AN INTEGRATED MANAGEMENT SYSTEM OF MULTIPOINT SPACE WEATHER OBSERVATION

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ABSTRACT

An outline of a planned system for the global space-weather monitoring network of NICT (National Institute of Information and Communications Technology) is given. This system can manage data collection much more easily than our current system by installations of autonomous recovery, periodical state monitoring, and dynamic warning procedures. According to a provisional experiment using a network simulator, the new system will work under limited network conditions, e.g., a 160 msec delay, a 10 % packet loss rate, and a 500 Kbps bandwidth.

Keywords: Space weather, Data collection, Real time monitoring

1 INTRODUCTION

The NICT (National Institute of Information and Communications Technology) has a project to establish a global observational network of space weather observations (NICT-SWM: Space Weather Monitoring Network) (Nagatsuma, 2009; Akioka, Kubo, Nagatsuma, & Ohtaka, 2009; Maruyama, Saito, Kawamura, Nozaki, Uemoto, Tsugawa, et al., 2009). The principal purpose of the project is to improve the reliability of the space weather forecast (http://swc.nict.go.jp/contents/index_e.php) by introducing real time data obtained by a global network of space-weather related observational facilities, e.g., ionosondes, magnetometers, HF radars, and GPS receivers. In this project, NICT will operate about 30 observatories covering a wide area in the northern hemisphere (Figure 1). All observational data will be transferred to NICT (KKB) and stored in a large-scale storage system in a real-time basis. However, it will become increasingly hard to manage the whole system because it contains such a large number of observational instruments, each having its own characteristics. The chance of trouble with data transfer networks connecting many observatories will be increased also. A shortage of human resources to maintain the system will be another difficult problem for us. For these reasons, we have developed an integrated management system of global multipoint observations. In this paper, we report an outline of this system.

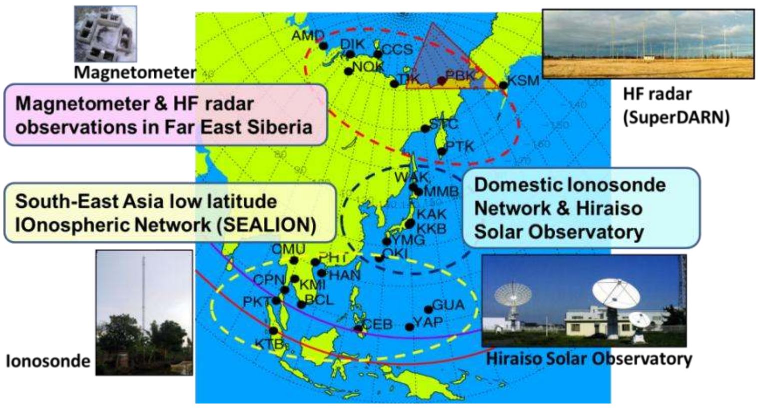

Figure 1. Observational network of the NICT-SWM project. The data processing server is located at Kokubunji, Tokyo (KKB).

2 CURRENT DATA COLLECTION SYSTEM

Figure 2 shows our current data collection system for space-weather research and forecasting work. This system is a complicated cluster of about 30 pre-existing observational systems for several independent research projects, such as SEALION (Maruyama, 2009; http://wdc.nict.go.jp/IONO2/SEALION/), having different system architectures, data transfer methods, and secure communication procedures. Each system has been managed by a small number of administrators (researchers), and in an extreme case, only one administrator must manage more than 10 systems in parallel. In addition, the current data collection system has difficulty with immediate recovery from malfunctions of the system because of the complicated situations mentioned above. We will replace the current system with the proposed new system to improve the present situation. Simplification of the operational system as a whole and establishment of a rapid failure-recovery mechanism will be the most important points in our new system. This will help us also to reduce the workloads of administrators.

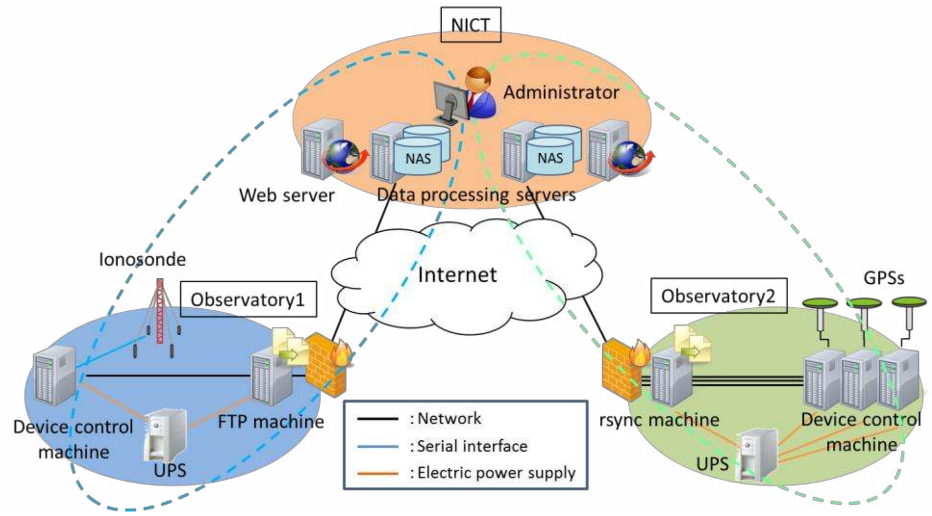

Figure 2. Current data collection system of the space weather group of NICT

3 PROPOSED SYSTEM

Figure 3 shows a general concept of the proposed system's architecture. At a remote station, observational instruments and their data transfer systems are controlled by one agent server with a low power consumption rate. Figure 4 shows the specification of the server. We will apply this concept to other observation systems. The agent server collects observation data and status from observational equipment and stores these in a large-scale distributed storage of NICT, which has a 2.2PB disk capacity. We have already established the storage system using Gfarm (Tatebe, Hiraga, & Soda, 2010), which is a distributed file system developed by Tukuba University for grid computing. The synchronization of data communication between the agent server in each remote station and the storage system in NICT is guaranteed by a combination of VPN (Virtual Private Network) and rsync, which is a free software application for Unix-like systems to synchronize files and directories from one location to another. A data processing cluster takes a role in the status analysis. In addition, we created a real-time monitoring site to manage all systems of NICT-SWM. Figure 5 shows an example of the monitoring page of the machine status in the proposed system. The status of a station is indicated by the color of its icon on the Google map. When the color of one of the icons changes from green to red, the administrator should click on the icon. Information on the machine status of the station is displayed on the bottom-left of Figure 5, and graphs showing the time variations of the system parameters are displayed on the right-hand part of the same figure. This new system will allow us to improve the performance of remote management. We have confirmed that the system works correctly in a test network environment that simulates the network connection between Japan and Seb Island, The Philippines, under a limited network condition, e.g., a 160 msec delay, a 10 % packet loss rate, and a 500 Kbps bandwidth. Currently, this system is running at some remote stations indicated by the monitoring page.

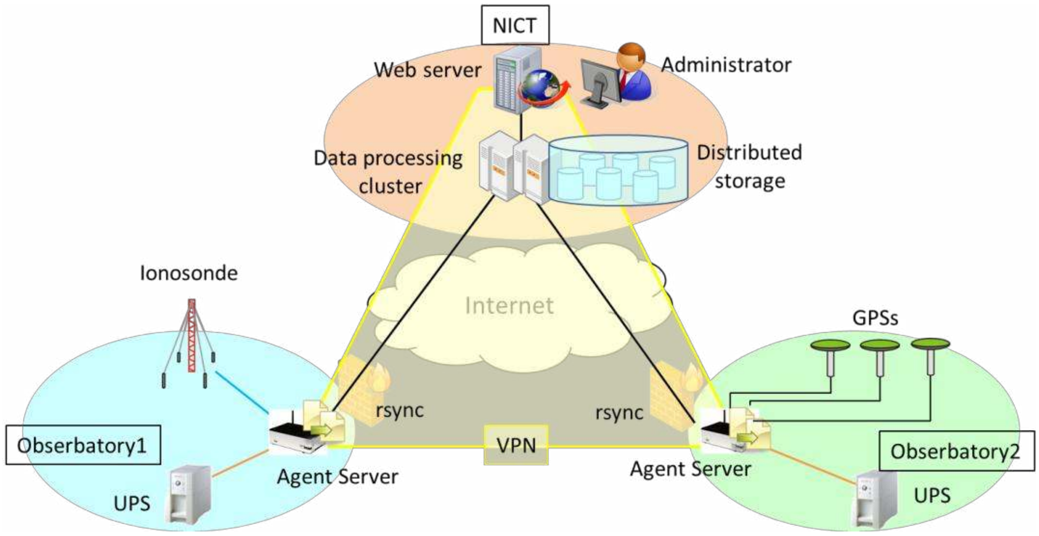

Figure 3. The proposed system's architecture of NICT-SWM

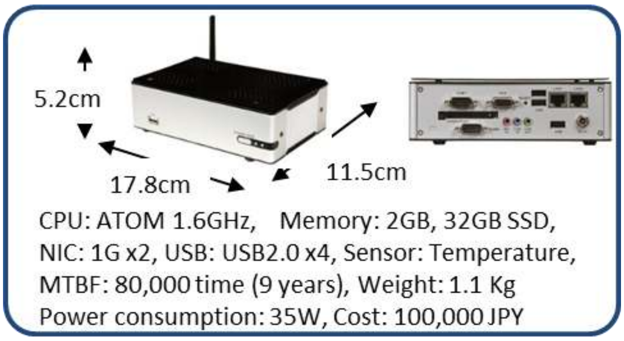

Figure 4. Specification of an agent server

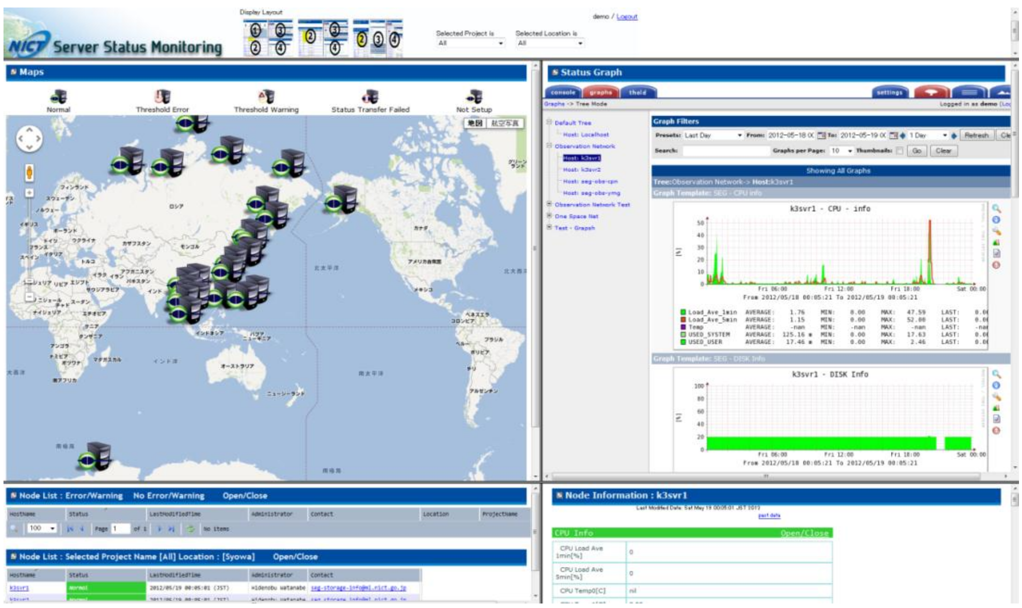

Figure 5. An example of the monitoring page of NICT-SWM

4 CONCLUDING REMARKS

We report the general concept of our new integrated management system of global space-weather observations that has been planned under the space weather project, NICT-SWM. Our system will be pertinent to correct data from many stations distributed in a broad area of the world, in a real-time basis with high reliability. We will evaluate the performance of the proposed system further in detail, and we will set the system in routine operation in the near future.

5 ACKNOWLEDGEMENTS

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6 REFERENCES

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