Chapter 46
Security in Context of the Internet of Things:
A Study

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ABSTRACT

The chapter discusses various security challenges in the design of the internet of things and their possible solutions. After presenting a precise introduction to the internet of things, its applications, and technologies enabling it, the chapter discusses its various architectures and models which follow with an introduction of development kits, boards, platforms, hardware, software, and devices used in the internet of things. A concise explanation and discussion on the internet of things standards and protocols with emphasis on their security is presented. Next, various possible security threats and attacks to the internet of things are presented. The subsequent sections of the chapter discuss identified security challenges at individual layers of various models along with their possible solutions. It further presents cryptographic and lightweight cryptographic primitives for the internet of things, existing use of cryptography in the internet of things protocols, security challenges, and its prospectus.

INTRODUCTION

The Internet of Things (IoT) is a technological revolution in the field of computing and communications due to practical and rapid innovation in many technologies including Internet, computing, artificial intelligence, data processing, communications, sensors, processors, networks, control and many other technologies underlying it. Web of Things, Internet of Objects, Embedded Intelligence, and Connected Devices are some of the aliases used for this technological revolution. It involves a very high prevalence of entities called things which have unique identities on the Internet and communicate to transfer data over it. Several other computing technologies such as Cyber-Physical Systems, Pervasive Computing,

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Ubiquitous Computing or Calm technology, Machine-to-Machine Interaction, Human-Computer Interaction, and Ambient Intelligence have a very close resemblance with the Internet of Things. Kevin Ashton is believed to have first used the term 'Internet of Things'. Though no uniquely agreed definition of this term has been agreed upon by academicians, researchers, practitioners, innovators, developers, and corporates, however, the definition given by ITU-T Y.2060 is most widely used. The term 'Internet of Things' is defined by ITU-T Y.2060 as: *"a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies"*. Further in the context of the Internet of Things, it defines 'Things' as: *'a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage, and data processing'.* A significant focus in this definition is on the edge devices. The services offered by or through the cloud such as 'data collection,' 'brokerage and storage,' 'data analytics,' 'inventory and sensor management,' 'visualization and monitoring,' and 'device relationship' play an important a role in the successful implementation of its capabilities. The Internet of Things can be realized as a centralized system, or a distributed system or a combination of both. In the centralized approach, objects, i.e., 'Things' are connected to centralized cloud infrastructures while as in distributed approach 'Things' at the edge of the network collaborate without the requirement of centralized control. All of these approaches create a worldwide network of interconnected objects. These objects range from human beings to everyday objects such as cars, appliances, etc. and specialized tools such as industrial machinery, medical devices, etc. All of these objects can behave as producers and consumers of services, and can also communicate directly or indirectly with each other. Internet of Things may be either cloud-centric or distributed. In a centralized approach of IoT, acquisition networks provide data to the Cloud. The requirements of various IoT applications: from eHealth to retail, from logistics to smart city management can be fulfilled using this approach. In this distributed approach of IoT, multiple entities located at the edge of the network can locally and remotely collaborate without depending on a purely centralized infrastructure.

Applications

Since its inception, Internet of Things has made significant progress in some application areas such as home automation, smart cities, agriculture, livestock management, healthcare, industrial control, transportation, and many other utilities. The active involvement and research of small and large business houses to offering IoT enabled services have increased applications of IoT in almost every sphere of human activity. However, the depth and breadth of this application vary significantly from one region to another due to various factors that include economic, regional, technical and others. Applications of the Internet of Things in different industries offer different services and solutions that benefit its users. As an example, with the application of the Internet of Things, home automation can be made more intelligent, remotely monitored, and more secure. Gadgets such as air conditioners, lights, security systems, etc. can be remotely monitored and controlled from different types of devices having diverse connectivity with the Internet. Another example is its use to make cities smart where the applications of the Internet of Things is very vast. It has potential to monitor and regulate cities intelligently, automatically offer and control services, real-time information sharing among netizens, real-time disaster management, etc. Another example is the use of Internet of Things in the domain of agriculture and livestock management. Alerts and automated processes can be set up for water control, air control, environmental monitoring and control, food safety, crop yield management, etc. Another example is its vast range of

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