v 4.100

Bluetooth
Operation, Procedures and Testing
-
Reloaded

Course Duration:

- 2 days.

Course Description:

- This unique course first explains the origins of Bluetooth and the business perspective of Bluetooth. The student obtains a detailed knowledge about the various sources and administratives for a successful Bluetooth implementation.

- The next part of the course is dedicated to the core specification of Bluetooth and a detailed consideration of the various parts of the Bluetooth protocol stack, including functions like pairing, security or power control and energy saving modes (e.g. BLE).

- Special focus is given to a detailed understanding of the lower layers of the Bluetooth protocol stack (Baseband, Link Controller, Link Manager) and an understanding of the signal processing chain within the Baseband.

- An important focus of this course lies on the updates with Bluetooth specification version 2.0, 3.0 and 4.0 namely the realization of the EDR-feature and of low energy operation

- The course has been extended by a consideration Bluetooth interoperability issues, especially with WiFi and LTE, and we will pinpoint some workarounds in case for interference situations.

- Of course, we put in the specifics and functions of various Bluetooth profiles, like for example GAP, SPP or A2DP, to name a few.

As in all INACON courses we integrated interactive exercises for a perfect learning experience.

Prerequisites:

- Thorough knowledge about communications technology and basic knowledge about communications protocols is required. .

Course Target:

- The student is enabled to implement and test the Bluetooth technology.

- The student will understand the implications and issues when integrating the Bluetooth Hard-and Software into other devices.

Some of your Questions that will be answered:

- How does Bluetooth operate?
- How does EDR 2.0 Mbit/s and 3 Mbit/s work?
- What is new with Bluetooth version 3.0 and 4.0?
- What is the benefit of low energy operation (BLE)?
- What are the functions of the various layers of the Bluetooth Protocol Stack and which layers do I need to implement my feature set?
- How can I test my Bluetooth implementation and what will be tested?
- What is the function of the various Bluetooth Profiles and which ones do I need to implement for which application?

Who should attend this Course:

- Design Engineers who need to implement or test the Bluetooth technology.
- Engineers who shall develop and test Bluetooth applications.

Table of Content:

Bluetooth and its Environment

Technology at a Glance

Advertising Events, Connection Events

- **At the very Bottomline of Bluetooth: The Access Code**
  - ⇒ Introduction
  - ⇒ Distinction of concurrent Piconets
  - ⇒ Types of Access Codes
    GIAC (General Inquiry Access Code), DIAC (Dedicated Inquiry Access Code), DAC (Device Access Code), CAC (Channel Access Code)
  - ⇒ Generating the Access Code
- **Bluetooth Addressing**
  - ⇒ Overview
  - ⇒ BD_ADDR
    Introduction, Tasks and Functions of the BD_ADDR, Authentication and Encryption, Hopping Sequence Calculation, Access Code Calculation, Initialization of Checksum Calculators
  - ⇒ Example of BD_ADDR and Local Name
- **The Bluetooth Clock**
  Important Clock Outputs, Master – Slave Relationship
- **Power Classes**
  BR / EDR, Power Class 1, Power Class 2, Power Class 3, BLE
- **Protocol Stack (Overview)**
  Overview, Bluetooth Controller, Bluetooth Host

Lower Layers – the Bluetooth Controller

- **The Physical Layer**
  - ⇒ Modulation Schemes
    GFSK, π/4-DQPSK, 8-DPSK
  - ⇒ Forward Error Correction
    1/3 Rate Encoding, 2/3 Rate Encoding
  - ⇒ Data Whitening
  - ⇒ Physical Channels in Bluetooth BR/EDR
    Overview, Inquiry Scan Physical Channel and Inquiry Procedure, Page Scan Physical Channel and Page Procedure, Detailed Packet Flow of the Page Procedure, Basic and Adapted Piconet Physical Channels, Relationship between Slot No and Transmit Direction
- **Baseband Packet Types and Formats (BR/EDR)**
  - ⇒ General Format Rules (BR = GFSK)
  - ⇒ General Format Rules (EDR)
  - ⇒ Format of Baseband Control Packets
    ID-Packet, NULL-Packet, POLL-Packet, FHS-Packet

⇒ Baseband Data Packets
Naming Conventions, Baseband Packet Type Table, Relationship between Packet Type and Logical Link, Packet Types on SCO and eSCO, Packet Types on ACL, Example of a Baseband Data Packet Format: DM1

- **Link Manager Operation**

⇒ Introduction and Overview

⇒ Important Link Manager Procedures

⇒ Authentication and Encryption
Overview

- **Detailed Consideration of BLE Operation**

⇒ State Machine
GAP-defined Roles: Observer, Broadcaster, Peripheral and Central

- **Baseband Packet Type and Format (BLE)**

⇒ General Format

⇒ Format of Advertising Channel PDU's

⇒ Format of Data Channel PDU's

Upper Layers – the Bluetooth Host

- **Protocols on the Host**

⇒ The Stack
Overview of Protocols, Port Numbers and PSM's

- **Host Controller Interface (HCI)**

⇒ Overview and Transport Plane

⇒ Communication through the HCI
Packet Types, Format and Content of Command Packets, Format and Content of Event Packets, Format and Content of Data Packets (SCO/eSCO/ACL)

⇒ Typical Scenario: Connection Establishment and Release
Initial Messaging / Paging, Authentication, Connection Active, Disconnection

- **Logical Link Control & Adaptation Protocol (L2CAP)**

⇒ Tasks and Functions
Interfaces the controller to the application, Provides logical channels, Segmentation and Reassembly, Error Control and Retransmission, QoS

⇒ Operation Modes
Connection-Less Operation, Basic L2CAP Mode, Flow Control Mode, Retransmission / enhanced Retransmission Mode, Streaming Mode

⇒ Channels and CID's

⇒ Protocol Service Multiplexers (PSM)

⇒ PDU-Formats in L2CAP
Basic L2CAP-Format (B-Frame), Connection-less L2CAP-Format (G-Frame), Retransmission and Streaming Mode Formats

- **SDP and ATT**

⇒ Commonalities

⇒ Client Server Model in SDP and ATT

⇒ Introducing UUID's
Example 1: Service Class Names for SDP, Example 2: GATT-based Services, Example 3: GATT-based Service Characteristics

⇒ Example of a Service (Headset Service)

⇒ PDU-Format in SDP

⇒ Operation of SDP
Step 1: Operation on L2CAP Channel ID 0001, Step 2: Service Interrogation between Client and Server, Description, Step 3: Headset Service Setup based on SDP-Information, Description

⇒ PDU- and Attribute-Format in ATT
Attribute-Structure

⇒ Service Description in ATT
Generic Table View, Service Description Example

- **Bluetooth Profiles**

⇒ General Information

⇒ Profile Stack for BR/EDR

⇒ Profile Stack for BLE