普通高等教育
物联网工程类规划教材

INTERNET OF THINGS, IOT

物联网
专业英语

Specialized English in IoT

魏旻◎编著

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内 容 提 要

本书是物联网专业英语教材，针对高等院校物联网工程类专业的需求而编写，选材广泛，体系完整，内容翔实。书中首先介绍了物联网的概貌、发展历程及参考架构，然后重点讲解了RFID、传感器、Wi-Fi、ZigBee、6LoWPAN、3G、5G、LTE、物联网安全、云计算等关键技术和相关应用，最后通过智能电网和智能家居等领域的典型案例对上述技术进行了进一步解读和说明。每篇课文后均配有生词、短语、缩略语及习题，用以巩固读者对课文的理解；每章后附有部分参考译文及练习题参考答案，并根据情况设置科技文献阅读、翻译、写作技巧、物联网信息检索、物联网国际标准化情况等内容，可供教师及学生学习参考。

本书既可作为高等本科院校、高等职业院校物联网相关专业的专业英语教材，也可作为从业人员自学的参考书。

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前 言

物联网技术处于高速发展之中，已经成为各国研究的热点，其国际合作化特征尤为明显。从业人员只有提高专业英语水平，才能便于获得最新、最先进的专业知识，因此，学好物联网专业英语是物联网领域从业人员开展科学研究、国际合作和工程实践的重要基础和保障。

本书作者所在的国家工业物联网示范性国际科技合作基地——工业物联网与网络化控制教育部重点实验室，在物联网标准方面与国际同步，在物联网技术方面处于国际前沿，其核心技术正在形成专利保护群，相关研究成果也得到了国际上的广泛认可。本书作者长期从事物联网技术方面的研究，牵头负责物联网国际标准的制定和相关科研项目（包括国际合作项目）的研究，为本书的编写奠定了坚实基础。在本书的编写过程中，作者参考了近年国内外出版的多本同类教材，并结合了作者多年来在物联网相关技术及“物联网专业英语”课程教学上的经验，形成本书如下主要特点。

1. 立足于物联网工程培养方案和物联网工程专业英语教学大纲，选取物联网专业的学生最需要掌握的关键技术专业英语作为教学内容。

2. 融入科技英语翻译技巧和科技文章撰写方法等内容。针对学生在科技文献翻译和撰写中存在的疑问，给出科技文献翻译和撰写的技巧，提高学生的专业英语阅读和写作能力。

3. 选材强调新颖、准确。本书参考了国外期刊中关于物联网技术的最新热点文章，强调物联网专业英语在技术上的准确性、基础性和学术性，可帮助学生扩展知识面，使他们更深入地理解物联网技术的发展状况。

4. 强调两个维度，即，第一维度基础、理论和学术，第二维度产业、案例和应用。在关键技术基础理论讲解的基础上，本书引入创新性的物联网技术实用模式内容，在其后紧跟与这些关键技术相结合的实际应用案例，不再将关键技术与应用分开讨论，让学生在学习中能够将理论与实践结合起来。

5. 突出技术并结合最新科研成果。本书依托重庆邮电大学的信息技术特色优

势，结合国家工业物联网国际科技合作基地、工业物联网与网络化控制教育部重点实验室项目、重庆市物联网工程技术研究中心团队的最新成果，满足国家战略、行业发展及地方经济对信息类人才的需求。

6. 本书融入了作者多年来参加ISO/IEC JTC1 WG10 物联网标准工作组、国家重大科技项目、国家863项目研究和参与制定国际标准的研究成果，可让读者对物联网体系架构、关键技术、标准与系统开发等有系统、全面、深入的理解。

7. 单元设置特色鲜明，每一单元包含以下内容：

- 课文——选材广泛、风格多样、切合实际的两篇英语专业文章；
- 单词——课文中出现的新词；
- 词组——课文中的常用词组；
- 缩略语——课文中出现的、业内人士必须掌握的缩略语；
- 习题翻译——培养读者的翻译能力；
- 参考译文——让读者对照理解，从而提高翻译能力；
- 科技文献的阅读、翻译、写作技巧及物联网文献检索等内容——提升读者物联网科技文献阅读、写作能力。

本书由魏旻组稿、统稿、编著，岳耸和陈俊华高级工程师、刘琳博士、王江博士参与了部分章节的整理和英文的校对，研究生毛久超、李潇伶、张琼、杨涛、庞巧、庄园参与了各章节的一些编写和英文的翻译，承蒙曲阜师范大学岳守国教授通读全书，提出修改意见。另外，在本书的编写过程中，王平教授给予了很多非常宝贵的意见，在此特别表示感谢。

编　者

2016年8月

目 录

Unit 1

Unit 2

CONTENTS

Unit 3

Unit 4

Unit 5

Unit 6

Unit 7

Unit 8

CONTENTS

Unit 9

Unit 10

Unit 11

Unit 1

Introduction to IoT

Passage A　An Overview of IoT

Passage B　Smart Objects and Related Technology

Passage C　IoT Endpoint Monitoring Systems

Passage A An Overview of IoT

Ⅰ. An Introduction

Today sensors appear everywhere. We find that there are sensors in our vehicles, smart phones, factories controlling CO_2 emissions, and even in the ground monitoring soil conditions in vineyards. While it seems that sensors have been used for quite a while, the research on wireless sensor networks (WSNs) can also date back to 1980s, and it is only in 2001 that WSNs began to attract an increased interest from industrial and research perspectives. This is due to the availability of inexpensive, low powered miniature components like processors, radios and sensors that were often integrated on a single chip (system on a chip (SoC)).

The idea of internet of things (IoT) was developed in parallel to WSNs. The term of internet of things was proposed by Kevin Ashton in 1999 and refers to uniquely identifiable objects and their virtual representations in an "internet-like" structure.

Various outlooks exist for defining the significant opportunity for globally interconnected and networked "smart things" resulting in an Internet of Things. The following statistics demonstrate that while the estimated volume of connected things may vary, the market impacts are projected to be quite significant.

- Global machine-to-machine connections will rise from two billion at the end of 2011 to 12 billion at the end of 2020. (Machina Research)
- The Internet of Everything — connected products ranging from cars to household goods — could be a $19 trillion opportunity. (Cisco Systems Inc. Chief Executive Officer John Chambers)
- Only 0.6% of physical objects that maybe part of Internet of Things are currently connected. (Cisco)
- The vision of more than 50 billion connected devices will see profound changes in the way people, businesses and society interact. (Ericsson)
- The Internet of Everything could boost global corporate profits by 21 percent by 2022, Cisco said. By 2020, 50 billion objects will be connected to the Internet, according to the slides. (Bloomberg)

While IoT does not assume a specific communication technology, wireless communication technologies will play a major role, and in particular, WSNs will facilitate many applications and many industries. The small, rugged, inexpensive and low powered WSN sensors will bring the IoT to even the smallest objects installed in any kind of environment, at reasonable costs. Integration of these objects into IoT will be a major evolution of WSNs. A WSN can generally be described as a network of nodes that cooperatively sense and control the environment, enabling interaction between persons or computers and the surrounding environment. In fact, the activity of sensing, processing and communication with a limited amount of energy ignites a cross layer design approach, typically requiring the joint consideration of distributed signal/data processing, medium access control, and communication protocols.

Through synthesizing existing WSNs applications as part of the infrastructure system, potential new applications can be identified and developed to meet future technology and market trends. For instance, WSN technology applications for smart grid, smart water, intelligent transportation systems, and smart home generate huge amounts of data, and this data can serve many purposes.

Additionally, as the modern world shifts to this new age of WSNs in the IoT, there will be a number of legal implications that will have to be clarified over time. One of the most pressing issues is the ownership and use of the data that is collected, consolidated, correlated and mined for additional value. Data brokers will have a flourishing business as the pooling of information from various sources will lead to new and unknown business opportunities and potential legal liabilities. The recent US National Security Administration scandal and other indignities have shown that there is wide interest in gathering data for varied uses.

One of the more complex issues which arise within this new world is the thought of machines making autonomous decisions, with unknown impacts on the environment or society within which it functions. This can be as simple as a refrigerator requesting replenishment for milk and butter at the local store for its owner, or as complex as a robot that has been programmed to survive in a harsh environment that originally did not foresee human interaction. It can also be as simple as a vehicle that records its usage, as does the black box in the aerospace industry, but then not only providing the information to understand the cause of an accident, but also is using evidence against the owner and operator. For example, a machine will notifiy legal authorities if it is used against the law.

It comes to the point where a machine starts acting as if it were a legal entity. The question of liability starts to get fuzzy and the liability for the "owner" and "operator" of the machine gets more difficult to articulate if there is no real human intervention in the actions of the machine or robot.

This is certainly the worst case scenario, but the question is how to balance the cost of potential liabilities with the benefits of IoT solutions? This quickly starts to become more of a societal or ethical, and moral discussion. That is what we usually refer to as generational shifts in values –but the IoT trend will not wait for a generation.

Ⅱ. Definitions and Market Requirements of IoT

ISO/IEC JTC 1/SWG 5 (Special Group 5 - IoT) gave IoT a definition as follows:

"An infrastructure of interconnected objects, people, systems and information resources together with intelligent services to allow them to process information of the physical and the virtual world and react".

To ensure that standards support the anticipated size of the IoT, ISO/IEC JTC 1/SWG 5 (Special Group 5 - IoT) has determined that the following issues and topics need to be considered as the market requirements of the IoT:

- Ease of use
- Data Management
- Security
- Privacy/Confidentiality
- Regulation
- Infrastructure
- Awareness of service
- Accessibility and usage context
- Cohesive set of standards across all standards domains
- Distributed IT and Communications Management – e.g. software defined structures and virtualized systems management (e.g. SDN / NFV)
- Cross domain / vertical routing management (e.g. one to many distribution flows across the

applications domains)

- Governance of IoT

Ⅲ. Standards of IoT

Standardization is a major prerequisite to achieve interoperability, not only between products of different vendors, but also between different solutions, applications and domains. The latter is of special interest to IoT and WSN as common access to devices, sensors and actors from various application domains leading to new cross domain applications is the major concern of IoT.

Interoperability has to be considered at different layers ranging from component to communication, information, function and business layer. The component layer basically reflects not merely devices like sensors and actuators, but also gateways and servers which run the applications. The communication layer is responsible for the data exchange between the components while the information layer represents the actual data. The function layer is concerned with the functionality which can be not only software applications, but also hardware solutions. At the business layer the business interactions are described. From the WSN and IoT approach to provide information exchange between "things" and applications covering various application domains, common communication and information layer standards are of main interests, but generic functions might also be used by different application areas. At the component layer we will find various types of devices, but still standards defining for example form factors and connectors for modules (e.g. wireless modules, control processing unit (CPU) boards) can make sense.

As a prerequisite for the successful standardization, use cases and requirements have to be collected and architecture standards are needed to structure the overall system and identify the relevant functions, information flows and interfaces.

As WSN will be used in the wider context of IoT, IoT standards and standardization activities are also considered. This concerns particularly the higher communication protocol, information and function layer.

IEEE 802.15.4 is the most relevant communication standard for the WSN. It defines the physical and link layer for short-range wireless transmission with low power consumption, low complexity and low cost. It uses the ISM frequency bands at 800/900 MHz and 2.4 GHz. IEEE 802.15.4 is the foundation for other standards like ZigBee, WirelessHART, WIA-PA and ISA.100.11a, which defines regional or market specific versions. The base standard was published in 2003 and revised in 2006 and 2011. Various amendments have been added to cover additional physical layer protocols, regional frequency bands and specific application areas. Current work is covering additional frequency bands (e.g. TV white space, regional bands), ultralow power operation and specific applications like train control.

Bluetooth is also a wireless short range protocol defined by the Bluetooth Special Interest Group. With Bluetooth 4.0 they have included a low energy protocol variant for low power applications. RFID is not only used in the WSN context, but is of general interest to IoT.

ISO/IEC JTC 1/SC 31 is one of the major standardization drivers with its ISO/IEC 18000 series of standards defining diverse RFID technologies. Other bodies like ISO, EPCglobal and DASH7 have either contributed to or used these standards.

While the lower communication layers are often specific for a certain application approach like WSN, the network and higher communication layer should preferably use common protocols in order to allow interoperability across networks. Still specific requirements of certain technologies, such as low power consumption and small computational footprints in the case of WSNs, have to be taken into account. The IP protocol suite is today the defacto standard for these layers.

While previous domain specific standards have defined their own protocol stack they all move today to IP. It is the preferred solution in the case of WSN and IoT IPv6. The IPv6 standards set (network to application layer) from Internet Engineering Task Force (IETF) (RFC 2460 and others) is available and stable. In order to support low power constrained devices and networks, especially considering IEEE 802.15.4, IETF is working on specific extensions and protocols. The 6LoWPAN working group defines the mapping of IPv6 on IEEE 802.15.4 (e.g. RFC 6282). The roll working group considers routing over low power and lossy networks (e.g. RFC 6550). The constrained application protocol (CoAP) working group defines an application protocol for constrained devices and networks. This is an alternative to the HTTP protocol used for RESTful web services taking into account the special requirements of constrained devices and networks.

The ZigBee specifications enhance the IEEE 802.15.4 standard by adding network and security layers and an application framework. They cover various application areas like home and building automation, health care, energy and light management and telecom services. The original Zigbee specifications define their own network and application layer protocols, while the latest Zigbee IP specification builds on IPv6 and CoAP.

For the actual data exchange between applications various approaches exist, often using a service oriented architecture (SOA). Examples are OPCUA which is an IEC standard and SOAP, WSDL and REST defined by World Wide Web Consortium (W3C). XML as defined by W3C is the commonly used encoding format. In the context of WSN it has to be considered how far these protocols fit to constrained devices and networks.

The Open Geospatial Consortium (OGC) has defined a set of open standards for integration, interoperability and exploitation of web-connected sensors and sensor-based systems (sensor web enablement).

For the management of devices and networks the SNMP protocol defined by IETF is widely used. NETCONF is a new approach for network management in IETF. Currently activities have started to cover management of constrained devices and networks explicitly in IETF. Other devices management protocols considered for IoT are TR-69 from Broadband Forum (BBF) and Open Mobile Alliance (OMA) Device Management. Semantic representation of the information is an important issue in WSN and IoT in order to ease knowledge sharing and auto-configuration of systems and applications. W3C is defining the base protocols like RDF, RDFS and OWL in its semantic web activities. Again the specific requirements of constrained networks and devices have to be taken into account. Furthermore semantic sensor network ontology has been defined. For querying geographically distributed information OGC has defined GeoSPARQL. The European Telecommunications Standards Institute (ETSI) TC SmartM2M has started from use cases and requirements for several application areas to develop M2M communication architecture and the related interfaces between devices, gateways, network notes and applications with a focus on offering M2M services. This work is introduced into OneM2M.

ISO/IEC JTC 1/WG 7 (Sensor Networks) has developed the ISO/IEC 29182 services for a sensor network reference architecture and services and interfaces for collaborative information processing. They are working on sensor network interfaces for generic applications and smart grid systems.

ITU has set up a M2M focus group to study the IoT standardization landscape and identify common requirements. Its initial focus is on the health sector. A joint coordination activity (JCA-IoT) shall coordinate the ITU-T work on IoT, including network aspects of identification functionality and ubiquitous sensor networks (USNs). In addition ITU has varies more or less related activities for example on next generation networks including USN, security and identification (naming and numbering).

IEEE has in addition to the 802.15.4 also activities on smart transducers (1451 series) and for ubiquitous green community control (1888 series). Information models, sometimes with semantic representation and even ontology are already available for different application areas like for smart grid from IEC TC 57, industry automation from IEC TC 65 and ISO TC 184 and building automation from ISO TC 205 and ISO/IEC JTC 1/SC 25.

Important in the IoT context are also product data standards as defined for example by IEC SC 3D, identification standards as defined by ISO and ITU and location standards as defined for example by ISO/IEC JTC 1/SC 31 and OGC.

Ⅳ. IoT Applications

1. WSN Application in Intelligent Transportation

Wireless sensing in intelligent transportation differs on several points from the traditional concepts and design requirements for WSN. In most cases, sensors can rely on some sort of infrastructure for power supply, for example the aspect of energy efficiency is usually of secondary importance in these systems. WSN applications in intelligent transportation can be subdivided into two categories:

(1) Stationary sensor networks, either on board of a vehicle or as part of a traffic infrastructure.

(2) Floating sensor networks, in which individual vehicles or other mobile entities act as the sensors.

The latter category comprises applications related to the tracking and optimization of the flow of goods, vehicles and people, whereas the former comprises mainly applications that were formerly covered by wired sensors.

Intelligent traffic management solutions rely on the accurate measurement and reliable prediction of traffic flows within a city. This includes not only an estimation of the density of cars on a given street or the number of passengers inside a given bus or train but also the analysis of the origins and destinations of the vehicles and passengers. Monitoring the traffic situation on a street or intersection can be achieved by means of traditional wired sensors, such as cameras, inductive loops, etc. While wireless technology can be beneficial in reducing deployment costs of such sensors, it does not directly affect the accuracy or usefulness of the measurement results.

However, by broadening the definition of the term “sensor” and making use of wireless technology readily available in many vehicles and smart phones, the vehicles themselves as well as the passengers using the public transportation systems can become “sensors” for the accurate measurement of traffic flows within a city.

City logistics is another use case in this area. Urbanization is posing a lot of challenges, especially in rapidly developing countries where already huge cities are still growing and the increasingly wealthy population leads to a constantly rising flow of goods into and out of the city centers.

Delivery vehicles account for a large portion of the air pollution in the cities, and streamlining the flow of goods between the city and its surroundings is the key to solving a lot of the traffic problems and improving the air quality. A promising approach towards reducing the traffic load caused by delivery vehicles is the introduction of urban consolidation centers (UCCs), i.e. warehouses just outside the city where all the goods destined for retailers in a city are first consolidated and then shipped with an optimized routing, making the best possible use of truck capacity and reducing the total number of vehicles needed and the total distance travelled for delivering all goods to their destinations.

To achieve such optimization, careful analysis and planning of traffic flows in the city as well as monitoring of the actual flow of the goods are needed. The challenges and the solutions are similar to the ones discussed above, but with a finer granularity. Rather than just tracking a subset of vehicles as they move through the city, tracking of goods at least at a pallet level is required. The pallet (or other packaging unit) thus becomes the "sensor" for measuring the flow of goods, and a combination of multiple wireless technologies (GPS, RFID, WLAN, cellular) in combination with sophisticated data analysis techniques are applied to obtain the required data for optimizing the scheduling and routing of the deliveries and ensure timely arrival while minimizing the environmental impact of the transportation.

2. IoT Applications in Smart Grid

The power grid is not only an important part of the electric power industry, but also an important part of a country's sustainability. With the dependence on electric power gradually increasing, demand for the reliability and quality of the power grid is also increasing in the world. Utilities, research institutions and scholars have researched how to modernize the power grid to one that is efficient, clean, safe, reliable, and interactive. A smart electricity grid opens the door to new applications with far-reaching impacts: providing the capacity to safely integrate more renewable energy sources (RES), electric vehicles and distributed generators into the network; delivering power more efficiently and reliably through demand response and comprehensive control and monitoring capabilities; using automatic grid reconfiguration to prevent or restore outages (self-healing capabilities); enabling consumers to have greater control over their electricity consumption and to actively participate in the electricity market. General architecture transmission line based on WSNs as shown in Figure 1.1.

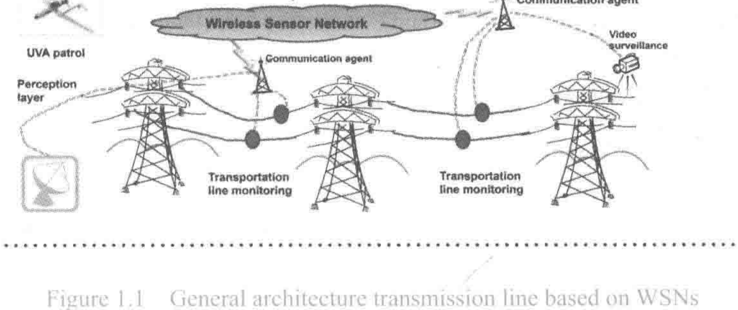

Figure 1.1 General architecture transmission line based on WSNs

Sensors will be a key enabler for the smart grid to reach its potential. The idea behind the "smart" grid is that the grid will respond to real time demand; in order to do this, it will require sensors to provide this "real time" information. WSNs as "smart sensing peripheral information" can be an important means to promote smart grid technology development. WSN technology in the smart grid will also further promote the industrial development of WSNs.

V. New Words

sensor ['sensə] *n.* 传感器

integrated ['ɪntɪgreɪtɪd] *adj.* 综合的；完整的；互相协调的

object ['ɒbdʒɪkt] *n.* 目标；对象；客体

proliferate [prə'lɪfəreɪt] *vi.* 增殖；扩散；激增

process ['prɑsɛs] *v.* 加工；处理

synthesize ['sɪnθəsaɪz] *v.* 合成；不同元素间的整合

cohesive [kəʊ'hiːsɪv] *adj.* 有结合力的；紧密结合的；有黏着力的

VI. Phrases

internet-like 网络化

smart grid 智能电网

smart water 智能水资源处理

smart home 智能家电

data Management 数据管理

awareness of service 服务意识

VII. Abbreviations

WSNs Wireless Sensor Networks 无线传感器网络

SoC System on a Chip 片上系统

IoT internet of things 物联网

ISO International Standardization Organization 国际标准化组织

IEC International Electro technical Commission 国际电工技术委员会

JTC1 Joint Technical Committee 1 第一联合技术委员会

SWG5 Special Working Group 5 第五特别工作组

SDN Software Define Network 软件定义网络

NFV Network Functions Virtualization 网络功能虚拟化

IT Information Technology 信息技术