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Enabling the Internet of Things: Fundamentals, Design, and Applications

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Preface

Objectives

The emerging paradigm of Internet-of-Things (IoT) plays a consequential role to improve almost all aspects of human life, i.e. domestic automation, transportation, education, health, agriculture, industry, etc. The simple conception of IoT as a network of identifiable connected smart things is fundamentally based on the integration of various diversified technologies including pervasive computing, sensor technology, embedded system, communication technologies, sensor networking, Internet protocols, etc. for the provisioning of intelligent computing services. In our experience we have noticed that although the simple idea of IoT is easy to comprehend, at the undergraduate level, students are unable to describe the importance and placement of IoT components in an IoT system. This book tries to provide the basic, precise, and accurate demonstration of IoT building blocks as well as their role in various IoT systems. The objective of this book is to provide a good starting point for undergraduate students who have basic prior knowledge of Internet architecture. At an abstract level, this book is an effort to partially fill the gap associated with the understanding of IoT concepts through the designing of the IoT system prototypes in Packet Tracer. We believe that after implementing IoT system prototypes in Packet Tracer, students will find it easier to grasp complete details of IoT systems.

Key Feature

Concerning the building of IoT foundations, this book can be used as a textbook at the undergraduate level. The key feature of this book is that it targets core aspects of IoT

and provides its readership a better perspective both in terms of basic understanding of IoT technologies as well as the designing of IoT systems in Packet Tracer. To the best of our knowledge, this book can be considered as the first attempt to design simple IoT systems using Blockly programming language.

Audience

This book is suitable for undergraduate students enrolled in the IoT course. This book assumes that the reader has a good understanding of Computer Networks and basic programming concepts. Students are comprehensively facilitated in this book to explain IoT essentials besides the guidance of designing IoT systems in Packet Tracer.

Approach

At the end of each chapter, review questions in the form of case studies have been asked to explore students' clarity about IoT concepts discussed in that particular chapter. In this book, the design and implementation of IoT systems at an abstract level are presented in Blockly language.

Organization of the Book

To address the issues related to the understanding of IoT fundamentals at the undergraduate level, this book is structured as follows:

[Chapter 1](#) is exclusively written to introduce the evolution, vision, definition, characteristics, enablers, architectures of the IoT paradigm, and its distinction from other related technologies. This chapter builds the foundation for the understanding of IoT systems and is considered a prerequisite for the following chapters.

The primary focus of [Chapter 2](#) is to establish an understanding of the IoT building blocks along with the necessary details related to various IoT hardware and software technologies. Besides, this chapter also provides a concise design and implementation perspective of IoT systems in Packet Tracer.

The contents of [Chapter 3](#) are oriented along the lines of sensing principles and understanding of various aspects related to the design and implementation of wireless sensors and sensor networks. The layer-level functionality of wireless sensor networks in this chapter explains the effective communication requirements of sensors in IoT systems.

[Chapter 4](#) describes the basics of IoT gateways in terms of its architecture and functionalities. In addition, this chapter also elaborates how IoT gateways having advanced features of data filtering and analytics support Edge computing and how Edge computing-based solutions provide benefits to specific IoT-based real-life applications.

[Chapter 5](#) discusses the mapping of IoT protocols to layered IoT architecture and provides in-depth details of various infrastructure, service discovery, and application layer protocols of IoT protocol stack in terms of their functionality and usage in a real-life scenario.

[Chapter 6](#) focuses on the description and explanation of components and employment of Cloud and Fog architectures in different IoT systems.

[Chapter 7](#) introduces real-life application domains (i.e. domestic automation, smart transportation, smart agriculture and farming, smart manufacturing and industry automation, energy conservation, etc.) where

the IoT technologies play a vital role to improve the standard of human life through the automation of these systems.

In [Chapter 8](#), the classification of IoT attacks, as well as constraints and requirements of IoT systems, are discussed. Moreover, the discussion about security threats at each layer of IoT architecture is also the part of this chapter.

[Chapter 9](#) illustrates the nature of social relationships between IoT devices, explains the functionality of the components of social IoT architecture, and provides an understanding of the applicability of social aspects of smart devices in IoT applications.

[Chapters 10](#) and [11](#) are devoted to the design and implementation details of IoT projects in Packet Tracer exploiting constructs of Blockly programming language.

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1

Internet of Things (IoT) Fundamentals

LEARNING OBJECTIVES

After studying this chapter, students will be able to:

- describe the evolution of the IoT concept.
- state the vision and definition of IoT.
- explain the basic characteristics of IoT.
- distinguish the IoT from other related technologies.
- elaborate the IoT enablers.
- explain the IoT architectures.
- articulate the pros and cons of IoT.
- apply the IoT architecture concepts for specific IoT applications.
- understand the implementation aspect of IoT architecture.

1.1 Introduction

In our daily lives, the augmented practice of Information and Communication Technologies (ICT) plays a paramount role in the development of emerging information societies. In developed countries, ICT is being employed to develop various innovative applications and services to address the