Monte Carlo Mass Production for the ZEUS Experiment on the Grid

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Outline:

- Introduction
- Integrated Production System
- ZEUS Grid-Toolkit
- Monitoring
- Conclusions
The ZEUS Experiment

- HERA-II luminosity upgrade beams:
  - $p = 920$ GeV
  - $e^{\pm} = 27.6$ GeV
  - $\sqrt{s} \approx 320$ GeV

- detector upgrades
  - trigger
  - microvertex detector
  - forward tracking
Traditional MC Production System

- handles MC requests
- stores all MC files at a central place
- pioneering distributed computing

Production by Institute

1996 41.7 million events 1997 54.6 million events
Monte Carlo Demand

- physics data volume
- triggers, analyses
- HERA-II event simulation and reconstruction

CPU time:

<table>
<thead>
<tr>
<th>Executable</th>
<th>runtime ratio (post/pre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>simulation</td>
<td>2.08</td>
</tr>
<tr>
<td>trigger</td>
<td>1.7</td>
</tr>
<tr>
<td>reconstruction</td>
<td>3.46</td>
</tr>
</tbody>
</table>

output files: 2.8 (1.13 - 3.3) times larger

- need for additional resources
LCG Job Submission

zeusmc-ui

User Interface

job desc.
edg-job-submit
edg-job-status
edg-job-get-output

DESY

Resource Broker
Input Sandbox
job status
Output Sandbox
match job to site

RALPPLCG2

Site Info

Compute Element
grid-mapfile
jobmanager
local batch system

Storage Element
Worker Node

DESYZEUS

Site Info

Compute Element
grid-mapfile
jobmanager
local batch system

Storage Element
Worker Node
Grid3

sites : 32
CPUs : 4 400+
Using the Grid: ZEUS

Advantages

- established distributed MC system since 1996
  - MC requests
  - bookkeeping
  - storage
- portable software
- lightweight jobs
  - three executables, each less than 25 MB
  - input data: 50 MB
  - calibrations, run scripts, etc.: 200 MB
- close collaboration with DESY/IT grid group
Using the Grid: Design Aspects

- submitted jobs must run on their own
  - data handling
  - calibrations
  - error logging and handling
  - (re-)submission, bookkeeping

- different middleware with different interfaces

- different sites

- preserve existing MC system
Using the Grid: Design Aspects

- submitted jobs must run on their own
  - data handling
  - calibrations
  - error logging and handling
  - (re-)submission, bookkeeping

- different middleware with different interfaces
  - ZEUS grid-toolkit

- different sites
  - good monitoring

- preserve existing MC system
  - build bridge from the existing MC system to the grid
Bridge to the Grid

- Status: no more upgrades
  - Gateway (grid UI)
    - LCG–2
    - gLite
      - Status: production
      - gLite site
      - gLite site
      - gLite site
      - gLite site
      - Status: awaiting deployment
    - LCG–2 site
    - LCG–2 site
    - LCG–2 site
    - Status: production
  - classical site
  - classical site
  - classical site

- MC production
  - LCG–2 site
  - gLite site
  - Status: production

- Globus site
  - Status: production

- Grid3
Dataflow

Resource Broker
distribute jobs

zeusmc–ui (gateway)
bridge to existing MC system

Site A
Site B
Site C

input data

Disk Pool
acs/generated

DESY Storage Element

DESY Tape Pool

gridsplit
Mozart
Zgana
Zephyr

gridsplit
Mozart
Zgana
Zephyr

gridsplit
Mozart
Zgana
Zephyr

gridsplit
Mozart
Zgana
Zephyr

zeusmc−ui (gateway)
register input
data
LCG Sites

available for ZEUS: 2000 CPUs
Beyond LCG: Grid3 Site in Wisconsin

- at the University of Wisconsin
- uses Condor to submit jobs to 1440 CPUs
- approach:
  - use Globus toolkit and emulate LCG behavior
  - install a job wrapper script at CE
  - install LCG storage tools
  - use own JobCommand implementation in ZEUS grid-toolkit
- first Grid3 site participating in ZEUS MC production
ZEUS Grid-Toolkit

- set of Perl classes for
  - basic data structures
  - job submission
  - data transfer
  - output validation

- implementation using grid tools encapsulated
- fixes known deficiencies of grid tools
- independent of the ZEUS software
- used by at least one other experiment

http://www-zeus.desy.de/grid
How to improve the Grid Production?

- more sites
- monitoring
- move critical services to reliable sites
- exclude broken sites
- try to fix or circumvent problems
- identify and remove bottlenecks
each grid job stored in a database
continous submission of jobs
<table>
<thead>
<tr>
<th>Job ID</th>
<th>Site</th>
<th>State</th>
<th>Date of Last State Change</th>
<th>Last History Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>6001</td>
<td>1000</td>
<td>SUBMITTED</td>
<td>Thu Feb 24 14:37:33 2005</td>
<td>SUBMITTED and scheduled at gridit001.pd.infn.it:2119/jobmanager-leglaf-long <a href="https://grid-rb.desy.de:9000/x7ogmSK0m-Jlx7Y1p6B36Q">https://grid-rb.desy.de:9000/x7ogmSK0m-Jlx7Y1p6B36Q</a></td>
</tr>
<tr>
<td>16001</td>
<td>1000</td>
<td>SUBMITTED</td>
<td>Thu Feb 24 11:54:37 2005</td>
<td>SUBMITTED and running at zeus-ce.desy.de:2119/jobmanager-legpbs-long <a href="https://grid-rb.desy.de:9000/cWPGrtZcDo0M1dveFTda1A">https://grid-rb.desy.de:9000/cWPGrtZcDo0M1dveFTda1A</a></td>
</tr>
</tbody>
</table>

**State**

- **SUBMITTED**
- **DONE**

**Date of Last State Change**

- Thu Feb 24 14:37:33 2005
- Thu Feb 24 11:49:45 2005
- Thu Feb 24 11:44:53 2005
- Thu Feb 24 11:54:37 2005
- Thu Feb 24 14:42:23 2005

**Last History Entry**

- SUBMITTED and scheduled at gridit001.pd.infn.it:2119/jobmanager-leglaf-long https://grid-rb.desy.de:9000/x7ogmSK0m-Jlx7Y1p6B36Q
- SUBMITTED and running at zeus-ce.desy.de:2119/jobmanager-legpbs-long https://grid-rb.desy.de:9000/XLskr65mgDXW78G6Hg271A
- SUBMITTED and running at zeus-ce.desy.de:2119/jobmanager-legpbs-long https://grid-rb.desy.de:9000/cWPGrtZcDo0M1dveFTda1A
Produced Events and Submissions

- Produced: 1.71723e+07 events
- Submissions: 233,753 total, 230,147 successful

Graphs showing event production and job submissions over the last week.
# Error List

## ZEUS Grid Latest Errors

<table>
<thead>
<tr>
<th>date</th>
<th>CE name</th>
<th>queue</th>
<th>funnel id</th>
<th>first event</th>
<th>error</th>
<th>url</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thu Feb 24</td>
<td>heplnx201.pp.rl.ac.uk</td>
<td>zeus</td>
<td>82P020.H10384.HRW6505.RMS.2J.32</td>
<td>17001</td>
<td>could not copy and register the output file to default SE; timeout reached 1200;</td>
<td>https://</td>
</tr>
<tr>
<td>Thu Feb 24</td>
<td>heplnx201.pp.rl.ac.uk</td>
<td>zeus</td>
<td>82P020.H10384.HRW6505.RMS.2J.31</td>
<td>13001</td>
<td>could not copy and register the output file to default SE; timeout reached 1200;</td>
<td>https://</td>
</tr>
<tr>
<td>Thu Feb 24</td>
<td>heplnx201.pp.rl.ac.uk</td>
<td>zeus</td>
<td>82P020.H10384.HRW6505.RMS.2J.19</td>
<td>19001</td>
<td>could not copy and register the output file to default SE; timeout reached 1200;</td>
<td>https://</td>
</tr>
<tr>
<td>Thu Feb 24</td>
<td>heplnx201.pp.rl.ac.uk</td>
<td>zeus</td>
<td>82P020.H10384.HRW6505.RMS.2J.113</td>
<td>1001</td>
<td>could not copy and register the output file to default SE; timeout reached 1200;</td>
<td>https://</td>
</tr>
<tr>
<td>Thu Feb 24</td>
<td>heplnx201.pp.rl.ac.uk</td>
<td>zeus</td>
<td>82p020.s8954.sat.edu.q80.009</td>
<td>9001</td>
<td>at heplnx201.pp.rl.ac.uk:2119/jobmanager-torque-zeus</td>
<td>https://</td>
</tr>
</tbody>
</table>
Overall Production

<table>
<thead>
<tr>
<th>Date</th>
<th>ZEUS MC events [millions]</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-Nov</td>
<td></td>
</tr>
<tr>
<td>26-Dec</td>
<td></td>
</tr>
<tr>
<td>25-Jan</td>
<td></td>
</tr>
<tr>
<td>24-Feb</td>
<td></td>
</tr>
<tr>
<td>26-Mar</td>
<td></td>
</tr>
<tr>
<td>25-Apr</td>
<td></td>
</tr>
</tbody>
</table>

Italy (36.3 %)
- INFN-PADOVA
- INFN-BOLOGNA
- INFN-CATANIA
- INFN-CAGLIARI
- INFN-CNAF
- INFN-FIRENZE
- INFN-NAPOLI
- INFN-NAPOLI-ATLAS
- INFN-BARI
- INFN-FERRARA
- INFN-PISA
- SNS-PISA
- INFN-TRIESTE
- INAF-TRIESTE
- INFN-ROMA2
- INFN-ROMA1-VIRGO

Germany (27.4 %)
- DESYPRO
- DESYUHH
- DESYZEUS

United Kingdom (29.8 %)
- RALLCG2
- RALPPLCG2
- UCL-HEP
- UCL-CCC
- OXFORD-01-LCG2
- SCOTGRID-GLA
Overall Production

[Graph showing ZEUS MC events by date and country contribution, with countries Italy, Germany, United Kingdom, and Canada, and institutions such as INFN-PADOVA, INFN-BOLOGNA, etc.]
Overall Production

Zeus MC Events [millions]

- Italy (36.3%)
  - INFN-PADOVA
  - INFN-BOLOGNA
  - INFN-CATANIA
  - INFN-CAGLIARI
  - INFN-CNAF
  - INFN-FIRENZE
  - INFN-NAPOLI
  - INFN-NAPOLI-ATLAS
  - INFN-BARI
  - INFN-FERRARA
  - INFN-PISA
  - SNS-PISA
  - INFN-TRIESTE
  - INAF-TRIESTE
  - INFN-ROMA2
  - INFN-ROMA1-VIRGO

- Germany (27.4%)
  - DESYPRO
  - DESYUHH
  - DESYZEUS

- United Kingdom (29.8%)
  - RALLCG2
  - RALPPLCG2
  - UCL-HEP
  - UCL-CCC
  - OXFORD-01-LCG2
  - SCOTGRID-GLA

- Canada (1.1%)
  - TORONTO-LCG2

- Spain (3.7%)
  - UAMLCG2

Date

26-Nov 26-Dec 25-Jan 24-Feb 26-Mar 25-Apr
Overall Production

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Conclusions

- integrated system using static and grid resources
- ZEUS grid-toolkit
- uses different grids
- 29 different sites produced events
- doubled production capacity
- http://www-zeus.desy.de/grid/