

Course ID
BLE3D

Course Duration
3 days

Course Title

BLE: Bluetooth Low Energy Training

Aimed At

This Bluetooth Low Energy training is for technical professionals who require an in-depth understanding of the BLE technology.

Prerequisites

Prior familiarity with wireless networks.

**Course
in a Nutshell**

Bluetooth Low Energy (Bluetooth LE, BLE, or BTLE), aka Bluetooth Smart, is a low-power short-range wireless technology used in Wireless Personal Area Network (WPAN), Machine-to-Machine (M2M) Communications, and Internet of Things (IoT) applications. This BLE training will help you acquire an in-depth understanding of all aspects of Bluetooth Low Energy, including the technology, security, and coexistence issues.

Customize It!

We can customize your Bluetooth Smart training session to your team's background and learning objectives by making it more or less technical, shortening or lengthening the course, adding or omitting topics, and tailoring it to your industry/application.

**Course
Outline**

Part 1: BLE Training Introduction

- **Short-range wireless characteristics**
 - Wired vs wireless
 - Local area and personal area networks
 - LAN and PAN examples
 - Categories of information transmission
 - BLE training overview
- **Characteristics of Bluetooth**
 - Bluetooth usage models
 - The Bluetooth piconet
 - Point-to-point, point-to-multipoint, and scatternets
 - The Bluetooth Special Interest Group (BSIG)
 - Bluetooth BR/EDR, LE, and AMP summary of operations
- **BLE architecture**
 - Controller
 - Host
 - Application layer
 - BLE usage models

- **Other low-energy wireless technologies**
 - ZigBee
 - Z-Wave
 - ANT
 - X10
 - Wi-Fi

Part 2: The BLE Radio

- **RF propagation: How far will it go?**
 - Simplified path loss model
 - Finding maximum range using simple rules
 - RF penetration through typical obstructions
- **BLE modulation and data rates**
 - Basic modulation methods
 - Gaussian filtered frequency shift keying
 - Bandwidth comparisons
- **BLE channel set and radio performance**
 - Advertising channels
 - Data channels
 - Transmit power and data rate
 - Receive sensitivity requirements
 - Receive interference performance

Part 3: BLE Link Layer

- **Device states**
 - Standby, scanner, advertiser, initiator, connection
- **Packet types and processing**
 - Device addresses
 - Packet formats
 - Protocol data unit (PDU) structure
 - PDU processing
- **Advertising**
 - PDU types
 - Advertising events
 - Responses to advertising
- **Scanning**
 - PDU types
 - Scanning events
- **Initiating**
 - PDU type
 - Link layer data fields
- **Connecting**

- Connection timing
- **Data channel selection**
 - Mapping and remapping
 - Hopping example
- **Acknowledgment and flow control**
 - Data channel PDU
 - Packet acknowledgment and retransmissions
- **Control processes**
 - Control PDU types
 - Control operations

Part 4: BLE Higher Protocols

- **Logical Link Control and Adaptation Protocol (L2CAP)**
 - Role of L2CAP in data services
 - L2CAP functions and assumptions
 - L2CAP frame types and connection
 - L2CAP events and actions
- **Host interfacing and examples**
 - Role of the host controller interface (HCI)
 - HCI commands and events
 - HCI as a high-level language
- **Attribute protocol (ATT)**
 - Attribute definition
 - ATT operation on attributes
 - ATT retrieval example

Part 5: BLE Profiles, Implementation, and Qualification

- **Profile overview**
 - Profiles and their purpose
 - Generic Bluetooth profile stack
- **Generic Access Profile (GAP)**
 - Purpose and term definitions
 - BLE GAP functions
 - Device roles
- **Generic Attribute Profile (GATT)**
 - Purpose and term definitions
 - GATT server
 - GATT client
- **Example: Find Me profile (FMP)**
 - Concept and device roles
 - FMP example: lost key fob
- **Example: Heart Rate profile (HRP)**

- Concept and device roles
- Heart rate sensor
- Collector
- Connection establishment
- **Implementation**
 - LE devices and integration
 - Low power methods and battery conservation
 - Sample BLE performance
 - BLE integration choices
- **Qualification**
 - FCC Part 95 overview
 - BSIG qualification overview
 - Qualification steps

Part 6: Bluetooth Low Energy Security

- **Security concepts**
 - Authentication
 - Authorization
 - Data integrity
 - Data confidentiality
 - Privacy
- **Cryptographic methods**
 - Shared key
 - Public key
- **BLE keys**
 - Temporary key
 - Short-term key
 - Long-term key
 - Identity resolving key
 - Connection signature resolving key
- **Pairing and bonding**
 - Pairing information exchange
 - Authentication and signing
 - Key distribution
 - Bonding

Part 7: Coexisting with Other Networks

- **Overview of coexistence challenges**
 - Interoperability and coexistence
 - Methods of evaluating coexistence problems
 - Good neighbor policy

- **Coexisting with legacy Bluetooth**
 - Piconet interference characteristics
- **Coexisting with Wi-Fi**
 - Wi-Fi effect on BLE
 - BLE effect on Wi-Fi
- **Techniques for improving coexistence**
 - The “Two Meter Rule”
 - Collocating devices in the same host

Part 8: Comparisons and Conclusions

- **BLE Comparison with Other M2M/IoT Technologies**
 - Legacy Bluetooth
 - ZigBee
 - Z-Wave
 - ANT
 - X10
 - Wi-Fi
 - Other technologies of interest to the client
- **Conclusions**
- **Wrap-up: Course Recap, Discussion, and Evaluation**

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