Current Progress of Grid project in KMA

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ABSTRACT: Korea Meteorological Administration (KMA) which operates the world's fastest weather prediction system is one of the pioneer groups to implement Grid in meteorology. As a supercomputer provider Cray has supported to establish infrastructure on the KMA's Cray X1E system using UNICORE which is Grid middleware. This paper will provide the current progress of Grid project at KMA and a future plan.

KEYWORDS: Cray X1E, Grid, UNICORE, VPN, security

1. Introduction

Korea Meteorological Administration (KMA) is a government agency providing meteorological services to the public and actively carrying out programs for research and international cooperation [1]. It operates one of the largest X1E systems in the world for numerical weather prediction and climate research.

Korea government has tried to enhance the competitiveness of science and technology by constructing cyberinfrastructure such as the Grid which lags behind developed countries. As a part of the plan, an initiative for the comprehensive implementation of Korean national Grid intrastructure (K*Grid) was started in 2002. KMA keeps pace with this plan as a leading group on supercomputer area in Korea. Cray Korea supports KMA's role with 4 application analysts and 5 system engineers.

In this paper, we will give the overall concept of KMA's Grid project and how to implement. Section 2 introduces KMA's Cray X1E system, while section 3 discusses Grid project and UNICORE, middleware for Grid used as a tool to share the computational resource. Section 4 and 5 highlights current status and future plan.

2. KMA's Cray X1E

Since Feb. 2006, KMA has put into production the fastest operational numerical weather prediction system in the world. The Cray X1E system is the 2nd supercomputer of KMA which is the replacement of the old NEC SX-5/28.

It was installed in two phases: the initial system (2.4 Tflops of peak performance) in Oct, 2004 and the final system (18.5 Tflops of peak performance) in Dec, 2005. The TOP500.org announced that KMA's Cray X1E system ranked at No. 16 on the list published in Nov, 2005 [2].

Figure 1. KMA's Cray X1E

Ref	Cray X1E
Total CPU	1024 MSP
Peak Performance	18.5 TF
Main Memory	4 TB
Capacity of DAS disk	67 TB
Capacity of SAN disk	21 TB
Capacity of Tape drive	1 PB
Functions	For NWP operation Research & Development

Table 1. Configuration of KMA's Cray X1E system

The system is composed of the main compute server of 8 Cray X1E cabinets, login servers, pre-post servers and storage system for backup. The X1E is a liquid cooled parallel vector processor system. Each X1E module contains four Multi-streaming processors (MSPs) and has 16 GB of uniform memory access shared memory [3]. The sustained performance is 15.7 Tflops. Detailed information is on Table 1.

To maintain the system in more secure environment with constant electricity, temperature and humidity, the system is housed in an Internet Data Center, external to KMA. Communication between the places is through four one-gigabit dedicated lines. Figure 2 shows specific structure of network.
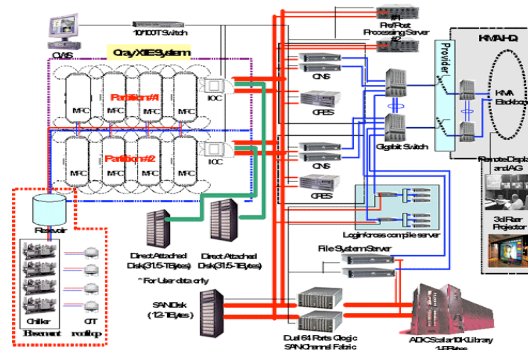

Figure 2. Network configuration of KMA's supercomputer system

3. Grid
3.1 Grid projects in KMA

There are hundreds of definitions of Grid. Although it is hard to say what Grid is, one of the Grid concepts is to integrate the distributed computing platforms via express network to share computing and data resources. Generally Grid comprises of Computational Grid, Data Grid and Access Grid. Computation Grid simply means to share computational resources in remote access and Data Grid indicates to share data by sharing meta data in widely separated storage center.

Access Grid is an ensemble of resources for communication including multimedia displays, presentation and interactive environments and interface to Grid middleware.

From a point of view as an operational agency, KMA has focused on efficient use of computational resources, sharing of an enormous meteorological data and well suited communication tool such as Access Grid. Cray fully understand the needs of KMA and keeps on strengthening the collaboration.

KMA has established a plan for Grid computing in 2003. The final goal is to contribute to weather and climate research by implementing Grid Portal and to play a leading role in the implementation of MetGrid project. As a first step, KMA made a decision to provide computing resources of the Cray X1E using UNICORE which was widely used Grid middleware in Europe, to Republic Of Korea Air force (ROKAF) and APEC Climate Center (APCC). ROKAF has a strong relationship with KMA in developing model and sharing data and APCC, recently founded international organization for research in Asian Pacific climate, also has a strong partnership with KMA. Cray has been co-worked with KMA to succeed this project as well as Access Grid.

3.2 UNICORE

3.2.1 What is UNICORE?

Originally UNICORE (UNiform Interface to COmputing REsources) had been started for the users of German supercomputer centers to access different platforms in secure, seamless and intuitive ways [4]. It provides a science and engineering Grid combining resources of supercomputer centers and making them available through the Internet. Strong authentication is performed in a consistent and transparent manner and the differences between platforms are hidden from the user thus creating a seamless HPC portal for accessing supercomputers, compiling and running applications, and transferring.

UNICORE allows remote users to run on KMA supercomputer while minimizing security risks of unauthorized use. It also provides a simple interface to beginners in running meteorological applications. Figure 3 shows an example of UNICORE interface.
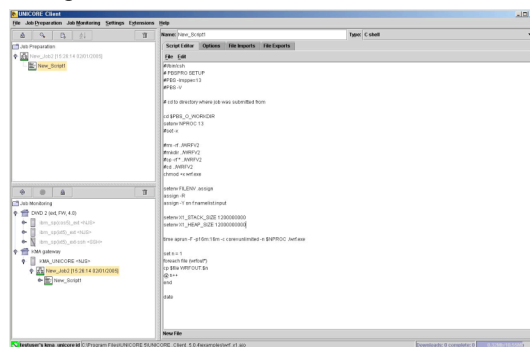

Figure. 3. Interface of UNICORE

In remote access, it cannot be overemphasized the importance of security. UNICORE addresses security of all levels. User authentication is performed using X.509 certificates. To transfer jobs, control information and application data, OpenSSL is used to guarantee data integrity and confidentiality. In addition, only one opened port in firewall is required.

3.2.2 UNICORE Software package

Its architecture is three-tired: UNICORE Client, Server level of UNICORE and Target System Interface (TSI). UNICORE Client produces and controls complicated jobs based on Java. There are two components in server level. The first one is Gateway which works as a secure entry point in a UNICORE site. Network Job Supervisor (NJS) maps abstract requests to concrete jobs. TSI has a role in scheduleing batch jobs. More detailed information about UNICORE can be found on http://unicore.org.

4. Current Status

4.1 Installation of UNICORE on KMA

The main role of KMA's Cray X1E system is to operate numerical weather prediction models. Therefore it could limit users doing R&D parts because of stable operation. Even for the 1st supercomputer of KMA, external users can not access to the NEC SX-5/28 at all. On this point of view, the overall system and policy was constructed to beef up the security.
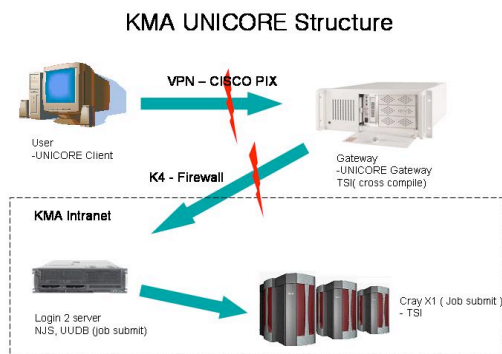

KMA UNICORE Structure

Figure 4. UNICORE Structure with VPN

Figure 4 explains the structure of UNICORE which is installed on KMA. UNICORE Gateway is established outside of intranet, however inside the first firewall. Users can submit jobs through Gateway and NJS server delivers it to the Cray X1E server on which TSI is set up. NJS and TSI could be installed on same server.

On the contrary to NJS or TSI, we should care about security of Gateway as it is located on an external site. While official UNICORE manual recommends to setting up Gateway inside firewall, it could not be applied in KMA. The security guideline of internal network does not permit the Gateway, an external server, to access the intranet. Further step is needed to strengthen the security. This issue has been settled by using Remote access VPN [1] that have only authorized user access Gateway as a first barrier. Regards to web CA tools, we strongly recommend to install inside the intranet. UNICORE can have fatal security hole if the CA is hacked. It is desirable for the authorized user to confirm the certificates.

4.2 Operation

KMA shares its computational resource with ROKAF and APCC using VPN and UNICORE at present time. Each of them is 160 km and 350 km away from KMA. File transferring speed is about 10Mbytes/s which is quite good. Figure 5 designates the overall structure of network. For the next step, we could test on Deutscher Wetterdienst's supercomputer, IBM p690 systems, for the international use. After installing Client,

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[1] Remote Access VPN: A way for the host to connect the target network via Virtual Private Network

we submitted a simple script. It works successfully, but file transferring speed is only about 11Kbytes/s, poor for model operations.
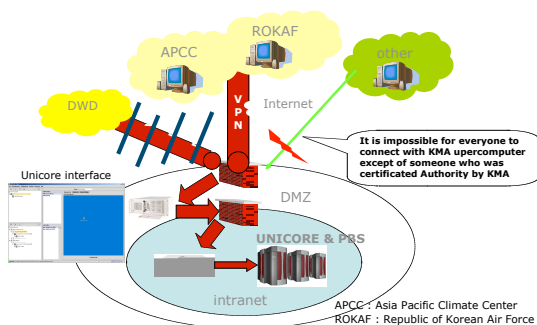

Figure 5. Diagram of remote access to KMA's Cray X1E system

4.3 Access Grid

The Access Grid is an Internet-based model for video conference that focuses on group-to-group communication. For instance, the Access Grid is used for large-scale distributed meetings, collaborative work sessions, seminars, lectures, tutorials, and training. Even though the Access Grid is concentrated on group interactions, it also provides an access point for individual desktop users, permitting one-to-many or one-to-one communication. KMA uses Access Grid system for international meetings or workshops those are geographically separated.

KMA has both of fixed and portable systems. Their hardware specs are as follows.
1) Fixed Access Grid system
a. Display node
   CPU: 2.4GHz×2 / Memory: 1GB / Window xp
b. Video node
   CPU: 2.4GHz / Memory: 1GB / Window xp / video card×4

c. Audio node
   CPU: 2.4GHz / Memory: 1GB / Window xp / sound card×2
d. 3 webcams for video communication and 4 mic for audio communication.

2) Portable Access Grid system
a. all in one node
   CPU: 2.4GHz×2 / Memory: 1GB / video card ×2 / audio card×2
c. 1 webcam for video communication and 1 mic for audio communication.

5. Future Plan

It is clear that "Ubiquitous" and "On demand" are the trend of Information Technology. The Grid technology will open the new era of the Earth system for observation and modeling. Especially the result of research for the Earth System is adopted in the operational procedure very quickly. So it is important to share the resources with operation and research.

5.1 uMeteo-K Grid

To improve and help the research activities, KMA and Center for Atmospheric and Earthquake Research (CATER) will build the Grid infrastructure at universities. Researchers can share the computing power, data and human resources. This is the vision of uMeteo-K Grid in Korea. In this year CATER will support the Access Grid at universities and KMA is preparing the policy for sharing data and computing power including the 2nd supercomputer system.

5.2 MetGrid

The vision for numerical weather prediction especially for operation is based on the ensemble techniques with multi-models at the leading centers. MetGrid is the project for the operation of ensemble multi-models. Supercomputer centers of KMA, DWD, NCAR, CMA, UKMet, ECMWF, and MeteoFrance are the members of MetGrid. At 1st stage centers will exchange the ensemble data under the frame of THORPEX/TIGGE. At final stage centers will share the computing power with Grid to realize the Global Interactive Weather Forecasting System of GEOSS (Global Earth Observation System of Systems).

6. Conclusion

We showed the current status and a future plan of KMA's Grid Project. KMA takes a step forward to achieve its goal, and Cray will consistently make efforts to support this project and strengthen the partnership with KMA.

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References

1. KMA official site: www.kma.go.kr. See also http://super.kma.go.kr

2. Top500 Supercomputer Sites: www.top500.org

3. Cray Inc., 2004: Cray X1 Series System Overview, S-2346-25, www.cray.com/craydoc

4. UNICORE: UNICORE Client User Guide, unicore.sourceforge.net/manuals_readmes.html