Collaborative research that is made possible by sharing across the Internet of resources (data, computation, people’s expertise...)

- Crosses organisational boundaries
- Often very compute intensive
- Often very data intensive
- Sometimes large-scale collaboration

**CERN-LHC project is an excellent example of all the above**
LHC program

- LHC: 7 TeV on 7 TeV protons or 2.76 TeV/u Pb on Pb in the existing 27 km LEP tunnel. First collisions summer 2008

- Four experiments ATLAS, CMS mainly for pp, also for Pb-Pb. ALICE geared to Pb-Pb; LHCb specialized for b study.

- Indian groups in ALICE and CMS

- Indian contribution towards LHC machine: Corrector magnets, cryogenic equipment, precision support jacks.
India-CMS Collaboration

- Panjab U, Delhi U, BARC, TIFR (2 groups), and recently, Visva-Bharati U
- Hardware responsibilities:
  - Outer hadron calorimeter.
    Physics necessity: ensure more hermetic detector to look for missing energy signals of LSP/other new physics.
  - Silicon Pre-shower Detector.
    Physics necessity: discriminate between $\gamma/\pi^0$ to detect the Higgs $\rightarrow \gamma\gamma$ decay mode (for low mass Higgs favored by existing data)
36 Nations, 160 Institutions, 2008 Scientists and Engineers (November 2003)

**CMS Collaboration**

**TRIGGER & DATA ACQUISITION**
- Austria, CERN, Finland, France, Greece, Hungary, Italy, Korea, Poland, Portugal, Switzerland, UK, USA

**TRACKER**
- Austria, Belgium, CERN, Finland, France, New Zealand, Germany, Italy, Japan*, Switzerland, UK, USA

**CRYSTAL ECAL**
- Belarus, CERN, China, Croatia, Cyprus, France, Ireland, Italy, Japan*, Portugal, Russia, Serbia, Switzerland, UK, USA

**RETURN YOKE**
- Barrel: Czech Rep., Estonia, Germany, Greece, Russia, Endcap: Japan*, USA, Brazil

**SUPERCONDUCTING MAGNET**
- All countries in CMS contribute to Magnet financing in particular: Finland, France, Italy, Japan*, Korea, Switzerland, USA

**FORWARD CALORIMETER**
- Hungary, Iran, Russia, Turkey, USA

**PRESHOWER**
- Armenia, Belarus, CERN, Greece, India, Russia, Taipei, Uzbekistan

**HCAL**
- Barrel: Bulgaria, India, Spain*, USA, Endcap: Belarus, Bulgaria, Russia, Ukraine, HO: India

**MUON CHAMBERS**
- Barrel: Austria, Bulgaria, CERN, China, Germany, Hungary, Italy, Spain, Endcap: Belarus, Bulgaria, China, Korea, Pakistan, Russia, USA

* Only through industrial contracts

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India-ALICE Collaboration

**PMD** (photon multiplicity detector)

- **Bhubaneswar**, Institute of Physics
- **Chandigarh**, Panjab University
- **Jaipur**, University of Rajasthan
- **Jammu**, University of Jammu
- **Kolkata**, Variable Energy Cyclotron Centre
- **Mumbai**, Bhabha Atomic Research Centre
- **Mumbai**, Indian Institute of Technology

**Muon Arm**

- **Aligarh**, Aligarh Muslim University
- **Kolkata**, Saha Institute of Nuclear Physics
Indian contribution to ALICE : PMD, Muon Arm
Contributions in LHC Grid

• DAE in collaboration with IT Division CERN is developing global Grid components & tools for the WLCG
• Indian scientists are participating in the CMS and ALICE experiment & detector development
• India has operational ALICE (Kolkata) and CMS (TIFR) Tier II regional centres of WLCG network in India connected to DAE (BARC, IOPB, SINP) Institutes and 14 Universities.

India’s total kind contribution is over 60 MCHF
GRID project, Tier-2/3 CMS, ALICE centers

1 Bunch crossing; ~17 interactions per 25 nsecs; 100 triggers per second. Event is ~1 MByte in size

Tier 0 +1

Tier 1

~0.6 - 2.5 Gbits/sec

FNAL Center
UK Center
Italy Center
France Center

Tier 2

~2.5 Gbits/sec

Tier 2 Center

Tier 3

~622 Mbits/sec

Physics data cache

Institute

Workstations

Tier 4

100 - 1000 Mbits/sec

Physicists work on analysis “channels”
Each institute has ~10 physicists working on one or more channels

DAE/ DST-WLCG Tier II Grid in India

Barc, IOPB and 14 Universities have been operational since 2007.
Regional DAE-WLCG Tier-2 in India

Tier 0/1 Centre

CERN/GEANT

Tier 2 Centre and CMS users

Internet

300/1000 Mbps

34/100 Mbps

100 Mbps

POP in Mumbai

Uses WLCG tools

Tier 2 and Alice users

Tier 2/3 Centers in India

Tier 2 Centre and CMS users

2/10 Mbps

34/100 Mbps

34/100 Mbps

100 Mbps

VECC

ALICE: Universities & Institutes Tier 3

2/10 Mbps

Tier 3 and CMS Users

BARC

CMS: Universities & Institutes Tier 3

DAE/DST/ERNET: Geant link operational since August 2006

Physical and Routing Schematic at TIFR, Mumbai

Note: The 3750G configured to route CERN traffic on the 1Gbps Grid nodes can now access internet through the current 34Mbps link

The EU-IndiaGrid Project Joining European and Indian grids for e-science

- To support the interconnection and interoperability of the prominent European Grid infrastructure (EGEE) with the Indian Grid infrastructure for the benefit of eScience applications
- Two year project started from Oct 2006 with BUDGET of 1208 k-EUR total fund out of which 1015.9 k-EUR from European Commission (5 Europe & 9 Indian partners)
First year of EU-IndiaGrid

- Established production quality sustained Grid services and achieved good progress
  - Integrated EGEE and Indian sites into a common infrastructure
    - Interoperability ........ to be achieved
  - CDAC & MIT, Anna University
    - Offered pilot clusters to users..... INFN & VECC
    - Developed users from at least 5 disciplines
      HEP, Condense Matter Physics, Bio, Weather, Climate etc.
- Demonstrated a viable general process to bring other application communities on board
  - E-governance............ NIC
INDIACMS-TIFR

• India-CMS Tier2 center at TIFR, Mumbai

• System administrators:
  P.V. Deshpande (pvd@tifr.res.in)
  P. Nagaraj (pn@tifr.res.in)

• Expect to hire more staff
Tier2: IndiaCMS-TIFR, Mumbai, India

Network
- Network bandwidth recently upgraded to 1 Gbps
- Link is tested successfully between TIFR and CERN and commissioned. Full utilization is underway

Storage
- Current: 50 TB (raw) disk space. HP EVA 8000 system
- DPM using SRM is used to provide storage services

Projection: 400 TB (raw) using DPM, SLC4 and gLite 3.1
- Common problems: No special problems so far.
Computing

Current: 80K SI2000 equivalent Dual Xeon@3.6 GHz, 2 GB RAM, Rack mountable servers SLC3 for managing servers and SLC4 for worker nodes. Torque for batch processing and gLite 3.1 for middleware

Projection: 45 Blade servers (4C 2P 5355 CPU family @ 2.6 GHz, 2 GB RAM per core, SLC4, gLite 3.1)
Display Reliability Graphs

Overall Service Availability for Site: INDIACMS-TIFR VO:OPS (Weekly Report)

Individual Service Availability for site: INDIACMS-TIFR VO:OPS (Weekly Report)

Graphs for Individual Sites:
CERN-CIC

(Host-wise details for a Site can be seen by clicking over the relevant graph below)

Aggregate Data Movement

Site-wise Data Transfer From CERN-CIC To INDIACMS-TIFR

Weekly Report
(Site-wise Data Transfer From All Sites To INDIACMS-TIFR)
Revert Source/Dest Site(s)

Averaged Throughput
Site-wise Data Transfer From All Sites To INDIACMS-TIFR

<table>
<thead>
<tr>
<th>Date</th>
<th>Throughput (MB/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/03</td>
<td>3.3</td>
</tr>
<tr>
<td>17/03</td>
<td>9.1</td>
</tr>
<tr>
<td>24/03</td>
<td>18.4</td>
</tr>
<tr>
<td>31/03</td>
<td>18.8</td>
</tr>
</tbody>
</table>


TIFR – India
e513-e-rci65-3 Vlan2106 - daily

[Graph showing network traffic over 24 hours, with labels for average bits in and out.]
Downloads from ASGC using only the 34 Mbps line

CMS PhEDEx - Transfer Rate
132 Hours from 2008-03-29 17:00 to 2008-04-04 05:00 UTC

Maximum: 5.97 MB/s, Minimum: 0.74 MB/s, Average: 2.87 MB/s, Current: 0.75 MB/s

Downloads from CERN using the 300/1000 Mbps line

CMS PhEDEx - Transfer Rate
132 Hours from 2008-03-29 17:00 to 2008-04-04 05:00 UTC

Maximum: 28.44 MB/s, Minimum: 4.27 MB/s, Average: 20.52 MB/s, Current: 8.53 MB/s

Gaps in plots

- The reasons are known.
  - The bigger gap at the same time in the two plots is because of expired proxy certificate - an oversight.
  - The other small gaps are because of problems on the server side.
Next steps

• Downloads and PHEDEX transfers having stabilized, to get commissioned and integrated into CMS-GRID

• Technical hurdle: designated Tier-1 center is Taiwan, but we have limited bandwidth for that.

• **Solution:**
  - One does peering of Indian 1 Gbps line with ASGC 10 Gbps line to Europe somewhere (Amsterdam/CERN)
  - Else make CERN the designated Tier-1 center

• Sorting out this administrative issue
KOLKATA TIER-2
Site Name :- IN-DAE-VECC-01
VO :- ALICE
Country :- INDIA
System Administrator (1): Tapas Samanta
   email : tsamanta@veccal.ernet.in
System Administrator (2): Vikas Singhal
   email : vikasssinghal@gmail.com
## Hardware Status

### Computing Power

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present KSI2k No. (Till March 2008)</td>
<td>35</td>
</tr>
<tr>
<td>Pledged KSI2k No. (Till March 2008)</td>
<td>266</td>
</tr>
<tr>
<td>Expected Procurement* (By May 2008)</td>
<td>240</td>
</tr>
</tbody>
</table>

* Purchase is under process.

### Storage

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present (Till March 2008)</td>
<td>4TB</td>
</tr>
<tr>
<td>Pledged KSI2k No. (Till March 2008)</td>
<td>100TB</td>
</tr>
<tr>
<td>Expected Procurement (By May 2008)</td>
<td>100TB</td>
</tr>
</tbody>
</table>
Running Services

<table>
<thead>
<tr>
<th>Service</th>
<th>Processor</th>
<th>RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOBOX</td>
<td>Dual Intel Xeon 2.4 Ghz</td>
<td>4GB</td>
</tr>
<tr>
<td>ALIEN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE</td>
<td>Dual Intel Xeon 3.0 GHz</td>
<td>4GB</td>
</tr>
<tr>
<td>SE</td>
<td>Dual Intel Xeon 3.0 GHz</td>
<td>4GB</td>
</tr>
<tr>
<td>13 WN</td>
<td>Dual Intel Xeon 3.0 GHz</td>
<td>4GB</td>
</tr>
</tbody>
</table>

Bandwidth Status

100 Mbps is running fine since 14/01/2008 and Upgraded soon to 155 Mbps.

Indian ALICE Grid Users

- 7 Institutes:
  1. Jaipur University, Jaipur
  2. Panjab University, Chandigarh
  3. IOP, Bhubaneswar
  4. Jammu University, Jammu
  5. IIT Bombay, Mumbai
  6. AMU, Aligarh
  7. VECC, Kolkata

- 50 Researchers

Issue: India CA is not ready, Ad-hoc solution provided by ASGC CA.
Certificate issued by ASGC CA is presently not recognized in ALICE environment.
Performance So far (data challenges)

- Contributed in
  - PDC-04
  - PDC-06
  - PDC-07
  - PDC-08

- 25 Jobs are running continuously in ALIEN environment.
- Reached reliability and availability levels of over 90% till March 2008.
  \[(\text{IN-DAE-VECC-01} : - 93\%)\]
Performance So far

• Storage Element installation and configuration?

• How to minimize up-gradation work like middleware, CA certificate, host, server, proxy etc.?

• New hardware procurement
  ✓ How to decide new hardware procurement? (Any guideline or prescribed specification for Grid Services and Worker node.)
  ✓ Should new hardware compatible with older one?
  ✓ Should we go for big backup system (Is backup of full storage element required or only for services)?
  ✓ Should we go for Infiniband network to interconnect different servers, worker nodes etc?
Initiatives by Indian Government

• 11th five year plan proposals for E_infrastructure (National Knowledge Network) to be managed by a Steering Committee

• Grid for S&T applications, which will interlink about 100 Govt. Labs, IIT’s, Universities & Colleges, submitted to GOI from PSA’s office as XI plan proposal

• The MoES proposes to setup 4 large centre of excellence in the country in a Grid fashion to carry out advance research in Climate & Weather applications
Thank you
Weekly Report
(Site-wise Data Transfer From All Sites To INDIACMS-TIFR)
Revert Source/Dest Site(s)

Aggregate Data Movement
Site-wise Data Transfer From All Sites To INDIACMS-TIFR