy intelligent, connected solutions. From sensor integration and embedded programming to network protocols and cloud platform integration, this program covers the entire IoT technology stack. Attendees will gain hands-on experience with popular IoT hardware platforms like ESP32 and Raspberry Pi, mastering crucial concepts such as data acquisition, real-time communication, power optimization, and device security. Training Course on IoT Device Development and Connectivity is meticulously designed to empower engineers and developers to create robust, scalable, and innovative IoT products that meet the growing demands of smart homes, industrial automation, healthcare, and smart cities.

The curriculum emphasizes practical application and industry best practices, focusing on Edge Computing, LoRaWAN, MQTT, secure boot, and over-the-air (OTA) updates. Participants will delve into advanced topics like predictive maintenance, machine learning at the edge, and digital twin technology, understanding how to leverage these concepts for actionable insights and enhanced system performance. By the end of this program, participants will possess the expertise to architect and implement end-to-end IoT solutions, ensuring seamless connectivity, data integrity, and robust security. This course is indispensable for professionals aiming to excel in the rapidly expanding IoT landscape, enabling them to drive innovation and unlock new opportunities in the connected world.

Programme Curriculum

Training Course on IoT Device Development and Connectivity

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Course Objectives

1. Design and develop IoT devices leveraging various microcontrollers and single-board computers.
2. Integrate diverse sensors and actuators for effective data acquisition and control.
3. Master key IoT communication protocols including MQTT, CoAP, and LoRaWAN.
4. Implement secure boot and secure firmware update mechanisms for IoT devices.
5. Develop power-efficient IoT solutions to maximize battery life and sustainability.
6. Connect IoT devices to leading cloud platforms like AWS IoT, Azure IoT Hub, and Google Cloud IoT.
7. Apply edge computing principles to optimize data processing and reduce latency.
8. Utilize containerization (Docker) for streamlined IoT application deployment.
9. Implement machine learning models at the edge (TinyML) for intelligent device behavior.
10. Develop robust data management strategies for IoT sensor data.
11. Troubleshoot and debug complex IoT connectivity issues effectively.
12. Explore and implement digital twin concepts for real-time monitoring and simulation.
13. Understand and address IoT cybersecurity threats and best practices.

Organizational Benefits

1. Accelerated development of new IoT products and solutions.
2. Improved security and reliability of deployed IoT devices and systems.
3. Reduced operational costs through optimized power consumption and efficient data handling.
4. Enhanced capabilities in leveraging cloud platforms for scalable IoT deployments.
5. Faster time-to-market for innovative IoT services and applications.

6. Increased internal expertise in cutting-edge IoT technologies like Edge AI and LoRaWAN.
7. Better data-driven decision-making by effectively collecting and analyzing IoT data.
8. Mitigation of cybersecurity risks through advanced security implementation.
9. Greater competitive advantage in the rapidly expanding IoT market.
10. Development of more sustainable and energy-efficient connected devices.

Target Participants

- Embedded systems engineers
- Software developers
- Hardware engineers
- Network engineers
- System architects

Course Outline

Module 1: Introduction to IoT Device Ecosystem

- **Defining IoT:** Concepts, architecture, and applications across various industries.
- **IoT Device Categories:** Sensors, actuators, microcontrollers, gateways.
- **Key IoT Components:** Hardware platforms (ESP32, Raspberry Pi), operating systems, communication modules.
- **IoT Design Principles:** Scalability, reliability, security, power efficiency.
- **Case Study:** Analyzing the architecture of a smart home system and identifying key device types.

Module 2: Embedded Programming for IoT Devices

- **Microcontroller Basics:** GPIO, ADC, DAC, Timers, Interrupts.
- **Programming with Arduino IDE (ESP32/ESP8266):** Basic setup, sensor readings.
- **Python for Raspberry Pi:** Interfacing with GPIO, libraries for sensors.
- **Firmware Development Best Practices:** Code structure, modularity, debugging.
- **Case Study:** Programming an ESP32 to read temperature and humidity data from a sensor.

Module 3: Sensor and Actuator Integration

- **Types of Sensors:** Temperature, humidity, motion, light, pressure, environmental.
- **Sensor Interfacing Protocols:** I2C, SPI, UART, Analog.
- **Actuator Control:** Relays, motors, LEDs, servo motors.
- **Data Preprocessing and Calibration:** Filtering noise, converting raw sensor data.
- **Case Study:** Building a weather station prototype with multiple sensors (temperature, pressure, humidity).

Module 4: IoT Communication Protocols - Short Range

- **Wi-Fi for IoT:** ESP-NOW, MQTT over Wi-Fi, advantages and limitations.
- **Bluetooth Low Energy (BLE):** GATT profiles, beacons, mesh networking.
- **Zigbee and Z-Wave:** Home automation protocols, mesh network concepts.
- **NFC and RFID:** Proximity communication, identification.
- **Case Study:** Developing a BLE-enabled smart lock prototype with secure communication.

Module 5: IoT Communication Protocols - Long Range

- **LoRa and LoRaWAN:** Architecture, classes, gateways, network servers.
- **NB-IoT and LTE-M:** Cellular IoT technologies, low power consumption.
- **Sigfox:** Ultra-narrowband technology for low-data-rate applications.
- **Satellite IoT:** Global coverage for remote deployments.
- **Case Study:** Deploying a LoRaWAN sensor node to transmit environmental data over long distances.

Module 6: MQTT and Message Queuing

- **MQTT Protocol Deep Dive:** Publish/Subscribe model, topics, QoS levels.
- **MQTT Brokers:** Mosquitto, HiveMQ, EMQX.
- **MQTT Client Libraries:** Paho MQTT (Python, C++), Node-RED.
- **Message Payload Design:** JSON, Protobuf, efficient data serialization.
- **Case Study:** Building a real-time chat application using MQTT for device-to-device communication.

Module 7: Cloud Platform Integration (AWS IoT)

- **AWS IoT Core:** Device gateway, message broker, device shadow.
- **AWS Lambda for IoT:** Serverless computing for backend logic.
- **DynamoDB and S3 for IoT Data Storage:** Scalable data persistence.
- **AWS IoT Analytics and Greengrass:** Data processing and edge capabilities.
- **Case Study:** Connecting an IoT device to AWS IoT Core and storing sensor data in DynamoDB.

Module 8: Cloud Platform Integration (Azure IoT Hub & Google Cloud IoT)

- **Azure IoT Hub:** Device connectivity, device twins, C2D/D2C messaging.
- **Azure Stream Analytics and Azure Functions:** Data processing and serverless logic.
- **Google Cloud IoT Core:** Device registration, data ingestion, Pub/Sub.
- **Google Cloud Functions and BigQuery:** Data processing and analytics.
- **Case Study:** Ingesting sensor data into Azure IoT Hub and visualizing it on a dashboard.

Module 9: IoT Device Security

- **Threat Modeling for IoT Devices:** Identifying vulnerabilities and attack vectors.
- **Secure Boot and Trusted Execution Environments (TEE):** Protecting device integrity.
- **Secure Firmware Updates (OTA):** Cryptographic signatures, rollback prevention.
- **Data Encryption and Authentication:** TLS/SSL for communication, device identity.
- **Case Study:** Implementing signed firmware updates for an ESP32 device to prevent tampering.

Module 10: Power Management and Optimization

- **Understanding Power Consumption:** Deep sleep, light sleep, active modes.
- **Power Gating and Dynamic Voltage Scaling (DVS):** Hardware-level power control.
- **Energy Harvesting Techniques:** Solar, kinetic, thermal.
- **Battery Technologies and Management:** Li-Ion, LiFePO4, charging circuits.
- **Case Study:** Designing a low-power IoT sensor node with a multi-year battery life.

Module 11: Edge Computing for IoT

- **Edge vs. Cloud Computing:** Advantages, use cases, latency reduction.
- **Edge Gateways:** Data aggregation, protocol conversion, local processing.
- **Containerization (Docker) at the Edge:** Deploying applications efficiently.
- **Data Filtering and Aggregation at the Edge:** Reducing cloud traffic.
- **Case Study:** Implementing an edge gateway that filters and aggregates sensor data before sending to the cloud.

Module 12: Machine Learning at the Edge (TinyML)

- **Introduction to TinyML:** Running ML models on resource-constrained devices.
- **Model Optimization:** Quantization, pruning, model conversion (TensorFlow Lite Micro).
- **Data Collection for Edge ML:** On-device data labeling and preprocessing.
- **Deploying ML Models:** Integrating inference engines with embedded code.
- **Case Study:** Developing a simple gesture recognition system on an embedded device using TinyML.

Module 13: IoT Data Management and Analytics

- **Time-Series Databases for IoT:** InfluxDB, TimescaleDB, storing sensor data efficiently.
- **Data Visualization Tools:** Grafana, Power BI, custom dashboards.
- **Stream Processing for Real-time Analytics:** Apache Kafka, Flink.
- **Data Quality and Validation:** Handling missing data, outliers.
- **Case Study:** Building a real-time dashboard to visualize and analyze sensor data from multiple IoT devices.

Module 14: Digital Twin and Predictive Maintenance

- **Digital Twin Concepts:** Virtual representation of physical assets, synchronization.
- **Building a Digital Twin:** Data models, simulation, integration with IoT data.
- **Predictive Maintenance Strategies:** Anomaly detection, remaining useful life estimation.
- **Fleet Management and Remote Monitoring:** Managing large deployments of IoT devices.
- **Case Study:** Creating a simplified digital twin for an industrial pump to monitor its health and predict failures.

Module 15: IoT Project Lifecycle and Best Practices

- **IoT Solution Architecture Design:** From c

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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