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**INVESTIGATION AND IMPROVEMENT OF
MULTIMODAL METHOD FOR INTERNET
OF THINGS OBJECTS IDENTIFICATION
AND AUTHENTICATION**

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Abstract

This report analyses security means in multilayered architecture of Internet of Things (IoT) for secure communication and data transmission. The IoT is a global network of objects with sensors, controllers, software and capable of gathering, processing, exchanging information, which functioning is based on interactions between existing or completely newly developed information and communication technologies. This allows to link a many various types of objects over the internet, so it is necessary to develop a multilayered architecture of IoT with security means, which would allow identifying physical objects, establish their operation rules, protect outgoing confidential information, ensure the integrity of data received and lower consumption of energy resources. The agents in the smart environment of objects of the IoT interact with each other with application layer protocols, which must ensure accessibility of information for authorized users, reliability of the messages between a sender and a receiver, security of the data at any time. The communication of objects of the IoT an application layer is often attempted to interfere with during malicious scripts, social engineering, software vulnerabilities, phishing and sniffing attacks. This paper presents a systematic literature review of conference and journal articles on the topic of IoT security. The review has been undertaken to define IoT security at the application layer, identify the security requirements and analyze proposed security means solutions for their integration in multilayered architecture of IoT.

Keywords: Internet of Things, Data Transmission, Multilayered Architecture, Secure Communication, Security Means.

Contents

1. Introduction	Error! Bookmark not defined.
2. Daiktų interneto architektūra	5
3. Daiktų interneto elementai	6
4. Daiktų interneto objektų identifikavimo protokolai	8
5. Daiktų interneto objektų identifikavimo standartai	Error! Bookmark not defined.
6. Daiktų interneto objektų identifikavimo metodai	Error! Bookmark not defined.
7. Išvados	9
8. Literatūra	9

1. Introduction

The surroundings of the smart devices and the internet have become a common daily phenomenon in our lives. In most areas of life and economy, the management and monitoring take place through the using of the internet as well as various digital devices interacting across the network. The data transmitted over the network not just through „human to human” or „human to computer” interactions but also through the sensors interacting with devices, which otherwise called of the internet objects [20]. This has formed the IoT, which is a new network configuration that includes the communication of physical objects and interaction of various objects with the internet. The IoT is often referred to as the next stage of the evolution of the internet, where things become active participants of business, information, and social processes, who can communicate and interact with each other, as well as a smart environment surrounding them by exchanging data, reacting autonomously to the events of the physical world and influencing the environment by carrying out various activities and providing the smart services [28]. The benefits of smart environments and the IoT include comfort, security, optimal use of energy resources and many other services that greatly improve the quality of life. The possibilities of using the IoT are not limited just to providing services to people but allows to adopt technologies in the industry, trade, education, transport and even in the digital reality, where smart software agents communicate and make decisions [14].

The IoT understood as the global infrastructure, which is committed for the information society, providing modern services, connecting objects with the basis of already existing and developing information and communication technologies [24]. By identifying, collecting data, processing and using communication capabilities, the IoT allows the full use of objects for various services, ensuring high security and privacy requirements. The security is one of the core components of the smart environments of the IoT, as these environments interact with people and objects in the environment [10]. Smart environments designed for manufacturing, military, health and other very critical applications from a security point of view and it is necessary to protect these environments from dangers and external malicious effects. An important aspect of safety is privacy, which is defined as an indicator of the protection of human rights, establishing rules and limits, that prevent interference with a personal life, because smart environments and IoT technology become a part of the everyday and everywhere life of

the future are directly threatened by the fact that these systems will be used for tracking and interfere in the private life [16].

The number of things connected to the internet is steadily increasing and it is predicted that by 2020, there will be about 16 billion interacting physical objects [27]. Such a scale of objects of the IoT closely connects the real-world with the digital information technology world, which is based on automatic identification, real-time location, sensors and controllers technologies [12]. The IoT resources and provided services are distributed across the information network, so it is necessary to develop a multilayered architecture with flexible interfaces, which would ensure the interoperability of resources, security, and reliability [4].

The aim of this paper is to overview and analyze security means at the application layer in the multilayered architecture of the IoT, which would allow secure communication of objects of the IoT in a smart environment, reliable data transmission and ensure lower consumption of energy resources.

The rest of the paper is organized as follows. Section 2 presents related works on the security issues and challenges in the IoT. Section 3 discusses the multilayered architecture of the IoT that indicating the basic security aspects, which must be implemented. Section 4 describes the most common security problems at the application layer of the architecture of the IoT and provides an overview of the security means and their applicability to the IoT multilayered architecture. Section 5 concludes the paper and provides a discussion on the further research.

2. A Multilayered Architecture of the IoT

The IoT should be capable of interconnecting millions or billions of the heterogeneous objects through the internet, so there is a critical need for a flexible, reliable and secure multilayered architecture [5]. The increasing number of the proposed IoT architectures has not yet converged to a reference model, but some global projects are constantly developing try to create a common architecture based on the analysis of the needs of the researchers and the industry [2]. The security strategies should be very carefully designed for managing the tradeoffs among the security, privacy, and utility to provide the security in a multilayered architecture of the IoT [3]. Fig. 1 illustrates a multilayered architecture of the IoT, which consist of objects, objects communication, service management, application and business layers.

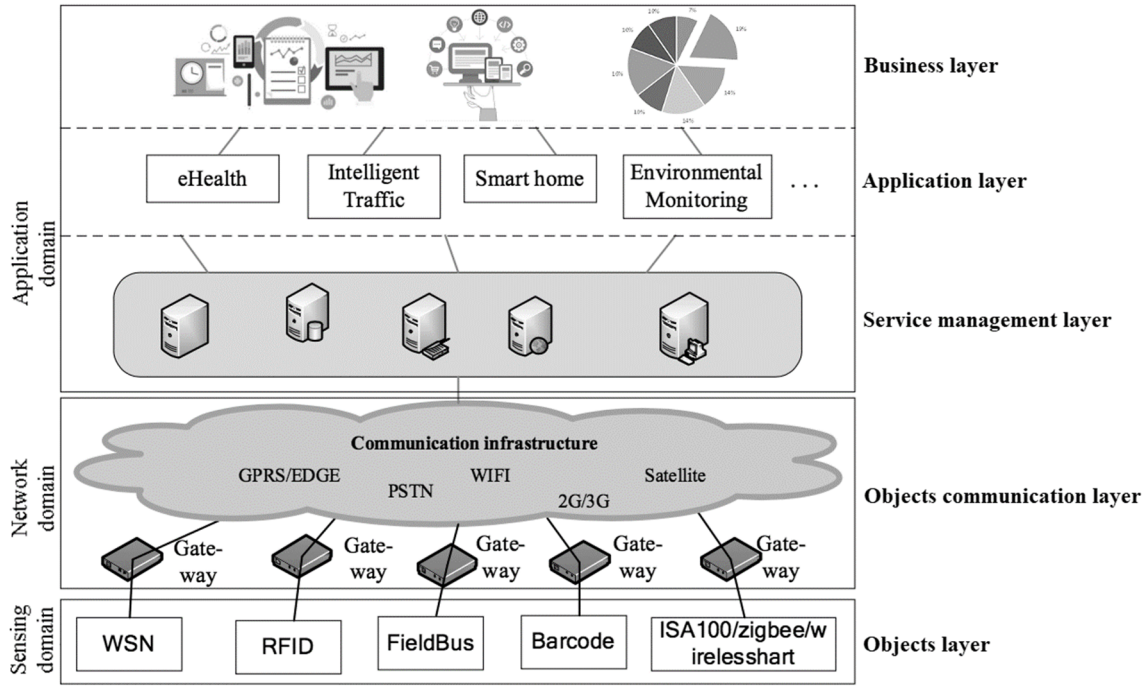


Fig. 1. A multilayered architecture of the IoT [18]

The objects layer is known as the perception layer, which collects all kinds of information through the physical equipment and identifies the physical world. This layer includes the sensors and actuators in order to perform different functionalities such as acceleration, location, temperature, vibration, etc. The miniaturization of hardware has enabled the powerful sensors due to producing in much smaller forms, which are integrated into the objects in the physical world. The sensors can be a barcode, embedded or infrared sensor depends upon the identification method of the objects. The collected information from sensors is passed to the object abstraction layer for its secure transmission to the processing system of information. Some common security problems in this layer are node capture, fake node, malicious data, timing, and reply attacks [7].

The objects communication layer is known as the network layer, which transmits the information produced by the objects layer to the service management layer through the secure channels. This layer is responsible for aggregating the information from existing sources and transmitting it to correct destinations. The transmission of information is based on networks like local area network (LAN), radio access network (RAN), wireless sensors network (WSN), etc. These networks can be in the form of a private, public or hybrid models and are built to support the objects communication requirements for latency, bandwidth or security. Some security problems in this layer are acknowledgment flooding, malicious code injection, unauthorized network access, denial of service, and man in the middle attacks [13].

3. Related Work

Several researches have been led to deal with the security issues in the IoT. Most of these researches focus on the security attacks and threats of the IoT. A summary of the mentioned researches on the security issues in the IoT is provided in Table 1.

Table 1. Researches on the security issues in the IoT

References	Year	Security issues
[6]	2015	Evasion attack, insertion attack, side channel attack, spoofing attack
[17]	2014	Congestion attack, cloning attack, flooding attack, integrity attack
[22]	2013	Distributed denial of service attack, network attack, radio signal attack
[26]	2012	Counterfeit attack, malicious attack, meanwhile attack, phishing attack
[29]	2013	Exploit attack, node capture attack, replay attack, side channel attack

Glenn A. Fink et al. [6] discussed various kinds of vulnerabilities in the IoT and also societal effects such as standards, privacy, and security. The discussion on the security system, which is related to crime, cyber welfare, emergent behavior, scientific and technology challenges, social and regulatory challenges, was made. Various kinds of techniques were provided to mitigate these threats.

Gurpreet Singh Matharu et al. [17] described the general architecture and briefed several challenges in the IoT such as robustness in connectivity, interoperability, and standardization, naming and identity management, safety and security of objects, data confidentiality, and encryption. Security issues related to all the four layers of the IoT general architecture were discussed, analyzed and determined. Finally, the appropriate strategies for solving security issues were suggested.

Chen Qiang et al. [22] discussed the privacy protection, wireless communication, and information security. The existing researches on the network security technology were investigated. Based on that, a new IoT security method was provided. The difficulty in processing of the massive amount, the ensuring security and reliability of the IoT data were highlighted. The need to solve security issues and avoid a big security risk of the application of the IoT was stressed.

Hui Suo et al. [26] reviewed the researches of the IoT and discussed the security issues. The discussion on the security architecture, features, and requirements in each level of the IoT was made. The issues, which are related to the key agreement, identity authentication, cloud computing, authentication in the IoT layers namely perceptual layer, network layer, support layer, and application layer were discussed. Eventually, several key challenges in the IoT were summarized.

Kai Zhao et al. [29] discussed the security issues of the IoT three-layer system structure and offered some different solutions in each layer. The common attacks such as node capture, fake node, malicious data, replay attack and routing threats in object layer were elaborated. The cryptographic algorithms and key management techniques were deployed in order to solve these attacks. The compatibility and cluster security problems were resolved key agreement mechanism.

4. Security Means of the IoT at the Application Layer

At IoT application layer, there are not many security solutions, and most of them rely on the security means. The application level has to ensure the privacy, the confidentiality, and the secure storage of information in order to cover the individual privacy protection. A summary of the security means of the IoT at the application layer is provided in Table 2.

Table 2. Security means of the IoT at the application layer

References	Security issues	Security effects	Security means
[1]	Malicious script	System hijacking	Authentication
[9]	Phishing attack	User data leakage	Risk assessment
[15]	Sniffing attack	Data interception	Data security
[21]	Social Engineering	Illegal intervention	Access permissions
[23]	Software vulnerabilities	Buffer over flow	Awareness of security

The malicious script [1] is the kind of harmful computer code designed to create the system vulnerabilities, security breaches, the information and data theft. The application layer can be secured by authentication, which prevents the access to any miscreant users by integrated identity identifications.

The phishing attack [9] is an attempt to obtain the sensitive information such as usernames, passwords, money for malicious reasons. The application layer can be secured by a risk assessment that gives justification for the security strategies and provides improvements in the security of structure.

The sniffing attack [15] is theft or interception of data by capturing and analyzing traffic transmitted over the network using a sniffer application. The application layer can be secured by a data security that gives privacy of the overall system, protects any unauthorized access and prevent malicious activities.

The social engineering [21] refers to psychological manipulation of people into performing actions or divulging confidential information. The application layer can be secured by access permissions, which prevents and controls the ability of the attackers to view, change and execute contents of the file system.

The software vulnerabilities [23] are a weakness, which can be exploited by a threat actor to perform unauthorized actions within a computer system. The application layer can be secured by the awareness of security including maintenance system, best practices in deployment and development auditing.

5. Conclusions and Future Works

This paper respectively expounds the IoT multilayered architecture problems and the security means at the application layer. The analysis of the security problems in different architecture layers demonstrate that there is no reliable protection in many IoT areas and resolve these existing issues research should be done. In future research is planned to make a detailed security analysis in multilayered architecture of the IoT.

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