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Development of WiFi Mesh Infrastructure for Internet of Things applications

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Abstract

This paper described the design of WiFi mesh infrastructure in order to improve the performance of an ad hoc network, WLAN, and WMAN so that the interconnection becomes easier and cheaper. The built system consisting of some WiFi routers were configured to form a WiFi mesh network so that it can build the Internet cloud. The operating system used in this research is quick mesh project (QMP). In addition, the WiFi node as a client developed for the internet of things (IoT) applications. These nodes using message queuing protocol telemetry transport (MQTT) based publish and subscribe. WiFi mesh infrastructure is working well with the average value of the measured throughput was 110.5 kbps.

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Keywords: WiFi mesh, QMP, MQTT, IoT

1. Introduction

Wireless mesh network (WMN) is a communications network made up of radio nodes organized in a mesh topology. WMN usually consist of mesh clients, mesh routers and gateways. Clients are electronic devices, embedded systems, and sensors that can communicate with each other in a network. The router is an electronic device serves as a liaison between two or more networks to carry data from one network to another. Gateway is an electronic device that bridges the network to the Internet [1]. When one node can no longer operate, the rest of the nodes in the WMN can still communicate with each other, either directly or through one or more intermediate nodes.

Excellence on a WMN is the ease in adding new nodes without re-installation as a whole. WMN have been used for several applications in the field of remote monitoring and control systems such as environmental monitoring [2], the water meter infrastructure [3], automatic street light monitoring system [4], and Real-Time Indoor Carbon Dioxide Monitoring [5]. These studies use a wireless module technology based physical layer such as Zigbee and radio frequency (RF) and thus require a gateway to connect to the internet. This wireless mesh network has low security. Therefore, research that can establish a wireless mesh network based on the latest technology and cover the lack of previous studies is important.

In this paper, we propose a WMN infrastructure based on WiFi technology that has the ease of installation, connectivity and can be used in applications IoT. Wifi is a wireless communication technology-based on internet protocol (IP) that has the quality of communication and better data security than the physical layer technology. In this study, we constructed mesh wifi router as an Internet cloud and the wifi node as a client. Wifi Client designed small size, low power and easy to install with other devices. Through this infrastructure, internet connectivity can reach significant level and support the IoT applications in various fields.

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2. Design of system

WiFi mesh infrastructure built is composed of WiFi client, WiFi routers, and gateways as shown in fig 1.

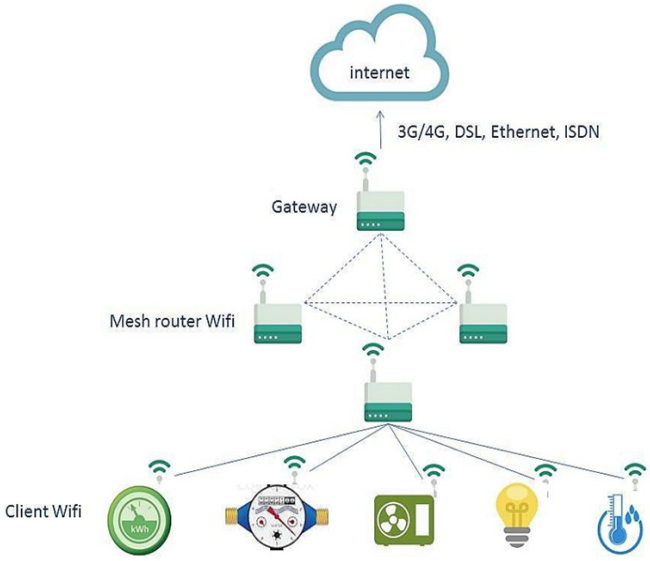

Fig. 1. WiFi mesh infrastructure

In the system that we have built, we designed a WiFi client used as a bridge that connects various kinds of electronic devices to the mesh network. These devices can be a meter-meter, air-conditioning, lights and sensors. WiFi Client connected to the internet via a WiFi router. Several adjacent WiFi routers will form a mesh topology that builds the internet cloud to the surrounding area. One of the router to function as a gateway and connected to the internet via 3G / 4G, DSL, Ethernet, and ISDN.

2.1 Design of WiFi client

WiFi client hardware design that has been built is shown in Figure 2. WiFi client has six main components, namely power supply, a microcontroller (ATmega328), sensors / actuators, a watchdog timer (WDT), EEPROM and WiFi module (esp8266). A power supply is an electronic device that supplies electrical energy to WiFi clients. The power supply has an input voltage of 220 VAC and an output voltage of 3.3 VDC. A microcontroller that we use is ATmega328. This type of microcontroller 8 bits which have 32KB ISP flash memory with read-while-write capability, 1KB EEPROM, 2KB of SRAM, 23 general purpose I / O lines, 32 general purpose registers work, three flexible time / counter with compare modes, interruptions internal and external, programmable serial USART, 2-wire serial interface byte-oriented, SPI serial ports, 6-channel 10-bit A / D converter (8-channels in TQFP and QFN package / MLF), watchdog programmable timer with internal oscillator and five software selectable power saving mode. the device operates between 1.8 to 5.5 volts [6]. The microcontroller is a device that regulates all processing logic on the client wifi like recording sensor data, communicates with the Internet and gives a command to the external device connected to the client wifi. In addition, the microcontroller will perform data storage to the EEPROM when power loss.

WDT is an additional circuit on the client wifi which serves to restart the microcontroller when the failed process. WDT is based timer 555. This timer provides a moment of time to the microcontroller to work and then will restart automatically. Therefore, we added a simple program on the microcontroller to prevent this restart. WDT has been widely used by people because it is simple and easy in its regulation

On the WiFi client, we use esp8266 as communication modules and connected in series with the microcontroller. Esp8266 is radio-based protocol TCP / IP stack. Esp8266 works at a frequency of 2.4 GHz which can be integrated with sensors and other electronic devices using GPIO. ESP8266 has been designed for mobile, wearable electronics and Internet of Things applications with the aim of achieving the lowest power consumption with a combination of several proprietary techniques [7].