

Trackable RESources (TRES)



Brian Christiansen and Danny Auble
SchedMD LLC

Slurm User Group Meeting 2015

Overview



- Need
- Setup
- Transition
- Reporting
- Fairshare
- Priority

Need

- Limits on more resources other than CPU/Memory/Nodes
 - GRES, Licenses, etc
- Method for accounting what resources were really used
 - more than just cpu anyway
- Easier way to add more limits
 - No database alteration needed for future TRES

Setup

- All TRES are global and are defined in the `slurm.conf`
 - Available to all clusters
- AccountingStorageTRES
 - Used to define which TRES are to be tracked on the system. By default CPU, Energy, Memory, and Node are tracked. This will be the case whether specified or not.
- Example
 - AccountingStorageTRES=gres/**gpu:tesla**,license/**iop1**,bb/**cray**

Setup

- PriorityWeightTRES

- A comma separated list of TRES Types and weights that sets the degree that each TRES Type contributes to the job's priority
- PriorityWeightTRES=CPU=1000,Mem=2000,GRES/gpu=3000

- TRESBillingWeights

- For each partition this option is used to define the billing weights of each TRES type that will be used in calculating the usage of a job.
- TRESBillingWeights="CPU=1.0,Mem=0.25,GRES/gpu=2.0"

Transition

- sacctmgr
 - [Grp|Max] [cpu|mem|node]* limits now [Grp|Max]TRES*
 - GrpTRES=cpu=500,mem=10000,nodes=100
 - (GrpCpus=500 GrpMem=10000 GrpNodes=100)
 - Old definitions still work, for legacy scripts
 - -1 still how to removing limits GrpTRES=cpu=-1,mem=-1,nodes=1000

Transition

- sacctmgr
 - New/Extended Association|QOS options (all work for any TRES)
 - GrpTRES
 - GrpTRESMins
 - GrpTRESRunMins
 - MaxTRESPerJob
 - MaxTRESPerNode
 - MaxTRESMinsPerJob
 - MaxTRESPerUser*
 - MinTRESPerJob*

*only applicable to QOS

Transition



- `scontrol/squeue/sacct`
 - Can display TRES as well
 - When a limit is violated the reason field in a job has a unique reason for each TRES type/limit combo
 - `QOSGrpCpuLimit`
 - `QOSGrpMemLimit`
 - `AssocGrpCpuLimit`
 - `AssocGrpMemLimit`
 - etc

Reporting



- Data is King!
- sreport
 - Previously would only report on CPU utilization
 - Now can report on **any** TRES (except Node)

Reporting

- Need more memory? Or less cpus?

```
$ sreport -tminper cluster utilization --tres="cpu,mem" start=2015-09-01T00:00:00
```

```
-----  
Cluster Utilization 2015-09-01T00:00:00 - 2015-09-01T23:59:59
```

```
Use reported in TRES Minutes/Percentage of Total
```

Cluster	TRES Name	Allocated	Down	PLND Down	Reserved	Idle	Reported
compy	cpu	253440(20.00%)	0(0.00%)	0(0.00%)	0(0.00%)	1013760(80.00%)	1267200(100.00%)
compy	mem	4582306080(90.00%)	0(0.00%)	0(0.00%)	509145120(10.00%)	0(0.00%)	5091451200(100.00%)

Reporting

- GPUs being used?

```
$ sreport -tminper cluster utilization --tres="cpu,gres/gpu" start=2015-09-02T00:00:00
```

Cluster Utilization 2015-09-02T00:00:00 - 2015-09-2T23:59:59

Use reported in TRES Minutes/Percentage of Total

Cluster	TRES Name	Allocated	Down	PLND Down	Reserved	Idle	Reported
compy	cpu	1140480(90.00%)	0(0.00%)	0(0.00%)	126720(10.00%)	0(0.00%)	1267200(100.00%)
compy	gres/gpu	63360(20.00%)	0(0.00%)	0(0.00%)	0(0.00%)	253440(80.00%)	316800(100.00%)

Reporting

- Which GPUs are being used most?

```
$ sreport -tminper cluster utilization --tres="gres/gpu:k40,gres/gpu:k80" start=2015-09-02T00:00:00
```

Cluster Utilization 2015-09-02T00:00:00 - 2015-09-2T23:59:59

Use reported in TRES Minutes/Percentage of Total

Cluster	TRES Name	Allocated	Down	PLND Down	Reserved	Idle	Reported
compy	gres/gpu:k40	63360(20.00%)	0(0.00%)	0(0.00%)	0(0.00%)	253440(80.00%)	316800(100.00%)
compy	gres/gpu:k80	190080(60.00%)	0(0.00%)	0(0.00%)	0(0.00%)	126720(40.00%)	316800(100.00%)

Fairshare



- Previously only total cpus was accounted for in fairshare
- If a job used 1 CPU and all the memory on the machine the job was only charged for 1 CPU when it really used the whole node
- Now, any TRES can be accounted for in fairshare
 - TRESBillingWeights

Fairshare

- TresBillingWeights configured per partition
- Billing weights are specified as a comma-separated list of <TRES Type>=<TRES Billing Weight> pairs
- TRESBillingWeights=CPU=1.0,Mem=0.25,GRES/gpu=2.0
 - Mem is weighted per gigabyte
- Two methods of calculating billable TRES
 - MAX_TRES
 - SUM of TRES

Fairshare



- SUM of TRES
 - Default
 - $\text{SUM}(\text{<TRES> + <TRES Weight>, \dots)$
 - Good if you want to account for what you are using
- MAX_TRES
 - $\text{PriorityFlags} = \text{MAX_TRES}$
 - $\text{MAX}(\text{Node TRES}) + \text{SUM}(\text{Global TRES})$
 - Good if you want to account if any one resource is blocking other jobs from running on a node

Fairshare

- TRESBillingWeights=CPU=1.0,Mem=0.25
- 16CPU, 64GB nodes

SUM of TRES:

	CPU	Mem	
Job1:	$(1 * 1.0)$	$+$	$(60 * 0.25) = (1 + 15) = 16$
Job2:	$(16 * 1.0)$	$+$	$(1 * 0.25) = (16 + .25) = 16.25$
Job3:	$(16 * 1.0)$	$+$	$(60 * 0.25) = (16 + 15) = 31$

MAX_TRES:

	CPU	Mem	
Job1:	$\text{MAX}((1 * 1.0), (60 * 0.25))$		$= 15$
Job2:	$\text{MAX}((15 * 1.0), (1 * 0.25))$		$= 15$
Job3:	$\text{MAX}((16 * 1.0), (64 * 0.25))$		$= 16$

Priority

- PriorityWeightTRES
 - List of TRES Types and weights
 - PriorityWeightTRES=CPU=1000,Mem=2000,GRES/gpu=3000
- Control how much a TRES contributes to the job's priority
- Node TRES (i.e. CPU, Mem, GRES, Node) are normalized against total TRES configured in a partition
- Global TRES (i.e. license, bb) are normalized against the global amount in the system

Priority

- Ex. If a partition has 80 cpus and a job uses 8, then the priority factor is .1 (or 10%)
- AccountingStorageTRES=cpu,mem,gres/gpu
- PriorityWeightTRES=cpu=1000,gres/gpu=3000

```
$ sprio
```

JOBID	PRIORITY	AGE	FAIRSHARE	TRES
3	625	0	500	cpu=125
5	600	0	500	cpu=100
6	812	0	500	cpu=12,gres/gpu=300

Questions?

