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# *ArCond and parallel data processing at Tier3 clusters*

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# *Condor batch system for ATLAS Tier3*

- **Condor – a popular batch system for parallel job processing**
- **For ATLAS-specific tasks, it requires additional features:**
  - **better compatibility with IO intensive tasks**
    - data discovery mechanism. Data can be are either on a central file server or uniformly distributed on computers (ANL-preferred option)
    - Merging, moving, copying outputs from each core
  - **Requires a better integration with Tier3 data analysis tasks, such as:**
    - Submission of arbitrary athena packages
    - MC generation and simulation
    - running ROOT/C++ code over D3PD's or ntuples
    - running custom packages (like NLO QCD etc.)

# *ArCond (Ar*gonne's *Cond*or*)*

http://atlaswww.hep.anl.gov/asc/arcond/

- **A Condor front-end:**
  - job submission
  - data discovery
  - checking job status
  - merging outputs
- **A PYTHON package which talks to the standard condor commands and provides an interface between Condor and a user for IO intensive jobs with input and output**
- **Minimum requirement: PYTHON (any version) and ROOT**
- **Designed for analysis of data flatly distributed over multiple PCs**
- **Can also be used in a combination with XROOTD**

# ArCond. What is this?

http://atlaswww.hep.anl.gov/asc/arcond/

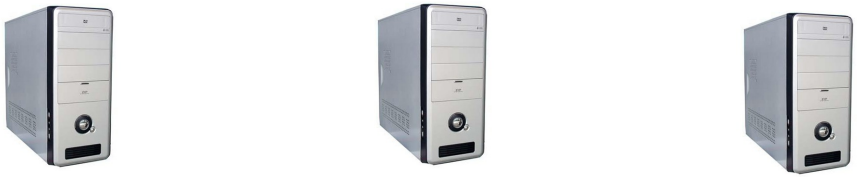
Optimized for speed:  a file-based database. Can work with xrootd.
Fetching 30k file names from 10 computers  takes 0.5 sec
Takes ~2-3 sec to update a database with ~10k files. Fully scalable

**Submission steps:**

- input=/data09
- prepare submission scripts with input option file files
- Tar a user package (if needed)
- Submit
- When ready, copy the outputs, move, merge etc..

Check a database, build a list with all files (6 files)

Submits N(cores)xN(computers) jobs
Each job has its own input list



**A condor batch system**

/data09/AOD**1**.root
/data09/AOD**2**.root

/data09/AOD**3**.root
/data09//AOD**4**.root

/data09/AOD**5**.root
/data09/AOD**6**.root

# Running Arcond at Tier3s

- Setup ArCond as:
  - For ATLAS cluster (atlasXX.hep.anl.gov), just setup any release
    - *https://atlaswww.hep.anl.gov/twiki/bin/view/Workbook/SettingUpAccount*
    - *does not use XROOTD*
  - For ASC cluster:
    - *source /export/home/atlasadmin/condor/Arcond/etc/arcond/arcond_setup.sh*
    - *uses XROOTD*
- Go to some directory (tmp) and do: arc_setup
- You will see the structure:
  - arcond.conf – user configuration file (look at it!)
  - user/Analysis_jobOptions_BASIC.py – analysis job option file. Can be anything
  - user/ShellScript_BASIC.sh - a user shell script executed on each node (with athena.py XX if you need!)
  - Job (directory) where the submission scripts are generated (do not edit)
  - DataCollector (directory) where input file lists are collected (do not edit)
  - patterns (directory) can specify computers for submission (usually configured by admins, but you can change it)

# Some help

- Type “arc_help” for help:

```
--- ArCond help ---

arc_add          >> Merge all output ROOT files located in Job/*/*
arc_check        >> Check outputs
arc_clean        >> Clear all submissions from previous runs
arc_cp           >> Copy and rename all output files located in Job/*/*
arc_exe          >> Run a shell script. Usage: arc_exe -i script.sh
arc_get
arc_ls           >> lists all files in a dataset. Usage: arc_ls <data set>.
arc_mv           >> Move and rename all output files located in Job/*/*
arc_setup        >> Setup script. Initialize ArCond directory structure
arc_setup_admin      >> Setup Admin script. Initialize tools for administ
arc_split        >> Split dataset for multiple nodes (admin tool)
arc_ssh          >> Parallel ssh to the set of nodes (admin tool)
arc_update       >> ArCond update script
arcond           >> Main submission script for a T3g PC farm
----- Done -----
```

For the next slides I'll assume the ASC-cluster setup

For ANL cluster, everything is identical only “xrootd” is not included to the file path

# Submitting with Arcond

- Check data availability using “arc_ls”. Example:
  - arc_ls /xrootd/atlastier3/data09_900GeV

  Output:

  - ascwrk1.hep.anl.gov:/xrootd/atlastier3/data09_900GeV/ESD/r988/data09_900GeV.00141994.physics_MinBias.recon.ESD.r988_tid101490_00/ESD.101490._000009.pool.root.1
  - ascwrk1.hep.anl.gov:/xrootd/atlastier3/data09_900GeV/ESD/r988/data09_900GeV.00141994.physics_MinBias.recon.ESD.r988_tid101490_00/ESD.101490._000118.pool.root.1
  - ascwrk1.hep.anl.gov:/xrootd/atlastier3/data09_900GeV/ESD/r988/data09_900GeV.00141994.physics_MinBias.recon.ESD.r988_tid101490_00/ESD.101490._000057.pool.root.1
  - ascwrk1.hep.anl.gov:/xrootd/atlastier3/data09_900GeV/ESD/r988/data09_900GeV.00141994.physics_MinBias.recon.ESD.r988_tid101490_00/ESD.101490._000167.pool.root.2
  - ascwrk1.hep.anl.gov:/xrootd/atlastier3/data09_900GeV/ESD/r988/data09_900GeV.00141994.physics_MinBias.recon.ESD.r988_tid101490_00/ESD.101490._000177.pool.root.2
  - ascwrk1.hep.anl.gov:/xrootd/atlastier3/data09_900GeV/ESD/r988/data09_900GeV.001
  - .....

Arcond recursively scans all files and inside the root directory /xrootd/atlastier3/data09_900GeV

# Submitting with Arcond

- Before submitting, check what you are doing. Read "arcond.conf"
  - atlas_release=15.6.5 # atlas release
  - events = 100 # events for each job (put -1 for all)
  - input_data = /xrootd/atlastier3/data09_900GeV/ # input file locations
    - *set to empty if no input*
    - *can also be a central storage (not distributed among many computers)*
  - max_jobs_per_node=14 # (for 16-core PowerEdge R710 . put -1 for all cores)
  - package_dir=/users/15.6.5/NtupleMaker # athena user package

Then type "arcond" to submit the package

The default arcond.conf is pre-configured to submit "NtupleMaker" package to run over distributed by xrootd ESD files

# Submitting a job..

- Unlike **pathena** and **dq2**, Arcond talks to the user and asks 4 questions
- Say “no” to interrupt the submission

```
chakanau@ascwrk1:tmp$ arcond
 Input configuration=/users/chakanau/tmp/arcond.conf
---> Input data located at = /xrootd/atlastier3/data09_900GeV/ESD/r988/
---> Nr of included PCs = 3
---> Maximum number of cores per node = 14
---> Checking computing cores
    -->1 PC node=ascwrk0.hep.anl.gov with=15 cores found, but 14 is used
    -->2 PC node=ascwrk1.hep.anl.gov with=15 cores found, but 14 is used
    -->3 PC node=ascwrk2.hep.anl.gov with=15 cores found, but 14 is used
---> Total number of found cores= 42
Start the data discovery tool? (say "y" for yes, "n" for no )
--->OK, discover the data using ArCond database
    -->1 PC node=ascwrk0.hep.anl.gov with=15 cores found
    -->1 PC node=ascwrk2.hep.anl.gov with=15 cores found
    -->1 PC node=ascwrk1.hep.anl.gov with=15 cores found
---> Checking for duplicate input data files
   --> ## SUMMARY: Total number of input files = 385
Project file:/users/chakanau/tmp/Job/NtupleMaker.tgz was found.
Do you want to rebuild it (y/n)? y
---> Final checking computing cores
---> Root package directory = /users/chakanau/public/2010_jamb_march/testarea/15.6.5/
---> Package name = NtupleMaker
---> Package submission file = Job/NtupleMaker.tgz
---> Package submission log file = Job/NtupleMaker.log
---> Number of events in one job = 100
---> Atlas release = 15.6.3
---> Nr of available PC nodes = 3
---> Nr of available CPUs in all PC nodes= 42
---> Data splitted for = 42  ranges
---> 42  jobs will be submitted to = 3   PCs
```

We told to use 14 cores in arcond.conf

385 AOD files found on all nodes.
All duplicate files are removed (if any)

For ANL cluster, there is extra option “f” (discover “on-fly”)

# *Submitting a job.. continue..*

**Do you want to prepare the submission scripts (y/n)? y**

---> Submission scripts in Job/* are ready
**Submit all prepared jobs to the PC farm? (y/n)y**

ROOT submission directory=/users/chakanau/tmp/Job/
 Submitted to:run40_ascwrk0.hep.anl.gov
 Submitted to:run3_ascwrk2.hep.anl.gov
 Submitted to:run25_ascwrk1.hep.anl.gov
 Submitted to:run34_ascwrk0.hep.anl.gov
 Submitted to:run36_ascwrk0.hep.anl.gov
.....
.....
Check the status using **condor_q**

Job submitted!

# Checking and getting jobs back

- Run condor commands: condor_status or condor_q
- Your jobs are in “idle” state?
  - check who is running on the farm as:
    - condor_status -submitters (OR) condor_q -global
- Check output files as: arc_check
- If arc_check tells that all output files “Analysis.root” are ready, combine output files to one file using arc_add. This creates “Analysis_all.root”
- Use arc_mv or arc_cp if want just keep the outputs from each core without merging
- To debug program and check errors:
  - ./Job/runXXX/Analysis.log - athena log file
  - ./Job/runN_atlasXXX/Job.ShellScript.atlasXXX/job.local.out - Condor log file

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# What jobs can be submitted

- Up to you. Just define your execution sequence in “user/ShellScript_BASIC.sh”
- Can be any sequence of Linux commands, cp, sync, untar etc.
- For athena jobs, it runs “athena.py Analysis.py”
  - “Analysis.py” is rebuilt from the template “Analysis_jobOptions_BASIC.py”
- But you can also run any program
  - we are currently using for NLO QCD and MC generation.
- Compilation of athena programs is not needed if you copy your “Install” area inside the shell script “user/ShellScript_BASIC.sh”

# *Example II. Generation of MC truth*

- Login on ASC cluster
- Setup: source /export/home/atlasadmin/condor/Arcond/etc/arcond/arcond_setup.sh
- Copy ~chakanau/public/2010_jamb_march/MCtruthASC to some directory
- Study the directory **user/**:
  - **Analysis_jobOptions_BASIC.py** – the standard option file for Pythia
  - **ShellScript_BASIC.sh –** has the usual command for event generation:

```
get_files PDGTABLE.MeV
get_files -scripts csc_evgen_trf.py

PhysicsScript='Analysis.py'
runno=5144
maxevents=5000
firstevent=1
# random seed. Change for each run!
rseed=$RANDOM
evgenfile=$PACKAGE_NAME'.evgen.pool.root'
histogramfile=$PACKAGE_NAME'.evgen_histo.root'
ntuplefile=$PACKAGE_NAME'.evgen_ntuple.root'

ls -la
echo `date`
echo "ArCond: Starting: csc_evgen_trf.py"
csc_evgen_trf.py $runno $firstevent $maxevents $rseed \
                 $PhysicsScript  $evgenfile \
                 $histogramfile $ntuplefile > $PACKAGE_NAME'_gen.log' 2>&1
```

- Type “arcond”
- This time Arcond does not ask for data input (input_data= is empty!)
- When ready (check arc_check) use “./arc_cp” (local version!) to copy ROOT output files to the current directory

# Tips for administrators

- One can collect information about which input data (and which releases) are used by looking at ".arcond_history" in user directories. This is a simple CSV file with the structure:
  - CSV Structure: Input data, Athena version, package, submission date:

/data2/data09_900GeV/MinBias.merge/ESD/r988 | 15.6.1 |/users/chakanau/testarea/15.6.1/analysis/Ntuple | local | 2010-03-15 11:33:47

/xrootd/atlastier3/data09_900GeV/ESD/r988/ | 15.6.3 | /users/chakanau/public/2010_jamb_march/testarea/15.6.5/NtupleMaker | local | 2010-03-29 19:33:36

| 15.6.5 | Pythia | local | 2010-03-30 09:31:03

# *Tips for administrators: How to redistribute data between many computers*

- **Option 1.** Use XROOTD (cannot comment, not an expert)
- **Option 2.**
  - Copy data to some central storage using dq2-get
  - Make a passwordless login using ssh-agent to all PC nodes
    - *Most of us have this already*
  - Type "arc_setup_admin".
  - It will fetch several simple PYTHON scripts based on the Linux rsync comand
  - Specify hosts in "host.py" and define input and output directories (on all nodes) in the "arc_sync" script
  - Run this script. The script builds a file list from central storage, splits it and copy equal fractions of files on each node.
  - If
    - *data are corrupted;*
    - *a new node is added*
    - *something went wrong on a salve PC*
      - **execute the same script again. It checks file timestamp and size**
      - **For ANL claster, 100 GB can be redistributed between 3 PCs for ~1h**

# *Some useful features*

- Simple. Does not have any server, process daemons  etc..
- No maintenances (but Condor needs it!)
- Well tested
  - ~500 jobs since 2008.  <0.1% fault rate
- **Designed for easy debugging** (did you  try to debug pathena?)
  - **How to check correctness of the submission shell script:**
    - *Generate submission scripts (in Job) but say "no" to submit*
    - *Go to the directory "Job/run[Core]-[Computer]" and run "ShellScript.sh"*
    - *If it fails, correct "usr/ShellScript_BASIC.sh"*
    - *It works on the interactive note but fails on the worker node?*
    - *ssh to the worker node and run again this script*
  - **Wants to check the current status, log files etc of a submitted job?**
    - *ssh to a worker node and check ../condor/exec/directory. Look at the running job!*
  - Wants to debug a script on a failed worker node?
    - *ssh to this worker node and run ShellScript.sh manually!*