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Research on Software Defined Sensor Network Architecture

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Abstract

Introduce Software Defined Network and network virtualization technology into the field of Wireless Sensor Network, and understand the working mechanism of OPENFLOW and the network architecture, WSN data plane and control of software-defined wireless sensor network The separation of planes, the construction of virtual wireless sensor networks, the in-network data processing and forwarding are carried out in-depth research, the design and realization of virtual sensor network layout and construction schemes, the construction of state-based rule-action forwarding strategies, and Develop the DEMO system and simulate and test the network to improve the reuse rate of the underlying network equipment.

Keywords

Software-defined network, WSN, SDN.

1. INTRODUCTION

The recently proposed software-defined networking (SDN) and network virtualization technologies are the first choice to solve the above problems. For heterogeneous sensor networks, although there are many types of sensors on the data collection side and various data collected (such as temperature, humidity, care, etc.), data transmission and forwarding is something that all sensor nodes must do. This commonality can be used to build Virtual Wireless Sensor Networks (VWSN) are used to solve the problem of low reuse rate of the underlying physical equipment for private networks and reduce the cost of network development.

At present, foreign scholars and scientific research institutions have devoted themselves to the research of software-defined wireless sensor networks and virtual wireless sensor networks. VWSN has aroused the research enthusiasm of a large number of scholars due to its flexibility and resource reuse. Many foreign research institutions have initiated research on this subject and have achieved some results, publishing a series of high-quality papers. Research on software-defined wireless sensor networks mainly includes the following:

Salvatore Costanzo and others of the European Communications Association proposed Software Defined Wireless Networks. This article is the first attempt to introduce SDN into the WSN field. SDWN provides a more flexible rule to classify data packets, that is, traffic matching can consider data packets. Any part, and supports the use of periodic sleep and wake-up to achieve the energy efficiency of the wireless sensor network.

Tie Luo et al. proposed Sensor OpenFlow, launched a software-based WSN architecture, and solved the key technical challenges of its core component Sensor OpenFlow. Introduce SDN technology to the field of wireless sensor networks. Sensor OpenFlow is different from traditional OpenFlow in that it supports data packet processing in the network and various types of addressing defined for WSN.

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Laura Galluccio and others of the University of Kentucky in Italy proposed SDN-WISE: Software Defined WIrelessSEnsor networks. Define a complete architecture that allows software developers to implement their controllers in any programming language of their choice. In addition, SDNWSN introduces a software layer that allows multiple virtual networks to run on the same physical wireless sensor or WPAN network, similar to the role of FlowVisor in OpenFlow networks.

The research of virtual wireless sensor network is mainly divided into the following two directions:

One is the study of gateway protocols for virtual sensor networks. At present, there are many applications that need to collect data from various sensor networks to provide users with comprehensive services. In order to reduce the complexity of processing heterogeneous sensor network data, researchers have designed a common gateway interface between heterogeneous networks, which can Different types of sensor networks are integrated into a new virtual sensor network.

The second is to focus on researching middleware based on virtual sensor networks. In the literature [1], the author proposed a small virtual machine called "Maté" for sensor networks, which can be deployed on the top layer of the component-based open source operating system TinyOS, thereby realizing the virtualization of the underlying sensor nodes. In the literature [2], the author made improvements on the basis of the Maté virtual machine, and proposed a new virtual machine Agilla, which can expand and deploy applications by dynamically injecting code into the sensor network system. Compared with more flexible and convenient.

In addition, FRESnel (Federated Secure Sensor Network Laboratory) of the University of Cambridge in the United Kingdom has also participated in the research of virtual sensor networks. They are working to establish a super-large-scale sensor network platform, which is completely shielded from the bottom layer. The details of the hardware facilities: The sensor node monitors various physical information, such as temperature, light intensity, volume, speed, etc., and on top of the underlying physics, a variety of sensor network applications belonging to different users can share sensor node resources. For users, how the different nodes at the bottom layer collaborate is completely transparent, and there is no need for human control from time to time. The purpose of the project is to provide a seamless and collaborative platform for a variety of sensing applications, which coincides with the VSN concept.

This project introduces Software Defined Network (SDN) and network virtualization technology into the wireless sensor network (Wireless Sensor Network, WSN) field. The working mechanism of OPENFLOW, the separation of WSN data plane and control plane, virtual wireless transmission In-depth research on the construction of Virtual Wireless Sensor Networks (VWSN), data processing and forwarding in the network, based on the SDN-WISE architecture, design and implementation of the virtual sensor network layout and construction plan, and build a state-based rule-action forwarding strategy, And develop the DEMO system and simulate and test the network.

2. SYSTEM MODEL

The main research contents of this project are as follows:

(1) Research on decoupling of architecture, data plane and control plane.

The network is divided into a data plane and a control plane. The data plane is executed by sensor nodes and the control plane is executed by the controller. There are two types of data forwarding: forwarding that requires data processing within the network and forwarding that does not require data processing within the network.

(2) Research on the layout and construction of VWSN.

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It mainly includes VWSN construction algorithm, virtual cluster construction and data processing and forwarding strategy research. For the WSN private network, it is proposed to use the virtual cluster tree algorithm to cluster the sensor nodes and select the appropriate cluster head node. Based on the clustering, a virtual cluster tree construction algorithm combining top-down and bottom-up is adopted. Shield the heterogeneous characteristics of WSN and provide transparent applications.

(3) Design VWSN multi-path forwarding mechanism and path recovery algorithm. In wireless communication, the signal is unstable, network topology changes frequently, network dynamics are strong, and single path forwarding has certain risks. The VWSN multi-path forwarding mechanism and path recovery algorithm are proposed. When forwarding, the optimal one is selected. If the forwarding fails, the path recovery algorithm is activated and the backup path is selected for data forwarding.

(4) Develop DEMO program and carry out simulation and test. The test includes hardware platform test and simulation test. The hardware test plans to use TI CC2530 development board component wireless sensor network, and the sensors plan to use temperature, humidity, light, flame, etc. The network simulation is like OMNET++ simulation tool, it is planned to set 1000 kinds of random topologies, and analyze the performance parameters of this scheme and existing schemes.

3. CONCLUSION

Introduce Software Defined Network (SDN) and network virtualization technology into the wireless sensor network (Wireless Sensor Network, WSN) field, construct a state-based rule-action forwarding strategy, and develop a DEMO system and simulate the network The test intends to increase the reuse rate of the underlying network equipment.

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