What is this talk about?

- LSF as a product
- basic commands user perspective
- basic commands admin perspective
- CERN installation
- Unix users/groups and LSF groups
- share management at CERN
- EGEE related: CE information system, LSF information providers
- Pros/Cons
- LSF features (to be compared to other system), what is used at CERN, what not
- problems seen in the past, and ways to avoid this
What is this talk NOT about?

- ELFms: quattor, lemon and leaf
- software and configuration management
Wishlist received:

- Very basic LSF introduction
- Differences / advantages / disadvantages compared to other batch systems
- What is special with the CERN cluster
- Main difficulties
- Local vs grid users
- Preexec and post exec in the context of virtualization

-> hope to be able to cover these
very basic commands

job submission: `bsub`
- `-q <queue name>`
- `-R "resource requirements"`
- `-J Jobname`

other interesting options:
- `-E pre_exec_command`
- `-m <hostname>`

Examples:
- `bsub -q 8nm "sleep 5"`
- `bsub -R"type=SLC4"`
- `bsub -R"swp>14"`
- `bsub -R"amd"`

see also: `man bsub`
job submission: bjobs
- -u <user|usergroup|all>
- -q <queue_name>
- -a

other interesting options:
- -l
- -r
- -p

Examples:
- "bjobs -u all" to list all jobs of all users
- "bjobs -a" to list your jobs including those which recently finished
- "bjobs -u u_zp" to list all jobs in unix group zp, i.e. ATLAS (local + grid)
- "bjobs -l 12345" verbose output of job id 12345
- "bjobs -u all -r" list all running jobs of all users

see also : man bjobs
very basic commands (cont.)

queue status `bqueues`
- `-q <queuename>`
- `-l`

Examples:
- “bqueues” list all queues and their status
- “bqueues -l -q 8nm” show features of 8nm queue

see also: man `bqueues`
very basic commands (cont.)

- “lshosts” show all hosts in the cluster, and their resources
- “lsid” shows information about the master node and batch instance name
- “bhosts” show all hosts in the cluster, with batch related features
- “btop 12345” puts job 12345 on top of the queue
- “bmod -R”amd” 12345” modifies Resource requirements for a queued job 12345
- “bugroup” gives information about a user group, eg. “bugroup u_zp”
- “bmgroup” gives information about a group of hosts, eg. “bmgroup g_iR”

**Note:**

- user groups can be defined inside the LSF configuration files. They can but do not have to correspond to a unix GID.
- LSF groups can contain other LSF groups

```
~ > bugroup u_ATLAS
GROUP_NAME   USERS
u_ATLAS      u_ATLASRTT/ u_zp/ grid_ATLASSGM/ zp_PROD/ grid_ATLASPRD/ zp_TZERO/zp_TOKYO/ zp_BURST/ grid_ATLAS/
```
basic concepts (LSF6.1)

distinguish between communication layer and LSF/batch commands

- batch commands start with a “b”
  - bjobs
  - bqueues
  - bhosts
  - btop
  - bmod
  - badmin

- commands related to the basic communication layer start with an “ls”
  - lshosts
  - lsadmin
  - lsid

This structure is also reflected in the structure of the config files. There are configuration files for the resource part (“ls*”) and for the batch part
basic admin commands

• “Isadmin” used to administrate the resource part
  • needed to add or remove hosts
  • needed to change resources on hosts
  Examples: Isadmin reconfig

• “badmin” used to administrate batch part
  • changes in shares
  • changes in queues
  Example: badmin reconfig

is required to make LSF aware of any changes in the batch configuration part

Notes: These commands are supposed to cause no service interruption. Do use these instead of restarting Lsf. Use them always together: first Isadmin reconfig, then a badmin reconfig for a full reconfiguration. If a queue changed, badmin reconfig is usually enough.
Host types in a LSF cluster

- LSF server:
  - Each node which runs the LSF daemons is a LSF server
- LSF Master node(s):
  - There is one and only one active master node in each batch instance
  - This node is the only one which runs a master batch daemon and the scheduler
  - In general, each node in a cluster can be a master node
  - Fail-over: if the primary master node fails, LSF will try to fail over to another one

Notes:
- Each master node candidate needs to have access to the current LSF event and info files
- Each server requires a license key, one per core
  (LSF7: 1 CPU license plus 1 Multicore option per additional core)
- Submit only hosts: host which only have the clients installed, but do not run the daemons
CERN LSF installation (batch)
Farm management

- Central users management
  - CERN has a central management of Unix users, the Computer Resources Administration (CRA)
  - UID's need to be centralized. If a new one is needed, it has to be reserved
  - GID's are determined by the experiment (VO)
  - Secondary groups are not supported

- LSF servers
  - In general, all machines running LSF have to be Quattor managed
  - We disallow “on the fly” adding of machines which is possible in LSF
    - Number of license keys are limited
    - Avoid adding of badly configured machines to the cluster
      Example: user laptop starting to eat batch jobs

- LSF software
  - Arrives as tar ball from the company
  - Build our own rpms from these tar balls
  - Software is locally installed, only some configuration files are shared via AFS
Farm management (cont)

- base software: available in the ELFms software repository
  - LSF base packages, used both for CASTOR and batch
  - CERN-CC addons for batch nodes, like eexec and elim scripts
  - ncm-Isfclient component to configure the local configuration files
  - special local configuration file templates for batch and castor
  - Check [https://twiki.cern.ch/twiki/bin/view/FIOgroup/ScLSFrpm](https://twiki.cern.ch/twiki/bin/view/FIOgroup/ScLSFrpm) for latest release

- common LSF configuration files
  - kept on AFS
  - automatic creation of some configuration files
    - LSF hosts file, including host resources
    - lsb.hosts and lsb.users which contain user group and share definitions
  - User share allocation stored in Oracle, editable with a GUI

- LSF reconfiguration
  - Done once per day, early in the morning
### CDB WebUpdate Tool - LSF Accounts

**Main Menu | Accounts | LSF Groups | LSF Subgroups | LSF Users | LSF Shares | LSF Subgroups Fractions**

#### Add a new Account

<table>
<thead>
<tr>
<th>Account Name</th>
<th>Group Code</th>
<th>Group ID</th>
<th># LSF Groups</th>
<th>Last Modified</th>
<th>Inactive?</th>
<th>Inactive since</th>
<th>Reason for being inactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>alp</td>
<td>xu</td>
<td>1157</td>
<td>1</td>
<td>07JUL06 vmsb</td>
<td>no</td>
<td>Account is active</td>
<td>Account is active</td>
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<tr>
<td>alice</td>
<td>z2</td>
<td>1395</td>
<td>1</td>
<td>07JUL06 vmsb</td>
<td>no</td>
<td>Account is active</td>
<td>Account is active</td>
</tr>
<tr>
<td>atlas</td>
<td>zp</td>
<td>1307</td>
<td>2</td>
<td>07JUL06 vmsb</td>
<td>no</td>
<td>Account is active</td>
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<tr>
<td>c3</td>
<td>c3</td>
<td>1028</td>
<td>1</td>
<td>07JUL06 vmsb</td>
<td>no</td>
<td>Account is active</td>
<td>Account is active</td>
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<tr>
<td>cms</td>
<td>zh</td>
<td>1399</td>
<td>1</td>
<td>07JUL06 vmsb</td>
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<td>Account is active</td>
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<tr>
<td>compass</td>
<td>vy</td>
<td>1685</td>
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<tr>
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<td>xx</td>
<td>1180</td>
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<td>vk</td>
<td>1645</td>
<td>1</td>
<td>07JUL06 vmsb</td>
<td>no</td>
<td>Account is active</td>
<td>Account is active</td>
</tr>
<tr>
<td>fluka_rp</td>
<td>hc</td>
<td>1059</td>
<td>1</td>
<td>18OCT07 panzer</td>
<td>no</td>
<td>Account is active</td>
<td>Account is active</td>
</tr>
<tr>
<td>geant4</td>
<td>zb</td>
<td>1196</td>
<td>1</td>
<td>07JUL06 vmsb</td>
<td>no</td>
<td>Account is active</td>
<td>Account is active</td>
</tr>
<tr>
<td>grid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>herp</td>
<td>uh</td>
<td>2397</td>
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<td>07JUL06 vmsb</td>
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<td>Account is active</td>
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<tr>
<td>luck</td>
<td>ve</td>
<td>1476</td>
<td>1</td>
<td>07JUL06 vmsb</td>
<td>no</td>
<td>Account is active</td>
<td>Account is active</td>
</tr>
</tbody>
</table>
Share management

Fair share scheduling:

Idea:
- all nodes are in one big group of worker nodes
- each experiment (VO) has its share of this total allocation, in kSi2k
- the allocation has been agreed in advance with the experiments
- the total share allocation is a basic input for the resource planning
- advantage: if one group is less active others can use the machines

Reality:
- we have some special sub-clusters which are not part of the share
- these special cluster do still belong to the same instance
Share management

Fair share nodes: (CERN specific)

- Nodes which are part of the fair share can be identified by their attributes
  - “share”: these nodes are available to all users, including GRID
  - “grid4”: these nodes are SLC4 nodes available to the GRID
  - “lcg”: these nodes are SLC3 nodes available to the GRID

Reminder: use “lshosts -R share” to get the complete list of “public” batch nodes

Notes:

- on public nodes the number of job slots is determined by the number of cores
- the rule is SlotNumber=NumberOfCores + 1
- local and grid jobs use the same resources!
- if a job is scheduled to a host it has only the right to use one CPU
- multithreaded jobs should reserve an appropriate number of job slots
CERN specifics summary

- All batch machines are under the control of the same scheduler.
- The batch cluster contains machines of:
  - very different hardware, disk space, memory,
  - Operating systems and architectures
    - SLC3 (being retired)
    - SLC4/32 bit
    - SLC4/64 bit
  - shares spread over all these architectures
- Each batch node has several job slots.
- Local and grid jobs compete for the resources.
- Currently most CPUs are INTEL, very few are AMD.
Share management

CERN IT Department

IT Home > FIO

CDB WebUpdate Tool - LSF Groups Shares

Main Menu | Accounts | LSF Groups | LSF Subgroups | LSF Users | LSF Shares | LSF Subgroups Shares

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Share (kSEK)</th>
<th>Account Name</th>
<th>Last Modified</th>
<th>User</th>
<th>Comments</th>
<th>Now Share (kSEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>u_ALEPH</td>
<td>1</td>
<td>seph</td>
<td>28APR07 17:39:32</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
<td></td>
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<tr>
<td>u_ALICE</td>
<td>812</td>
<td>alice</td>
<td>28APR07 17:39:32</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
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</tr>
<tr>
<td>u_ATLAS</td>
<td>656</td>
<td>alias</td>
<td>28APR07 17:41:06</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
<td></td>
</tr>
<tr>
<td>u_ATLASCAT</td>
<td>20</td>
<td>alias</td>
<td>28APR07 17:41:07</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
<td></td>
</tr>
<tr>
<td>u_C3</td>
<td>10</td>
<td>c3</td>
<td>28APR07 17:41:07</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
<td></td>
</tr>
<tr>
<td>u_CMS</td>
<td>1800</td>
<td>cms</td>
<td>20JUL07 10:55:03</td>
<td>panzer</td>
<td>reduce by factor 2, given dedicated resources to CMS BPS</td>
<td></td>
</tr>
<tr>
<td>u_COMPASS</td>
<td>800</td>
<td>compass</td>
<td>17JUL07 15:48:28</td>
<td>panzer</td>
<td>get the August shares already earlier BPS</td>
<td></td>
</tr>
<tr>
<td>u_DELPHI</td>
<td>1</td>
<td>delphi</td>
<td>23APR07 17:42:34</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
<td></td>
</tr>
<tr>
<td>u_DIMAC</td>
<td>100</td>
<td>dirac</td>
<td>23APR07 17:42:34</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
<td></td>
</tr>
<tr>
<td>u_DTEAM</td>
<td>10</td>
<td>grid</td>
<td>23APR07 17:42:34</td>
<td>panzer</td>
<td>BPS resource plan 2007</td>
<td></td>
</tr>
<tr>
<td>u_GEANT4</td>
<td>50</td>
<td>geant4</td>
<td>17JUL07 15:48:28</td>
<td>panzer</td>
<td>go back to the base shares BPS</td>
<td></td>
</tr>
</tbody>
</table>
### CDB WebUpdate Tool - LSF Subgroups Fractions

<table>
<thead>
<tr>
<th>Subgroup Name</th>
<th>Group Name</th>
<th>Fraction</th>
<th>Account Name</th>
<th>Last Modified</th>
<th>User</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>u_xlim</td>
<td>u_ALEPH</td>
<td>12%</td>
<td>aleph</td>
<td>26AUG07 17:13:04</td>
<td>dimenna</td>
<td>123,456</td>
</tr>
<tr>
<td>xu_PROD</td>
<td>u_ALEPH</td>
<td>59%</td>
<td>aleph</td>
<td>07JUL06 15:40:52</td>
<td>venu</td>
<td>initial values from July 2006</td>
</tr>
<tr>
<td>grid_ALICE</td>
<td>u_ALICE</td>
<td>19%</td>
<td>alice</td>
<td>26AUG06 15:06:11</td>
<td>uschweck</td>
<td>20% of the total grid resources of 50% of the total</td>
</tr>
<tr>
<td>grid_ALICEPRD</td>
<td>u_ALICE</td>
<td>1%</td>
<td>alice</td>
<td>01SEP06 18:48:43</td>
<td>uschweck</td>
<td>production goes here for Alice</td>
</tr>
<tr>
<td>grid_ALICETAG</td>
<td>u_ALICE</td>
<td>39%</td>
<td>alice</td>
<td>01SEP06 19:40:43</td>
<td>uschweck</td>
<td>not used for production</td>
</tr>
<tr>
<td>uu_zz</td>
<td>u_ALICE</td>
<td>56%</td>
<td>alice</td>
<td>07JUL06 15:40:52</td>
<td>venu</td>
<td>initial values from July 2006</td>
</tr>
<tr>
<td>grid_ATLAS</td>
<td>u_ATLAS</td>
<td>5%</td>
<td>atlas</td>
<td>26AUG06 15:31:21</td>
<td>uschweck</td>
<td>20% of Grid allocation of 23% of the total</td>
</tr>
<tr>
<td>grid_ATLASPRD</td>
<td>u_ATLAS</td>
<td>17%</td>
<td>atlas</td>
<td>23OCT06 11:59:09</td>
<td>uschweck</td>
<td>reduced by 1 what SGM account gets (D. Liko)</td>
</tr>
</tbody>
</table>

### Additional Actions
- View LSF Group Subgroups
- View History
- Change LSF Group Info
- Change LSF Group Share
- Change LSF Group Subgroups Fractions

### Website
- [www.cern.ch/it-fio](http://www.cern.ch/it-fio)
GRID related information

All accounts:
- have a GID which determines the VO
- local accounts of the same VO have the same GID
  password and group entries are centrally managed (NOT by yaim!)

“normal” pool accounts:
- have a local home directory on each batch node
- ... which is created by the installation of a special package (NOT by aim!)

SGM accounts:
- have a AFS directory, can get an AFS token via gssklog
- have a local home directory installed by a package (NOT by yaim!)

local accounts:
- live in AFS
- no local home directories
processing of local user jobs on batch nodes:
- a process is forked of which retrieves an AFS token for the job
- this process (started via eexec) forks off a child which renews the AFS token
- the job itself is wrapped into a job wrapper (run as part of the user job). This
  - creates a local directory in /pool/lsf/<username>/jobid
  - cd's into this
  - starts the user job itself
  - cleans the job directory after the job ends

processing of grid user jobs on batch nodes:
- the eexec process will immediately exist and start the job wrapper
- the job wrapper essentially does nothing in this case. Just starts the user job
- the grid user local home is located in the /pool area
- local and grid jobs compete for the local disk space on each box
Information system and CEs:

- All CEs see the same batch system, with all jobs and all OS versions
- bjobs does NOT tell you for which arch a specific job is waiting!
- if no explicit resource requirements are given,
  - jobs are scheduled to nodes which match the type of the submission host
  - jobs from a SLC3 CE would always be scheduled to SLC3 nodes
  - the reported job slots and number of jobs would be all not only SLC3

the LSF information providers can deal with that if
- a little additional tool kit (I named it “btools”) is installed
- in that case a CE will only report jobs which match the LSF type of the CE
- with that, a SLC4 submitting CE will only see the SLC4 fraction of batch
- still, fair share is on ALL hosts in lxbatch!
**GRID related information**

• **Information system and CEs:**
  Fair share reporting must be aware of LSF groups
  • do not report the Unix group! This is meaningless!
  • do not report the top level LSF group! Not interested in this, either!
  • but report on sub group fraction share, eg. prod, sgm or normal grid user

Example: *lcg-info-dynamic-scheduler.conf*

```plaintext
[Main]
static_ldif_file:
/opt/glite/etc/gip/ldif/static-file-CE.ldif
vomap :
  grid_ATLAS:atlas
  grid_ATLASSGM:/atlas/Role=lcgadmin
  grid_ATLASPRD:/atlas/Role=production
...
```

These groups must be matched by the lrm's information:

```plaintext
{'group': 'grid_ATLASPRD','jobid': '906798','user': 'atlprd67','qtime': 1193305262.0,'queue': 'grid_atlas','state': 'queued','maxwalltime': 2160.0}
{'group': 'grid_ATLASPRD','jobid': '907893','user': 'atlprd67','qtime': 1193306089.0,'queue': 'grid_atlas','state': 'queued','maxwalltime': 2160.0}
```
This is archived by setting a flag in the configuration file of the LSF info providers:

# which kind of group shall we report
# GID  : use primary unix GID for each account (default)
# LSF  : use lowest level LSF group (-> shares!)
# LSFR : use top    level LSF group
# defaults to GID since this is what yaim can configure ...

ReportWhichGroup = LSF

The default setting here is the GID. Which is what yaim would configure for pbs
Other features of the LSF information providers:

• they support sharing of batch system query results between CEs
• originally introduced to reduce the load on the batch system
• turned out to be necessary (!) to synchronize the CEs
GRID related information

How the caching works:

• When a CE queries the batch system, the result is written into a cache file
• The cache file contains a time stamp
• The cache file is stored on an NFS volume visible to all Ces
• If another CE needs to do a query it
  • Checks if the information is cached, valid, and locked
  • If valid and not locked, it will use it’s contents
  • If it’s locked it will wait and retry
  • If the lock is stale since long, it will take the lock and do the query itself
  • If the information is no longer valid,
  • it will lock it and query the system
• Store the result in the cache file and remove the lock
• Return the contents
LSF pro's and con's

Pro LSF:
- very stable
- very scalable:
  - 500k jobs
  - soon >10k hosts per instance
- very flexible
- excellent support

Contra LSF:
- commercial
- sources closed
- expensive
Other features

● LSF API
  ● API to access LSF from C programs
  ● used by btools (bjobsinfo, for the information system)
    ● possibility to write own scheduling plugins
      ● used by CASTOR
      ● opens all kind of possibilities

● plugins on the worker nodes:
  ● elim
    ● there is a problem on the machine
    ● taking machines out of production (draining of nodes!)
  ● eexec
    ● pre-job execution, used for token grabbing and extension

● pre/post exec scripts (not used right now)
  ● runs before/after the user job
  ● may run in different environment

● job starter (used at CERN)
  ● gets the user job as argument and starts it
Other features (cont.)

- job chains
  - users can define dependencies between their jobs
  - one job keeps being queued until another one has finished
- job arrays
  - useful for large bunches of similar jobs, reduces load on the system
- ...
  - and more features
Features we do not use (yet)

- interactive queues (actually testing)
- SLA scheduling
  - deadline (complete NNN jobs by XXX noon)
  - velocity (run NNN jobs at a time)
  - throughput (run NNN jobs within one hour)
  - -> eventually interesting for GRID applications
- LSF monitoring as provided by Platform
  - supported with the new version (Monday)
  - we use lemon to monitor the machines
- parallel scheduling
  - rarely used at CERN in general
  - used for LINPACK (top 500 list) last year on new nodes
- advance reservation, preemption, ...
Problems seen, FAQs

LSF master monitoring from LEMON: last year:

- lxmaster01:
  - 2 CPU Xeon
  - 4GB memory
  - SLC3

-> high load make the system unresponsive

-> clear slope upwards: the master needs more memory
Problems seen, FAQs

LSF 6.1: scalability (vendor information) limited to ~ 5k hosts
- currently ~3000 machines in lxbatch, mostly dual CPU single core,
- about 6500 cores

New LSF version: up to 20k hosts in the near future (communication layer)
LSF 7.0: better scalability but why?

- Major difference:
  - the whole communication layer replaced by a product called EGÓ, (Enterprise Grid Orchestrator)
  - LSF runs on top of this layer
  - LSF is just one product
  - The EGO layer is highly scalable
- Concept of lending and borrowing:
  - Moving resources between different consumers
- Other products run on EGO, for example Platform VM orchestrator
Problems seen, FAQs

Test results with new system:
LSF7 + 64bit SLC4 Quadcore master with 16GB memory

- Batch system queries:
- 50k jobs queued
- queries from batch nodes
- network saturates
- batch system still responded
Problems seen, FAQs

Test results with new system:

LSF7 + 64bit SLC4 Quadcore master with 16GB memory

- job load test:
  - vendor: up to 500k jobs
  - submit primitive jobs in 50k
  - system breaks down above 500k

maximum seen in current system: 90k due to a single user with 70k jobs, causing lots of problems
Next steps

• There will be an intervention on the LSF system on Monday:
  • migration to new LSF master hardware. The new machines have
    • 16 GB Memory
    • Dual Quadcore CPUs
    • mirrored disks (as previous one)
    • redundant power supplies (as previous one)
    • installed in the UPS area (as previous one)
  • migration to new LSF version
    • major release update
    • from LSF6.1 to LSF 7.0
  • better internal management
    • more fine-grained packaging (rpm packages)
    • different representation inside CDB

Note: LSF7 is already in use for CASTOR2 since several months
Q: How the LSF server and the CE scalability is connected together?
A: LSF can run up to 500k jobs, a current CE 3k at most before it falls over.

Q: One CE is able to serve how many nodes?
A: All our CE nodes could serve all our (grid4) batch nodes. It has access to all of them but we decided to strictly separate OS and archs. Note, however, that if you burn your share on SLC3 you'll have to wait on SLC4.

Q: MPI ? PVM jobs?
A: the batch nodes have mpich installed. Parallel scheduling is in place. Locally it works although the setup is not made for parallel jobs.
Any Questions?