Bluetooth® Low Energy stack v3.x programming guidelines

Introduction

The main purpose of this document is to provide developers with reference programming guidelines on how to develop a Bluetooth® Low Energy (Bluetooth® LE) application using the Bluetooth® Low Energy stack v3.x family APIs and related event callbacks.

The document describes the Bluetooth® Low Energy stack v3.x stack library framework, API interfaces, and event callbacks allowing access to the Bluetooth® Low Energy functions provided by the STMicroelectronics Bluetooth® Low Energy devices system-on-chip.

The following Bluetooth® Low Energy device supports the Bluetooth® Low Energy (Bluetooth® LE) stack v3.x family:

- BlueNRG-LP device
- BlueNRG-LPS device (Bluetooth® Low Energy stack v3.1 or later)

The document also focuses on the key changes about APIs and the callback interface, Bluetooth® Low Energy stack initialization versus the Bluetooth® Low Energy stack v2.x family.

This programming manual also provides some fundamental concepts about the Bluetooth® LE technology in order to associate the Bluetooth® Low Energy stack v3.x APIs, parameters, and related event callbacks to the Bluetooth® Low Energy protocol stack features. The user is expected to have a basic knowledge of Bluetooth® Low Energy technology and its main features.

For more information about the supported devices and the Bluetooth® Low Energy specifications, refer to Section 6 References at the end of this document.

The manual is structured as follows:

- Fundamentals of the Bluetooth® Low Energy (Bluetooth® LE) technology
- Bluetooth® Low Energy stack v3.x library APIs and the event callback overview.
- How to design an application using the Bluetooth® Low Energy stack v3.x library APIs and event callbacks.

Note: *The document content is valid for all the specified Bluetooth® Low Energy devices. Any specific difference is highlighted whenever required.*

Understanding Bluetooth Low Energy Stmicroelectronics

Himanshu Bhalla,Oren Haggai

Understanding Bluetooth Low Energy Stmicroelectronics:

Sustainable, Innovative and Intelligent Societies and Cities Carlos Filipe da Silva Portela,2023-06-09 This book combines two main topics applied to cities and societies innovation and sustainability The book begins by showing a brief overview of the book s main topics then the book addresses four main areas which allow our communities to be more attractive engaging and fun analytical descriptive and predictive healthy secure and sustainable and innovative connected and monitored This book represents a union of inputs from researchers and practitioners where each chapter has distinct valuable and practical contributions that turn it unique The content ranges from theoretical like studies or analyses to practical like industrial solutions or engaging systems Both branches focus on turning our society more attractive intelligent inclusive sustainable and ready for the future **Industry 4.0, China 2025, IoT** Wolfgang Babel,2022-11-02 The book gives an overview about automation technology over the last 50 years based on my own experiences It is a good summery for automation since 1970 for all who want to know about the context of automation developments and their standards It is a fundamental summery and enables the reader to get experience in the complex field of automation In detail the question is arised whether Industry 4 0 China 2025 IoT AI are a revolution or more an evolution of timewise established availbale technologies in HW SW and algorithms Is the hype about Industry 4 0 justified or not In that context a timelline since 1970 ist shown for AI ANN essential milestones in automation e g OSI model automation pyramid standards for bus systems main SW languages robots AI ANN pattern recognittion Ethernet the 12 most important international field busses their main features and characterisitcs foundation of committees harmonization and standardization efforts OPC UA and cloud computing field devices PLCs SCADA MES ERP and automation history All that history is seen in the context of controller DSP Digital signal processor FPGAs Field Programmable Gate Arrays ASICs Application Specific Integrated Circuit Chip on Board It is include the HW history from Intel 8080 to octuple multicore processors In the same way it is shown the history of field device out from laboratory into the field with all difficulties and benefits of that transition The issues are summerized in a pyramid of complexity Requirements for robustness and safety are shown for field devices In the same way it is shown the development of mainframes workstations and PC s SAP a leading ERP System is explained in mor detail Specially it is figured out how SAP works and what has to be considered in working with such kind of system The differences between MES and ERP systems are discussed specially also for future combined SAP MES systems Explained are the problems of middlesized companies SMEs in dealing with Industry 4 0 and automation Further examples are given and discussed for automized quality control in automotvie PCB handling CIGS Solar cell production Also shown is the upgrade for older products and make them ready for automation standards In detail the history oft he modern robotics is shown for the automotive industry In summery also is figured out the Industry 5 0 which is just coming up more and more **I-Bytes Technology Industry** IT-Shades,2020-06-13 This document brings together a set of latest data points and publicly available information relevant for Technology Industry We are very

excited to share this content and believe that readers will benefit from this periodic publication immensely *Inside Bluetooth Low Energy, Second Edition* Naresh Kumar Gupta,2016-06-30 This updated and expanded second edition of the Artech House bestseller Inside Bluetooth Low Energy presents the recent developments within the Bluetooth Core Specifications 4 1 and 4 2 This new edition explores both Internet of Things IoT and Bluetooth Low Energy LE in one single flow and demonstrates how this technology is very well suited for IoT implementations The book covers all the advances within the new specifications including Bluetooth LE enhanced power efficiency faster connections and enhanced privacy and security Developed for ultra low power devices such as heart rate monitors thermometers and sensors Bluetooth LE is one of the latest most exciting enhancements to Bluetooth technology This cutting edge book presents an easy to understand broad based explanation of Bluetooth LE its building blocks and how they all come together Packed with examples and practical scenarios the book helps readers rapidly gain a clear solid understanding of Bluetooth LE in order to work more effectively with its specification This book explores the architecture of the Bluetooth LE stack and functionality of its layers and includes a broad view of the technology identifies the various building blocks and explains how they come together Readers will also find discussions on Bluetooth basics providing the background information needed to master Bluetooth LE **Arduino V: Machine Learning** Steven F. Barrett,2022-12-27 This book is about the Arduino microcontroller and the Arduino concept The visionary Arduino represented a new innovation in microcontroller hardware in 2005 the concept of open source hardware making a broad range of computing accessible for all This book Arduino V AI and Machine Learning is an accessible primer on Artificial Intelligence and Machine Learning for those without a deep AI and ML background The author concentrates on Artificial Intelligence AI and Machine Learning ML applications for microcontroller based systems The intent is to introduce the concepts and allow readers to practice on low cost accessible Arduino hardware and software Readers should find this book a starting point an introduction to this fascinating field A number of references are provided for further exploration **Asia Electronics Industry** ,2003 *I Bytes Technology Industry* ITShades.com,2021-01-14 This document brings together a set of latest data points and publicly available information relevant for Technology Industry We are very excited to share this content and believe that readers will benefit from this periodic publication immensely **Inside Bluetooth Low Energy** Naresh Gupta,2016 This updated and expanded second edition of the Artech House bestseller Inside Bluetooth Low Energy presents the recent developments within the Bluetooth Core Specifications 4 1 and 4 2 This new edition explores both Internet of Things IoT and Bluetooth Low Energy LE in one single flow and demonstrates how this technology is very well suited for IoT implementations The book covers all the advances within the new specifications including Bluetooth LE enhanced power efficiency faster connections and enhanced privacy and security Developed for ultra low power devices such as heart rate monitors thermometers and sensors Bluetooth LE is one of the latest most exciting enhancements to Bluetooth technology This cutting edge book presents an easy to understand broad based explanation of

Bluetooth LE its building blocks and how they all come together Packed with examples and practical scenarios the book helps readers rapidly gain a clear solid understanding of Bluetooth LE in order to work more effectively with its specification This book explores the architecture of the Bluetooth LE stack and functionality of its layers and includes a broad view of the technology identifies the various building blocks and explains how they come together Readers will also find discussions on Bluetooth basics providing the background information needed to master Bluetooth LE **Bluetooth Low Energy** Robin Heydon,2012-10-26 The First Complete Guide to Bluetooth Low Energy How It Works What It Can Do and How to Apply It A radical departure from conventional Bluetooth technology Bluetooth low energy BLE enables breakthrough wireless applications in industries ranging from healthcare to transportation Running on a coin sized battery BLE can operate reliably for years connecting and extending everything from personal area network devices to next generation sensors Now one of the standard s leading developers has written the first comprehensive accessible introduction to BLE for every system developer designer and engineer Robin Heydon a member of the Bluetooth SIG Hall of Fame has brought together essential information previously scattered through multiple standards documents sharing the context and expert insights needed to implement high performance working systems He first reviews BLE s design goals explaining how they drove key architectural decisions and introduces BLE s innovative usage models Next he thoroughly covers how the two main parts of BLE the controller and host work together and then addresses key issues from security and profiles through testing and qualification This knowledge has enabled the creation of Bluetooth Smart and Bluetooth Smart Ready devices This guide is an indispensable companion to the official BLE standards documents and is for every technical professional and decision maker considering BLE planning BLE products or transforming plans into working systems Topics Include BLE device types design goals terminology and core concepts Architecture controller host applications and stack splits Usage models presence detection data broadcasting connectionless models and gateways Physical Layer modulation frequency band radio channels power tolerance and range Direct Test Mode transceiver testing hardware interfaces and HCI Link Layer state machine packets channels broadcasting encryption and optimization HCI physical logical interfaces controller setup and connection management L2CAP channels and packet structure and LE signaling channels Attributes grouping services characteristics and protocols Security pairing bonding and data signing Generic Access Profiles roles modes procedures security modes data advertising and services Applications devices services profiles and peripherals Testing qualification starting projects selecting features planning testing compliance and more **Intro to Bluetooth Low Energy** Mohammad Afaneh,2018-08-27 Bluetooth Low Energy BLE is an exciting new technology that was introduced in 2010 It targets applications in the Internet of Things IoT space With the recent release of Bluetooth 5 in late 2016 and Bluetooth mesh in mid 2017 which builds on top of BLE Bluetooth is now more capable than ever of becoming the standard wireless protocol used in many IoT applications including smart homes smart cities medical devices wearables and sensor connectivity

Learning a new technology is always challenging and usually comes with a learning curve Some technologies are easier to learn than others Unfortunately Bluetooth Low Energy BLE can be one of those hard ones The lack of good resources including blogs tutorials and up to date books that help a beginner to learn BLE makes the task even more difficult That is in fact the primary goal of this book to provide you with a complete understanding of the basics and core concepts of BLE that you can learn in a single weekend Here s a tiny list of the benefits this book will help you achieve Understand what Bluetooth Low Energy is and how it compares to Bluetooth Classic Become better informed about the use cases where BLE makes the most sense Learn all about Bluetooth 5 and the new features it brought us Understand how two BLE devices discover and connect with each other Understand how BLE devices exchange and transfer data between each other Fully grasp concepts such as Peripherals Centrals Advertising Connections GATT GAP and many others Learn about the newly released Bluetooth mesh standard What readers are saying I bought your BLE book and I love it I am an iOS developer and your material helped me understand some of the finer points of BLE Alex Carrizo Senior iOS Developer iOS SME at Mobile Apps Company Topics include The basics of Bluetooth Low Energy Bluetooth 5 0 The difference between BLE and Bluetooth Classic the one used for streaming audio and connecting headsets The benefits and limitations of using BLE and which use cases make the most sense for BLE The difference between a BLE Central and a BLE Peripheral All about GATT Generic Attribute Profile and GAP Generic Access Profile How Bluetooth 5 achieves double the speed four times the range and eight times the advertising capacity How BLE devices advertise and discover each other How two BLE devices connect to each other How BLE devices exchange and transfer data between each other Profiles Services and Characteristics How secure BLE is and how BLE devices secure the communication channel between them The different connection and advertising parameters and what each of them means An introduction to Bluetooth mesh About the Author Mohammad Afaneh has been an embedded engineer for over 10 years Since 2014 he has focused solely on learning and developing Bluetooth Low Energy applications He even spent days and weeks reading through the 2 800 page Bluetooth specification document looking for answers to questions he couldn t find answers to in other books and resources He shares everything he knows about development for BLE technology at his website www novelbits io and via training classes around the world   Getting Started with Bluetooth Low Energy ,2014 With Bluetooth Low Energy BLE smart devices are about to become even smarter This practical guide demonstrates how this exciting wireless technology helps developers build mobile apps that share data with external hardware and how hardware engineers can gain easy and reliable access to mobile operating systems This book provides a solid high level overview of how devices use BLE to communicate with each other You u2019 ll learn useful low cost tools for developing and testing BLE enabled mobile apps and embedded firmware and get examples using various development platforms u2014 including iOS and Android for app developers and embedded platforms for product designers and hardware engineers Understand how data is organized and transferred by BLE devices Explore BLE u2019 s concepts key limitations

and network topology Dig into the protocol stack to grasp how and why BLE operates Learn how BLE devices discover each other and establish secure connections Set up the tools and infrastructure for BLE application development Get examples for connecting BLE to iPhones iPads Android devices and sensors Develop code for a simple device that transmits heart rate data to a mobile device   **Getting Started with Bluetooth Low Energy** Kevin Townsend,Carles Cufí,Akiba,Robert Davidson,2014-04-30 With Bluetooth Low Energy BLE smart devices are about to become even smarter This practical guide demonstrates how this exciting wireless technology helps developers build mobile apps that share data with external hardware and how hardware engineers can gain easy and reliable access to mobile operating systems This book provides a solid high level overview of how devices use BLE to communicate with each other You ll learn useful low cost tools for developing and testing BLE enabled mobile apps and embedded firmware and get examples using various development platforms including iOS and Android for app developers and embedded platforms for product designers and hardware engineers Understand how data is organized and transferred by BLE devices Explore BLE s concepts key limitations and network topology Dig into the protocol stack to grasp how and why BLE operates Learn how BLE devices discover each other and establish secure connections Set up the tools and infrastructure for BLE application development Get examples for connecting BLE to iPhones iPads Android devices and sensors Develop code for a simple device that transmits heart rate data to a mobile device   **The Bluetooth low energy Handbook - Everything You Need To Know About Bluetooth low energy** Roy Eaton,   *Make: Bluetooth* Alasdair Allan,Don Coleman,Sandeep Mistry,2015-12-02 This book is where your adventures with Bluetooth LE begin You ll start your journey by getting familiar with your hardware options Arduino BLE modules computers including Raspberry Pi and mobile phones From there you ll write code and wire circuits to connect off the shelf sensors and even go all the way to writing your own Bluetooth Services Along the way you ll look at lightbulbs locks and Apple s iBeacon technology as well as get an understanding of Bluetooth security both how to beat other people s security and how to make your hardware secure   **Inside Bluetooth Low Energy** Naresh Chand Gupta,2013 Bluetooth Low Energy LE is one of the latest enhancements to Bluetooth technology and as the name suggests it is aimed at ultra low power devices such as heart rate monitors thermometers and sensors Due to very low power consumption devices compliant with this standard can operate for several years on coin cell batteries without the need for recharging This cutting edge book helps you understand the whats whys and hows of Bluetooth LE It includes a broad view of the technology identifies the various building blocks and explains how they come together You also find discussions on Bluetooth basics providing the background information needed to master Bluetooth LE Back cover   **The Complete Guide to Understanding Bluetooth Technology** RONALD K. LEYVA,2025-02-10 Unlock the secrets of Bluetooth technology with The Complete Guide to Understanding Bluetooth Technology by Ronald K Leyva Whether you re a curious beginner or a tech savvy enthusiast this comprehensive guide takes you on an exciting journey through the science and applications of Bluetooth offering clear and

accessible explanations of one of the world s most pervasive wireless communication technologies In this book you ll discover how Bluetooth works from the basic principles of wireless data transfer to the complex protocols that enable devices to connect seamlessly With a focus on both technical and practical aspects Leyva explores the evolution of Bluetooth its key innovations and its ever expanding role in today s connected world Explore essential topics such as The inner workings of Bluetooth from pairing and security to frequency and range A deep dive into Bluetooth s role in modern devices like smartphones wearables and IoT systems Key Bluetooth advancements including the rise of Bluetooth Low Energy BLE and how it s transforming industries like healthcare and smart homes The future of Bluetooth technology in the age of 5G AI and the Internet of Everything IoE This book not only explains the hows and whys behind Bluetooth technology but also addresses common issues providing solutions to enhance performance and minimize interference You ll also learn how to secure your Bluetooth devices from potential vulnerabilities ensuring that your connections stay safe and private The Complete Guide to Understanding Bluetooth Technology is perfect for anyone eager to dive into the world of wireless communication Whether you re a beginner looking to get acquainted with Bluetooth or someone wanting to deepen your technical knowledge this book equips you with the tools and insights to fully grasp Bluetooth s power and potential Discover the future of wireless communication today and gain a deeper understanding of how Bluetooth connects the world About the Author Ronald K Leyva is an expert in wireless communication technologies with years of experience in the field His passion for understanding and demystifying the inner workings of modern tech has driven him to write detailed accessible guides for both beginners and advanced users alike   *Bluetooth Low Energy* Tony Gaitatzis,2017   **Bluetooth Tutorial** Gordon Colbach,2019-06-11 Bluetooth Tutorial Design Protocol and Specifications for BLE Bluetooth Low Energy 4 0 and Bluetooth 5 starts from the ground up for a new user and does a gradual progression into the technical details around Bluetooth technology The latest update adds information about Bluetooth 4 0 also known as Bluetooth Low Energy BLE and Bluetooth 5 0 Introduction Bluetooth is the name given to a new technology standard using short range radio links intended to replace the cables connecting portable and or fixed electronic devices The standard defines a uniform structure for a wide range of devices to communicate with each other with minimal user effort Bluetooth key features are robustness low complexity low power and low cost The technology also offers wireless access to LANs PSTN the mobile phone network and the Internet for a host of home appliances and portable handheld interfaces The immediate need for Bluetooth came from the desire to connect peripherals and devices without cables The available technology IrDA OBEX Infrared Data Association Object Exchange Protocol is based in infrared links that are limited to line of sight connections Bluetooth is further fueled by the demand for mobile and wireless access to LANs Internet over mobile and other existing networks where the backbone is wired but the interface is free to move This not only makes the network easier to use but also extends its reach What is inside Overview on Wireless Technologies Usage Scenarios and related Taxonomy Bluetooth Architecture Protocol Stack Baseband

Link Manager Protocol Logical Link Control and Adaptation Service Discovery Cable Replacement Telephony Bluetooth Adopted Protocols PPP TCP UDP IP OBEX Content Formats WAP Bluetooth Usage Models File Transfer Synchronization Three in One Phone Ultimate Headset Bluetooth Specifications Bluetooth 1 0 and 1 0B Bluetooth 1 1 Bluetooth 1 2 Bluetooth 2 0 EDR Bluetooth 2 1 EDR Bluetooth 3 0 HS Bluetooth 4 0 LE Bluetooth Low Energy Bluetooth 4 1 Bluetooth 4 2 Bluetooth 5 Bluetooth Connection Establishment Bluetooth Security Zigbee Architecture Zigbee Device Types Zigbee Network Model

Getting Started with Bluetooth Low Energy ,2014   **Unraveling Bluetooth LE Audio** Himanshu Bhalla,Oren Haggai,2021 Explore how Bluetooth Low Energy LE has transformed the audio landscape from music streaming to voice recognition applications This book describes the rationale behind moving to LE audio the potential power savings and how various specifications need to be linked together to develop a final end product LE Audio is a natural development of the Bluetooth audio standard The standard is spread across more than a dozen different specifications from application profiles down to the core transports in both Host part and Controller part You ll see how this new architecture of the Bluetooth audio stack defines a LE Audio stack from the Core Controller to the Host Protocols and Profiles You ll also learn how to free yourself from wires and charging LE Audio introduces a new audio compression codec called LC3 Low Complexity Communication Codec which covers sampling rates for the full range of voice and media application at high fidelity low complexity and low bit rate and is ideal for new applications such as voice assistance and gaming Unraveling Bluetooth Low Energy Audio provides full context to anyone who is curious to learn about the new LE Audio technology You will Understand the advantages of LE audio over current standards Describe the overall Bluetooth LE audio stack and its various blocks Enable LE audio with the Core Controller specification See how an end to end application works its through the LE audio ecosystem Examine how LE Audio addresses current and future trends in interoperable wireless audio

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Understanding Bluetooth Low Energy Stmicroelectronics Introduction

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