HEP Computing in Korea

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Abstract

The current status of High Energy Physics (HEP) computing system and plan of HEP data grid in Korea are reported. The main infrastructure is located at the Center for High Energy Physics at Kyungpook National University for the experiment of Compact Muon Solenoid (CMS), Collider Detector at Fermilab (CDF), Belle and the Alpha Magnetic Spectrometer (AMS). Recently, we have been concentrating on computing in CMS experiment. The current status of regional data center in Korea and Service Challenge 4 (SC4) for CMS experiment are also reported.

Key words: HEP; CMS; CDF; BELLE; AMS; SC4; TEIN; APII; GLORIAD; KOREN; KREONET; PHEDEX

1. Introduction: Korean HEP activities

Large-scale enterprise experiments in which Koreans are involved now and will be in the future are Belle and K2K at KEK in Japan (in progress), CDF at Fermilab in USA (in progress), AMS on the International Space Station(ISS) (data taking starts in 2007), CMS at CERN in Europe (data taking starts in 2007) and other experiments, such as PHENIX at BNL, ZEUS at DESY, D0 at Fermilab, as well as ALICE, OPERA, KIMS, STAR etc. International Linear Collider experiment might start in mid 2010s.

2. Korean HEP Institutions

Belle is an experiment at the KEK B-factory. Its goal is to study the origin of CP violation in B-meson Decays [1]. Korean Belle collaboration consists of Korea University, Yonsei University, Ewha University, Seoul National University, Sungkyunkwan University, Chonnam National University, Kyungpook National University and Gyeongsang National University.

The CDF experimental collaboration is committed to studying high energy particle collisions at the world's highest energy particle accelerator. The goal is to discover the identity and properties of the particles that make up the universe and to understand the forces and interactions between those particles [2]. Korean CDF collaboration consists of Seoul National University, Sungkyunkwan University and Kyungpook National University.

Belle and CDF are producing a large volume of data, which need to be processed and analyzed with simulations. These need computing facility and data storage and the collaborations are working for data gridification.

AMS is an experiment to search in space for dark matter, missing matter and antimatter on the international space station. AMS will observe the properties of electrons, positrons, protons, antiprotons, and nuclei in high-energy radiation from space. Some types of particles may be present already in cosmic rays. AMS may observe them, thus learning about the particles themselves as well as their distant astrophysical sources [3].

The Large Hadron Collider (LHC) is a particle

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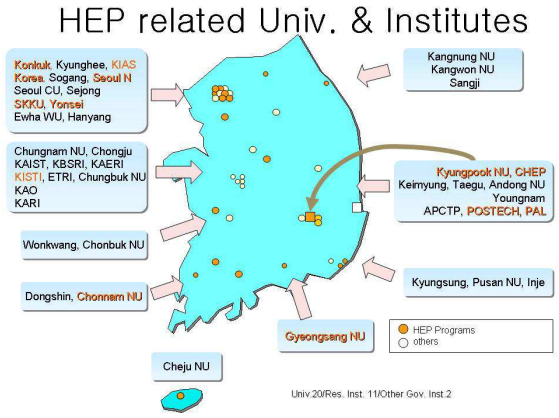

Fig. 1. HEP related institutions in Korea

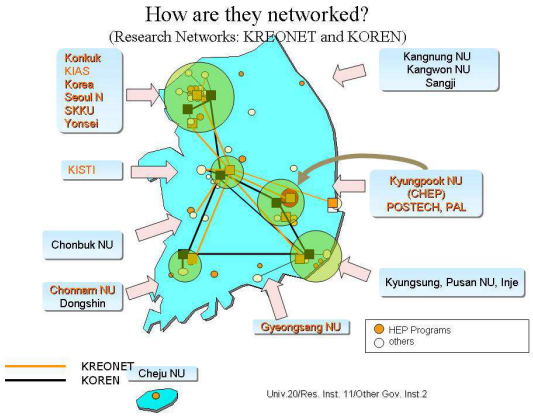

Fig. 2. HEP network in Korea

accelerator which will probe deeper into matter than ever before. Due to switch on in 2007, it will ultimately collide beams of protons at an energy of 14 TeV. Beams of lead nuclei will be also accelerated, smashing together with a collision energy of 1150 TeV. The CMS experiment is one of two large general-purpose particle physics detectors being built on the proton-proton LHC. It will be located in an underground chamber at Cessy in France, just across the border from Geneva. The completed detector will be cylindrical, 21 metres long and 16 metres diameter and weigh approximately 12500 tonnes [4]. The main goals of the CMS experiment are explore physics at the TeV scale, the discovery of the Higgs boson, to look for evidence of supersymmetry and to be able to study aspects of heavy ion collisions.

Korean CMS collaboration consists of Kangwon National University, Konkuk University, Korea University, Seoul National Education University, Yonsei University, Seoul National University, Sungkyunkwan University, Chungbuk University, Wonkwang University, Chonnam National University, Dongshin University, Seonam University, Kyungpook National University, Gyeongsang National University and Cheju National University.

Figure 1 shows HEP related universities and institutes in Korea.

Figure 2 shows how the institutions are connected with two research networks, KREONET and KOREN.

3. Korean HEP Computing and Grid R&D

The Center for High Energy Physics (CHEP) at Kyungpook National University (KNU) is the place where most of these experimental activities are centered. Naturally the computing resources and R&D activities are based on the CHEP activities. CHEP is building a supercomputing center for HEP to be equipped with

- CPU $> 1{,}000$
- Disk cache 1,000 TB
- Tape storage 3,000 TB
- Networking > 20 Gbps
- Technology in Grid
- Time before 2007.

Data grid R&D and collaborations in Korea are

- Domestic grid WG since 2001
- HEP/Physics network WG since 2002
- LCG grid testbeds since 2002
- iVDGL since 2002
- LCG2 since 2005

iVDGL served 100 researchers in HEP, Astronomy, Bio-Chemistry etc. It is providing more than 2,000 CPUs with US sites (Korean sites: 84 CPUs). It's renamed OSG since 2005.

Storage Resource Broker (SRB) is used for Belle in federation of Taiwan, Japan, Australia, China, Poland, Korea SRB sites and for domestic usage (KISTI, KBSI).

We are also part of Ultralight collaboration and participated in SC04 and SC05.

Other Grid R&D works are

- CMS MC productions and analyses
- Decentralized Analysis Farm (DeCAF) for CDF
- Belle gridification works
- AMS MC production but not in the Grid mode

DeCAF is running and serving 800 researchers around the World for CDF experiment. For a KNU certificate authority (CA) a server is installed and almost ready for operation. CA, SRB and MC production are also used for Belle experiment.

4. LCG Service Challenge 4 at KNU

4.1. *CHEP Resources*

Recently, CHEP has particpated in the LCG Service Challenge 4 (SC4) as a Tier-2 (T2) center. SC4 started in June and ended on September 30. The minimum requirement for a Tier-1 or for a Tier-2 center for CMS experiment is

	Tier-1	Tier-2
CPU	2.5 MSi2K	2.5 MSi2K
Disk	1.2 PB	200 TB
Mass Storage	2.8 PB	
WAN	in: 7.2 GBbps out: 3.5 GBbps	> 1 Gbps
CPU node IO BW	1 Gbps	1 Gbps

At the moment CHEP has 230 kSi2K CPU, 51 TB hard disk and 45 TB mass storage system. These are about 25% of total requirement of a CMS Tier-2 center in 2008. The CHEP network systems are conneted with KREONET, KOREN as domestic links. They were 155 Mbps at best before 2002. Now they are 1∼2.5 Gbps via KOREN and 10 Gbps via KREONET. Some domestic links are connected now with 10 Gbps (CHEP-KISTI, KISTI-GIST, and Daejeon-Seoul area >40 Gbps).

International Links are conneted with APII, TEIN and GLORIAD. Figure 3 shows APII/TEIN network. APII is about 2 Mbps to Japan and will be 10 Gbps in this year. It is 155 Mbps to China . It was at first 30 Mbps to US but now it is 10 Gbps

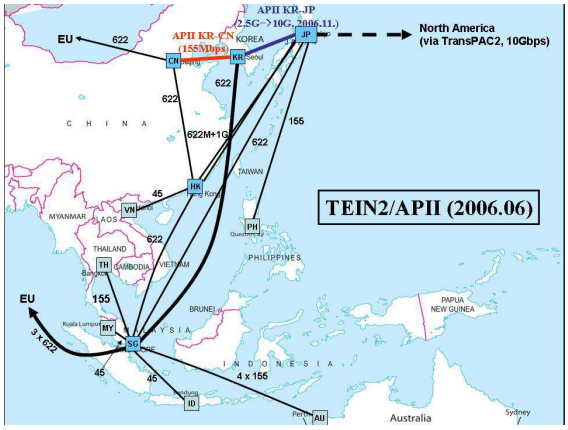

Fig. 3. APII/TEIN network around Korea

via Gloriad. TEIN has new direct link to CERN with two 622 Mbps lines.

Figure 4 shows GLORIAD network.

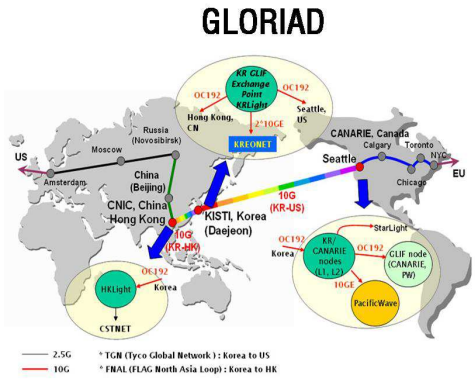

Fig. 4. GLORIAD network

GLORIAD connects US-Korea-Hong Kong with 10 Gbps. These achievements were made possible, driven by applications demands. HEP played the leading role.

4.2. *Status of CMS SC4 at KNU*

Figure 5 shows SC4 transfer rate plot. It is transferrd rates by all destinations for last 48 hours at August 26 by PheDEx monitoring [5]. The marked box shows that the transfer rate for T2 KNU load is about 10∼60 MB/s and it is about 10% of the total rates. 8 CMS Tier-1 sites and 24 Tier-2 sites are participated in SC4.

Figure 6 shows SC4 cumulative transferred volume plot. It shows cumulative transferred data by all destinations for last 48 hours at August 26 by

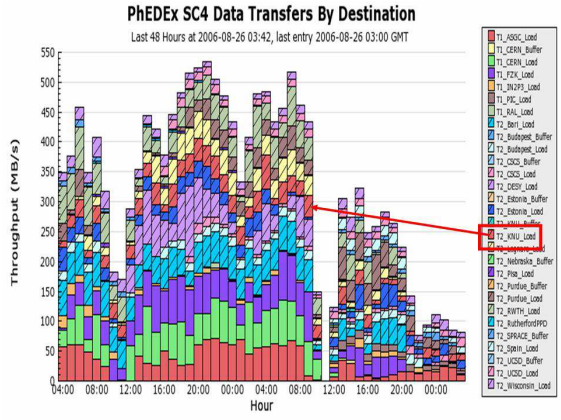

Fig. 5. SC4 transfer rate plot

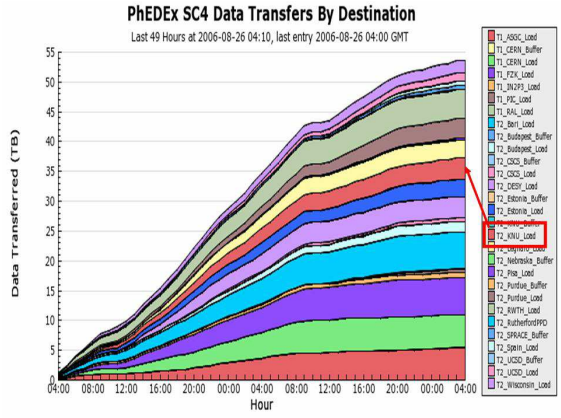

Fig. 6. SC4 cumulative transferred volume plot

PheDEx. The marked box shows that the transferred data for T2 KNU load is about 4 TB within 2 days and it is about 7% of the total transferred volume by all sites.

Figure 7 shows SC4 transfer quality plot. It shows

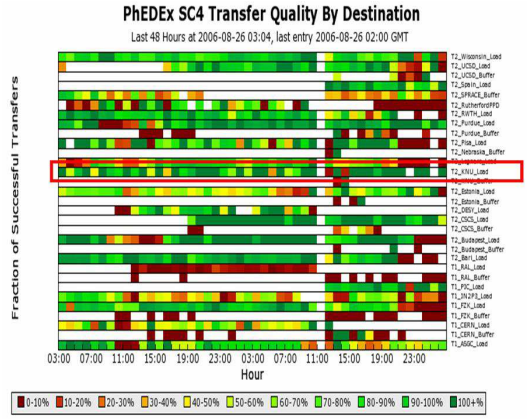

Fig. 7. SC4 transfer quality plot

fraction of successful transfers by all destinations for last 48 hours at August 26 by PheDEx . The marked box shows that the transfer quality is very good for T2 KNU load.

5. Summary

Korean HEP computing is now in the phase from base configuration to more intensified system. HEP data grid R&D and network tests have been performed in collaboration with international and domestic partners. Enough bandwidth with new technology such as GLORIAD 10 Gbps are ready and will be up to 40 Gbps in 2008. To meet the demands in Korean HEP some HEP data grid collaborations and HEP working groups for networks are formed. They are supported by governments (MIC, MOST) and various groups of experts. We will continue R&D for data grid technology and networking for improvement.

Korean HEP is proposing a regional data center for CMS and it is in preparation. The CMS SC4 at KNU is working properly. HEP is an excellent promising example of computational physics with widely dispersed resources all over the world and with excellent collaboration.

Acknowledgements

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