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Queues for Newbies – How to speak LSF in a SAS® World

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ABSTRACT

Wouldn't it be great to never have to wait in line at the bank, the airport, the hospital waiting room? The same applies in the SAS® world, running SAS jobs (although I will return to the airport analogy in later scenarios).

Ideally every SAS user has dedicated resources available on demand & scalable to process their task as near to real-time as possible. One way to achieve this is for every user to have their own dedicated PC (or server), cores, memory, etc. However, like all options, this has its drawbacks - for a large number of users, it's expensive, difficult to manage, but above from a technology perspective there would be a lot of wasted utilisation, with most machines only operating a fraction of the time.

These days there is pressure to centralise processing - in an effort to reign in IT costs, simplify management, apply governance. But for a server to have enough "grunt" to be able to process requests on demand means either an overpowered server, or contention for resources. LSF aims to manage this contention to ensure priority is properly applied to the right users at the right time.

The critical IT decision on a SAS server: How to share!

AUDIENCE

There are more than 2000 pages of SAS Grid & Platform Suite documentation. This paper is intended as an introduction to what it means to run SAS program on a SAS Grid, and take a "sneak peek" under the hood at LSF, and some of its basic principles.

This paper assumes the audience has sound knowledge of running SAS programs, including using SAS/Connect to Remote-Submit jobs between SAS sessions, but assumes little or no LSF or SAS Grid knowledge.

There are many excellent (and more detailed) SAS Grid papers available; many are listed at the end of this paper.

Although not tied to any specific software version, the reference documentation is SAS version 9.4, the screenshots are SAS version 9.3 & Platform RTM for SAS version 2.08

SCENARIOS

Let's return to the airport analogy; imagine various scenarios at the airport departure lounge:

One single queue

You arrive, you line up at the back of the queue, and you wait your turn; no matter how simple or difficult your check-in will be (or anyone else's), you are all dealt with one a time equally by however many staff at the check-in desks.

One regular queue & one express queue

Neither more important than the other, but because some passengers fulfill certain criteria (e.g, check-in online beforehand, no check-in baggage, etc), their requirements are the airport are less demanding.

One regular queue, one express queue and a high-priority queue (frequent flyers, gold club members, etc.)

You get the idea..

Now how will the check-in staff process each these queue combinations, above? All of the above scenarios could be processed by the service staff in a number of ways:

- All queues serviced from a general staff pool (but then no-one is on stand-by for the important flyers).
- Dedicated staff for each queue (running the risk of some queues being over-utilised whilst others are under-utilised).
- Some dedicated & "floating" staff.

The same applies in the SAS world, trying to find the best way to manage demand of a shared resource. This is achieved with a combination of SAS Grid Manager& IBM Platform Computing technology.

WHAT MAKES THIS POSSIBLE?

SAS Grid Manager is a suite of SAS & OEM software designed to manage the SAS Grid. Underlying the grid is the Platform Suite for SAS from Platform Computing, including:

- Platform LSF –to manage job dispatching & load balancing across the grid
- Platform Process Manager – used by SAS to control job submissions to LSF
- Platform Grid Management Service - used by the SAS Grid plug-in to obtain information about the grid.
- Enterprise Grid Orchestrator – enables critical service management for High Availability

SAS Grid Manager also includes a Grid Manager plug-In for SAS Management Console.

Not part of the SAS Grid Manager installation but available from the SAS Support website is **Platform RTM for SAS** - a boon for LSF "Newbies": "A web-based tool that enables you to graphically view the status of devices and services in a SAS grid environment as well as manage the policies and configuration of the grid." Although LSF can be configured & run from the command-line & direct manipulation of text-based configuration files, the RTM GUI is very simple to use to configure & monitor an LSF cluster.

Figure 1: Platform RTM for SAS home screen

There are three key benefits of SAS Grid Manager:

- Workload Management - resource management of users, jobs, priorities, etc.
- Parallel Workload Management - allow SAS products (such as Data Integration Studio & Enterprise Miner) to execute some tasks in parallel.
- Scheduling - create workflows (including time and/or event based triggers) in the Schedule Manager of SAS Management Console.

Note: Even if an organisation mandates a non-SAS scheduler (such as Control-M), the batch job can still be submitted to the SAS Grid, using the SASGSUB command to submit SAS programs to the Grid from the command line.

SOME GRID DEFINITIONS

Note: Quotations are taken from the SAS/Grid or LSF documentation.

Host: An individual computer, typically a multi-processor server. Hosts may be used for program submission, program execution, or a combination of both.

Cluster: "A group of computers (hosts) running that work together in a single unit, combing computer power and sharing workload and resources."

Job: "A unit of work of work run in the LSF system". Typically a SAS program, although one SAS program could be broken up into multiple jobs.

Queue: "A cluster wide container for jobs". This is where submitted jobs wait prior to being sent to a host for execution. It is possible that one host may service many queues, and equally possible that many hosts may be used to service a single queue.

Slot: "The number of processes that are allowed to run concurrently on a machine. A machine cannot run more concurrent processes than it has job slots." By default, the number of job slots on a host equates to the number of processor cores in that host (although this can be reconfigured for faster processors)

Depending on your infrastructure, you can have multiple queues on one host, or multiple hosts in a queue.

The handshaking of LSF hosts (i.e, managing the requesting, dispatching, scheduling, execution & tracking) is controlled though a series of LSF daemons (mbatchd, mbschd, sbatchd, elim, etc) which are not covered in this paper. For more information on how these daemons function, document references are provided at the end of this paper.

SO WHAT ACTUALLY HAPPENS WHEN YOU SUBMIT A JOB ON THE GRID?

Many users are already familiar with using SAS/Connect to Remote-Submit code, typically between SAS on a workstation and SAS on a server. Trends towards centralising & managing IT costs in large organisations means that SAS on workstations is being increasingly phased out in favour of SAS clients (Enterprise Guide, Enterprise Miner, Data Integration Studio, etc), and SAS is being consolidated to run solely on servers.

However with SAS Grid Manager, SAS/Connect & Remote-Submits are still there, but now they take place between hosts in the cluster, with the SAS Grid Manager managing which jobs are submitted to which servers.

Your job is submitted to a SAS session to a SAS Application Context, running on a Host in a Grid Cluster. This server also has LSF & SAS/Connect installed. The SAS Application Context has a Logical Grid Server defined. LSF Remote-Submits the job to one (or more) hosts in the cluster (including possibly even the same host which submitted the request).

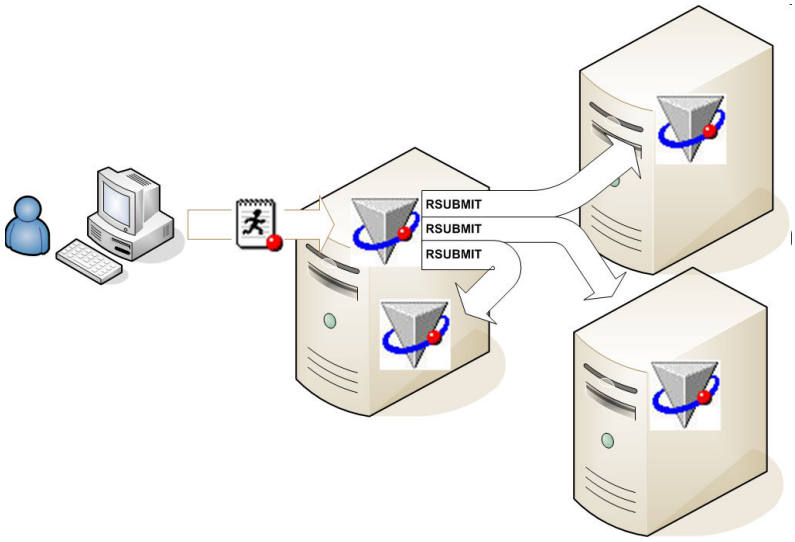

Figure 2: Simplified view of SAS Grid Processing

Behind the scenes, the SAS Grid Manager has taken care of dispatching your job, selecting which host to run it on, etc - all of this is controlled by the queue configuration of the SAS Application Server context where you originally submitted your job.

WHERE DID ALL THESE ADDITIONAL LIBRARIES COME FROM?

In a Grid-enabled environment, you will now notice a new set of libraries. These arise from SAS/Connect's Remote Library Services (RLS) surfacing the libraries of the remote SAS session(s) to the SAS client, as well as one very grid-focused library called (not surprisingly) GRIDWORK.

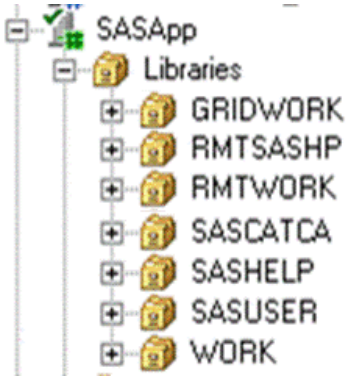

Figure 3: SAS libraries in a Grid-enabled Enterprise Guide session

- **WORK**, SASUSER, etc - These are the libraries of the requesting SAS session.
- **RMTWORK** (and RMTUSER, RMTHELP, etc) - These are the SASWORK, SASUSER, SASHELP libraries of the remote SAS session. These are surfaced to the requesting SAS session (and the user) as RMTWORK, etc via SAS/Connect's Remote Library Services. (Note: the actual naming convention of RMTWORK & RMTUSER will depend on how the Grid was installed.)
- **GRIDWORK** - Above are defined the libraries WORK (on the requesting SAS session) and RMTWORK (on the remote SAS session); GRIDWORK is entirely different concept. GRIDWORK is a "grid staging" folder, containing the SAS program submitted by the Grid Client Manager, as well as the resulting LOG & LST files, plus any staging files required by or created by the job.

TYPICAL QUEUE SETTINGS

There are a huge number of configurable settings, most of which will probably not be required until you wind up managing many queues for a large organisation. *[It's like the multi-hundred date, time & datetime SAS formats available, of which most of us use around a dozen.]*

Some of the more common queue settings include:

- **PRIORITY** - jobs with higher priorities always take preference.
- **QJOB_LIMIT** - the maximum job slots queue can use.
- **PJOB_LIMIT** - the maximum job slots per processor in a queue.
- **UJOB_LIMIT** - the maximum job slots per user in a queue.
- **USERS** - limits usage of a queue to specific users and/or groups.
- **CPULIMIT** - a time limit applied to jobs.
- **DISPATCH_WINDOW** - the time window when jobs can be dispatched to a queue.
- **RUN_WINDOW** - the time window when jobs can be run on a queue. Similar to DISPATCH_WINDOW, however, any jobs still running when the RUN_WINDOW has expired will be suspended.
- **FAIRSHARE** - By default jobs of equal priority are processed on a "First-Come-First-Serve" basis. Fairshare aims to reduce one user "hogging" resources should they flood the queue with many jobs. The more frequently and heavily you use the queue, your more your priority is adjusted lower, allowing other jobs on the same queue to run. This reduction in priority is tempered over time.

These settings are all stored in LSF configuration files buried within the LSFCONFIG folder of your SAS installation, and could be manually managed. Fortunately, the more common settings can be configured using Platform RTM for SAS.

The following figure is the LSF Queue Configuration summary, showing key metrics such as QJOB_LIMIT, UJOB_LIMIT, etc:

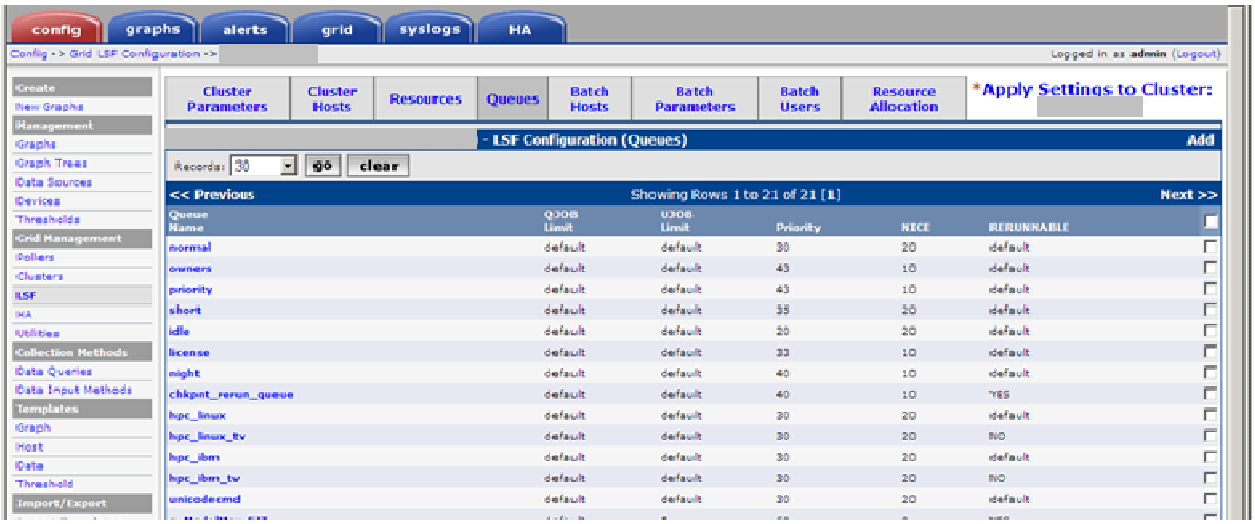

Figure 4: Platform RTM for SAS – Queue configuration summary

The following figure shows the configuration page for a particular queue:

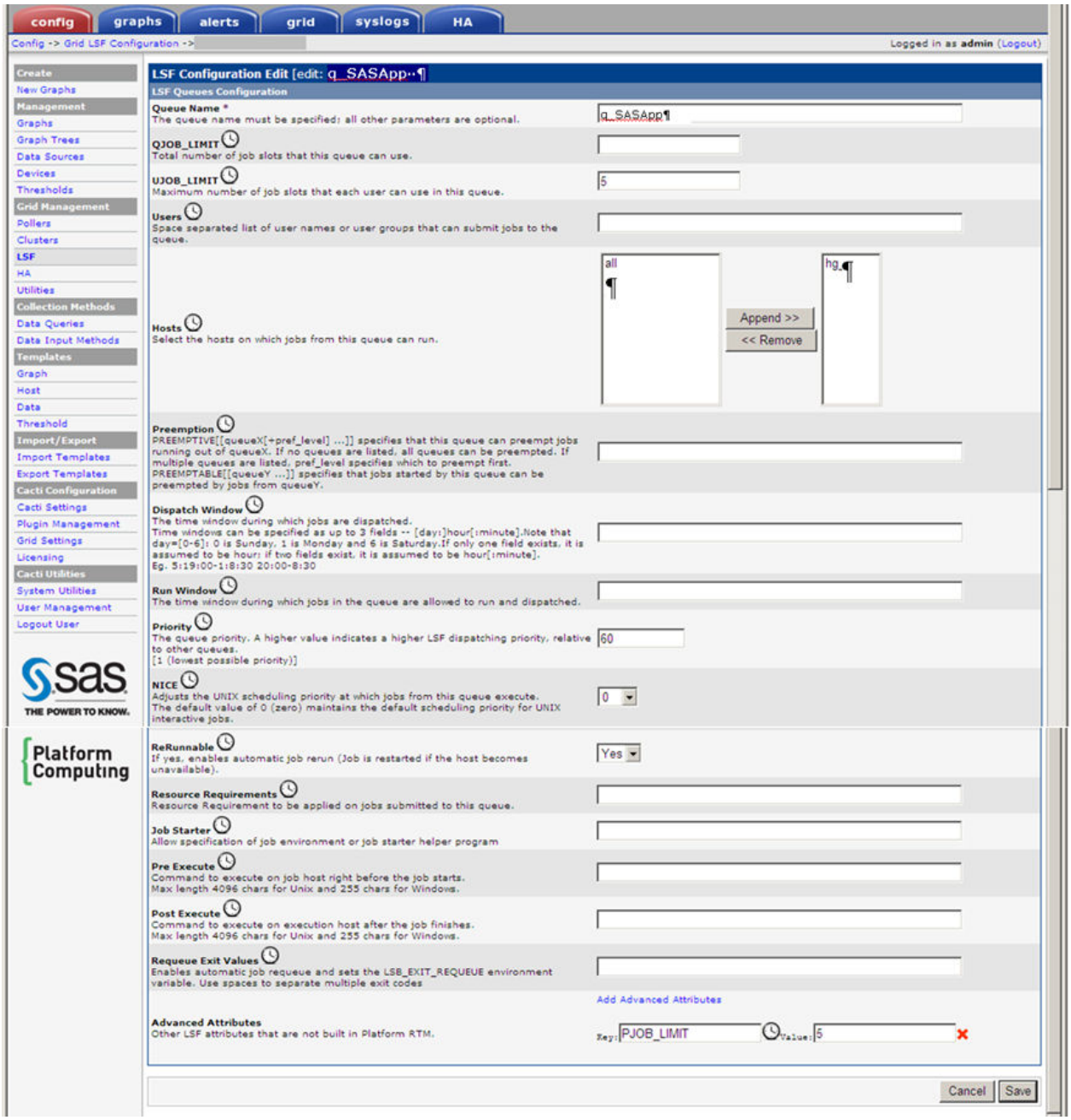

Figure 5: Platform RTM for SAS – Queue-specific settings

Below are some sample queues and their settings. These settings can be found in
$LSFCONFIG/conf/lsbatch/cluster_*XYZ*/configdir/lsb.queues

```
Begin Queue
QUEUE_NAME=normal
PRIORITY=30
DESCRIPTION=For normal low priority jobs, running only if hosts are lightly loaded.
End Queue

Begin Queue
QUEUE_NAME=priority
PRIORITY=43
DESCRIPTION=Jobs submitted for this queue are scheduled as urgentjobs. Jobs in this
queue can preempt jobs in lower priority queues.
PREEMPTION=PREEMPTIVE
End Queue

Begin Queue
QUEUE_NAME=short
PRIORITY=35
DESCRIPTION=For short jobs that would not take much CPU time. Scheduled with higher
priority.
CPULIMIT=15
End Queue

Begin Queue
QUEUE_NAME=night
PRIORITY=40
DESCRIPTION=For large heavy duty jobs, running during off hours and weekends.
Scheduled with higher priority.
RUN_WINDOW=5:19:00-1:8:30 20:00-8:30
End Queue
```

Figure 6. lsb.queues settings

These queues are applied by assigning particular SAS Logical Grid Servers to specific queues:

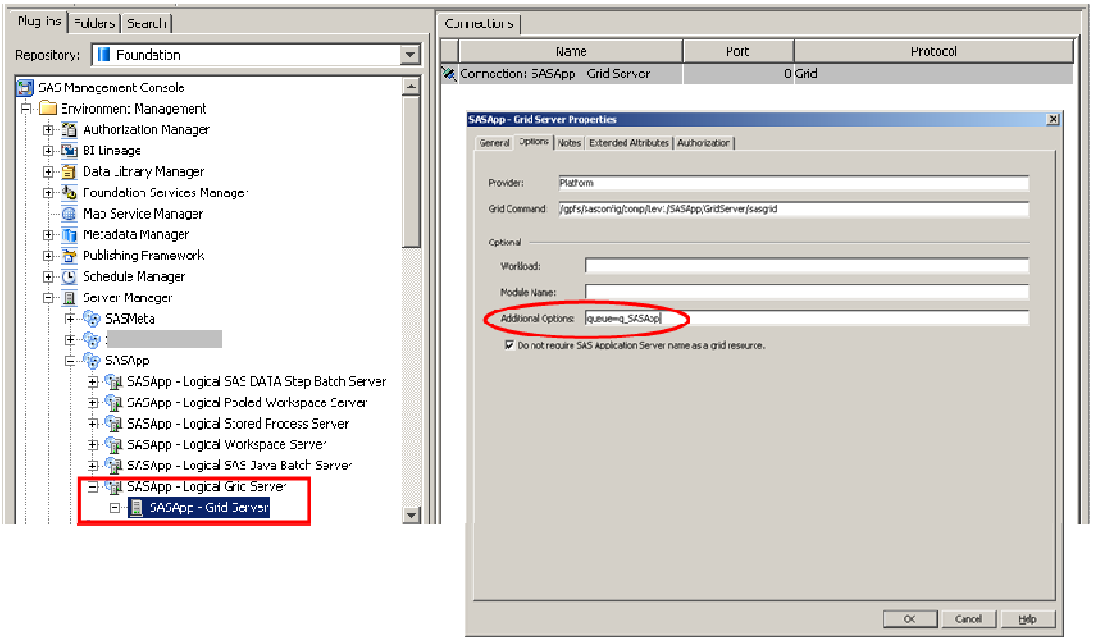

Figure 7: SAS Management Console – Logical Grid Server properties

RECOMMENDATIONS

Although it may sound obvious, plan your Grid by understanding your demand:

- Understand what is required, when & for which users
- Clarify batch processing, how much resources to dedicate to different groups, and how much resources to share
- Consider the SAS software is using the grid - Enterprise Guide, Data Integration Studio, Enterprise Miner, etc - all of which will have different resource requirements. SAS analytics jobs exceptionally resource demanding, but whilst maximising resources, you must also ensure that the grid remains available for other users.
- Consider your range of SAS users – for example, dashboard & web reports may seem to have minimal impact on the platform, but think about the target audience: typically Senior Management, possible even “C” level, who will want their information “now”. If the SAS platform includes critical reports, suggest a queue of limited resources but a high priority to deliver the reports quickly.

If it helps. use a “real world” analogy (airport, bank, hospital, etc) to help visualise your plan with stakeholders.

Some priority suggestions:

- **Support 90** - emergency only (hopefully never required), for specific support users, low job slots.
- **Batch 80** - critical jobs, maximum resources, possibly RUN_WINDOW overnight
- **Reports 70** - dashboards, web reports, etc, important but low demand
- **Dept1 50** - For regular EG, DI, EM usage.
- **Dept2 50** - Note: all departments should share a common priority.
- *etc.*
- **Guest 20** - useful for occasional users without impacting on other regular users.

FINAL WORD - THE "CLOUD"

The virtual world of Cloud Computing has opened up an endless number of possibilities. Whereas sites were previously hindered by the sheer expense & delay of on boarding infrastructure, operating systems, databases, etc, now these are being replaced by Infrastructure-As-A-Service, Platform-As-A-Service, etc. Cap-Ex is being replaced by Op-Ex, meaning organisations effectively ‘rent” resources, paying for just what is required when it is required.

Platform LSF is ideally suited to benefit from the Cloud, as it can be easily configured to request, start up & load-balance additional (virtual) resources as required – for example, month-end processing. Naturally, how effective this can be implemented on a SAS platform will also depend on other factors, such as licensing, etc.

CONCLUSION

This is just the tip of the tip of the SAS Grid iceberg. On a server with shared (and often constrained) resources, effective management of these resources is vital. SAS Grid manager & the Platform Computing suite of software resource management layer to ensure SAS applications are best utilised across a SAS platform’s available resources, and the web-based Platform RTM for SAS is the ideal “Swiss army knife” to manage & monitor your SAS Grid.

REFERENCES

SAS Grid Computing in SAS 9.4, Second Edition

SAS® 9.4 Intelligence Platform Application Server Administration Guide

Administering Platform LSF, Version 7 Update 6, Platform Computing Inc.

RECOMMENDED READING

- *SAS Support website – "Introduction to SAS Grid Computing". http://support.sas.com/rnd/scalability/grid*
- *SGF Paper 370-2012 - RTM and SASGSUB, the Power to Know®… what your Grid is doing. Erwan Granger, SAS Institute Inc, Cary, NC*
- *MWSUG 2012 paper - SAS Grid: Grid Scheduling Policy and Resource Allocation. Adam H. Diaz, IBM Platform Computing*
- *SUGI 31, Paper 211-31 - SAS® Goes Grid - Managing the Workload across Your Enterprise. Cheryl Doninger, SAS Institute, Cary, NC & Alan Wong, Platform Computing, Markham, Ontario*

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