Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

MGI37-01 Room:413 Time:April 29 09:00-09:15

A Report of Big-Data Processing and Operation of the NICT Science Cloud

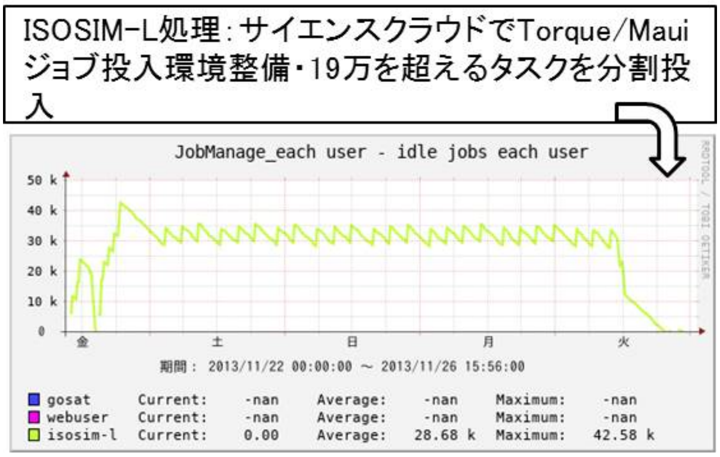
MURANAGA, Kazuya[1*] ; UKAWA, Kentaro[1] ; YUTAKA, Suzuki[1] ; MURATA, Ken T.[2] ; WATANABE, Hidenobu[2] ; MIZUHARA, Takamichi[3] ; TATEBE, Osamu[4] ; TANAKA, Masahiro[4] ; KIMURA, Eizen[5]

[1]Systems Engineering Consultants Co., LTD., [2]National Institute of Information and Communications Technology, [3]CLEALINKTECHNOL Co.,Ltd., [4]University of Tsukuba, [5]Ehime University

This paper is to propose a cloud system for science, which has been developed at NICT (National Institute of Information and Communications Technology), Japan. The NICT science cloud is an open cloud system for scientists who are going to carry out their informatics studies for their own science.

The NICT science cloud is not for simple uses. Many functions are expected to the science cloud; such as data standardization, data collection and crawling, large and distributed data storage system, security and reliability, database and meta-database, data stewardship, long-term data preservation, data rescue and preservation, data mining, parallel processing, data publication and provision, semantic web, 3D and 4D visualization, out-reach and in-reach, and capacity buildings.

In the present talk we discuss the basic concept of the NICT Science Cloud: (1) data transfer and crawling, (2) data preservation and stewardship and (3) data processing and visualization. After brief introductions of several functions and tools for them, we discuss systems via mash-up of these technologies, which are for practical research works.



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MGI37-02 Room:413 Time:April 29 09:15-09:30

High-speed File Transfer Tool with the Gfarm File System

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A distributed storage system of scale-out type is gradually being used in the High Performance Computing (HPC) to store large scale data. NICT is also running an about 3 petabyte-scale (PB) distributed storage system with the Gfarm file system and a 10Gbps Layer 2 network (JGN-X) in Japan. Gfarm is open source software of a distributed file system for a petabyte-scale grid computing, and has been adopted as a shared storage of the High Performance Computing Infrastructure (HPCI).

When Gfarm copies data between storage servers in long-distance network, it uses a multiple TCP streaming technique to transfer data faster because TCP single streaming is known to produce a low network throughput in a long distance network. However, efficiency of high-speed by the technique becomes low as more distant.

We developed a high-speed file transfer tool worked with Gfarm. The tool adopts the UDT protocol as a data transfer protocol and has a control function for a parallel data transfer. UDT is a reliable UDP based application level data transport protocol over wide area high-speed networks, and uses UDP protocol to transfer bulk data with its own reliability control and congestion control mechanisms. In fact, UDT can provide a high network throughput than TCP in a long distance network.

We explain our tool and report the performance results of the tool in basic evaluation.

MGI37-03 Room:413 Time:April 29 09:30-09:45

An Examination of Data I/O Speed on a Parallel Data Storage System

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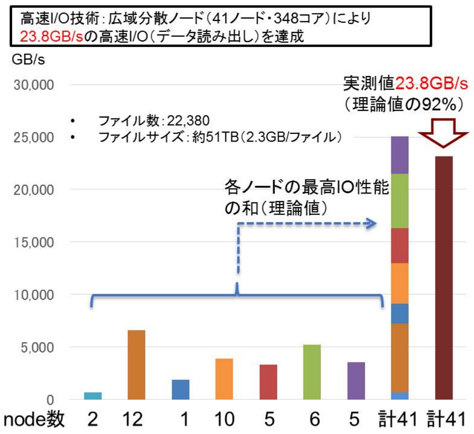
In the present study, we examine performance of parallelization of I/O on the NICT Science Cloud system. We examine two types of data file system; parallel file system (GPFS) and distributed file system (Gfarm). The later file system shows a tremendous fast I/O, as fast as 23 GB/sec using only 30 servers. We should pay attention to this I/O speed (23GB/sec is 184 Gbps) from the viewpoint of network speed. Since general network speed so far is 10 Gpbs or 40 Gbps in a cloud system, this 184 Gpbs is fast enough that the I/O cannot be a bottle-neck for big data processing.

We also discuss that the distributed file system shows better scalability compared with the GPSF system. Parallelization efficiency in the present examination is higher than 90% in case of parallel file system. This suggests that, in the near future, we can expect higher I/O speed using more file servers. For instance, if the I/O speed is as fast as 100 GB/sec, it takes only 1,000 sec. (17 min.) to read 100 TB data files.



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MGI37-04 Room:413 Time:April 29 09:45-10:00

STARS touch: A web-application for time-dependent observation data

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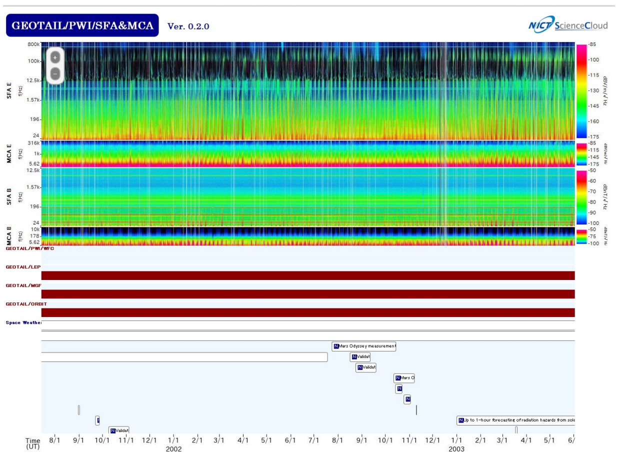
In the present study, we discuss a Web application for time-dependent science data, which is named ”STARS touch”. This Web application is based on a technique of asynchronous data transfer of graphic files for several types of data plots. The cloud system create a huge number of data plots with various time scale (e.g., from few minutes to few years) for each data-set. Parallel processing techniques to create such huge number of graphic data files are also discussed. We also make a live demonstration of the STARS touch to show several types of applications not only for research works but also for social data previews.



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MGI37-05 Room:413 Time:April 29 10:00-10:15

High performance data processing for detection of bipolar waveforms from KAGUYA/WFC-L using the NICT Science Cloud

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Lunar orbiter named KAGUYA was launched in September, 2007, and was operated until June, 2009. The WFC (waveform capture) onboard KAGUYA measures plasma waves below 1MHz around the moon. The WFC-L, one of subsystems of WFC, is a waveform receiver measuring waveform from 100 Hz to 100 kHz with its sampling frequency at 250 kHz. Characteristic bipolar waveforms which can be classified into some patterns were observed by the WFC-L. We developed an automatic detection algorithm to pick up these bipolar waveforms , but it takes huge computation time because the total amount of the WFC-L data is about 190 GB.

In the present study, we introduced the Science Cloud system served by National Institute of Information and Communications (NICT) in order to improve the performance of trial and error process for the development of detection algorithm. The NICT Science Cloud is a cloud system built for scientific research and data service especially for big data science. We utilized parallel data processing under the work flow control implemented in the NICT Science Cloud. We report the performance of the NICT Science Cloud in the present paper.

In order to define an appropriate workflow to the data processing servers, Pwrake (Parallel Workflow extension for Rake) was introduced as a task scheduler. Pwrake is extended for file sharing systems from Rake which is a build tool described by Ruby language. It is possible to assign tasks to each node and to perform parallel data processing by describing the contents of processing, the node to be used, and the number of cores.

We confirmed that total processing time reduced down to 1/140 times compared with a case of 1 node and 1 core, when we used 10 nodes and 24 cores. Because of the effect of hyper-thread technology, processing speed is not proportional to the number of the resources. By utilizing the system, it is expected that a higher-precision detection algorithm can be developed efficiently. As further works, development of more intelligent detection algorithm as well as evaluation of the performance using much larger resources of the NICT Science Cloud will be necessary.

Keywords: Lunar Orbiter KAGUYA, Waveform Capture, NICT Science Cloud, parallel processing

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MGI37-06 Room:413 Time:April 29 10:15-10:30

Comparison of grid data formats in meteorology: the reason for indexed sequential access method (ISAM) used in JMA

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Many format standards are used for grid data of simulation such as numerical weather prediction (NWP). Wright and Gao (2008) argued there are direct-access and sequential formats, and a choice is needed between fastness of partial read and compactness of data files. However, a JMA's local standard NuSDaS (Toyoda, 2001) uses the third category, ISAM (indexed sequential access method) which achieves both fastness and compactness. These three types of file formats are comared (Table 1).

In the operational NWP (1) data structure is often sparse, (2) each file is written by a single process, and (3) many subsequent processes read a part of data tile. In this situation the weakness (cost of indexing) is not outstanding and the strength (fastness and compactness) are enjoyed.

It is also noted that the weakness of sequential access (full scan for partial data) will be aggravated in the future computing with larger data size.

References

Bruce WRIGHT and Feng GAO, 2008: GRIB vs NetCDF: Evaluation of the Technical Aspects. WMO ET-ADRS Doc.2.3(1) http://goo.gl/AFrsls

TOYODA Eizi, 2001: NuSDaS: Numerical Prediction Standard Data-set System. JpGU presentation A2-011 http://goo.gl/JE0a3M

Keywords: GRIB, netCDF, NuSDaS, grid data, indexed sequential access method

Types of File Structure

	Sequential Access	Direct Access	Indexed Sequential Access Method (ISAM)
Partial Write	Simple: *append to EOF (end of file)*	Simple: *seek and write*	Complex: *append to EOF, then index location*
File Size	Most Compact	Sparse array Bloated	Compact
Partial Read	Slow: *all records must be scanned*	Fastest: *only seek and read*	Fast: *look up index, seek and read*
Other Strength	No definition needed when creating file	Parallel write to single file	
Meteorological Examples	GRIB GTOOL3	GrADS Binary netCDF	NuSDaS

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MGI37-P01 Room:Poster Time:April 29 18:15-19:30

Construction of the Large-Scale Statistical Analysis Environment of the STP field data based on the NICT Science Cloud

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[1]National Institute of Information and Communications Technology, [2]University of Tsukuba, [3]Ehime University

There are two major research methods for geo-space science; one is computer simulation, and the other is satellite and/or ground-based observation. Both methods have their advantages and disadvantages: Computer simulations can provide data in whole time and space in the simulation domain, whereas satellite observation data are expected to provide more accurate information. Therefore it is effective for the improved reliability of data and the increased possibilities of explaining phenomena to utilize multi-satellite observation data in combination with sophisticated simulation data with high time resolution. It has a potential to lead to data assimilations in the future.

However, the amount of both multi-satellite observation data and simulation data with high time resolution is very large. We need computational techniques to analyze both data simultaneously. For statistical analysis and visualization, the typical data processing of both multi-satellite observation data and simulation data with high time resolution is called data intensive processing. In the data intensive processing, the same processing is applied to plenty of data files.

We have built a large-scale environment for the statistical analysis where the data obtained through satellites observations and computer simulation are used to construct a uniform, integrated dataset. In this environment, plenty of data are integrated in the following manner: (1)Archiving large quantities of data files, (2)Resampling time series and convert coordinates, (3)Extracting parameters from simulation data, and (4)Merging both data into one file.

(1)Archiving large quantities of data files: Using the STARS (Solar-Terrestrial data Analysis and Reference System) meta-database that provides meta-information of observation data files managed at distributed observation data sites over the internet, users download data files without knowing where the data files are managed. On the other hand, simulation data is saved from supercomputer to petabyte-scale distributed storage that is connected to 10GbE (JGN-X).

(2)Resampling time series and convert coordinates: We developed an original data class (SEDOC class) to support our reading of data files and converting them into a common data format. The data class defines schemata for several types of data. Since this class encapsulates data files, users easily read any data files without paying attention to their data formats. The SEDOC class supports a function of resampling time series through linear interpolations and converting them into major coordinates systems.

(3)Extracting parameter from simulation data: We have developed a 3-D visualization system that visualizes both of these data simultaneously and extract parameters from simulation data in the arbitrary coordinate value.

(4)Merging both data into a single file: Time scale and coordinate are regularized over data files.

We found a practical problem of the system, especially in case of long durational data analyses. It is the problem of the computational load on the processes two to four. It is necessary to solve this problem in order to achieve data-intensive processing for plenty of data files with non-negligible file I/O and CPU utilization.

To overcome this problem, we developed a parallel and distributed data analysis system using the Gfarm and Pwrake based on the NICT Science Cloud. The Gfarm shares both computational resources and perform parallel distributed processing. In addition, the Gfarm provides the Gfarm file system which behaves as a virtual directory tree among nodes. The Pwrake throws a job for each Gfarm node that has a target data file in the local disk. It utilizes local disk I/O to achieve effective load balance.

In today's presentation, we show latest results using archived long durational data and discuss the present Gfarm+Pwrake system extended to wide area.

Keywords: computer simulation data, satellite observation data, parallel distributed processing, Gfarm, Pwrake, NICT Science Cloud

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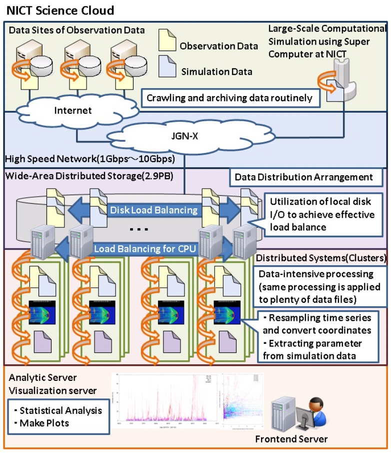

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MGI37-P02 Room:Poster Time:April 29 18:15-19:30

Radio observation network of Tohoku University

YAGI, Manabu[1*] ; OBARA, Takahiro[1] ; KAGITANI, Masato[1] ; YONEDA, Mizuki[1] ; KUMAMOTO, Atsushi[1] ; MISAWA, Hiroaki[1] ; TSUCHIYA, Fuminori[1] ; IWAI, Kazumasa[2] ; TERADA, Naoki[1] ; OHYA, Hiroyo[3]

[1]Tohoku Univ., [2]NAOJ, [3]Chiba Univ.

Planetary Plasma and Atmospheric Research Center (PPARC) of the Tohoku University is now in progress to build a upper atmosphere, planetary, and space physics database under collaboration with the Inter-university Upper atmosphere Global Observation NETwork (IUGONET). The core data of the database are planetary and solar radio observation by Iitate Planetary Radio Telescope (IPRT) and Jupiter/galaxy decameter radio receiver working in Iitate observatory, that is one of the observatory of Tohoku University. Development of database of LF/VLF wave observation at Athabasca, Ny-Alesund, and Asia VLF Observation Network (AVON) are undergoing collaborated with Chiba University. In the presentation, we will introduce the observations of solar radio burst with high time resolution using the AMATERAS spectrometer of IPRT, as well as lightning and precipitation of high energy electrons into the atmosphere observed by LF/VLF wave.

Keywords: radio observation, database, upper atmosphere