Simulation and Realization of Wireless Emergency Communication System of Digital Mine

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Abstract

The key question of underwell disaster rescue is that the information of disaster place can not be collected and transported to the rescue base for the failure of normal communication equipment. A new wireless emergency communication has been introduced in this paper that a temporary wireless channel has been putted with repeaters of Wi-Fi ,the Wi-Fi end equipment with sensors to be treated as disaster place information collecters, then the disaster information can be transported with it.The wireless emergency communication system has been simulated used NS2. The result shows that the system performs well on delay time, jitter and stability. And it is suitable for the requirement of emergency communication after underwell disaster.

Keywords: Wi-Fi, Emergency communication, Channel

Introduction

In the recent years with the development of wireless communication technology and the requirements of the informatization of mine, the modern radio communication technology as the PHS system has been used underground. Undermine where the space is limited, the environment of the propagation of radio is special. Because of simple deployment of network, low power of transmission, low consumption of power, strong sustainability and easily to meet the safety requirements of design undermine, the SDR(Short Distance Radio) technique such as Wi-Fi have begun to be applied undermines.

1. Wireless Mesh Network and Wi-Fi techology

Wireless Mesh Network (Wireless Mesh Network, WMN) is a new type of wireless broadband access network, which has both advantages of wireless LAN and Ad Hoc network and is a high-capacity, high-speed and wide coverage network and is a effective way to access broadband network.

The Nodes of the WMN are classified into two types: router node and client node. Structure of WMN is divided into three types depending on different functions of node: the infrastructure structure (hierarchical structure), the client structure (planar structure), the hybrid structure. The client node accesses the backbone of network through mesh routers in the hybrid structure. Network of this structure could be connected with a number of other networks such as the Internet, WLAN, WiMAX, cellular network and sensor network. At the same time, the connectivity of WMN is enhanced and the coverage of WMN is enlarged because of the routing capability of client node. Among them, the routers connect with the Internet in cable mode and the connection between routers or the router connect with other networks in radio.

Wi-Fi (Wireless Fidelity) belongs to wireless LAN, which usually refers to the new solution of products which adhere to IEEE802.11b standard access to LAN in radio. The high transfer rate, high reliability, fast speed building network, convenient, portable, flexible network architecture, flexibility and lower prices are the main characteristics of Wi-Fi.

WMN is similar to Wi-Fi but it inherited and expanded the function of Wi-Fi. The function that radio access to network in a high speed is supplied by WMN in a larger scope indoor and outdoor at the same time. WMN used IEEE802.11b / g standards the same to Wi-Fi.The computers, PDAs, mobile phones and other devices which support Wi-Fi protocol directly accessing to WMN without any new hardware or software.

2. The requirement analysis of emergency wireless communications system underground

As the mine accident has happened, power supply underground will be cut off quickly, the communication system forestall paralyzed. the rapid establishment of emergence rescue communications system including the establishment of the cable and the broadband radio base on RF (radio frequency)technology can guarantee the communication underground for the salvage and the reduction of the loss of accident when the communication system paralyses .

The RF technique such as Bluetooth, Wi-Fi and ZigBee can be used to establish the emergency communication channel rapidly. Because of high transmission speed, reliability, the rapid speed of network construction, convenience and good mobility, the Wi-Fi technology is chosen to establish broadband channels of radio communication system undermine in this paper.

The emergency rescue system based on Wi-Fi broadband wireless technology includes three parts: commanding and dispatching center on the ground, the rescue base underground and rescue team worked in the place of the accident. Wireless communication channel underground is made of rescue base underground, wireless transmission channels, collection front and transport vehicles.

In figure 1, command and dispatch center on the ground connects with rescue base underground in cable mode, The command and dispatch center demonstrates the possibility of the rescue plans and choose one. The cables and equipments are deployed rapidly to establish the information connection between command and dispatch center and rescue base to accomplish building the platform of rescue base underground. Diagram of the system is shown in Figure 1.

Underground rescue base connects with Wi-Fi RF modules wirelessly. In order to ensure the security of rescue staff, in the area around the accident happened where the condition is unknown, , the wireless communicate channel is rapidly build through automatic deploy devices, which is on the basis of Wi-Fi gradually relay(extent) to the accident place until it reached. And then the link of emergency rescue transmission underground is quickly established by the cable and wireless RF mixed networking. This network method made up of cable and radio is called hybrid wireless mesh network that we usually refer to.

With the self-organization function of Wi-Fi technology , once the distance between two nodes exceed the scope of their communication, the new nodes will automatically become routing nodes adding into Wi-Fi networks to prolong the length of communication links to ensure the smooth communication. During the process of link building, various environmental parameters are returned form the collection terminal. Then the people in rescue base and commanding and dispatching center analyze the various environmental parameters to make further arrangements for the rescue work. If the parameters indicate that the environment is safe, rescue workers could directly access to the region to explore or rescue. Otherwise, rescue workers must firstly remove the dangerous factors undermine for the next step of rescue .At the same time, rescue workers take the data equipments with them, which depend on the built Wi-Fi network. The equipments supply the voice service which help rescue staff underground connect with each other or with staff at commanding and dispatching center on the ground, besides, the equipment supply the location-based service.

3. The System Simulation and Performance Analysis

3.1 NS simulation software

NS2 software is a discrete event simulator which is free for the network study, it is developed on the platform of Unix and the latest version is ns-2.30. Simulate tests such as cable, wireless networks TCP, routing, data links, multicast protocol and QoS of network are supported by NS2. Besides, tracking, showing simulation results, network topology generation and many other tools are provided by NS2. The functions of the software are generalized as: A dynamic network operation can be simulated in one computer.

The NS is an open source software of network simulation and its function is flexible. In addition, the network researchers all the world and fans of the software are adding the new modules to NS to make it more strong .NS-2 is the second version of NS, which is the latest and the most popular version. The network simulation environment it supports is very widely, including LAN, wireless LAN, IP network, mobile IP network, mobile Ad hoc network and satellite network and so on.

The structure of NS2 is object-oriented, which is described by language C + + and Otcl. The calculation and operation of bottom layer such as routing calculate, discarding the data packets received and so on are implemented by the classes of C + + . The configuration of node, topology, providing user interface of top layer are implemented by the classes of Otcl, while C++ is used to finish the practical tasks.

3.2 The System Simulation and Analysis

The simulation tool of the test is mentioned on the third section .The test requires installing software ns-2.30 under the LINUX operating system. It uses 2.4 GHZ frequency and Direct Sequence Spread Spectrum (DSSS) protocol in physical layer whose transmitting rate is 2 Mbps. It uses the 802.11 MAC protocol in MAC layer and DSDV (destination sequence distance vector) protocol in routing layer.

In the simulation, each node represents a deploy device (Wi-Fi module). After the accident undermine, the

system will be automatically build under the control of the rescue centre and transmit the data to the rescue base underground.

The system consists of five mobile nodes (nodes 0,1,2,3,4), which transmits data within the fixed scope of 1000m × 1000m . A fixed rate link(CBR) is established between node 4 and node 0. The fixed packet size of CBR is 512 bytes, and interval time of sending is 4 s .From the 10s, node 0 started to sent CBR data packets to node 4. The total time of simulation was 200s. At the beginning, node 0 and node 4 couldn't interchange routing information because of the long distance .From the 10s, node 0 started to sent CBR packets to node 4 .But the CBR packets were discarded by node 0 initially because the cache space was inadequate or the address resolution was wrong . Until the 36 s, node 4 began to receive CBR packets transmitted from node 1,2,3.

The performance of the system is analyzed mainly from the throughput, delay time, the loss rate of packet and jitter rate. The average transfer rate of node 4 and node 0 is 0.217 KB / s and the largest rate is 0.318 KB / s could be seen in the result. The analysis of throughput is shown in Figure 2. The analysis of delay time is shown in Figure 3.At the beginning, node 4 couldn't receive the data from node 0 because the cache space was adequate or the address resolution was wrong, what lead to a long delay time. From the 36s, the system went into a stable stage in short delay time. According to the simulation, total 93 packages have been sent by node 0 and 12 packages have been discarded, The loss rate of packet is 12.9%. The analysis of jitter rate is shown in Figure 4, jitter rate of packet is the variance of delay time. Because the state of Internet is changing all the time, when the data flow is large, many packets must be waiting in the queue to be sent. Therefore, different time will be cost when packets were transmitted from source nodes to destination nodes. The difference of time is jitter, the network is more instable if the jitter is greater.

Through analyzing the parameters from the simulation, That can be found that with the time increasing, the change of transmission rate of the underground emergency wireless communication system based on Wi-Fi ultimately tend to be stable whose delay time is small. The simulation results indicate that the design suits for underground emergency rescue communication. The performance is stable.

4. Conclusion

A kind of communication technology based on Wi-Fi hybrid wireless mesh network broadband wireless on is introduced in this paper, which support building mine emergency wireless communication channel rapidly. The simulation software of the system is NS2. The result indicates that the system performs well on delay time and jitter.The transmission rate goes to be stable with the time going. The design meets the requirements of emergency communication system underground.The parameters of the system are adjusted to meet the application requirements of different environment.

References

Fang Xuming, He Rong. (2004). short-range wireless and mobile communications, Beijing, Telecom Press.

http://www.baisi.net/forum-438-1.html.

Mohammad Ahmad Munawar. (2004). *Multi-interface Multi-channel Wireless Mesh Networks*.

Shu Feng, Yan Yongqing, Chen Ming. (2006). *technical difficulties and application prospects of WMN*, Jiangsu communication technology, 2006.6.

Xu LeiMing. (2003). *Ns and network simulation, Beijing*, Telecom Press.

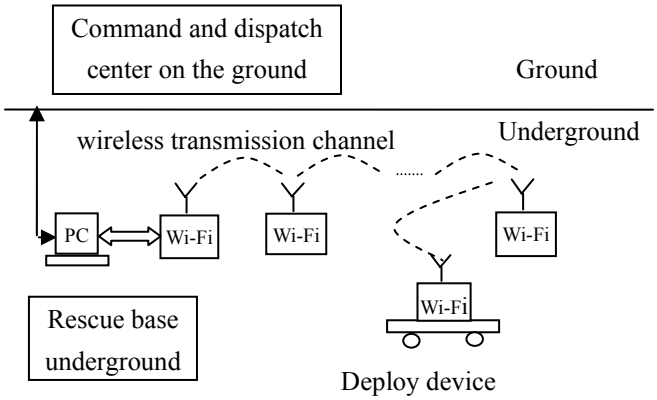

Figure 1. mine emergency wireless communication system

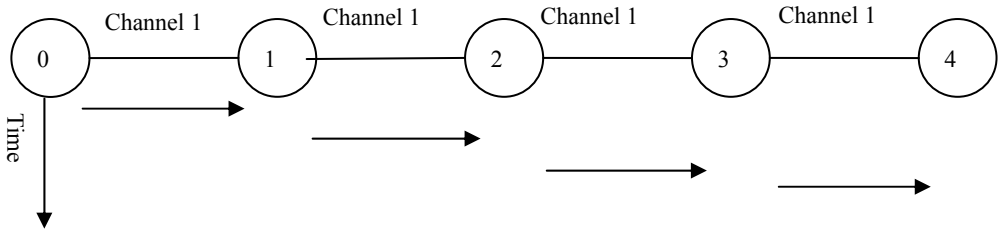

Figure 2. diagram of nodes running

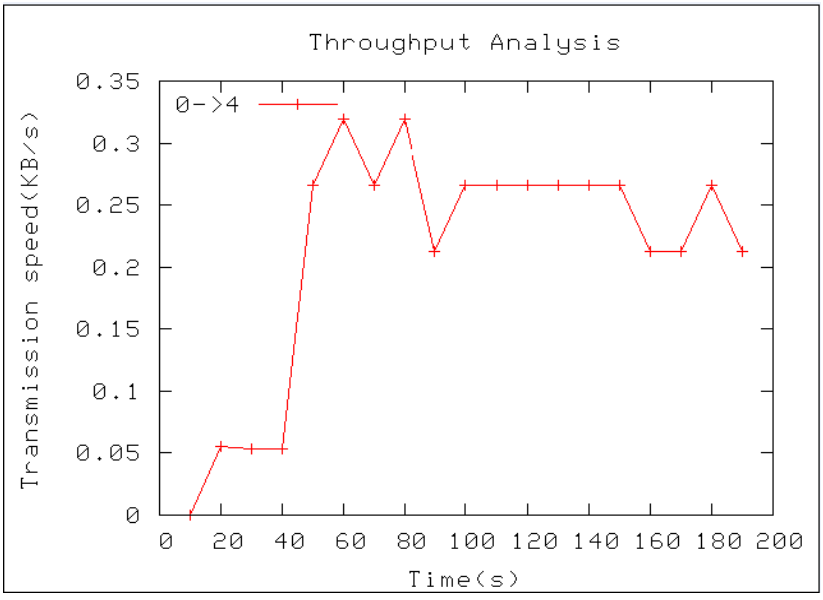

Figure 3. The throughput characteristic simulation of system

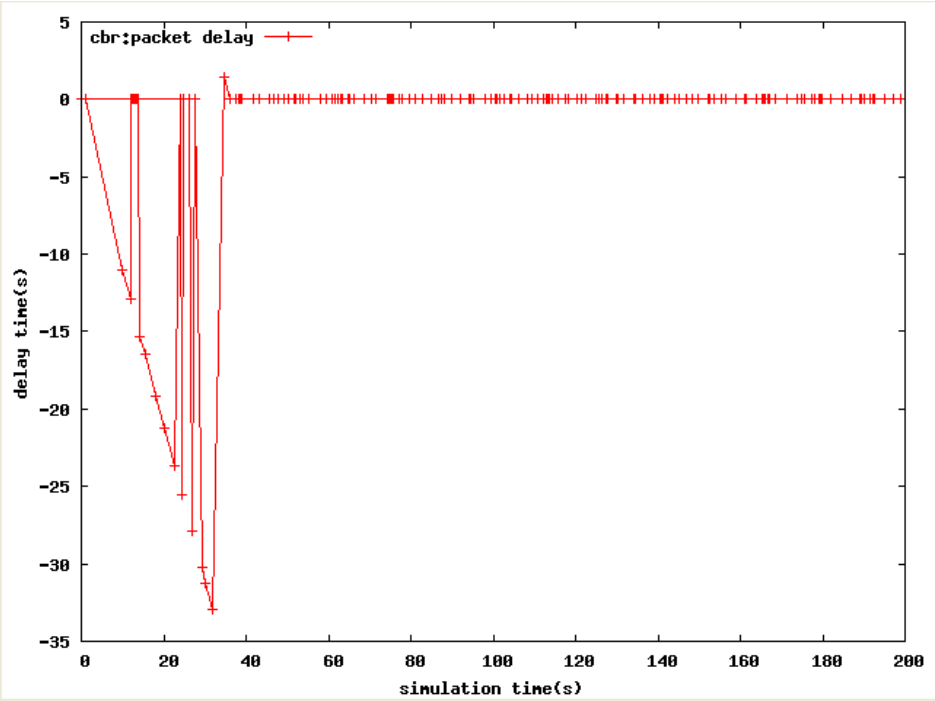

Figure 4. The delay time characteristic simulation of system

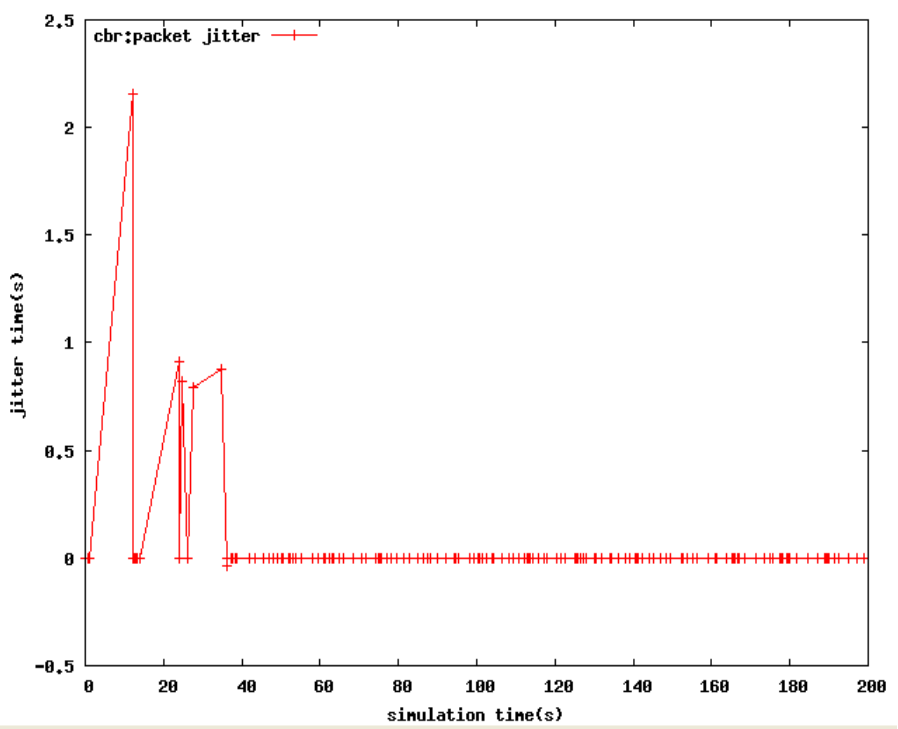

Figure 5. The jitter characteristic simulation of system