

Smart Router Development for WIFI Sharing Systems

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Abstract

With the increasing popularity of smart devices, the need for people to use mobile devices to surf the internet is growing. In order to meet the needs of users, major operators have launched 5G network, but only relying on mobile network can not meet the needs of users to surf the internet anytime and anywhere. In this case, the wireless router can provide users with a convenient and stable network environment. However, traditional home and private routers simply allow and provide wireless networking to certain groups of people. In order to break through the limitations of scope and usage scenarios, and maximize the benefits people get from the network, the project plans to develop an intelligent router to realize WIFI sharing. The project is designed based on OpenWRT open-source embedded system. Through the transformation of the router, the compiled OpenWRT system is transplanted to the router. At the same time, the entire project needs to cooperate with the relevant interfaces of the client module and the server module to realize the function of WIFI sharing. The system is an intelligent extension of the router function to meet the sharing requirements of the project. Through the use case testing, the reliability and practicability of the project function and process are verified. This project aims to provide a feasible reference design scheme, which has certain market application value and research significance.

Keywords

WIFI; OpenWRT; Router; Internet Interception.

1. Chapter 1 Introduction

1.1. Background and Objective

1.1.1. Problem Description and Background

In recent years, with the rapid development of mobile internet and communication technology, the current scientific and technological conditions allow people to pursue a more intelligent and humanized lifestyle. As the time goes on, the number of users of telecom operators is surging, and the connection demand is growing rapidly. At present, the existing mobile network connection methods are only cellular network technology and wireless network technology. For mobile communication technologies such as cellular network, customers can use cellular network when they are not at home, in the office or anywhere where free or low-cost WIFI is not provided. However, cellular data connection (3G, LTE and even 5G) cannot meet the high demand of customers for data rate, data volume and cost. Meanwhile, too many cellular data connections will bring huge traffic burden to operators, which is easy to cause unexpected congestion of cellular networks. In addition, there are some situations to consider, such as multi device connection. At present, some laptops and iPads cannot connect directly to the cellular network unless they use portable 4G to WIFI hotspots. Wireless network technology is provided by scene operation, which generally belongs to short-range wireless technology used in small regional offices or families. Other scenarios cannot meet the needs of people. For example, customers need WIFI on the road and seamless network connection from home to out.

1.1.2. Project Objective

This project divides the development into three modules to realize WIFI sharing. They are router software module, client software module and server software module. Other students will be responsible for the client software module and server software module.

The development objectives and contents of router module include:

- (1) Investigate the research background and related implementation technologies of the development and determine the functions of the router module in this project.
- (2) Select the overall design scheme of WIFI sharing, determine the design framework of router module and other modules, and decompose the work elements.
- (3) Develop software system. The router module will use the OpenWRT system. Transplant OpenWRT system to router.
- (4) Realize the communication protocol with the client and server. Provide information for client and server.
- (5) Finally realize the functions of information transmission, internet interception, user connection management and time recording.

1.2. Literature Review

With the world's attention to the internet, people began to study various ways of internet access and availability, and explore how to make people more convenient and effective to connect the network. One way is WIFI hotspot network. For public WIFI hotspots, these hotspots are usually used free of charge. Places such as coffee shops, libraries and retail stores may provide users with free public WIFI connections. However, research shows that using public hotspots, there is a risk of tracking behavior and privacy disclosure in WIFI capture portals and login pages [1]. For mobile WIFI hotspots, people use mobile phones to create WIFI hotspots from their mobile data. Mobile hotspot users need to carefully monitor their data usage to avoid expensive plan expiration, access may be limited, and coverage may be limited [2]. Therefore, in general, the range, power, speed, and price of hot spots may vary according to people's location. Different from the connection mode of WIFI, we propose to expand the use authority of WIFI and consider the scheme of WIFI sharing from reality. WIFI sharing system is used to share secure WIFI signals with others within the same distance in an organized way, such as in the house where neighbors or home renters live. Establish a connection between the user's computing device and the WIFI network without sharing SSID, password or a combination of SSID and password [3]. WIFI sharing system with mesh network functionality may include a WIFI signal with an established network connection and a user computing device seeking to access the network connection through the WIFI signal. The system allows the user computing device to rent or share WIFI signals through the system and establish a secure connection between the user computing device and the WIFI network without sharing SSID and / or password [4]. In addition, if the signal strength of the connected WIFI signal drops below the minimum threshold, the system automatically changes the user computing device to another WIFI signal on and near the system [5]. In short, the existing WIFI hotspots have many limitations and defects, and the WIFI sharing scheme has certain innovation and implementation significance.

1.3. Project Design

In the development of wireless technology in the past, a wireless router was always defined as a terminal device that provided a wireless network. Traditional wireless routers only provide simple data exchange and internet access functions. Compared with the traditional wireless router, the wireless router of OpenWRT system selected in this project not only provides basic functions, but also provides rich expansion functions. The biggest difference between OpenWRT wireless router and traditional router is that it has an independent and perfect

operating system, which is also the basis for realizing these extended functions. On the router based on OpenWRT, this project can meet the project objectives and requirements by using the built-in files of the router and running the developed program script.

This project uses OpenWRT system to develop router module. OpenWRT is a deeply customized build-root system, which is a collection of make files and patches. It can construct and use the corresponding cross compilation tool chain to automatically construct a complete OpenWRT embedded system based on Linux [1]. Unlike many other distributions for routers, OpenWRT is a router operating system written from scratch, fully functional and easy to modify. The Linux kernel in OpenWRT will support these functions. In terms of software, it uses embedded operating system, has perfect message mechanism and network services, and can realize applications with high complexity, strong real-time and high stability.

The implementation and prototype development of WIFI sharing system need three modules: client module, router module and server module. In addition to providing the basic functions of network access, the router module also plays the role of information recording and transmission and performing user network connection management in the whole project.

Relationship with client: To realize the communication protocol, the router should receive and save the information from the client.

2. Chapter 2 Methodology and Results

2.1. Methodology

2.1.1. Router Firmware System:

OpenWRT is a highly modular, highly automated embedded Linux system with powerful network components and scalability, and is often used in industrial control equipment, small robots, smart homes, and routers. Compared with a single, static system, the package management of OpenWRT system provides a fully writable file system. OpenWRT is different from many other distributions for routers. It is a router operating system written from scratch, fully functional and easy to modify. For developers, OpenWRT uses the framework to build applications without building a complete firmware to support it. For users, this means that they have the ability to fully customize and use the device in an unprecedented way.

2.1.2. Functional Design and Strategy:

1. Iptables Firewall Design

Firewall is an organic combination of various software and hardware devices used for security management and screening. It is a technology that helps computer networks build a relatively isolated protective barrier between their internal and external networks to protect the security of user data and information.

Iptables is a packet filtering firewall under the Linux platform. Like most Linux software, this packet filtering firewall is free. It can replace expensive commercial firewall solutions to complete packet filtering, packet redirection, network address translation (NAT) and other functions. In daily Linux operation and maintenance work, Iptables firewall rules are often set to strengthen service security.

User MAC Address Filtering Policy:

The design strategy of router is not to accept or intercept all users, but to intercept selectively. Firstly, the router will be open to all users and define an access value for each user. The firewall control of the router is determined by the server. The router records and judges the messages sent by the server, records the MAC value, and judges the access value. Once the router receives an access value of 1, open file in /etc/firewall.user, write the accept rule. If the access value is 0, the drop rule will be written. This command can access the network but cannot communicate with data (internet forward chain).

2.Communication Design

Socket describes the IP address and port of the computer. Socket is used for data communication between programs running in the computer. There are sockets at both ends of the communication. It is a channel, and the data is transmitted between the two sockets. Socket hides the complex TCP or IP protocol family behind the socket interface due to the number of layers. Complete the socket related functions, then we can realize data communication.

The communication process is as follows:

- (1) The receiver program binds a socket to the specified IP address and port. Then waits and listens for the connection request of the client through this socket.
- (2) The client program sends a connection request to the address and port bound by the receiver program.
- (3) The receiving end accepts the connection request.
- (4) The sender and receiver communicate through read-write sockets.

The communication and information transmission design scheme used in this paper is to communicate with the server and client from the transmission layer. The technology used in programming is socket. The client sends the user ID and MAC address like the router. The router arranges the user ID, MAC address, time, and other information before sending it to the server.

3.Information Storage and Match Design

The saving of router information is temporary and limited. The running of script should not occupy and consume router resources excessively. The information recorded by the router is only user IP, MAC address, user machine name, etc., so there is no user ID information specified by us. In addition, since the access authority of the router is on the server, there is no provision for the initial time and end time, and the router system does not record and save time and other information, the function is realized by adding a dictionary to the script.

The client logged in from the client will the ID assigned by the server, so we record the information from the client and save it in the dictionary with the MAC address as the key and the user ID as the value. At the same time, the login time stamp of the user is recorded to facilitate future calculation. Similarly, take the MAC address as the key and the timestamp as the value.

4.Usage Time Calculation Design

In the code implementation, we know which users connect to the WIFI network by traversing dhcp.leases file. For the project, we only need to know the client user, that is, the user whose MAC address has the corresponding ID value. First, we store the user ID and MAC address in the dictionary. When we traverse the dhcp.leases file, we will record the MAC address in the list. When we cycle the file MAC reading once, the MAC address read once will be recorded in the list.

According to the list obtained after traversing and reading once, the dictionary will find out whether the key value is in this list. If not, it will be found that the user has been offline. Since the MAC is set as the key value in the two dictionaries, the value can be obtained according to the key value, and the time statistics are calculated by the time of the current system and the login time. Finally, send the ID, MAC, and usage time of the offline user to the server.

5.Multithreading Design

Router program script involves the parallel use of multiple functions. At the same time, in order to facilitate data sharing, multithreading method is used.

2.2. Test Evaluation and Analysis

Test scenarios are grouped according to problems or assumptions and tested from two user behaviors and situations: client users and non-client users.

The test scenario strategy is also a system test. Each module is assembled into a complete system for testing. This strategy is an effective way to verify whether the system can indeed provide the functions specified in the project specification or implementation plan. Conduct a comprehensive test on the final software system to ensure that the final software system meets the product requirements and follows the system design. Test scenarios are also grouped according to problems or assumptions and tested from two user behaviors and situations: client users and non-client users.

The comprehensive test task shows the final system prototype and application effect. The implementation of test cases and test scenarios, as well as the corresponding evaluation and results, fully comply with the task and function description of the project design.

3. Chapter 3 Conclusion and Future Work

The project designs and implements a WIFI sharing system based on smart router, which aims to provide a solution with certain reference significance for people's high demand for network and the current situation of communication technology. The WIFI sharing software platform is designed and completed through network communication. The platform deploys client module, server module and smart router module to connect mobile terminal equipment and smart router together. The OpenWRT system introduces the router module and realizes the functions of domain name access restriction and time recording. Through the study of Iptables firewall technology and OpenWRT system, combined with the knowledge accumulation of router application and communication technology, the router application script is designed and completed, which basically meets the requirements of WIFI sharing. The work of this project is summarized as follows:

The main research and development work of the project is summarized as follows:

- (1) This project explores the development status and existing problems of communication technology and puts forward an implementation scheme and significance to solve these problems.
- (2) According to a variety of software development and implementation technologies involved in WIFI sharing, combined with the characteristics of WIFI select different technologies in different applications and establish the overall design scheme. By expounding the development principle and module flow chart, this paper briefly describes the overall design scheme of WIFI sharing project.
- (3) It mainly completes the detailed design of router module software system, including the transplantation and compilation of OpenWRT system, the basic process of Open WRT development, the communication protocol with client and server, and the important functions of router in the project.
- (4) The system function of the router is comprehensively tested, including whether the OpenWRT system is successfully loaded, the web page access of the device in the LAN, and the test results and test exceptions are recorded.

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