



## Exploring Job Histories with ElasticSearch and HTCondor AdStash

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## **Usage reporting with Accounting ads**

#### \$ condor\_userprio –usage

	Wghted	Total Usage	Usage	Last
User Name	In Use	(wghted-hrs)	Start Time	Usage Time
todd@submit5.wisc.edu	0	0.04	10/10/2022 09:13	10/10/2022 09:22
fred@submit5.wisc.edu	0	1.02	10/10/2022 05:15	10/10/2022 09:29
Number of users: 2	0	1.06		10/09/2022 09:29





## **Usage reporting with Accounting ads**

m:	2022-05-16	Tot	tal	CH	ГС	0	SG	СНТС	-HPC	l
To:	2022-05-17	Hours	%Pool	Hours	%Pool	Hours	%Pool	Hours	%Pool	l
88	Projects	946,364	190.0%	308,057	32.6%	1,511	0.2%	65,066	6.9%	
1	Idantitiaa	339,219	35.8%	19,919	6.5%	0	0.0%	0	0.0%	l
2	Identities	117,976	12.5%	17,180	5.6%	605	40.1%	0	0.0%	l
3	redacted	94,461	10.0%	0	0.0%	0	0.0%	0	0.0%	1
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%	l
6		32,009	3.4%	32,009	10.4%	0	0.0%	0	0.0%	l
7		30,364	3.2%	30,364	9.9%	0	0.0%	0	0.0%	l
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%	l
10		23,381	2.5%	23,381	7.6%	0	0.0%	0	0.0%	l
11		18,804	2.0%	18,334	6.0%	0	0.0%	0	0.0%	1
12		17,412	1.8%	17,412	5.7%	0	0.0%	0	0.0%	l
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%	l
										÷





## **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 <u>condor adstash</u> 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
  - Example: Adstash unexpectedly broke with 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



- > 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

Default

This page lists every field in the **chtc-schedd-\*** recorded by Elasticsearch. To change a field type



Let's check page 790 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!

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







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**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 / 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	% Ftm' Cob	% d Shoi s Job	% Jobs t 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	429,04	80.8	5	.2 16.	7 5.6	5.6	48.2	3,528,787	1.18	0.892	0.13
1	Idantitias	1	133,282	4,91	80.3	0	.0 0.	1 27.0	0.2	0.0	354,176	1.53	0.895	0.01
2		1	71,443	8,90	2 89.1	0	.0 0.	0 18.6	ō 0.0	0.0	98,725	1.24	0.986	0.00
3	redacted	3	29,420	18,49	8 84.9	67	.6 0.	0 4.5	67.6	100.0	64,436	2.44	0.159	2.04
4		3	23,586	36,35	83.5	3	.0 1.	5 1.3	8 0.9	98.5	274,211	1.03	0.974	0.04
5		1	21,921	4,13	4 64.1	0	.0 0.	0 55.7	7 1.2	100.0	73,047	2.15	0.992	0.01
6		2	19,987	77,56	7 90.5	0	.0 0.	2 2.5	5 0.0	100.0	551,357	1.04	0.991	0.00
7		1	19,473	8,38	91.5	0	.0 0.	1 12.1	0.0	100.0	35,870	1.15	0.990	0.00
8		1	18,405	5,73	2 90.1	0	.0 0.	0 15.5	5 0.0	0.0	48,050	1.22	0.980	0.00
9		5	18,164	4,75	69.5	0	.9 8.	0 73.5	67.4	0.0	53,297	2.87	0.851	1.00
10		1	17,833	26,62	80.6	25	.2 0.	0 10.0	25.2	0.0	182,931	1.23	0.899	0.25
11		1	13,698	3,01	2 48.6	0	.0 0.	0 70.6	ō 0.0	0.0	29,728	2.37	0.965	0.00
12		1	13,606	1,63	2 89.5	0	.0 0.	0 20.2	2 0.0	0.0		1.28	0.968	0.00
13		1	13,133	3,50	5 81.3	0	.0 0.	9 24.3	8 0.0	0.0	30,382	1.42	0.945	0.00
14		1	10,851	7,36	7 90.8	0	.0 0.	0 11.9	0.0	0.0	39,613	1.14	0.987	0.00





- > 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?





- > 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

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	User	All CPU Hour	<b>W</b>	All GPU Hours	Num Uniq Job Ids	% Good CPU Hour	}	% Good GPU Hours		% kpt ble	% Rm'd Jobs	
13	TOTAL	6,83	7	2,564	1,728	97.	)	94.5		0.0	1.6	
1	Identities	3,23	)	100	1	100.	)	100.0		0.0	0.0	
2	Tedacled	2,05	1	2,054	1,575	93.	)	93.9		0.0	1.4	
3		86	5	219	12	99.	)	99.9		0.0	25.0	
4		25	9	25	3	100.	)	100.0		0.0	0.0	_
									1			



- > Was any of it good? </br>
- > Any other usage?
  - GPU hours?
  - Memory usage?
  - Files transferred?

#### > How was the user experience?

• How often were jobs interrupted or put on hold?





	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	ſ
1	Identities	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	rodactod	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	ſ
3	Teuacieu	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	<b></b> 0	55.7	12		73,047	2.15	0.992	0.01	
6		2	19,987	77,567	90.5	0.0	0.2	25	0.0	100.0	551,357	1.04	0.991	0.00	L
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	L
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	L
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	L
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	L
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	





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	
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	
Identities	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	
roductod	1	71,443	8,902	89 1	10	0.0	18.6	0.0	0.0	98,725	1.24	0.986	0.00	
Teuacieu	3	29,420	18,498	84 9	67.6	0.0	5	67.6	100.0	64,436	2.44	0.159	2.04	
	3	23,586	36,350	83.5	3.0	15	<b>~</b> ]/3	0.9	98.5	274,211	1.03	0.974	0.04	
	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	
	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	
	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	
	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	
	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	
	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	L
	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	
	1	13,606	1,632	89.5	0.0	0.0	20.2	0.0	0.0		1.28	0.968	0.00	L
	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	
	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	
	Project	ProjectNum UsersTOTAL49Identities redacted13333112111151111111111111111111111111111	Project         Num Users         All CPU Hours           TOTAL         49         465,485           Identities redacted         1         133,282           1         71,443         3         29,420           3         23,586         3         23,586           1         21,921         3         23,586           2         19,987         3         23,586           1         19,473         1         19,473           2         19,987         3         3           41         19,473         1         19,473           1         18,405         1         1           41         19,473         1         1           41         19,473         1         1           41         13,608         1         1           41         13,608         1         1           41         13,606         1         1           41         13,133         1         1           41         13,133         1         1           41         10,851         1         1	Project         Num Users         All CPU Hours         Num Uniq Job Ids           TOTAL         49         465,485         429,041           Identities redacted         1         133,282         4,910           1         71,443         8,902         18,498           29,420         18,498         3         23,586         36,350           21,921         4,134         4         4         4           21         19,987         77,567         4         4         4         4           21         19,987         77,567         4	Project         Num Users         All CPU Hours         Num Uniq Job Ids         Good CPU Hours           TOTAL         49         465,485         429,041         80.8           Identities redacted         1         133,282         4,910         80.3           1         71,443         8,902         891           3         29,420         18,498         84         9           3         23,586         36,350         83.5           1         21,921         4,134         64.1           2         19,987         77,567         90.5           1         19,473         8,381         91.5           1         19,473         8,381         91.5           1         19,473         8,381         91.5           1         19,473         8,381         91.5           1         19,473         8,381         91.5           1         18,405         5,732         90.1           5         18,164         4,759         69.5           1         13,698         3,012         48.6           1         13,698         3,012         48.6           1         13,805         16.32	Project         Num Users         All CPU Hours         Num Uniq Job Ids         Good CPU Hours         % Rm'd Job           TOTAL         49         465,485         429,041         80.8         5.2           Identities redacted         1         133,282         4,910         80.3         0.0           3         29,420         18,498         84         9         67.6           3         23,586         36,350         83.5         -0.0           1         21,921         4,134         64.1         0.0           2         19,987         77,567         90.5         0.0           1         19,473         8,381         91.5         0.0           1         19,877         26,623         80.6         25.2           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.0	Project         Num Users         All CPU Hours         Num Uniq Job Ids         Num CPU Hours         % Rm'd Job Short         % Short           TOTAL         49         465,485         429,041         80.8         5.2         16.7           Identities redacted         1         133,282         4,910         80.3         0.0         0.1           3         29,420         18,498         84.9         67.6         0.6           3         29,420         18,498         84.9         67.6         0.6           3         23,586         36,350         83.5         3.0         0.0           2         19,987         77,567         90.5         0.0         0.2           1         18,405         5,732         90.1         0.0         0.0           1         17,833         26,623         80.6         25.2         0.0           1         13,606         1,632         89.5         0.0         0.0           1         13,606         1,632         89.5         0.0         0.0           2         10,851         7,367         90.8         0.0         0.0	Project         Num Users         All CPU Hours         Num Uniq Job Ids         Good CPU Hours         % Num Job S         % Short Jobs         Jobs           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0           1         71,443         8,902         891         0.0         18.6           3         29,420         18,498         84.9         67.6         0.0         55.7           3         23,586         36,350         83.5         2.0         0.0         15.7           2         19,987         77,567         90.5         0.0         0.2         2.5           1         19,473         8,381         91.5         0.0         0.1         12.1           1         19,473         8,381         91.5         0.0         0.1         12.1           1         19,473         8,381         91.5         0.0         0.0         15.5           2         19,87         77,567         90.5         0.0         0.0         15.5           1 <td< td=""><td>Project         Num Users         All CPU Hours         Num Uniq Job Ids         Good CPU Hours         % 5hort Jobs         % w/&gt;1         Jobs w//1+           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2           1         71,443         8,902         891         0.0         0.0         18.6         0.0           1         71,443         8,902         891         0.0         0.0         18.6         0.0           3         29,420         18,498         84.9         67.6         0.0         55.7         67.6           3         23,586         36,350         83.5         2.0         0         0.0         18.6         0.0           1         19,987         77.567         90.5         0.0         0.2         2.5         0.0           1         19,473         8,381         91.5         0.0         0.1         12.1         0.0           1         18,405         5,732         90.1         0.0         0.0         15.5         <td< td=""><td>Project         Num Users         All CPU Hours         Num Unig Job Ids         Good CPU Hours         %         %         %         Jobs M/1+ Exec Att         Jobs W/1+ Holds         Jobs W/1+ Bising           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0           3         29,420         18,498         849         67.6         0.0         18.6         0.0         0.0           3         29,420         18,498         849         67.6         0.0         5.6         67.6         100.0           3         23,586         36,350         83.5         2.0         1.3         0.9         98.5           41         19,473         8,381         91.5         0.0         0.0         55.7         1.2         100.0           1         19,473         8,381         91.5         0.0         0.0         15.5         0.0         10.0           1         19,473         8,381         91.5         0.0         0.0         10.0         <t< td=""><td>Project         Num Users         All CPU Hours         Num Uniq Job lds         Good CPU Hours         % Ibbs         % Short Jobs         Jobs w/1 Ktt         Jobs Jobs         Jobs w/1 Holds         Jobs Jobs         Total Files W/1           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,5         274,211           1         17,443         8,902         894         0.0         0.0         55.7         1.2         100.0         64,436           1         19,987         77,567         90.5         0.0         0.0         55.7         1.2         100.0         358,70           1         19,473         8,381         91.5         0.0         0.0         112.1         0.0         0.0</td><td>Project         Num Users         All CPU Hours         Num Unig Job Ids         Good CPU Hours         % Ibbs         % Shot Jobs         Jobs W/1 Excc Att         Jobs W/1 Holds         Total Jobs         Shadw Starts / Job Id           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176         1.53           1         71,443         8,902         89.1         0.0         18.6         0.0         0.0         98,725         1.24           3         29,420         18,498         84.9         67.6         0.0         56.76         100.0         64,436         2.44           3         23,586         36,350         83.8         2.0         5         67.6         100.0         651,357         1.04           1         19,473         8,381         91.5         0.0         0.01         12.1         0.0         100.0         358,70         1.15           1         19,473         8,381         91.5         0.0</td><td>Project         Num Users         All CPU Hours         Num Job Ids         Num Obles         Good CPU Hours         Num Job Ids         Good CPU Hours         Shot Job         Jobs Mr/4         Jobs W/1+ Holds         Jobs W/1+ Holds         Total Sign W/1+ Holds         Shadw Starts         Atts / Shadw           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           Identities redacted         1         71,443         8,902         897         0         0.1         27.0         0.2         0.0         354,176         1.53         0.895           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,920         18,498         64.1         0.0         0.0         55.7         1.2         100.0         551,357         1.04         0.991           1         19,937         77,567         90.5</td></t<><td>Project         Num Users         All CPU Hours         Num Job Ids         Good CPU Hours         % Jobs         Jobs         Jobs         Total Jobs         Shadw Starts / Mids         Atts / Shadw Starts / Starts / Shadw         Holds           TOTAL         49         465485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18         0.892         0.01           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           1         71,443         8,902         89.3         0.0         18.6         0.0         0.0         98.725         1.24         0.966         0.00           3         29,420         18,499         84.9         67.6         0.0         56         67.6         1000         64,436         2.44         0.15         2.04           3         23,586         36,505         83.5         2.0         18.6         0.0         55.7         1.2         1000         55.1357         1.04         0.919         0.00           1         19,987         77.567</td></td></td<></td></td<>	Project         Num Users         All CPU Hours         Num Uniq Job Ids         Good CPU Hours         % 5hort Jobs         % w/>1         Jobs w//1+           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2           1         71,443         8,902         891         0.0         0.0         18.6         0.0           1         71,443         8,902         891         0.0         0.0         18.6         0.0           3         29,420         18,498         84.9         67.6         0.0         55.7         67.6           3         23,586         36,350         83.5         2.0         0         0.0         18.6         0.0           1         19,987         77.567         90.5         0.0         0.2         2.5         0.0           1         19,473         8,381         91.5         0.0         0.1         12.1         0.0           1         18,405         5,732         90.1         0.0         0.0         15.5 <td< td=""><td>Project         Num Users         All CPU Hours         Num Unig Job Ids         Good CPU Hours         %         %         %         Jobs M/1+ Exec Att         Jobs W/1+ Holds         Jobs W/1+ Bising           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0           3         29,420         18,498         849         67.6         0.0         18.6         0.0         0.0           3         29,420         18,498         849         67.6         0.0         5.6         67.6         100.0           3         23,586         36,350         83.5         2.0         1.3         0.9         98.5           41         19,473         8,381         91.5         0.0         0.0         55.7         1.2         100.0           1         19,473         8,381         91.5         0.0         0.0         15.5         0.0         10.0           1         19,473         8,381         91.5         0.0         0.0         10.0         <t< td=""><td>Project         Num Users         All CPU Hours         Num Uniq Job lds         Good CPU Hours         % Ibbs         % Short Jobs         Jobs w/1 Ktt         Jobs Jobs         Jobs w/1 Holds         Jobs Jobs         Total Files W/1           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,5         274,211           1         17,443         8,902         894         0.0         0.0         55.7         1.2         100.0         64,436           1         19,987         77,567         90.5         0.0         0.0         55.7         1.2         100.0         358,70           1         19,473         8,381         91.5         0.0         0.0         112.1         0.0         0.0</td><td>Project         Num Users         All CPU Hours         Num Unig Job Ids         Good CPU Hours         % Ibbs         % Shot Jobs         Jobs W/1 Excc Att         Jobs W/1 Holds         Total Jobs         Shadw Starts / Job Id           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176         1.53           1         71,443         8,902         89.1         0.0         18.6         0.0         0.0         98,725         1.24           3         29,420         18,498         84.9         67.6         0.0         56.76         100.0         64,436         2.44           3         23,586         36,350         83.8         2.0         5         67.6         100.0         651,357         1.04           1         19,473         8,381         91.5         0.0         0.01         12.1         0.0         100.0         358,70         1.15           1         19,473         8,381         91.5         0.0</td><td>Project         Num Users         All CPU Hours         Num Job Ids         Num Obles         Good CPU Hours         Num Job Ids         Good CPU Hours         Shot Job         Jobs Mr/4         Jobs W/1+ Holds         Jobs W/1+ Holds         Total Sign W/1+ Holds         Shadw Starts         Atts / Shadw           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           Identities redacted         1         71,443         8,902         897         0         0.1         27.0         0.2         0.0         354,176         1.53         0.895           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,920         18,498         64.1         0.0         0.0         55.7         1.2         100.0         551,357         1.04         0.991           1         19,937         77,567         90.5</td></t<><td>Project         Num Users         All CPU Hours         Num Job Ids         Good CPU Hours         % Jobs         Jobs         Jobs         Total Jobs         Shadw Starts / Mids         Atts / Shadw Starts / Starts / Shadw         Holds           TOTAL         49         465485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18         0.892         0.01           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           1         71,443         8,902         89.3         0.0         18.6         0.0         0.0         98.725         1.24         0.966         0.00           3         29,420         18,499         84.9         67.6         0.0         56         67.6         1000         64,436         2.44         0.15         2.04           3         23,586         36,505         83.5         2.0         18.6         0.0         55.7         1.2         1000         55.1357         1.04         0.919         0.00           1         19,987         77.567</td></td></td<>	Project         Num Users         All CPU Hours         Num Unig Job Ids         Good CPU Hours         %         %         %         Jobs M/1+ Exec Att         Jobs W/1+ Holds         Jobs W/1+ Bising           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0           3         29,420         18,498         849         67.6         0.0         18.6         0.0         0.0           3         29,420         18,498         849         67.6         0.0         5.6         67.6         100.0           3         23,586         36,350         83.5         2.0         1.3         0.9         98.5           41         19,473         8,381         91.5         0.0         0.0         55.7         1.2         100.0           1         19,473         8,381         91.5         0.0         0.0         15.5         0.0         10.0           1         19,473         8,381         91.5         0.0         0.0         10.0 <t< td=""><td>Project         Num Users         All CPU Hours         Num Uniq Job lds         Good CPU Hours         % Ibbs         % Short Jobs         Jobs w/1 Ktt         Jobs Jobs         Jobs w/1 Holds         Jobs Jobs         Total Files W/1           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,5         274,211           1         17,443         8,902         894         0.0         0.0         55.7         1.2         100.0         64,436           1         19,987         77,567         90.5         0.0         0.0         55.7         1.2         100.0         358,70           1         19,473         8,381         91.5         0.0         0.0         112.1         0.0         0.0</td><td>Project         Num Users         All CPU Hours         Num Unig Job Ids         Good CPU Hours         % Ibbs         % Shot Jobs         Jobs W/1 Excc Att         Jobs W/1 Holds         Total Jobs         Shadw Starts / Job Id           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176         1.53           1         71,443         8,902         89.1         0.0         18.6         0.0         0.0         98,725         1.24           3         29,420         18,498         84.9         67.6         0.0         56.76         100.0         64,436         2.44           3         23,586         36,350         83.8         2.0         5         67.6         100.0         651,357         1.04           1         19,473         8,381         91.5         0.0         0.01         12.1         0.0         100.0         358,70         1.15           1         19,473         8,381         91.5         0.0</td><td>Project         Num Users         All CPU Hours         Num Job Ids         Num Obles         Good CPU Hours         Num Job Ids         Good CPU Hours         Shot Job         Jobs Mr/4         Jobs W/1+ Holds         Jobs W/1+ Holds         Total Sign W/1+ Holds         Shadw Starts         Atts / Shadw           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           Identities redacted         1         71,443         8,902         897         0         0.1         27.0         0.2         0.0         354,176         1.53         0.895           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,920         18,498         64.1         0.0         0.0         55.7         1.2         100.0         551,357         1.04         0.991           1         19,937         77,567         90.5</td></t<> <td>Project         Num Users         All CPU Hours         Num Job Ids         Good CPU Hours         % Jobs         Jobs         Jobs         Total Jobs         Shadw Starts / Mids         Atts / Shadw Starts / Starts / Shadw         Holds           TOTAL         49         465485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18         0.892         0.01           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           1         71,443         8,902         89.3         0.0         18.6         0.0         0.0         98.725         1.24         0.966         0.00           3         29,420         18,499         84.9         67.6         0.0         56         67.6         1000         64,436         2.44         0.15         2.04           3         23,586         36,505         83.5         2.0         18.6         0.0         55.7         1.2         1000         55.1357         1.04         0.919         0.00           1         19,987         77.567</td>	Project         Num Users         All CPU Hours         Num Uniq Job lds         Good CPU Hours         % Ibbs         % Short Jobs         Jobs w/1 Ktt         Jobs Jobs         Jobs w/1 Holds         Jobs Jobs         Total Files W/1           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         894         0.0         18.6         0.0         0.0         98,5         274,211           1         17,443         8,902         894         0.0         0.0         55.7         1.2         100.0         64,436           1         19,987         77,567         90.5         0.0         0.0         55.7         1.2         100.0         358,70           1         19,473         8,381         91.5         0.0         0.0         112.1         0.0         0.0	Project         Num Users         All CPU Hours         Num Unig Job Ids         Good CPU Hours         % Ibbs         % Shot Jobs         Jobs W/1 Excc Att         Jobs W/1 Holds         Total Jobs         Shadw Starts / Job Id           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176         1.53           1         71,443         8,902         89.1         0.0         18.6         0.0         0.0         98,725         1.24           3         29,420         18,498         84.9         67.6         0.0         56.76         100.0         64,436         2.44           3         23,586         36,350         83.8         2.0         5         67.6         100.0         651,357         1.04           1         19,473         8,381         91.5         0.0         0.01         12.1         0.0         100.0         358,70         1.15           1         19,473         8,381         91.5         0.0	Project         Num Users         All CPU Hours         Num Job Ids         Num Obles         Good CPU Hours         Num Job Ids         Good CPU Hours         Shot Job         Jobs Mr/4         Jobs W/1+ Holds         Jobs W/1+ Holds         Total Sign W/1+ Holds         Shadw Starts         Atts / Shadw           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           Identities redacted         1         71,443         8,902         897         0         0.1         27.0         0.2         0.0         354,176         1.53         0.895           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,420         18,498         84.9         67.6         0         5         67.6         100.0         64,436         2.44         0.159           3         29,920         18,498         64.1         0.0         0.0         55.7         1.2         100.0         551,357         1.04         0.991           1         19,937         77,567         90.5	Project         Num Users         All CPU Hours         Num Job Ids         Good CPU Hours         % Jobs         Jobs         Jobs         Total Jobs         Shadw Starts / Mids         Atts / Shadw Starts / Starts / Shadw         Holds           TOTAL         49         465485         429,041         80.8         5.2         16.7         5.6         5.6         48.2         3,528,787         1.18         0.892         0.01           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           1         71,443         8,902         89.3         0.0         18.6         0.0         0.0         98.725         1.24         0.966         0.00           3         29,420         18,499         84.9         67.6         0.0         56         67.6         1000         64,436         2.44         0.15         2.04           3         23,586         36,505         83.5         2.0         18.6         0.0         55.7         1.2         1000         55.1357         1.04         0.919         0.00           1         19,987         77.567



Project	Num Users	All CPU Hours	Num Uniq Job Ids	% Good CPU Hours	% Rm'd Jobs	% Short Jobs	% Jobs w/>1 Exec Att	% Joł w/1 Hol	os I+ ds	% Jobs using S'ty	Total Files Xferd	Shadw Starts / Job Id	Exec Atts / Shadw Start	Holds / Job Id	
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	ſ
Identities	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	
rodactod	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	ſ
Teuacieu	3	29,420	18,498	84.9	67.6	0.0	4.5	6	7.6	100.0	64,436	2.44	0.159	2.04	
	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	
	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	
	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	L
	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	
	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	L
	5	18,164	4,759	69.5	0.9	8.0	73.5	6	7.4	0,0	3,297	2.87	0.851	1.00	
	1	17,833	26,623	80.6	25.2	0.0	10.0	2	52	J ko	<b>5</b> 18 <b>2</b> ,931	1.23	0.899	0.25	L
	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	
	1	13,606	1,632	89.5	0.0	0.0	20.2		0.0	0.0		1.28	0.968	0.00	L
	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	
	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	
	Project	ProjectNum UsersTOTAL49Identities redacted1113333131111111111111111111111111111111111	Project         Num Users         All CPU Hours           TOTAL         49         465,485           Identities redacted         1         133,282           1         71,443         29,420           3         29,420         3           3         23,586         1           41         21,921         1           41         19,473         1           41         19,473         1           41         19,473         1           41         19,473         1           41         19,473         1           41         13,606         1           41         13,608         1           41         13,608         1           41         13,608         1           41         13,606         1           41         13,606         1           41         13,606         1           41         13,606         1           41         13,608         1           41         13,608         1           41         13,606         1           41         13,606         1           41	Project         Num Users         All CPU Hours         Num Uniq Job Ids           TOTAL         49         465,485         429,041           Identities redacted         1         133,282         4,910           1         71,443         8,902         18,498           3         29,420         18,498           3         23,586         36,350           41         21,921         4,134           2         19,987         77,567           41         18,405         5,732           41         18,405         5,732           41         13,698         3,012           41         13,698         3,012           41         13,606         1,632           41         13,608         3,012           41         13,608         3,012           41         13,608         3,012           41         13,608         1,632           41         13,133         3,505           41         13,133         3,505	Project         Num Users         All CPU Hours         Num Uniq Job Ids         % Good CPU Hours           TOTAL         49         465,485         429,041         80.8           Identities redacted         1         133,282         4,910         80.3           1         71,443         8,902         89.1           3         29,420         18,498         84.9           3         23,586         36,350         83.5           41         21,921         4,134         64.1           1         19,473         8,381         91.5           1         19,473         8,381         91.5           1         18,405         5,732         90.1           1         18,405         5,732         90.1           1         18,405         5,732         90.1           1         18,405         3,012         48.6           1         13,698         3,012         48.6           1         13,606         1,632         89.5           1         13,133         3,505         81.3           1         13,133         3,505         81.3           1         10,851         7,367         90.8 <td>Project         Num Users         All CPU Hours         Num Uniq Job Ids         % Good CPU Hours         % m'd Jobs           TOTAL         49         465,485         429,041         80.8         5.2           Identities redacted         1         133,282         4,910         80.3         0.0           3         29,420         18,498         84.9         67.6           3         23,586         36,350         83.5         3.0           41         21,921         4,134         64.1         0.0           1         19,473         8,381         91.5         0.0           1         19,473         8,381         91.5         0.0           1         19,473         8,381         91.5         0.0           1         19,473         8,381         91.5         0.0           1         18,405         5,732         90.1         0.0           1         17,833         26,623         80.6         25.2           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.</td> <td>ProjectNum UsersAll CPU HoursNum Uniq Job Ids% Good CPU Hours% Mm'd Jobs% Short JobsTOTAL49465,485429,04180.85.216.7Identities redacted1133,2824,91080.30.00.1171,4438,90289.10.00.0329,42018,49884.967.60.0323,58636,35083.53.01.5421,9214,13464.10.00.0419,98777,56790.50.00.1119,4738,38191.50.00.1119,4738,38191.50.00.0113,6065,73290.10.00.0113,6083,01248.60.00.0113,6083,01248.60.00.0113,6061,63289.50.00.0113,6067,36790.80.00.0</td> <td>Project         Num Users         All CPU Hours         Num Uniq Job Ids         % Good CPU Hours         % Mm'd Jobs         % Short         % Mut           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0           1         71,443         8,902         89.1         0.0         0.0         18.6           2         29,420         18,498         84.9         67.6         0.0         4.5           3         23,586         36,350         83.5         3.0         1.5         1.3           2         19,987         77,567         90.5         0.0         0.2         2.5           41         19,473         8,381         91.5         0.0         0.1         15.7           5         18,164         4,759         69.5         0.9         8.0         73.5           1         18,405         5,732         90.1         0.0         0.0         15.5           4         1         13,698         3,012         48.6         0.0         0.0         0.0</td> <td>Project         Num Users         All CPU Hours         Num Uniq Job Ids         % Good CPU Hours         % Rmd Jobs         % Short         % Lex Att         % Jobs         % M/1         % M/1</td> <td>Project         Num Users         All CPU Hours         Num Uniq Di bids         <math>\frac{9}{CPU}</math> CPU Hours         <math>\frac{9}{Mm}</math> Shot         <math>\frac{9}{Mm}</math> Shot<td>Project         Num Users         All CPU Hours         Num Users         Num Hours         <math>\binom{6}{000}</math> (PU Hours         <math>\binom{6}{000}</math> (PU Hours        <math>\binom{6}{000}</math> (P</td><td>Project         Num Hours         Num Job         % Sod CPU Hours         % Jobs         % Short         % Jobs         % Jobs         % Jobs         Total Files wi/1           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         48.2         3,528,787           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         88.5         3.0         1.5         1.3         0.0         98,5         274,211           1         1,9473         8,381         91.5         0.0         0.2         2.5         0.0         10.0         358,70           1         1,9473</td><td>Project         Num         All CPU         Num         Num         <math>\binom{9}{\text{CPU}}</math> <math>\binom{9}{\text{Nobs}}</math>        &lt;</td><td>Project         Num Users         All CPU Hours         Num Job Ids         % Good CPU Hours         % Jobs         % Short Jobs         % Jobs         % Jobs         % Jobs         % Jobs         % Jobs         % Starts         % Starts</td><td>Project         Num Users         All CPU Hours         Num Users         % Users         % CPU Pure         % Shoth         % Shoth</td></td>	Project         Num Users         All CPU Hours         Num Uniq Job Ids         % Good CPU Hours         % m'd Jobs           TOTAL         49         465,485         429,041         80.8         5.2           Identities redacted         1         133,282         4,910         80.3         0.0           3         29,420         18,498         84.9         67.6           3         23,586         36,350         83.5         3.0           41         21,921         4,134         64.1         0.0           1         19,473         8,381         91.5         0.0           1         19,473         8,381         91.5         0.0           1         19,473         8,381         91.5         0.0           1         19,473         8,381         91.5         0.0           1         18,405         5,732         90.1         0.0           1         17,833         26,623         80.6         25.2           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.0           1         13,606         1,632         89.5         0.	ProjectNum UsersAll CPU HoursNum Uniq Job Ids% Good CPU Hours% Mm'd Jobs% Short JobsTOTAL49465,485429,04180.85.216.7Identities redacted1133,2824,91080.30.00.1171,4438,90289.10.00.0329,42018,49884.967.60.0323,58636,35083.53.01.5421,9214,13464.10.00.0419,98777,56790.50.00.1119,4738,38191.50.00.1119,4738,38191.50.00.0113,6065,73290.10.00.0113,6083,01248.60.00.0113,6083,01248.60.00.0113,6061,63289.50.00.0113,6067,36790.80.00.0	Project         Num Users         All CPU Hours         Num Uniq Job Ids         % Good CPU Hours         % Mm'd Jobs         % Short         % Mut           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0           1         71,443         8,902         89.1         0.0         0.0         18.6           2         29,420         18,498         84.9         67.6         0.0         4.5           3         23,586         36,350         83.5         3.0         1.5         1.3           2         19,987         77,567         90.5         0.0         0.2         2.5           41         19,473         8,381         91.5         0.0         0.1         15.7           5         18,164         4,759         69.5         0.9         8.0         73.5           1         18,405         5,732         90.1         0.0         0.0         15.5           4         1         13,698         3,012         48.6         0.0         0.0         0.0	Project         Num Users         All CPU Hours         Num Uniq Job Ids         % Good CPU Hours         % Rmd Jobs         % Short         % Lex Att         % Jobs         % M/1         % M/1	Project         Num Users         All CPU Hours         Num Uniq Di bids $\frac{9}{CPU}$ CPU Hours $\frac{9}{Mm}$ Shot <td>Project         Num Users         All CPU Hours         Num Users         Num Hours         <math>\binom{6}{000}</math> (PU Hours         <math>\binom{6}{000}</math> (PU Hours        <math>\binom{6}{000}</math> (P</td> <td>Project         Num Hours         Num Job         % Sod CPU Hours         % Jobs         % Short         % Jobs         % Jobs         % Jobs         Total Files wi/1           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         48.2         3,528,787           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         88.5         3.0         1.5         1.3         0.0         98,5         274,211           1         1,9473         8,381         91.5         0.0         0.2         2.5         0.0         10.0         358,70           1         1,9473</td> <td>Project         Num         All CPU         Num         Num         <math>\binom{9}{\text{CPU}}</math> <math>\binom{9}{\text{Nobs}}</math>        &lt;</td> <td>Project         Num Users         All CPU Hours         Num Job Ids         % Good CPU Hours         % Jobs         % Short Jobs         % Jobs         % Jobs         % Jobs         % Jobs         % Jobs         % Starts         % Starts</td> <td>Project         Num Users         All CPU Hours         Num Users         % Users         % CPU Pure         % Shoth         % Shoth</td>	Project         Num Users         All CPU Hours         Num Users         Num Hours $\binom{6}{000}$ (PU Hours $\binom{6}{000}$ (P	Project         Num Hours         Num Job         % Sod CPU Hours         % Jobs         % Short         % Jobs         % Jobs         % Jobs         Total Files wi/1           TOTAL         49         465,485         429,041         80.8         5.2         16.7         5.6         48.2         3,528,787           Identities redacted         1         133,282         4,910         80.3         0.0         0.1         27.0         0.2         0.0         354,176           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         89.1         0.0         0.0         18.6         0.0         0.0         98,725           1         71,443         8,902         88.5         3.0         1.5         1.3         0.0         98,5         274,211           1         1,9473         8,381         91.5         0.0         0.2         2.5         0.0         10.0         358,70           1         1,9473	Project         Num         All CPU         Num         Num $\binom{9}{\text{CPU}}$ $\binom{9}{\text{Nobs}}$ <	Project         Num Users         All CPU Hours         Num Job Ids         % Good CPU Hours         % Jobs         % Short Jobs         % Jobs         % Jobs         % Jobs         % Jobs         % Jobs         % Starts         % Starts	Project         Num Users         All CPU Hours         Num Users         % Users         % CPU Pure         % Shoth         % Shoth



## **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 ]





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	2	14,031	3,207	JobPolicy	99.9	1.48	67.8	1.1	
2	2 redacted	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	





- > Was any of it good? </br>
- > Any other usage?
  - GPU hours?
  - Memory usage?
  - Files transferred?

#### > How was the user experience?

• How often were jobs interrupted or put on hold?





## Want to try it ?

#### > Setup Elasticsearch

- How big of a server? \*see next slide\*
- Create an index named "htcondor-000001"
- Set ES index lifecycle policies details here
- > Install HTCSS

CENTER FOR

• Add to HTCSS config:

use feature: adstash

- Details: See <u>Manual / Admin Manual / Monitoring / Elasticsearch</u> and/or "man condor\_adstash"
- > Checkout and/or customize our report generation scripts
  - <u>https://github.com/CHTC/JobAccounting</u>
- > And/Or create dashboards with Grafana!
  - condor\_adstash inserts "RecordTime" as timestamp field

## How much hardware do I need for ES?

- For OSPool our original, organically expanding Elasticsearch host is a single node:
  - 64 GB RAM
  - 12 CPU cores
  - 1.4TB disk space used holding ~650 million job records (past 3 years of OSPool APs) so about 2GB per million jobs
- > Switching to Elasticsearch hosted on Kubernetes
  - Currently using 5 nodes with 512 GB each
  - Elasticsearch Kubernetes operator decides on memory and CPU (I have no clue what it's doing for this)

### **Thank You!**

Please add your institution to our world <u>map</u> of HTCondor Users at: <u>https://htcondor.org/user-map</u> and click "<u>Add Your Institution</u>" on upper right

#### PARTNERSHIP to ADVANCE THROUGHPUT COMPUTING

This work is supported by <u>NSF</u> under Cooperative Agreement <u>OAC-</u> <u>2030508</u> as part of the <u>PATh Project</u>. 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.



