A Study on Decentralized Mobile Wireless Network in Restricted Areas for Denuclearization

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1. Introduction

For verifying a denuclearization, the radiation dose and the sample collection should be assessed in the reported or suspected area. However, in such areas, infrastructure such as power or communication is often insufficient or absent. Therefore, in order to verify denuclearization, it is necessary to secure its own power grid or communication network.

We proposed a communication network that is based on the partial decentralized mobile closed network. It is very similar to a mesh network, but the power supply and installation methods have been improved to allow for outdoor use. In previous study, we conducted an experiment to measure the operation of the device within a limited range. Based on this result, the performance of the developed device was evaluated using a number of equipment in order to verify the effectiveness of the developed equipment.

2. Structure and Hardware for the network

2.1 Structure of the Network

Figure 1 is a schematic diagram of a partial decentralized network for Central Mesh Router and Mesh Routers, showing its characteristics well[1].

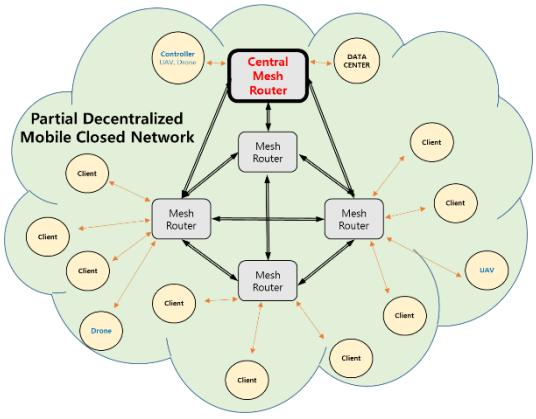

Fig. 1. Diagram showing a partial decentralized mobile closed network[1]

According to previous study, a partial decentralized network is composed of a Central Mesh Router and numerous Mesh Routers. In here, Central Mesh Router is specified to manage the network configuration to increase efficiency and security. Clients in shown the figure, such as various unmanned vehicles and radiation measuring devices, access a single closed network through communication with adjacent Mesh Routers over a distance. All clients perform the same as TCP/IP based Client-to-Client communication. Also, almost all the clients transmit the acquired data to the Data Center, which is the client adjacent to the Central Mesh Router. The controller for unmanned equipment also performs the task through Client-to-Client communication.

2.2 Hardware for the Network

The routers, which has easy mesh technology such as A9004M and A3004NS-M by EFM NETWORKS CO.,LTD, is used for the partial decentralized network. Easy Mesh network uses a wireless communication technology with transmission rates similar to that of a cable, which is used as a backbone network. Also, this technology can be quickly handover if the loss or delay in network occurs, cause 2.4 GHz and 5 GHz frequencies in ISM band is used.

It is important by battery selection regards weight and capacity because routers are moved by unmanned vehicle. Therefore, the required power for battery is 2 A of current at a voltage of 12 V in previous study[1].

3. Performance Test

3.1 Distribution of the Routers

Fig. 2. Distances from central mesh router to clients

In order to estimate for performance between Central Mesh Router and Mesh Routers, 200 × 200 m^2 of the area is enough but test area of 500 × 500 m^2 was selected to reduce the reflection of radio-wave. And, in order to find out the most effective distribution model, we adapted the distance between the Routers from 150

to 80 meters. Effective distribution model depends on the installation height and 80 ~ 100 meters are most effective range with 1 meter height. The figure 2 shows the network distribution by setting the maximum distances between Routers as 80 m. In addition, it can be seen that Mesh Routers (1, 4, 7) function as a router and a backhaul at the same time.

3.2 Performance Test

The first test was to measure the data transmission and reception speed by distance between Central Mesh Router and Mesh Router in an open terrain. Figure 3 shows the trend of decreasing speed of transmission and reception according to distance. In the range of 100 to 200 m, a large speed difference occurred due to environmental factors in the open terrain.

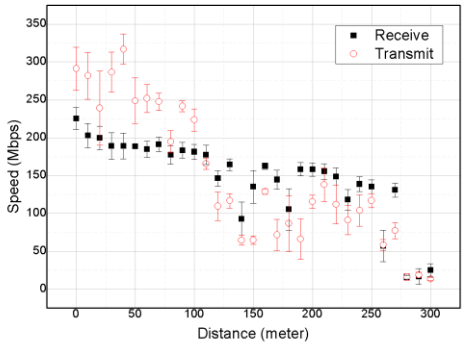

Fig. 3. Distance versus speed for reception and transmission

The second test was to measure the field intensity of the equipment that means the connection strength between Clients connected to the Router by distance in the open terrain. There is a point where the connection strength is significantly weakened, which is the criterion for adding a router.

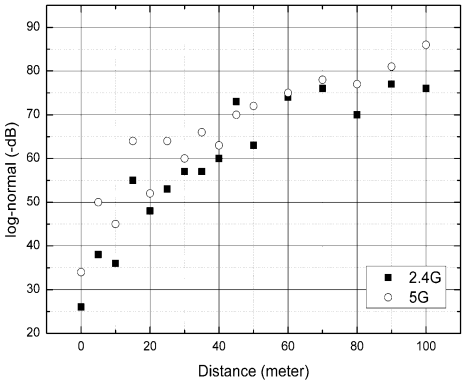

Fig. 4. Field intensity of equipment according to distance in open terrain

The purpose of this test is to find out the network quality in some sections. Figure 4 shows the field intensity of the equipment according to the distance. Frequencies of 2.4 GHz and 5 GHz show similar field intensity in open terrain. The strong field intensity was maintained up to 50 m (-65 dB). On the other hand, the field intensity was weak from a distance of about 100 m (-80 dB). Therefore, the distance between the Router and Client should not exceed 100 m considering the field intensity.

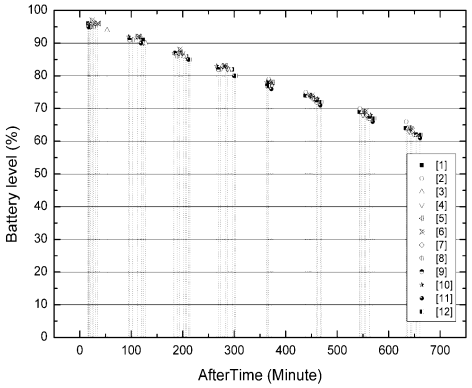

Fig. 5. Changes in battery over time

The third test was to check the remaining power of the battery over time. In the figure 5, it can be seen that it took about 400 minutes in the section from 90 % to 70 % where battery is reduced. It means that maximum 2,000 minutes of network utilization is possible when the current network is operated.

4. Conclusions

When the denuclearization situation occurs, there is a high possibility that the target region will not be able to receive support for a variety of basic infrastructures such as electricity and communications etc.

In this study, it aims to secure technology and development of equipment that can be quickly on figure an absent wireless network, in order to operate various wireless based equipment in unknown areas. Also, technical support is available so that equipment based on wireless network can be used in unknown areas.

In addition to denuclearization situation, scalability that can be used in various similar environments is secured.

REFERENCES

[1] Jung Youn Choi, Dong Yeong Kim, Jihye Seo, and Myungsoo Kim, Design of Partial Decentralized Mobile Closed Network using Wireless Mesh architecture, Proc. Of the KRS 2020 Spring Conference, Vol.18, No.1 p.349 ~ 350, 2020.