Course ID
PHY-WIBLUE
Course Duration
2-4 days

Course Title
Wi-Fi, Bluetooth & BLE Physical Layers Training

Aimed At

Wi-Fi, Bluetooth & BLE Physical Layers Training is aimed at technicians and engineers involved with designing, troubleshooting, or testing smart connected devices that interface with the Internet of Things (IoT) including home and building automation devices.

Prerequisites

For those taking Wi-Fi, Bluetooth & BLE Physical Layers Training, a technical background, especially in Telecommunications or Information Technology (IT), will be helpful.

Related Courses

- *WiFi Training in Depth: Technology, Security, Deployment … with M2M, IoT, 5G* (WIFI-DIVE, 2-5 days)
- *Advanced Wi-Fi Training: Technology, Security, Deployment; Coexistence with LTE and 5G* (WIFI-ADV, 2-3 days)
- *WiFi Hands-on* (WIFI-LAB, 2 days)
- *BLE: Bluetooth Low Energy Training* (BLE3D, 3 days)
- *Bluetooth Course: Operation, Security, Applications, Coexistence (*BLUEOP, 4 days)
- *ZigBee Hands-on* (ZIGBLAB, 2 days)
- *IoT-enabling Technologies Training: IEEE 802.15.4, WLLN, ZigBee, WAVE, Next Gen WiFi* (EIOT5D, 5 days)

Course in a Nutshell

In *Wi-Fi, Bluetooth & BLE Physical Layers Training*, you will learn about the technology and RF characteristics of Wi-Fi (IEEE 802.11 b/g/n and other specifications), Bluetooth, and Bluetooth Low Energy (Bluetooth LE or BLE) that are relevant to your jobs as design or test engineers. The course includes hands-on exercises that utilize laptops equipped with an internal Wi-Fi card.

Customize It!

We can tailor *Wi-Fi, Bluetooth & BLE Physical Layers Training* to include the technologies pertinent to your product line or to adapt the course to the needs of less technical audiences such as marketing and sales professionals.

Learning Objectives

- List the pros and cons of operating in the 2.4 and 5.0 GHz bands
- Explain the IEEE 802.11 (b, g, n, and other desired protocols), Bluetooth, and Bluetooth Low Energy (Bluetooth LE or BLE) physical (radio) layer specifications
- Discuss how Wi-Fi and Bluetooth devices can coexist in the same frequency band
- Compare and contrast the physical layer characteristics of Wi-Fi and Bluetooth devices
- Distinguish between the different types of interference and how they affect connectivity
- Identify the physical layer properties that impact coverage and performance

Course Outline

- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 1: Introduction**
  - Course objectives and overview
  - A close look at the 2.4 GHz and 5 GHz bands
    - FCC regulations (transmit power level, EIRP)
    - Devices that use this band
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 2: IEEE 802.11 Physical Layers**
  - IEEE 802.11 working group and specification
  - IEEE 802.11 physical layers
  - High level architecture and protocol stack
  - How devices connect to a Wi-Fi network
  - Carrier Sensing Multiple Access – Collision Avoidance (CSMA-CA)
  - Channel numbers and channel bandwidth: 2.4 and 5 GHz bands; primary and secondary channels
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 3: IEEE 802.11b Physical Layer**
  - Direct Sequence Spread Spectrum (DSSS)
  - Channel bandwidths
  - IEEE 802.11b data rates
  - How to disable IEEE 802.11b
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 4: IEEE 802.11g Physical Layer**
  - Orthogonal Frequency Division Multiple Access (OFDM)
    - Advantages
    - Subcarrier allocation
  - Major components of an 802.11g transmitter

        - Binary Convolutional Coders
        - Modulation and Coding Schemes (MCS)
        - Cyclic prefix / Guard Interval (GI)
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 5: IEEE 802.11n Physical Layer**
    - Extending the functionality of IEEE 802.11g OFDM
        - Wider channels
        - IEEE 802.11n subcarrier allocation
        - Low Density Parity Check Coders (LDPC)
        - Modulation and Coding Schemes (MCS)
        - Shorter Cyclic prefix / Guard Interval (GI)
    - MIMO
        - Spatial Multiplexing (SM)
        - Space Time Block coding (STBC)
    - Physical header packet header
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 6: Bluetooth Physical Layer**
    - Bluetooth SIG
    - Bluetooth specifications
    - High level architecture and protocol stack
    - Frequency Hopping Spread Spectrum (FHSS)
    - Channel numbers and channel bandwidth
    - How devices connect to a Bluetooth network
        - Legacy Bluetooth BR/EDR
        - Bluetooth Low Energy (BTLE)
    - Major components of a Bluetooth radio
        - Modulation
        - Forward Error Correction (FEC)
        - Automatic Repeat Request (ARQ)
    - Physical links
        - Asynchronous Connectionless (ACL)
        - Synchronous Connection-Orientated (SCO)
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 7: Bluetooth Low Energy**
    - Power optimization techniques
    - Architecture and protocol stack overview
    - Adaptive frequency hopping
    - Channel numbers and channel bandwidth
    - Modulation
    - Power modes consumption
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 8: Radio Propagation and Range**

- Link budgets
  - Maximum available path loss
  - Fade margin
- Decibels
- Multipath
  - Reflections, refraction, absorption
  - Delay spread
  - Impact on RSSI
- Radio performance mechanisms
  - Diversity
  - Equalization
  - Error correction
- Receiver sensitivity
- Antennas
  - Radiation patterns
- Wi-Fi channel planning

- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 9: Coexistence in the Unlicensed Frequency Bands**
  - Other devices in the 2.4 and 5.0 GHz bands
  - Characteristics of Bluetooth interference
  - Characteristics of Wi-Fi interference
  - How Bluetooth and Wi-Fi coexist
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 10: Higher Wi-Fi Protocols (of your choice) in Brief**
  - IEEE 802.11ac Very High Throughput
    - Beamforming
    - MU-MIMO
  - IEEE 802.11ax High Efficiency WLAN
    - OFDMA
  - Other IEEE 802.11 Protocols
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 11: Internet of Things (IoT)**
  - Machine-to-Machine (M2M) Communications
  - Internet of Things (IoT)
  - IoT applications
  - IoT-enabling technologies
- **Wi-Fi, Bluetooth & BLE Physical Layers Training Part 12: Lab Exercises to Understand the RF Environment in Which Your Products Operate**
  - Hands-on lab using inSSIDer (freeware), a Wi-Fi network visualization tool: The objective of this lab is to use a Wi-Fi analysis tool to visualize Wi-Fi in use in the immediate vicinity

and understand how Wi-Fi CCI (Co Channel Interference) and Wi-Fi ACI (Adjacent Channel Interference) can impact the operation of your devices
    - Demo of Chanelyzer, an interference analysis tool
    - Demo of advanced Wi-Fi tools such as Ekahau (which offers interference analytic, predictive, and measurement capabilities) and Eye PA (a frame capture software).
- **Wi-Fi, Bluetooth & BLE Physical Layers Training: Course Recap and Q/A**

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