



# Using HTCSS Adstash to Increase Goodput

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# Usage reporting with Accounting ads

```
$ condor_userprio -negotiator -allusers -usage -l > $TODAY.out
$ wc -l $TODAY.out
106236 2022-05-17.out

$ grep jcpatton $TODAY.out
Name3219 = jcpatton@chtc.wisc.edu

$ grep -P '^\D+3219' $TODAY.out
AccumulatedUsage3219 = 12483262.0
BeginUsageTime3219 = 1469463548
LastUsageTime3219 = 1650635607
Name3219 = "jcpatton@chtc.wisc.edu"
Priority3219 = 500.0
…
```

# Usage reporting with Accounting ads

| Fm: | 2022-05-16 | Total | | CHTC | | OSG | | CHTC-HPC | |
|---|---|---|---|---|---|---|---|---|---|
| To: | 2022-05-17 | Hours | %Pool | Hours | %Pool | Hours | %Pool | Hours | %Pool |
| 88 | Projects | 946,364 | 100.0% | 308,057 | 32.6% | 1,511 | 0.2% | 65,066 | 6.9% |
| 1 | | 339,218 | 35.8% | 19,919 | 6.5% | 0 | 0.0% | 0 | 0.0% |
| 2 | | 117,976 | 12.5% | 17,180 | 5.6% | 605 | 40.1% | 0 | 0.0% |
| 3 | | 94,461 | 10.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| 4 | | 44,959 | 4.8% | 44,959 | 14.6% | 0 | 0.0% | 0 | 0.0% |
| 5 | | 38,756 | 4.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| 6 | | 32,009 | 3.4% | 32,009 | 10.4% | 0 | 0.0% | 0 | 0.0% |
| 7 | | 30,364 | 3.2% | 30,364 | 9.9% | 0 | 0.0% | 0 | 0.0% |
| 8 | | 28,576 | 3.0% | 0 | 0.0% | 0 | 0.0% | 28,576 | 43.9% |
| 9 | | 27,070 | 2.9% | 21,680 | 7.0% | 0 | 0.0% | 0 | 0.0% |
| 10 | | 23,381 | 2.5% | 23,381 | 7.6% | 0 | 0.0% | 0 | 0.0% |
| 11 | | 18,804 | 2.0% | 18,334 | 6.0% | 0 | 0.0% | 0 | 0.0% |
| 12 | | 17,412 | 1.8% | 17,412 | 5.7% | 0 | 0.0% | 0 | 0.0% |
| 13 | | 15,376 | 1.6% | 15,376 | 5.0% | 0 | 0.0% | 0 | 0.0% |
| 14 | | 12,731 | 1.3% | 0 | 0.0% | 0 | 0.0% | 12,731 | 19.6% |

Identities redacted

# Usage reporting with Accounting ads

- So, we delivered almost a million CPU core hours that day.
  - …was any of it good?
- Any other usage?
  - GPU hours?
  - Memory usage?
  - Files transferred?
- How was the user experience?
  - How often were jobs interrupted or put on hold?

# Storing job history in Elasticsearch

- We use the `condor_adstash` tool to periodically push job history ads from access points to Elasticsearch (ES).
- Wins:
  - Query-able history of all* job ads
  - New attributes do not have to be predefined before inserting ads
  - Libraries in popular languages for querying ES
  - Kibana web UI for simple queries and graphs

# Storing job history in Elasticsearch

- Gotchas
  - Adstash does *remote* history queries, limited by knob setting `HISTORY_HELPER_MAX_HISTORY` (last 10,000 ads by default)
    - *may miss ads on busy APs, especially if outages occur
  - Unlike ClassAds (which may contain user-defined attrs), ES field names are case-sensitive and field values must have same type
    - By default, Adstash converts unknown attr names to lowercase and types unknown fields as text
  - (IMO) ES has a penchant for API breaking changes
    - Adstash broken for elasticsearch-py v8.0+

# Now what?

**52,918,476** hits

| | GlobalJobId | QDate | RecordTime | RemoteWallClockTime |
|---|---|---|---|---|
| > | submit3.chtc.wisc.edu#15282029.195702#1623463414 | 1,623,180,040 | 1,623,475,763 | 8,235 |
| > | submit3.chtc.wisc.edu#15282029.200212#1623469354 | 1,623,180,040 | 1,623,475,760 | 2,808 |
| > | submit3.chtc.wisc.edu#15282029.199736#1623468993 | 1,623,180,040 | 1,623,475,757 | 3,848 |
| > | submit3.chtc.wisc.edu#15282029.200294#1623469394 | 1,623,180,040 | 1,623,475,756 | 2,670 |
| > | submit3.chtc.wisc.edu#15282029.195730#1623463425 | 1,623,180,040 | 1,623,475,752 | 8,206 |
| > | submit3.chtc.wisc.edu#15282029.200285#1623469392 | 1,623,180,040 | 1,623,475,752 | 2,692 |
| > | submit3.chtc.wisc.edu#15282029.194963#1623462638 | 1,623,180,040 | 1,623,475,748 | 8,968 |
| > | submit3.chtc.wisc.edu#15282029.199741#1623468998 | 1,623,180,040 | 1,623,475,744 | 3,829 |
| > | submit3.chtc.wisc.edu#15282029.199725#1623468980 | 1,623,180,040 | 1,623,475,742 | 3,838 |
| > | submit3.chtc.wisc.edu#15282029.199770#1623469047 | 1,623,180,040 | 1,623,475,737 | 3,780 |
| > | submit3.chtc.wisc.edu#15282029.200232#1623469366 | 1,623,180,040 | 1,623,475,736 | 2,757 |
| > | submit3.chtc.wisc.edu#15282029.200287#1623469392 | 1,623,180,040 | 1,623,475,735 | 2,674 |

# Usage reporting with ~~Accounting ads~~ condor_adstash

- **Was any of our usage good?**
- Any other usage?
  - GPU hours?
  - Memory usage?
  - Files transferred?
- How was the user experience?
  - How often were jobs interrupted or put on hold?

# Let's use our job history for good(put)!

**Goodput**

*noun*

1. the opposite of badput.

**Badput**

*noun*

1. claimed computing resources that did not contribute meaningfully to a requested computing task (i.e. to science).

# Let's use our job history for good(put)!

- "good" CPU hours = total CPU hours – "bad" CPU hours
- What should count towards bad CPU hours?
  - The time spent by any job execution that doesn't exit on its own accord or that doesn't exit due to user action.
  - Evicted executions clearly lead to badput, what about held jobs and removed jobs?
  - Assumption: Good CPU hours are CPU hours used in the last execution attempt (i.e. "final run") of a job.

**Can we calculate goodput from a job ad?**

# Calculating goodput from a job ad


```
$ condor_history -limit 1 -l | wc -l
167
```

Let's check page 490 of the HTCondor manual…

# Pop quiz!

Which pair of attributes provides the total runtime across all a job's runs and the runtime of a job's final run, respectively?

A. `RemoteWallClockTime, CommittedTime`

B. `CommittedTime, RemoteWallClockTime`

C. `RemoteWallClockTime, LastRemoteWallClockTime`

D. `LastRemoteWallClockTime, RemoteWallClockTime`

# Pop quiz!

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**A. `RemoteWallClockTime, CommittedTime`**

B. `CommittedTime, RemoteWallClockTime`

`LastRemoteWallClockTime`

`me, RemoteWallClockTime`

**Undefined if job was removed!**

# Pop quiz!

**Only exists since HTCondor 9.4.0**

ides the total runtime across all a
f a job's final run, respectively?

A. RemoteWallClockTime, CommittedTime

B. CommittedTime, RemoteWallClockTime

**C. RemoteWallClockTime, LastRemoteWallClockTime**

D. LastRemoteWallClockTime, RemoteWallClockTime

# Calculating goodput from a job ad

- Current approach:

```
Total CPU Hours ~= CpusProvisioned * RemoteWallClockTime / 3600
Good CPU Hours ~= CpusProvisioned * {
            LastRemoteWallClockTime,
            CommittedTime,
            0
      } / 3600
```

- Finally, we can calculate goodput!

```
% Good CPU Hours = (Good CPU Hours/Total CPU Hours) * 100%
```

# Calculating goodput from a job ad

| | Project | Num Users | All CPU Hours | Num Uniq Job Ids | % Good CPU Hours | % Rm'd Jobs | % Short Jobs | % Jobs w/>1 Exec Att | % Jobs w/1+ Holds | % Jobs using S'ty | Total Files Xferd | Shadw Starts / Job Id | Exec Atts / Shadw Start | Holds / Job Id |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39 | TOTAL | 49 | 465,485 | 429,041 | 80.8 | 5.2 | 16.7 | 5.6 | 5.6 | 48.2 | 3,528,787 | 1.18 | 0.892 | 0.13 |
| 1 | Identities redacted | 1 | 133,282 | 4,910 | 80.3 | 0.0 | 0.1 | 27.0 | 0.2 | 0.0 | 354,176 | 1.53 | 0.895 | 0.01 |
| 2 | | 1 | 71,443 | 8,902 | 89.1 | 0.0 | 0.0 | 18.6 | 0.0 | 0.0 | 98,725 | 1.24 | 0.986 | 0.00 |
| 3 | | 3 | 29,420 | 18,493 | 84.9 | 67.6 | 0.0 | 4.5 | 67.6 | 100.0 | 64,436 | 2.44 | 0.159 | 2.04 |
| 4 | | 3 | 23,586 | 36,350 | 83.5 | 3.0 | 1.5 | 1.3 | 0.9 | 98.5 | 274,211 | 1.03 | 0.974 | 0.04 |
| 5 | | 1 | 21,921 | 4,134 | 64.1 | 0.0 | 0.0 | 55.7 | 1.2 | 100.0 | 73,047 | 2.15 | 0.992 | 0.01 |
| 6 | | 2 | 19,987 | 77,567 | 90.5 | 0.0 | 0.2 | 2.5 | 0.0 | 100.0 | 551,357 | 1.04 | 0.991 | 0.00 |
| 7 | | 1 | 19,473 | 8,381 | 91.5 | 0.0 | 0.1 | 12.1 | 0.0 | 100.0 | 35,870 | 1.15 | 0.990 | 0.00 |
| 8 | | 1 | 18,405 | 5,732 | 90.1 | 0.0 | 0.0 | 15.5 | 0.0 | 0.0 | 48,050 | 1.22 | 0.980 | 0.00 |
| 9 | | 5 | 18,164 | 4,759 | 69.5 | 0.9 | 8.0 | 73.5 | 67.4 | 0.0 | 53,297 | 2.87 | 0.851 | 1.00 |
| 10 | | 1 | 17,833 | 26,623 | 80.6 | 25.2 | 0.0 | 10.0 | 25.2 | 0.0 | 182,931 | 1.23 | 0.899 | 0.25 |
| 11 | | 1 | 13,698 | 3,012 | 48.6 | 0.0 | 0.0 | 70.6 | 0.0 | 0.0 | 29,728 | 2.37 | 0.965 | 0.00 |
| 12 | | 1 | 13,606 | 1,632 | 89.5 | 0.0 | 0.0 | 20.2 | 0.0 | 0.0 | | 1.28 | 0.968 | 0.00 |
| 13 | | 1 | 13,133 | 3,505 | 81.3 | 0.0 | 0.9 | 24.3 | 0.0 | 0.0 | 30,382 | 1.42 | 0.945 | 0.00 |
| 14 | | 1 | 10,851 | 7,367 | 90.8 | 0.0 | 0.0 | 11.9 | 0.0 | 0.0 | 39,613 | 1.14 | 0.987 | 0.00 |

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- **Was any of our usage good?** ✔
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  - How often were jobs interrupted or put on hold?

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- Was any of our usage good? ✔
- **Any other usage?** ✔
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- How was the user experience?
  - How often were jobs interrupted or

| | User | All CPU Hours | All GPU Hours | Num Uniq Job Ids | % Good CPU Hours | % Good GPU Hours | % Ckpt Able | % Rm'd Jobs |
|---|---|---|---|---|---|---|---|---|
| 13 | TOTAL | 6,837 | 2,564 | 1,728 | 97.9 | 94.5 | 0.0 | 1.6 |
| 1 | Identities redacted | 3,230 | 100 | 1 | 100.0 | 100.0 | 0.0 | 0.0 |
| 2 | | 2,054 | 2,054 | 1,575 | 93.9 | 93.9 | 0.0 | 1.4 |
| 3 | | 865 | 219 | 12 | 99.9 | 99.9 | 0.0 | 25.0 |
| 4 | | 259 | 25 | 3 | 100.0 | 100.0 | 0.0 | 0.0 |

# Usage reporting with ~~Accounting ads~~ condor_adstash

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- Any other usage? ✔
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# Finding users who are having a bad time

| | Project | Num Users | All CPU Hours | Num Uniq Job Ids | % Good CPU Hours | % Rm'd Jobs | % Short Jobs | % Jobs w/>1 Exec Att | % Jobs w/1+ Holds | % Jobs using S'ty | Total Files Xferd | Shadw Starts / Job Id | Exec Atts / Shadw Start | Holds / Job Id |
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| 2 | | 1 | 71,443 | 8,902 | 89.1 | 0.0 | 0.0 | 18.6 | 0.0 | 0.0 | 98,725 | 1.24 | 0.986 | 0.00 |
| 3 | | 3 | 29,420 | 18,498 | 84.9 | 67.6 | 0.0 | 4.5 | 67.6 | 100.0 | 64,436 | 2.44 | 0.159 | 2.04 |
| 4 | | 3 | 23,586 | 36,350 | 83.5 | 3.0 | 1.5 | 1.3 | 0.9 | 98.5 | 274,211 | 1.03 | 0.974 | 0.04 |
| 5 | | 1 | 21,921 | 4,134 | 64.1 | 0.0 | 0.0 | 55.7 | 0.0 | 0.0 | 73,047 | 2.15 | 0.992 | 0.01 |
| 6 | | 2 | 19,987 | 77,567 | 90.5 | 0.0 | 0.2 | 2.5 | 0.0 | 100.0 | 551,357 | 1.04 | 0.991 | 0.00 |
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| 8 | | 1 | 18,405 | 5,732 | 90.1 | 0.0 | 0.0 | 15.5 | 0.0 | 0.0 | 48,050 | 1.22 | 0.980 | 0.00 |
| 9 | | 5 | 18,164 | 4,759 | 69.5 | 0.9 | 8.0 | 73.5 | 67.4 | 0.0 | 53,297 | 2.87 | 0.851 | 1.00 |
| 10 | | 1 | 17,833 | 26,623 | 80.6 | 25.2 | 0.0 | 10.0 | 25.2 | 0.0 | 182,931 | 1.23 | 0.899 | 0.25 |
| 11 | | 1 | 13,698 | 3,012 | 48.6 | 0.0 | 0.0 | 70.6 | 0.0 | 0.0 | 29,728 | 2.37 | 0.965 | 0.00 |
| 12 | | 1 | 13,606 | 1,632 | 89.5 | 0.0 | 0.0 | 20.2 | 0.0 | 0.0 | | 1.28 | 0.968 | 0.00 |
| 13 | | 1 | 13,133 | 3,505 | 81.3 | 0.0 | 0.9 | 24.3 | 0.0 | 0.0 | 30,382 | 1.42 | 0.945 | 0.00 |
| 14 | | 1 | 10,851 | 7,367 | 90.8 | 0.0 | 0.0 | 11.9 | 0.0 | 0.0 | 39,613 | 1.14 | 0.987 | 0.00 |

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# Finding users who are having a bad time

- Additional reports have shown to be helpful, such as reporting on all jobs that had at least one hold event.

| | Project | Num Users | All CPU Hours | Num Uniq Job Ids | Most Common Hold Reason | % Holds Most Comm Reas | Holds / Job Id | % Good CPU Hours | % Rm'd Jobs |
|---|---|---|---|---|---|---|---|---|---|
| 14 | TOTAL | 16 | 27,201 | 24,199 | Download FileError | 54.6 | 2.30 | 39.8 | 86.4 |
| 1 | Identities redacted | 2 | 14,031 | 3,207 | JobPolicy | 99.9 | 1.48 | 67.8 | 1.1 |
| 2 | | 1 | 6,335 | 1,152 | StartdHeld Job | 75.5 | 3.90 | 0.0 | 100.0 |
| 3 | | 1 | 2,049 | 48 | StartdHeld Job | 100.0 | 3.12 | 38.6 | 0.0 |
| 4 | | 1 | 1,785 | 9 | Job Execute Exceeded | 100.0 | 3.00 | 20.7 | 0.0 |
| 5 | | 1 | 1,255 | 6,715 | JobPolicy | 100.0 | 1.00 | 0.0 | 100.0 |
| 6 | | 2 | 1,039 | 12,499 | Download FileError | 80.5 | 3.02 | 0.4 | 100.0 |
| 7 | | 1 | 317 | 50 | UploadFile Error | 100.0 | 1.00 | 44.2 | 0.0 |
| 8 | | 1 | 302 | 329 | System Policy | 99.9 | 4.75 | 0.0 | 100.0 |

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- Any other usage? ✔
  - GPU hours?
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  - Files transferred?
- **How was the user experience?** ✔
  - How often were jobs interrupted or put on hold?

# Improving HTCondor

- This project has prompted many additions to the job ad:

```
LastRemoteWallClockTime = 3764

NumHoldsByReason = [ UserRequest = 2;
    JobPolicy = 10; UnableToOpenInput = 1 ]

TransferInputStats = [ CedarFilesCountTotal =
    5; CedarFilesCountLastRun = 5 ]
```

# Remaining challenges

- How to find strangely behaved or broken “sites”?
  - Example: Job runs 3 times at Site A, failing to transfer output each time, before running and completing successfully at Site B.
  - Job ads lack information about intermediate job runs, must infer from cumulative and last run stats.
- How to determine if jobs are checkpointing *correctly*?
  - Are intermediate runs contributing to goodput or not?

# Thank You!

**Follow us on Twitter!**
**https://twitter.com/HTCondor**

PATh PARTNERSHIP to ADVANCE THROUGHPUT COMPUTING

This work is supported by NSF under Cooperative Agreement OAC-2030508 as part of the PATh Project. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF.