Implementation of site diversity system for Ku bands*

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Abstract. K-water uses its Mugunghwa Satellite No. 5-based communications network for remote acquisition and provision of hydrological information on rainfall, water levels, water quality, and warnings via its hydrological observation network. Due to rainfall attenuation during heavy rainfall seasons and typhoons, the satellite is greatly affected since it is using the Ku band frequency. Thus, to smoothly use data during rainfall attenuation and satellite malfunctions, K-water used the site diversity (SD) technology and developed a duplexing system that involved the setup of its main hub station at its HQ and its auxiliary hub station at Gunnam Dam, located 200 km away.

Keywords: Satellite, Communication, Site Diversity, Rain Attenuation

1 Hydrological Observation Satellite Communications Network

K-water's hydrological observation communications satellite network, which is shown in Fig. 1, has two hub stations (the main and the auxiliary), 25 dam control stations, 131 rainfall gauging stations, 53 water-level gauging stations, 124 warning stations, eight water-level gauging/warning stations, 23 water-level/rainfall gauging stations, two water-quality monitoring stations, 27 other stations, and 25 external Han River flood control stations, for a total of 420 terminal stations [1]-[3].

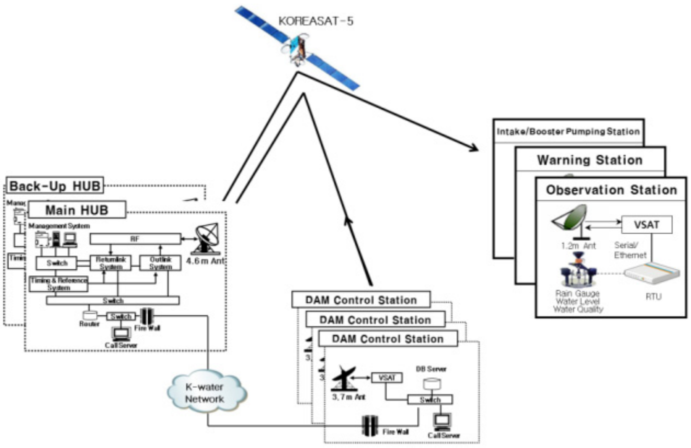

Fig. 1. Diagram of K-water's Satellite Communications Network

* This research was supported by a grant(11CCTI-B056624-02) from Construction Technology Innovation Program funded by Ministry of Land, Transport and Maritime Affairs of Korean government

The hub station, installed at K-water's HQ, controls all the observation stations and monitors their outputs and operational status. It automatically calls and recalls terminals on time, and stores data received after calls in the TM server and the DB server. It receives and stores event data from terminal stations, changes its communication speeds, automatically allocates data to terminal stations, copes with rainfall attenuation, and manages the communications satellite network via NMS. It also ensures data integrity and protects data from external attacks via firewalls and encryption equipment items[4]-[5].

Observation stations are classified into water-level gauging stations, rainfall gauging stations, water quality monitoring stations, and warning stations. They use a 1.2 m antenna and consist of the satellite modem IDU, the RF receiving unit BUC, and the receiving units that include LNB and ODU.

Observation stations receive call commands from their hub station and control station; send them response calls; store rainfall, water-level, and other events monitored from their sensors; and immediately send such event data to their hub station and control station.

2 Development of the SD System

K-water's current Mugunghwa Satellite No. 5 uses the Ku band frequency and thus experiences great rainfall attenuation and suffers from poor communication quality. In recent years, local brief heavy rainfall occurred quite frequently, thus new methods needed to be developed to reduce the influence of the rainfall attenuation [6].

In Korea, the seasonal rain front pattern involves the rain front lying across east to west in the July-August rainy season and vibrating north to south. K-water developed the SD system to reduce its communication problems due to attenuation and equipment malfunctions.

The SD system was developed by installing the hub station at the Daejeon HQ, and the auxiliary station, at Gunnam Dam in Yeoncheon-gun, Gyeonggi-do, 200 km away to the north.

Under the existing SD system, the automatic switching method activated the system when the satellite signal reception level fell below the critical value and remained for a specific time in that state, and when the number of malfunctioning observation stations reached or exceeded the defined number [7].

Herein, the SD system was developed so that it can switch not only when the satellite signal reception level falls below the critical level, but also to monitor problems in the hub station's communications satellite transmission equipment, including UPC, BUC, and SSPA, as well as in the receiving equipment, including LNA, BDC, and TRU (carrier and beacon), in real time.

The switching process was developed so that it can be regularly monitored by the switching server timer and can be activated when necessary. Conditions for automatic switching are outlined as follows:

- When a transmission equipment malfunction is monitored;
- When the SSPA output voltage continues to be lower than the predetermined value; and

• Even when no transmission equipment malfunction has been monitored, when the TRU receiving level is lower than the predetermined value.

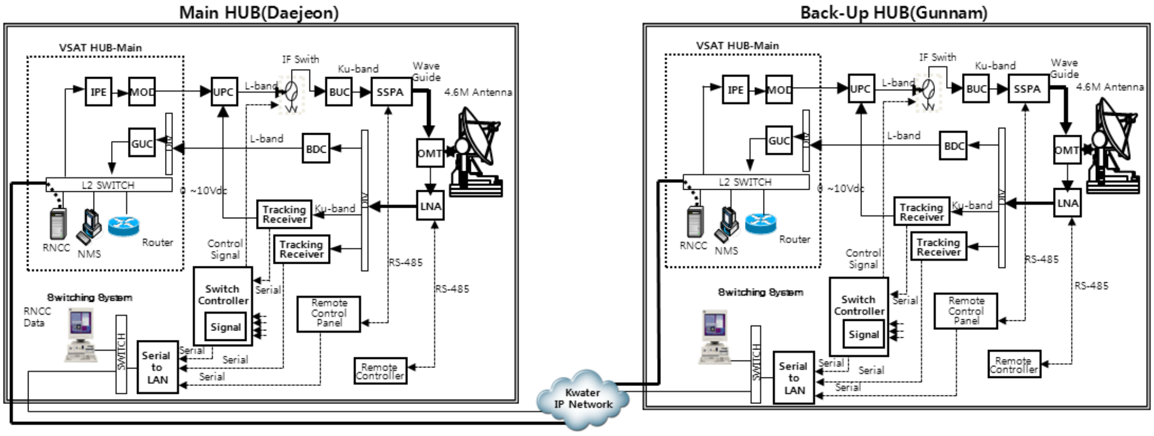

Fig. 2. Diagram of the SD System

3 Conclusion

The SD system was developed so that it can smoothly acquire data when rainfall attenuation occurs due to heavy rains in connection with the use of the Ku band frequency, and when the communications satellite equipment malfunctions. Specifically, the main hub station was installed at the HQ, and the auxiliary hub station, at Gunnam Dam, 200 km away from the HQ, based on the SD analysis that showed the best SD gains for Gunnam. In this way, the duplexing system was developed.

Besides, it would be installed in main control center of distributed water supply system, where the technique can be applied as auxiliary communication network in remote control terminals of many vertical water supply facilities.

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