Research on Testing and Verification of Internet of Things Technology Based on Edge Computing

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Abstract. With the expansion of the scale of the development and the deployment of IoT applications, the terminals and network devices of IoT are increasing day by day, resulting in massive data, most of which need to be processed on the edge. Edge computing can achieve localized processing of traffic and reduce traffic network traffic impact. Therefore, it is necessary to carry out the research of testing and verification of IoT technology based on edge computing, tackle key technologies of edge computing, and develop test and verification services.

Introduction

With the expansion of the scale and the deployment of IoT applications, IoT terminals and network devices are increasing day by day, resulting in massive data. Data from research institutes predict that by 2020, 50 billion devices will be connected to the Internet, generating more than 400 ZB of data. 45% of this data will need to be processed on the edge. Edge computing transfers the center of data storage and computation from the central data processing center to the edge, provides network, computing, storage and application services near objects or data sources, and provides edge intelligent services nearby. It can meet the key requirements of industry digitization in agile connection, real-time business, data optimization, application intelligence, security and privacy protection. Edge computing can not only localize traffic, reduce traffic impact of transmission network, but also help to achieve the best matching of application scenario requirements, power distribution and deployment costs. It has become the focus of attention in the era of the IoT. The edge computing framework, key technology research and technology validation applied to the IoT are of great significance to promote the research and development of edge computing technology and application deployment.

In this context, there is an urgent need to carry out the test and verification research of IoT technology based on edge computing. The key technology of edge computing is tackled to form the ability of edge computing test and verification. The construction of the platform can provide verification and testing services for mainstream terminals, open source/commercial edge platforms to access the IoT system.

Edge Computing and IoT Related Technologies

Introduction of Edge Computing Technology

Edge computing refers to an open platform that integrates network, computing, storage and application core capabilities on the side close to the object or data source. Edge computing provides near-end services, which are more suitable for real-time data analysis and intelligent processing, and more efficient and secure. Edge computing is a relative concept, which refers to arbitrary computing, storage and network resources between data sources and cloud computing center paths. Network edge resources mainly include user terminals such as mobile phones, personal computers, WiFi access points, cellular network base stations and routers and other infrastructure. These resources are numerous, independent and scattered around users, which are called edge nodes. Edge
computing is to integrate these independent and decentralized resources, which are close to users in spatial or network distance, to provide computing, storage and network services for applications. Edge computing includes downstream cloud services and upstream interconnection services. Edge computing refers to arbitrary computing, storage and network resources from data sources to large cloud computing centers. Edge computing is one of the big data processing methods. Unlike traditional cloud computing, data can be solved on the edge side without being transmitted to the remote cloud. It is more suitable for real-time data analysis and intelligent processing. Edge computing focuses on real-time and short-period data analysis, which has the advantages of security, fast and easy management. It can better support the real-time intelligent processing and execution of local services, meet the real-time needs of the network, and make more effective use of computing resources [2,3].

**IoT Technology**

IoT technology aims to connect physical objects with the Internet according to the communication protocols agreed by the IoT by using perception control technology, network communication technology, information processing technology and security management technology, so as to realize intelligent identification, location, tracking, monitoring and management of Internet resources. Perception control technology mainly includes sensors, radio frequency identification, multimedia, industrial control and so on. Network communication technology mainly includes industrial ethernet, short-distance wireless communication technology, low-power WAN and so on. Information processing technology mainly includes data cleaning, data analysis, data modeling and data storage. Security management technology includes encryption authentication, firewall, intrusion detection and so on [1,4].

**Design Framework of Test and Verification**

To tackle the key technologies of IoT based on edge computing in the field of IoT, edge computing technology is applied to enhance the networking capability of IoT. By developing a low-power, low-latency edge access system architecture for IoT applications, test and verification capabilities are formed. Through the establishment of the platform, we can provide verification and testing services for mainstream terminals, open source/commercial edge platforms to access the IoT system. Fig. 1 is the overall design framework of the paper [5].

![Figure 1. The overall design framework.](image-url)


IoT Access Layer

The IoT access layer includes field device layer and network layer. The field device layer supports the docking of multiple device protocols (OPC-UA, MQTT, CoAP, AMQP, HTTP, etc.). The network layer supports the access and configuration of multiple networks (fieldbus, real-time ethernet, TSN, 4G/5G, NB-IoT, etc.). Field devices and networks need to be connected to the IoT access layer through communication gateways. Mainstream network (Ethernet / TSN, etc.) and mainstream protocol (OPC-UA / MQTT) are used between the communication gateway up and IoT access layer to ensure secure, real-time and reliable connection, downward and various network/device connections lacking completeness.

Core Service Layer of Edge Computing

The core service layer of edge computing includes edge data analysis component and other micro services. Edge data analysis component includes device metadata management component, real-time data stream configuration management component, real-time data stream preprocessing component, real-time data storage component and database interface component. Other micro services include log management, business orchestration, security and data integrity management, connection configuration and other micro services[6].

IoT Access Testing and Verification Tool

The IoT access test and verification tool provides a complete integrated test environment, realizing real-time, security, data integrity, power consumption and reliability testing functions. According to the requirement of interface testing provided by edge device nodes, the test software modules are deployed to the IoT access layer and edge computing core service layer respectively. Meanwhile, edge APP is developed, and test man-machine interface is provided.

Edge APP Development

Edge computing platform provides API interface service for edge APP development through edge APP interface. Based on OPC-UA and MQTT, interconnection with other edge computing platforms and cloud platforms is realized. The edge APP mainly includes the functions of real-time state monitoring, intelligent process data analysis, data visualization and real-time diagnosis.

Cloud Interface

The cloud communication interface is reserved for edge computing platform, which lays a foundation for further testing and verification of edge cloud collaboration.

Interface with other Edge Computing Platforms

The platform proposed in this paper can obtain real-time data streams from other commercial/open source edge computing platforms. The original data or processed data stream can also be forwarded to other edge computing platforms[7].

Conclusion

Due to the rapid development of short-distance wireless communication (WiFi, Bluetooth, etc.), low-power wide area network communication technology (NB-IoT), 5G, edge computing and other technologies, the number of IoT devices accessed by edge computing platforms has shown a blowout growth. IoT terminals, systems and applications are becoming more and more complex. Testing and verification of IoT technology has begun to develop towards unified test management of heterogeneous networks, rapid reconfiguration iteration testing and intelligent processing of edge test data.

This paper has studied the edge computing technology, IoT technology and platform technology framework based on edge computing for testing and verification of IoT technology. Through the construction of platform, the ability of edge computing test and verification can be formed. It provides edge device node interface verification and testing services for smart city, smart home, industrial IoT, wearable devices, industrial applications, intelligent robots and other industries.
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