Compact and lightweight Small Satellite Earth Stations with Automatic Capture and Tracking

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1. Introduction

Satellite communication systems are useful in disaster recovery operations because of their wide coverage and the ease with which links can be established. The NTT Group's protocols for restoring communications infrastructure in the event of a disaster call for the use of satellite communication systems to provide evacuation and disaster response centers with temporary lines of communication while work is done to restore optical fiber and other transmission lines.

An older satellite earth station[1] for disaster response operations is shown in Figure 1. This system was built over fifteen years ago. Its setup procedure involves manual tasks such as manual alignment of the satellite dish, and can take at least one hour even when performed by experienced engineers. Furthermore, it is cumbersome to transport, and thus offers poor mobility and setup speed, which are essential factors in disaster response operations.

To overcome these issues, NTT Access Network Service Systems Laboratories have developed small satellite earth stations to provide communication links via specially installed public phones and Internet access points in evacuation and disaster response centers in the event of communications being disrupted by disasters and other emergencies[2]. These earth stations are compact and lightweight and use dish reflectors that can be dismantled and packed inside carrying cases. They are equipped with functions for automatically capturing and tracking satellites, and for remotely conducting uplink access tests. These functions make it possible to establish links rapidly, and reduce the setup operations that must be done by field workers.

2. Summary of development process

To reach this goal, we developed three new devices for the earth station terminal and a new program for the control station.

To offer terminal configurations suited to different kinds of disaster situation, we developed two different types of earth station — a flyaway type and a vehicle-mounted type. The flyaway type is easy to carry to a disaster area because it can be dismantled and packed into four separate carrying cases, while the vehicle-mounted type can be installed in a normal-sized car capable of reaching the stricken area quickly to help restore communications. Both terminals can be up and running in about 15 minutes owing to the satellite auto-capture function (older systems needed about 60 minutes). These stations support transmission speeds of up to 384 kbits/s for the return link, which can carry ten VoIP channels simultaneously.

The technologies that we developed are summarized in sections 2.1–2.4

Figure 1: Comparison of developed systems and older system

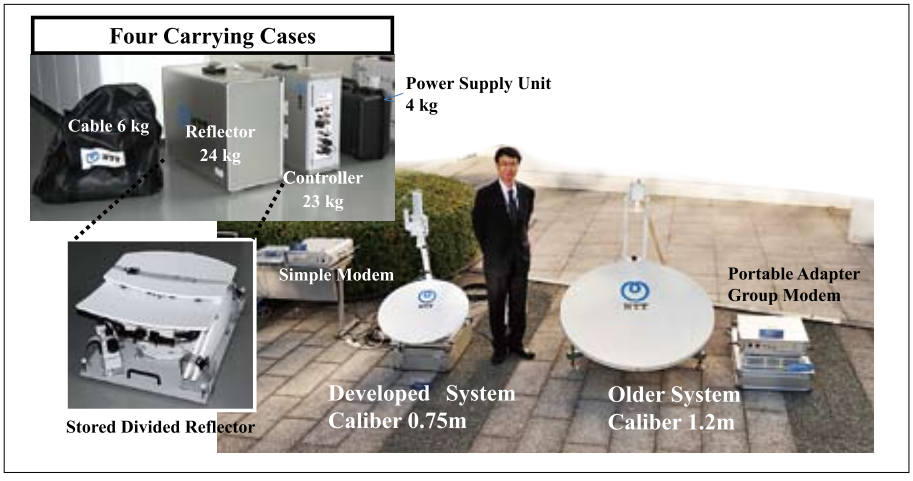
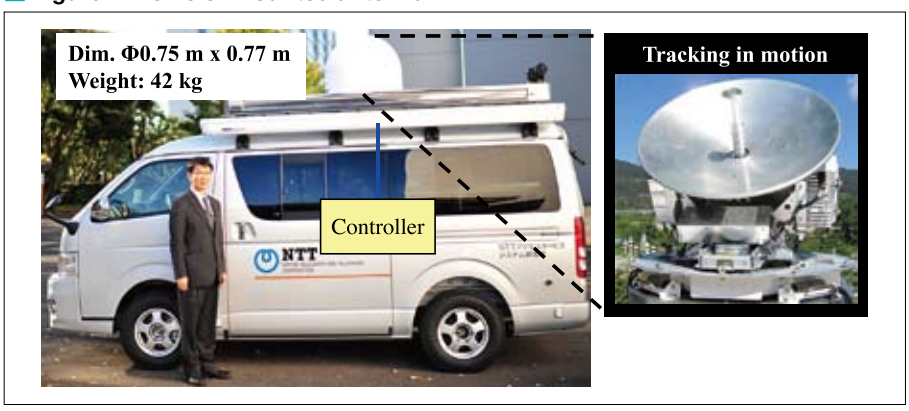


Figure 2: Vehicle -mounted antenna



2.1 Flyaway antenna

Our flyaway antenna is shown in Figure 1. This antenna can easily be carried by hand into disaster areas that are inaccessible by car or other means of transportation. We chose to use a 75-cm reflector dish that can be dismantled and packed inside a carrying case. The

Figure 3: Comparison of older modem and developed modem

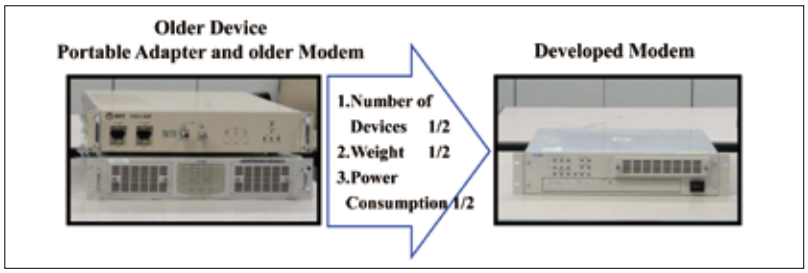
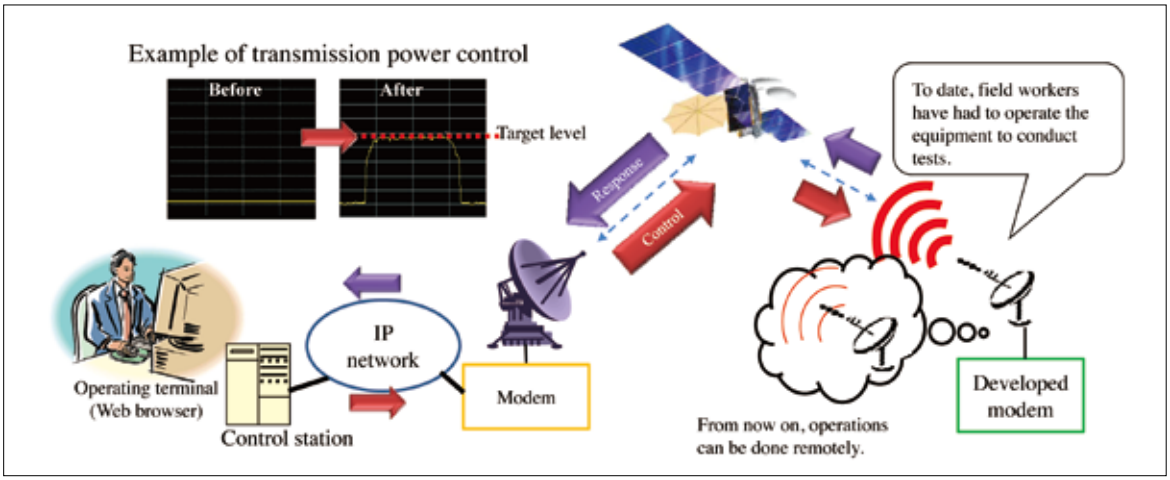


Figure 4: Procedure for remote uplink access test



other parts can also be carried in cases, which greatly increases their portability compared with existing devices. Moreover, no tools are needed for disassembly, packing, and reassembly and the automatic satellite capture function eliminates the need for operators to have special skills to set it up: setup can be finished within approximately 15 minutes.

2.2 Vehicle-mounted antenna

The vehicle-mounted earth station antenna that we developed is shown in Figure 2. This antenna is mounted on the roof of a vehicle and is suitable for use in disaster areas that are still accessible by vehicles. The dish diameter was reduced to approximately 60 cm to enable mounting even on ordinary cars. In addition to an automatic satellite capture function, it also has a function for automatically tracking satellites while the vehicle is moving. Antennas of this type are widely used in ships, but ours is considerably simplified, making it lighter in weight, lower in height, and less costly.

2.3 Modem

The modem that we developed for the earth station is shown in Figure 3. If a disaster affects a wide area, a large number of earth stations will need to be installed. However, there is a limit to the frequency range that can be used for satellite communications. Thus, to enable simultaneous use in as many places as possible, we have developed a modem with limited communication speed and frequency band for each earth station. This device uses the same transmission system as older satellite communication systems, and can thus be put to use with only minimal changes to the configuration and settings of existing base stations. By removing unnecessary functions and reducing the capacity to the minimum necessary, we were able to reduce the weight to one quarter and the size to one half of the older modem.

2.4 Remote uplink access test program.

In older systems, an uplink access test is carried out after the earth stations have been installed but before they begin operations. This test is conducted through phone conversations between technicians of the satellite operator and field workers to check that the antenna direction and power transmission levels are correct. Thus, in order to conduct these tests, the field workers need to be proficient in radio communication systems. However, in a large-scale disaster like the Great East Japan Earthquake of 2011, it can be difficult to assemble enough field workers with sufficient knowledge. To make it easy for field workers without specialist knowledge to set up earth stations in the field, NTT Access Network Service Systems Laboratories has developed an uplink access test program that can be operated remotely from a control station. The procedure for conducting this test remotely using this program is shown in Figure 4.

3. Conclusion

Small satellite earth stations can provide a communications infrastructure quickly in the event of disruption caused by a natural disaster. These systems were deployed by NTT Group during the 2012 fiscal year, and have been put to practical use in real disaster situations.

References
1 Akira MATSUSHITA, Taichiro SATOU, Isao YUMOTO, Yutaka YAMAGUCHI, Yuichi KAMEZAWA, and Hiroshi KAZAMA, “Satellite communication system used for isolated islands and disaster-affected areas”, SAT2005-1(2005-5), IEICE Technical Report, 2005.
2 Takashi HIROSE, Yoshinori SUZUKI, and Yutaka IMAIZUMI, “Small Satellite Earth Stations for Disaster Recovery Operations”, SAT2012-4(2012-10), IEICE Technical Report, 2012