Development of the Data Collection System and Its Applications

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Abstract: The Satellite Technology Research Centre (SaTReC), Korea Advanced Institute of Science and Technology (KAIST) has developed and is to launch STSAT-1 (Science and Technology Satellite – 1) on 27th September 2003. The data collection system (DCS) is the one of its payloads. The DCS is a data relay system used for transmission from ground-based sensors through satellite to receiving station. This is one of the important methods collecting global data from the remote locations. In this paper, the DCS on the STSAT-1 will be introduced and the development of the mobile terminal (MT) will be reported.

Key Words: DCS, mobile terminal, STSAT

1. Introduction

The Satellite Technology Research Centre (SaTReC), Korea Advanced Institute of Science and Technology (KAIST) has developed and is to launch STSAT-1 (Science and Technology Satellite–1) on 27th September 2003. The data collection system (DCS) is the one of its payloads including far-ultraviolet imaging spectrograph (FIMS), space physics package (SPS), and narrow field of view star sensor (NAST).

The DCS is a data relay system used for transmission from ground-based sensors through satellite to receiving station. For instance, the sensor on the buoy gathers data such as salinity, sea temperature and circulation, and transmits accumulated data to the satellite. The satellite transmits all the data collected from various buoys to the receiving station and the data are distributed to the users. The Fig. 1. shows this operation concept. The DCS is one of the important methods collecting environmental data globally from the remote locations. There are many applications in the meteorology, oceanography, communication and environmental monitoring such as fleet management, drifter buoy, ice motion monitoring, traffic information collection, moving terminal locating, search and rescue, river monitoring and control of the remote site equipments [1][2]. There are a few DCS services available such as Argos, GOES and ORBCOMM.

The DCS program on STSAT-1 was first developed from UN ESCAP/ICC meeting in 1997 to share a “simple common payload” on the satellites among Asian nations. The cooperative research centre for satellite systems (CRCSS) of Australia has launched Fedsat-1 in 2002 carrying the advanced data acquisition and messaging (ADAM) payload. The SaTReC, KAIST of Korea is just to launch the STSAT-1 with DCS payload tomorrow making a constellation with Fedsat-1. The DCS was developed in collaboration with CRCSS. The X-SAT of Singapore will also bring the same payload to the space in 2006 achieving the continuity of the DCS service.

In this paper, the DCS and the development work of its MT will be introduced. The chapter 2 will present mission development and chapter 3 shows the specification of the space segment of the DCS. The chapter 4 will report the development work of MT of the DCS and chapter 5 will illustrate the test and operation plan briefly. The chapter 6 will conclude with the lessons learned by this program.

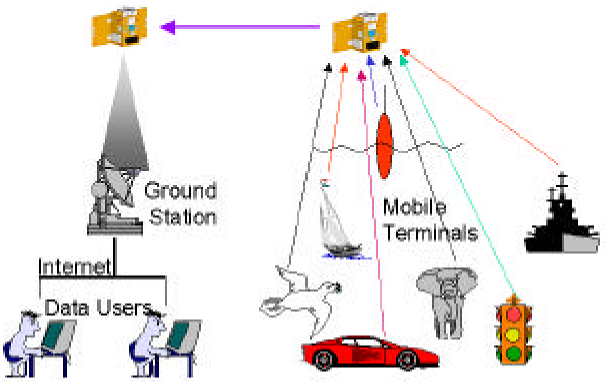

Fig. 1. Operation concept of the data collection system

2. Mission Development

The mission of this program is to develop a new DCS service that overcomes the current DCS services.

The program implements the data collection network based on the LEO satellite constellation. In this way, we can provide DCS service with wider coverage and increased revisit times while keeping the cost low and the development period short. The risk also reduces since the space segment is simple for the small LEO satellites. The participating nations cooperate in the development of the system, system operation and data collection, and share the collected data. As more nations participate in this program, we can achieve enhanced performance in terms of coverage and revisit time, and also assure of users of the secure and reliable continuing services.

For better communication, the two-way communication, the advanced multiple access scheme and channel coding are used. The two-way communication makes it possible to control the mobile terminals, the ground-based sensors. We can turn on the terminal only when it is needed, save power, and hence extend the lifetime of the terminal. User can also configure the terminals as they want. The advanced multiple access scheme makes 5 to 10 terminals to be able to access the satellite simultaneously. We also achieved higher data rate than conventional DCS, 4000bps for uplink and 1000bps for downlink.

The DCS also provides position estimation of the mobile terminal using the Doppler shift measurement within 100m RMSE. This will be helpful information in estimating the location of the terminal without GPS.

3. Space Segment of the DCS

The space segment of the DCS is composed of the UHF electronics, the base band process (BBP) and interface converter module. The base band processor for STSAT-1 is identical to the one on the FedSaT-1. Fig. 2. shows the block diagram of the space segment. The base band processor provide demodulated data to the interface converter module for the data storing and modulate the data from the on board computer for the transmission to the MT.

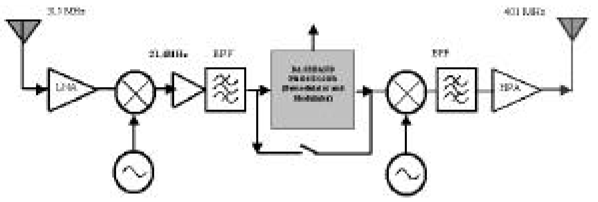

Fig. 2. The block diagram of space segment of the DCS

The Fig. 3. shows the DCS on the flight model of the STSAT-1. The DCS has been integrated to the STSAT-1 and fully tested. The STSAT-1 will be launched tomorrow 27th September 2003 at the Plesetsk in Russia.

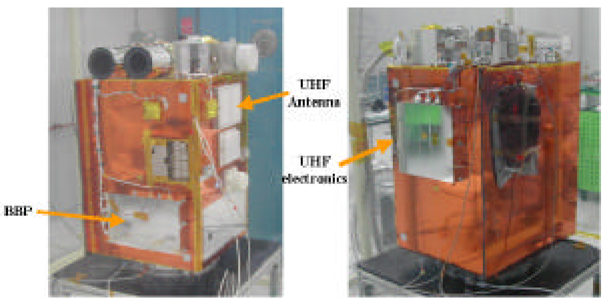

Fig. 3. The DCS on the STSAT-1 Flight model

4. Development of Mobile Terminal

The mobile terminal is a ground-based communication module to transmit the collected data to the satellite and receive messages from the satellite. Through the MT, the host transfers the collected data to the satellite and receives the messages from the user, satellite, and other MT. The Fig. 4. shows the functional block diagram of the MT. The MT functions can be divided into four categories. The interface forms the low level interface between the MT and the host. The signalling and mode control function is responsible for all higher level interface between the MT and the host, and between the MT and the satellite. The digital modem function and RF section takes care of modulation/demodulation and RF up/down conversion, respectively.

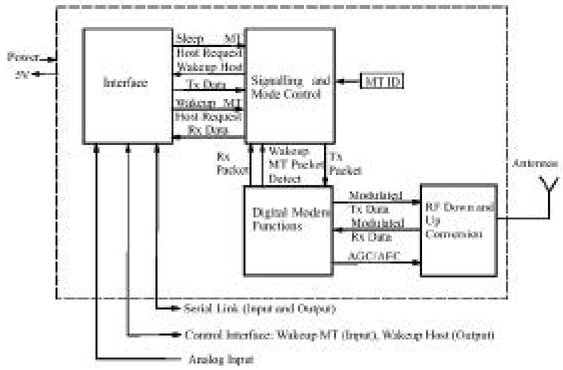

Fig. 4. The functional block diagram of the MT

The mobile terminal is under development by the collaboration of SaTReC, ITR and NTU. The Fig. 5. shows the prototype of the RF module of the MT.

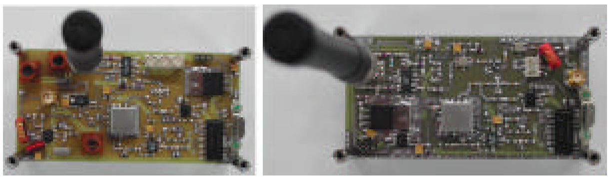

Fig. 5. The prototype of the RF module (Tx: right, Rx: left)

5. Test & Operation Plan

After the launch of the STSAT-1, the DCS will be first tested with the test MT. It is a modified space segment of the DCS and installed at the ground station for only test purpose. Through this test, we are going to verify all the functions of the DCS including data transmission, message reception, position estimation and code uploading.

After that, the mobile terminal developed will be used for the same test at stationary site. For the field test, Mobile terminal will be installed on the ship and operated. For the buoy application, the MT may need to be modified for smaller size and lighter weight. When it is possible, a number of buoys will be distributed around Korean peninsula for the operation with STSAT-1 and FedSat-1. The buoys will record various ocean environment data including temperature, salinity and circulation of the ocean. The Fig. 6 shows contact areas for the operation of the MT around Korea and Australia respectively.

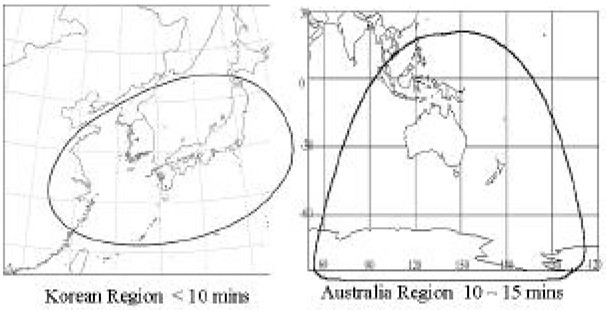

Fig. 6. Operation Mobile terminal contacts

The Fig. 7 shows the operation scenario of the DCS on the STSAT-1. The data collected from a few hundreds terminals around Korea and Australia will be stored in the mass memory system on the STSAT-1. These data are downloaded to the SaTReC receiving station via X-band downlink. The downlinked raw data will be processed to extracts the DCS data among other payloads data and archived. These archived data will be shared among the participating nations. The SaTReC will distribute the archived data to the their end users through the Internet access. The ground station also gathers the messages to the terminals for the control and uploads them to the satellite for the delivery to the responding mobile terminals.

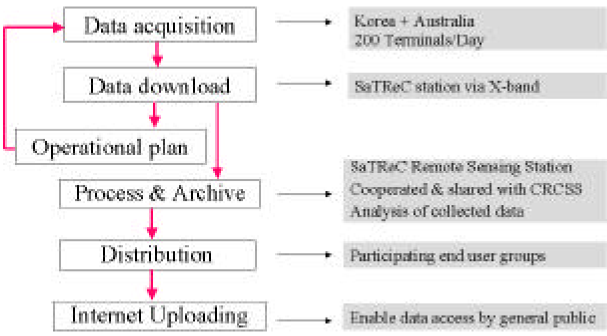

Fig. 7. The DCS operation scenario

6. Conclusion

The DCS is a data relay system used for transmission from ground-based sensors through satellite to receiving station. The DCS is one of the key methods to collect global environmental data from the remote locations for the various applications, especially in meteorology and oceanography.

The SaTReC of the KAIST is going to launch the STSAT-1 on 27th September 2003. The STSAT-1 has a Data Collection System payload among its four payloads. The DCS was developed under collaboration of the SaTReC, KIAST, Korea and ITR, Australia as a "simple common payload" proposed in UN ESCAP. The launch of the STSAT-1 will form the constellation of the small satellites with Fedsat-1 of Australia launched in 2002. In 2006, XSat of the Singapore will join the constellation with the same payload, too.

The ground segment of the service, the mobile terminal is under development through the collaboration of the three participating nations, Korea, Australia and Singapore. Through the test phase, we are expecting the real application of the constellation of the DCS.

The DCS on the STSAT-1, Fedsat-1 and Xsat achieved advanced technology in this field: the two-way communication, the constellation of the small LEO satellites, the higher data rate and the location estimation.

Through this program, we are going to demonstrate the advantages of the constellation of the small satellites and also demonstrate the advanced technologies on the Data Collection System. The most important demonstration will be the importance and achievement of the comprehensive collaboration among the Asia Pacific nations.

7. Acknowledgements

The Korean Ministry of Science and Technology (MOST) is acknowledged for supporting this research through a grant "Development and application of mobile terminal for LEO satellite, and verification using altimeter". The authors also thank for the close collaboration of ITR, CRCSS and NTU.

8. References

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