Grid Activities in Pakistan

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Pakistan – CERN Collaboration:

- *Detector Simulation and Studies*
- *Detector Construction*
- *R&D related to Gaseous detectors*
- *Physics Data Analysis*
- **Computing for LHC**
Background

- No single site had enough resources and bandwidth to become a Tier 2 site
- The Idea of a Tier 2 Federation was proposed Based on WLCG Tiered Architecture
- NCP is a Regional Center for this federation
- Other participating institutes were
  - The Commission on Science and Technology for Sustainable Development in the South (COMSATS)
  - National University of Science & Technology (NUST)
  - Pakistan Atomic Energy Commission (PAEC)
    - PAEC1
    - PAEC2
    - PAEC3
Background

- NCP as Regional centre had to provide a centralized storage.
- All other sites in Pakistan must be connected through dedicated fiber link.
- Required data was supposed to be fetched by other centers from NCP data storage repository.
Tiered Architecture of WLCG

Tier 0

Online System

~100 MBytes/sec

~20 TIPS

CERN Computer Centre

~100 MBytes/sec

Tier 0 is approximately 25,000 SpecInt95 equivalents

Tier 1

France Regional Centre

Germany Regional Centre

Italy Regional Centre

FermiLab ~4 TIPS

Tier 0

~622 Mbits/sec

or Air Freight (deprecated)

Tier 1

~622 Mbits/sec

Tier 2

Caltech ~1 TIPS

Tier2 Centre ~1 TIPS

Centre TIPS

Centre TIPS

~622 Mbits/sec

Tier 2

~0.25 TIPS

Institute

~0.25 TIPS

Institute

Institute

Physics data cache

~1 MBytes/sec

Physicist workstations

Tier 4

~PBytes/sec

There is a "bunch crossing" every 25 nsec.
There are 100 "triggers" per second.
Each triggered event is ~1 MByte in size

Image courtesy of Harvey Newman, Caltech
Tiered Architecture of WLCG

Tier 0
- Online System: ~100 MBytes/sec
- Offline Processor Farm: ~20 TIPS
- 1 TIPS is approximately 25,000 SpecInt95 equivalents
- CERN Computer Centre
- Tier 0 is the main processing centre.

Tier 1
- France Regional Centre
- Germany Regional Centre
- Italy Regional Centre
- Fermilab ~4 TIPS
- ~622 Mbits/sec or Air Freight (deprecated)

Tier 2
- Caltech ~1 TIPS
- Tier 2 Centre ~1 TIPS
- Centre TIPS
- ~622 Mbits/sec

Tier 3
- NCP
- NUST
- PAEC
- COMSTAS

Tier 4
- Institute ~0.25 TIPS
- ~622 Mbits/sec

Physicists work on analysis "channels". Each institute will have ~10 physicists working on one or more channels. Data for these channels should be cached by the institute server.

[ Image courtesy of Harvey Newman, Caltech ]
The effort to bring Pakistan on the WLCG map as a Grid Node was started in October, 2003.

A Grid Technology Workshop was organized by NCP from October 20-22, 2003.

The first ever test-bed was deployed during the workshop for tutorial.

This test-bed consisted of 09 machines

- 2 Computing Elements (CES)
- 1 Storage Element (SE)
- 1 Resource Broker (RB)
- 1 GIIS and GRIS Server
- 4 Worker nodes
## Computing Resources (2005)

<table>
<thead>
<tr>
<th>INSTITUTE</th>
<th>CPU/Cores</th>
<th>Bandwidth (kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMSATS</td>
<td>05</td>
<td>256</td>
</tr>
<tr>
<td>NUST</td>
<td>08</td>
<td>384</td>
</tr>
<tr>
<td>PAEC</td>
<td>33</td>
<td>512</td>
</tr>
<tr>
<td>NCP</td>
<td>08</td>
<td>384</td>
</tr>
</tbody>
</table>
MOU For WLCG in 2006

<table>
<thead>
<tr>
<th>Pakistan, Pakistan Tier-2 Federation</th>
<th>Planned to be pledged</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
</tr>
<tr>
<td>CPU(KSI2k)</td>
<td>870</td>
</tr>
<tr>
<td>Storage (TB)</td>
<td>200</td>
</tr>
<tr>
<td>Nominal WAN (Mbits/sec)</td>
<td>42</td>
</tr>
</tbody>
</table>
### Computing Resources (2010)

<table>
<thead>
<tr>
<th>INSTITUTE</th>
<th>CPU/ Cores</th>
<th>Bandwidth (Mbps)</th>
<th>Storage (TB)</th>
<th>HEPSPEC 2006</th>
<th>KSI2k</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCP &amp; PAEC installed</td>
<td>160</td>
<td>155</td>
<td>80</td>
<td>1600</td>
<td>300</td>
</tr>
<tr>
<td>NCP &amp; PAEC June 2010</td>
<td>200</td>
<td>-</td>
<td>115</td>
<td>2000</td>
<td>375</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
<td>155</td>
<td>195</td>
<td>3600</td>
<td>675</td>
</tr>
</tbody>
</table>
NCP is connected with 3 ISPs

- Fiber connection from Nayatel @ 10Mbps
- Wireless Radio LinkDotNet@ 3.5Mbps.
- Fiber Connection from HEC(PERN2)
  - 2Mbps internet
  - 155Mbps R&D link connected with TEIN3, GEANT2, and Internet2.

- User traffic and Grid traffic is divided among these links.
High Availability of Network

- High availability and fault Tolerance is achieved by:
  - Placing Physical redundant devices.
  - Running High availability protocol between redundant devices.
    - Hot Standby Routing Protocol (HSRP)
    - Virtual Router redundancy Protocol (VRRP)
    - Gateway Load balancing Protocol (GLBP)
Network Infrastructure
TEIN3 Connectivity

TEIN3 Backbone Topology January 2010

TEIN3 Project Partners
- AU Australia
- BD Bangladesh
- IN India
- ID Indonesia
- JP Japan
- KR Korea
- LA Laos
- MY Malaysia
- PK Pakistan
- TH Thailand
- VN Vietnam

Link Owners
- NICT
- NII
- MELIN
- NIA
- TeINet
- ORIENT

Number of Links
- 10 Gbps
- 45 Mbps
- 2.5 Gbps
- Planned
- 1 Gbps
- 10 Mbps
- 622 Mbps
- 155 Mbps

* SingAREN connected to TEIN3 SG PoP at 45 Mbps
* HARNET connected to TEIN3 HK PoP at 70 Mbps
WLCG Staff

- 2 network Administrators (Part Time)
- 1 System Manager (Part Time)
- 2 Grid Mangers
Contact persons for Grid node

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Today WLCG@NCP

- User Interface (UI)
- Storage Element (SE)
- Computing Element (CE)
- Worker Nodes (WN)
- Workload Management System (WMS)
- BDII (Top_BDII as well as Site_BDII)
- MONbox
- VOBOX
- PHEDEX
Today WLCG@NCP
Today WLCG@NCP
**Normalized CPU Time**

- **68,288** KSI2K hours of raw processing has been served by NCP

![Pie chart showing normalized CPU time per VO](image-url)
Current APEL Accounting Statistics
NCP-LCG2

- **SUM CPU Time Elapsed**
  - **145,429** KSI2K hours were used by different jobs

![Pie chart showing CPU time distribution per VO]

(C) CESSA 'EGEE View': NCP-LCG2 / xrdmtp / 2006:3-2010:2 / VO-DATE / Inc (x) / A00NBR-13N / 11 2010-02-16 17:41 UTC
Current APEL Accounting Statistics
NCP-LCG2

- **Total Number Of Jobs**
- **114,954 jobs executed**
NCP-LCG2 Availability and Reliability

EGEE Availability & Reliability
NCP-LCG2

Year 2009
PAKGRID-LCG2

- User Interface (UI)
- Computing Element (CE)
- Storage Element (SE)
- Site BDII
- MON
- Worker Nodes (WN)
- VoBox
- Merged with NCP recently
PAKGRID-LCG2
Normalized CPU Time

- **30,982** KSI2K hours of Normalized CPU Usage
Current APEL Accounting Statistics
PAKGRID-LCG2

SUM CPU Time Elapsed
- 93,650 KSI2K hours were used by different jobs
Current APEL Accounting Statistics
PAKGRID-LCG2

- 105,394 jobs executed
PAKGRID-LCG2 Availability and Reliability

EGEE Availability & Reliability
PAKGRID-LCG2

Year 2009

Percentage

Availability
Reliability
PK-GRID-CA

- An accredited certification Authority (CA) runs under the European Grid Policy Management Authority (EU-GRID-PMA).
- EU-GRID-PMA works under the umbrella of International Grid Trust Federation (IGTF).
- Reviewed by several members of EU-Grid-PMA.
- Three revisions were made which resulted from comments and suggestions by PMA members.
- The CA was presented in September 2004 in the 2nd meeting of the EU-Grid-PMA held in Brussels.
- NCP was formally approved by the EU-Grid-PMA as a Certification Authority in 2004.
PK-GRID-CA

PK-Grid-CA had started its operations since then.

First Certification Authority in Pakistan

Issues X.509 digital certificates to users/hosts to use grid resources under secure environment
PK-GRID-CA Statistics

- PK-Grid-CA root key
  - Length: 4096 bits (RSA)
  - Lifetime: 10 years
  - Validity: December 11, 2017

- So far **167** digital certificates have been issued to various organizations and persons in Pakistan:
  - 96 user certificates
  - 71 host certificates

- Out of those 167:
  - 77 got expired
  - 34 were revoked

- Currently active certificates: **56**

- For more information: [www.ncp.edu.pk/pk-grid-ca](http://www.ncp.edu.pk/pk-grid-ca)
PK-GRID-CA

- PK-Grid-CA Web Portal
  - Online Request submission for certificate
  - Online Revocation of certificate requests with client certificate authentication
  - Parsing the certificates and sending reminders to users about expiry dates of the certificates before expiry
  - Uploading of signed certificates in appropriate directory, insertion of the certificate pin-code, download path, download status and count information in database and renaming of the previous certificates according to the expiry dates
Current Status

- **NCP**
  - Running successfully as a production CMS Tier-2 site
  - Have managed to proceed even with lesser resources at start
  - Possess sufficient manpower and user community
  - Suffered hard time with inadequate network connectivity
Common Challenges

- **Internet Bandwidth**
  - Internet Prices are very High
  - Sporadically network disruptions at ISP level due to various reasons
  - Not many ISPs in Pakistan to provide bandwidth required for a T2 node.
  - *Higher education commission has provided 155 Mbps to NCP*

- **Electric Power**
  - Pakistan hassled dreadfully by the severe power-cuts in recent times
  - Extensive load-shedding harmfully impacted the battery-backups for power generation
Growth in Resources For Real Data

Network Connectivity at NCP-LCG2

CPU Capacity at NCP-LCG2

Data Storage at NCP-LCG2
Conclusion

- Despite all of the challenges
  - The effort to establish grid nodes in Pakistan kept continued successfully.
  - We sustained our visibility in WLCG map even with weaker infrastructure
  - We are already contributing in terms of CPU and storage resources to the LHC community
- Things are getting better and Grid node in Pakistan is stronger than ever
Questions