TRUST-BASED COMMUNICATION SYSTEMS FOR INTERNET OF THINGS APPLICATIONS

Edited by

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Scrivener Publishing

WILEY

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Scrivener Publishing
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Beverly, MA 01915-6106

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This edition first published 2022 by John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA and Scrivener Publishing LLC, 100 Cummings Center, Suite 541J, Beverly, MA 01915, USA

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Wiley Global Headquarters
111 River Street, Hoboken, NJ 07030, USA

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Library of Congress Cataloging-in-Publication Data

ISBN 9781119896333

Cover image: IoT industry 4.0 concept, Ekkasit919 | Dreamstime.com
Cover design by Kris Hackerott

Set in size of 11pt and Minion Pro by Manila Typesetting Company, Makati, Philippines

Printed in the USA

10 9 8 7 6 5 4 3 2 1

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Preface

With an enormous range of applications, Internet of Things (IoT) has magnetized industries and

academics from everywhere. IoT facilitates communication and operations through Internet access to all the devices with computing capabilities. Many applications can be applied in IoT, such as intelligent transportation systems, real-time medical monitoring, intelligent appliances and intelligent agriculture, and the smart grid. Internet of Things (IoT) makes a smart communication process between objects and their environment over the internet. Security and privacy are two important aspects of IoT applications. Smart objects and machine-to-machine communications with complete data security are now a demand. Similarly, privacy is another major challenge of IoT applications where an object is free from interference from other objects. Trust based communication is one way to deal with these primary IoT based aspects. Internet of Things (IoT) creates a world where smart objects and services interact autonomously. Therefore, a central issue is whether the service provided by a selected IoT device is trustworthy. Further, most IoT devices are mobile and will connect to the Internet on and off, depending on the location they roam into as well as the energy status of individual IoT devices. Considering the dynamic-heterogeneous characteristic of interconnected devices in IoT, it demands an effective and efficient trust-based IoT communication system that can scale to many heterogeneous devices in IoT systems. In heterogeneous and complex environments, those resources must trust each other. On-Off attacks threaten the IoT trust security through nodes performing good and bad behaviours randomly to avoid being rated as a menace.

Security and privacy are two important aspects of IoT applications. Smart objects and machine-to-machine communications with complete data security are now a demand. Similarly, privacy is another major challenge of IoT applications where an object is free from interference from other objects. Trust based communication is one way to deal with these

primary IoT based aspects. A trust-based communication system is needed to guarantee security, authentication, authorization, and confidentiality of connected things, regardless of their functionality because not all IoT devices will be trustworthy and some IoT devices may behave maliciously to disrupt the cloud service (e.g., an adversary) or just for their own gain (e.g., for increasing their chances to be selected to provide requested services). Furthermore, users who own IoT devices are likely to be socially connected via social networks. For participatory sensing IoT Applications, it is critical to assess source trustworthiness of IoT devices which report sensing results, so untrustworthy data can be filtered out before data analysis is taken.

This book encompasses all aspects of research and development of secure IoT applications. It delivers technologies to improve trust and eliminate malicious actors in participatory exchanges throughout the communication using IoT devices ss that these methods are not only be able to identify bad actors, but also to improve communication and trust in the environment without violating object privacy. This book also covers a broad spectrum of applications in the community from industry, government, and academia. This book brings together thought leaders, researchers, industry practitioners, potential users of communication technology, and IoT device manufacturers to develop the field, discuss new trends and opportunities, exchange ideas and practices, and promote interdisciplinary and cross-domain collaborations.

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Book Description

This book **"Trust-Based Communication Systems for Internet of Things Applications"** provides the conceptual and fundamental research related to secure and trust-based communication in IoT devices and applications. It also includes demonstrations on a wide range of interdisciplinary applications and innovative developments in the field of IoT such as IIoT, blockchain technology, etc. that address the latest findings and results regarding a wide variety of technological issues and developments to reform the scientific society.

The book contains 12 chapters. Chapter 1 titled **"An Analysis of the Internet of Things (IoT) as the Defining Technology of a Generation"** highlights the fundamental concepts of various IoT applications such as interoperability, smart cities, smart pharmacy, workplaces, home, transport, and vegetable traceability framework.

Chapter 2 titled **"Blockchain in IoT and Limitations"** presents the decentralized approach using blockchain technology to secure the IoT applications and highlight its limitations.

Chapter 3 titled **"IoT Protocol Security Mechanisms"** discusses several security aspects in IoT applications and discusses various cryptographic protocols which can be used in different IoT enabled applications to secure inter-communication.

Chapter 4 titled **"IoT Security, Privacy, Challenges, and Solutions"** presents a few highlights on IoT security, privacy, challenges, and solutions. The chapter begins with an introduction to IoT. and its architecture and later addresses various Internet of Things security challenges and best practices to safeguard.

Chapter 5 titled **"CIA-CPS: Concept, Issues, and Application of IoT in Cyber Physical System"** expresses the similarities and differences between IoT and CPS and various applications of IOT and CPS to show as to how both are making the life of common men easy in every walk of life.

Chapter 6 titled **"Trust Calculation in IoT Nodes Without Trusted Third Party Using PUF Methodology"** focuses the trust calculation in Physical Unclonable Function (PUF) based networks and finds the appropriate method in several facets of trust.

Chapter 7 titled **"Comparative Analysis of Indexing Schemes Used in Cloud Computing Data Management"** presents a comparative analysis of various indexing data structures used in cloud computing for data management. To evaluate the performance of the existing indexing structures, different experiments have been carried out.

Chapter 8 titled **"Evolution and Insight in Industrial Internet of Things (IIoT): Importance and Impact"** provides a system of IIoT, structure and IIoT layers, and IIoT applications, as well as IoT openings and difficulties. It shares the importance and progress from the Industrial IoT to the Industries 4.0 process as well as move towards the industrial Internet.

Chapter 9 titled **"Evolving Trends of Artificial Intelligence and Robotics in Smart City Application: Crafting Humane Built Environment"** examined the smart city concept from evolving trends of implementation with AI and Robotics in different built environment layers from micro to macro level of spaces. Additionally, a few application-based case studies and the initiatives taken by global agencies (UNESCO) were analyzed for making these implications more human-centric.

Chapter 10 titled **"T-Secure IoT in Smart Home System"** provides an approach to consumer satisfaction in the service of the system by the usage of a two-level bio-based Internet of Things (IoT) delivery framework for smart home systems and an android-based program for the monitoring and control of electronic devices.

Chapter 11 titled **"Intelligent Micro-Mobility E-Scooter: Revolutionizing Urban Transport"** presents a technical case study on how geofencing technology is used to track and trace the city's e-scooter, in case it is stolen. The geofencing technology provides alerts to the company on a real-time basis by using IoT. The study proposes a process framework to integrate the location-tracking and monitoring system based on GPS and geofencing capabilities.

Chapter 12 titled **"Automatic Booking of LPG and Leakage Detection System Using IoT"** presents an IoT based cost-effective gas leakage detection system that helps the common people in their household activities.

This book primarily covers all aspects of research and development in secured communication in IoT devices starting from the fundamentals of IoT devices and ending with the decentralized and blockchain based IoT systems and IIoT applications. We feel that after reading this book,

the reader will have a thorough, well rounded understanding of machine learning and data science fundamentals.

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1

An Analysis of the Internet of Things (IoT) as the Defining Technology of a Generation

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Abstract
Internet of Things can be best explained as a Complex Adaptive System which is emerging and in need of designing innovative ways of software and systems engineering, project management, and numerous other disciplines to develop it in the near future. IoT's application areas are very broad to allow it to support multiple users who have different needs in turn. Three groups of users, people, society or societies, and organizations represent the app. In this paper, we have laid emphasis on the various IoT applications such as interoperability, smart cities, smart pharmacy, workplaces, home, transport, and vegetable traceability framework.

***Keywords*:** IoT, mobile computing, smart home, wearable, etc.

1.1 Introduction

The IoT is an integrated system that looks at material with different levels of processing, hearing, and performance sharing that communicates as their integrated Internet platform as shown in Figure 1.1. The main purpose of the IoT, therefore, is to make things connected to other things and people, using any network, route, or service, anytime, anywhere.

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Prateek Agrawal, Vishu Madaan, Anand Sharma, Dilip Sharma, Akshat Agarwal and Sandeep Kautish (eds.) Trust-Based Communication Systems for Internet of Things Applications, (1–16)

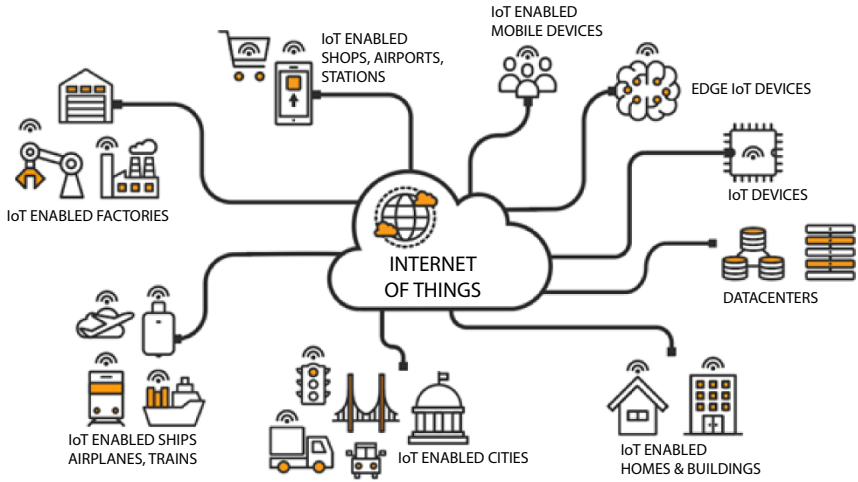

Figure 1.1 IoT.

The IoT is increasingly being considered the next step in the evolution of the Internet. Devices such as Smartphones, cars, industrial systems, cameras, toys, buildings, household items, industrial systems, and countless others can exchange information via the Internet these days. These devices can perform fine-tuning, tracking, setting, control, real-time monitoring, and process control regardless of their size and functions [1]. The widespread proliferation of Internet-enabled devices has taken place in recent years.

1.2 Growth of IoT

The Internet certainly become a part of the life of a social animal. It is a big room for people and knowledge. The Internet first emerged as the "Computer Internet." It is a digital network where it is possible to incorporate several services on top of it, such as the World Wide Web. It was an age of information sharing. There were several social websites that kept individuals linked all the time. This has led to the Internet being loaded with individuals rather than data. Technology, on the other hand, has been progressing day by day. A period of "MobiComp" (mobile computing) has also begun [2–4].

Mobile internet services for 3G and 4G have now resulted in quicker internet connectivity and increased video call quality. Mobile computing and wireless technology have become inexpensive and have gained more popularity. Therefore, there was a new computer-Ubiquitous computing.

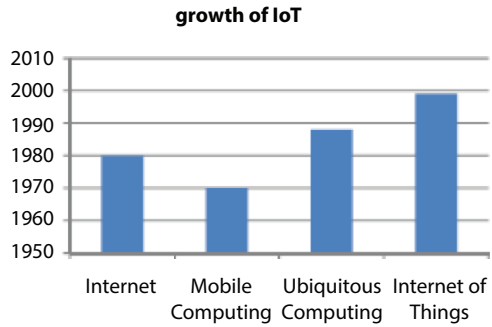

Figure 1.2 Growth of Internet of Things.

Intelligent space and minimal user participation are the subjects of this computing. Advances in technology have contributed to a reduction in size for smartphones and other portable devices. Ordinary mobiles and PCs have been replaced by smart phones, i-pads, laptops, and notebooks. There was also a shift in the device through which individuals access the internet. This, in turn, resulted in the configuration of sophisticated functions.

Devices were not only connected to the internet in such a situation, but also sensed, computed, and performed intelligent tasks. Later, physical items were programmed with identification tags such as bar code and RFID so that devices such as smart phones could scan them and upload their information to the internet. With the aid of a smart computer, this way of linking the real world with cyberspace contributed to the internet being called the "Internet of Things". Figure 1.2 shows that it has its origins in mobile computing, ubiquitous computing, and IT [5]. Therefore, from the above, IoT transforms the view of connectivity from "any-time, anywhere" for "anyone" to "any-time," any-place" for "any-thing".

1.3 IoT Technologies

These components are essential for the deployment of IoT-based devices:

i) **RFID:** It is a tiny chip that receives signals. It helps us to use radio waves, tags, and readers for direct automatic identification and date capture. Depending on whether power supplies are available or not, RFID tags may be passive or active.

ii) **WSN:** This is a network of autonomous sensors distributed in space. Their function is to monitor the status of RFID objects' position, temperature, motion, etc. A sensor network's sensing nodes transmit data to their sinks.
iii) **Middleware:** Designing of a software to hide the complexities of various technologies and make communication friendly. This architecture is termed as service-oriented architecture.
iv) **Cloud & Fog Computing:** It is a computing model for accessing the on-demand pool of computers, networks, servers, storage, databases, utilities, software, etc. There are several problems with IoT cloud computing, including synchronization, standardization, balancing, reliability, and management. The extension of cloud computing services to the vicinity of users has improved efficacy with the assistance of fog computation. Fog computation includes characteristics such as location, distribution, scalability, support for mobility, interactive real-time services, and fly analysis [6].
v) **IoT Application Software:** Piece of code for the development of various industry-oriented applications. All services are provided for the same reason.

1.4 Application Areas of Internet of Things

The IoT system can be used to target specific applications from household appliances, such as automated lighting, to medical science, to life-sustaining devices, such as a monitoring system for human heartbeat. IoT has been made highly accessible with the advent of technology and is used to produce big data, which is further used by Business Intelligence systems for decision-making objectives as shown in Figure 1.3.

i. Smart Homes

With thousands of people per month, the people graph searching for smart homes is growing exponentially. The most interesting thing is that several businesses and start-ups are included in Smart Homes for database analysis as shown in Figure 1.4. Prominent startup names such as AlertMe or Nest, as well as a variety of multinational companies such as Philips, Haier, or Belkin etc., are included in the list of startups.

Below mentioned are some of the few application areas pertaining to Smart Homes, including monitoring of energy and water supply usage to receive guidance about how to cut costs and money, remote control appliances, detection of gaps and breaches of windows and doors in order to deter intruders, and control of conditions within museums and art warehouses [7–9].

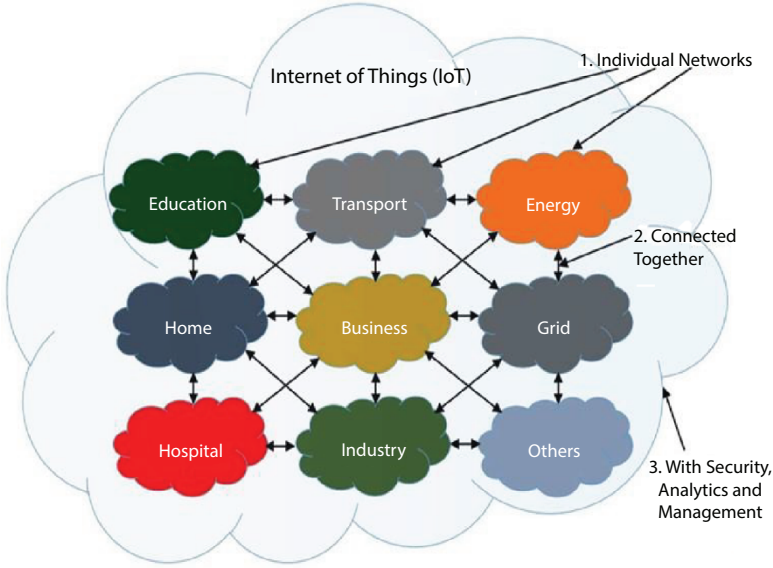

Figure 1.3 IoT applications.

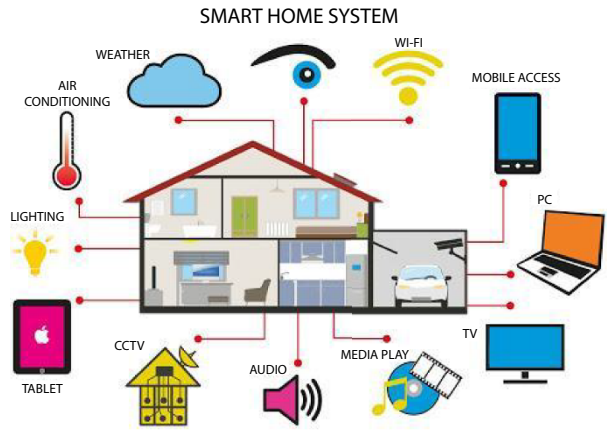

Figure 1.4 Smart home.

ii. Smart City

One of a city's first steps towards being a Smart City is Smart Parking. It addresses a variety of problems related to parking, notifies drivers of available spaces, and when the parking period has expired. The diagonal smart parking garage has already been developed by China: a first of its kind robotic valet to move cars into a specific parking spot. It turns out that applications like waste control and water management are environmentally safe [10–13]. Figure 1.5 shows a Smart City tracks the status of the parking areas in the city, monitors vibrations and material conditions in buildings, bridges, and historical monuments, detects Wifi and Bluetooth enabled devices, measures the energy radiated by cell stations and Wi-Fi routers, enhances driving and pedestrian overpasses, monitors surveillance of vehicles and sidewalk levels, manages intelligent highways with warning messages, and takes care of climate-specific diversions and unpredictable incidents such as collisions or traffic jams.

iii. Smart Grid

In order to enhance the efficiency, economy, and reliability of the delivery of energy, a Smart Grid effectively promises to collect knowledge on the actions of customers and electricity distributors in an automated manner. Talking precisely over a state and country, both distribution and transmission systems aim at forwarding and collecting information from nuclear power plants, thermal power plants, Smart Houses, Cities, and Factories, electric vehicles, wind power plants, solar panels, etc. to and from the Smart Grid through grid specific applications [14]. They can prevent or minimize the damage natural catastrophes create, increase the

Figure 1.5 Smart city.

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