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Logging 101: Leveraging the SAS Enhanced Logging Facility

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ABSTRACT

Logging and auditing are two of the most important aspects of security and utilization management for system administrators. SAS 9 contains an enhanced logging and auditing facility that provides the ability to better capture individual SAS job and workload utilization and performance. While applications such as SAS Management Console provide administrators with the ability to dynamically change logging levels and view log output, SAS programmers can take advantage of logging features using SAS 4GL language statements. This paper presents an overview of the enhanced logging facility in association with SAS Business Intelligence applications and independent ad hoc and batch jobs.

INTRODUCTION

Administrators are being asked to keep track of SAS applications, sometimes down to the usage of specific SAS data files, for auditing purposes. These audits feed security, utilization, and capacity management activities, all of which are required to support expanding hardware justifications for overloaded systems. In addition, compliance with industry regulations and governance standards requires submission of detailed and provable audit reports. SAS and IT administrators are looking for better ways to perform these tasks for SAS implementations, and the SAS enhanced logging facility is very helpful.

During this presentation, we will discuss how the enhanced logging facility and the SAS Audit, Performance and Measurement package can supply you with critical information about your SAS Intelligence Platform applications. We will then show you how this same information can be gathered for all your ad hoc and batch independent SAS user tasks that are not submitted via the SAS Enterprise BI infrastructure. Lastly, we will illustrate how you can integrate this information with hardware monitor output to support capacity planning and performance evaluation for the computer hardware supporting your SAS applications.

Bottom line: SAS provides an expanded set of tools that administrators can use to collect (log) information about system behavior, and SAS provides tools and guidelines that administrators can use to review and analyze the collected information. Administrators should review the level of log information that they need to collect and retain—because you cannot analyze information that is not there.

Previously written documents provide the SAS code for creating many of the examples shown in this paper. We will not repeat that information in this paper. Also, the SAS Global Forum 2012 presentation will include additional examples of reports that can be produced using the techniques discussed in this paper.

SOME BACKGROUND INFORMATION

Before addressing the gathering of log and performance data, it is helpful to first understand the SAS enhanced logging facility and the SAS Audit, Performance and Measurement (APM) package.

Beginning with SAS 9.2, a new, enhanced logging facility was incorporated into Base SAS. This facility provides the ability to finely tune the capturing of log and audit information about SAS activity. Since the captured data is stored in external files, SAS programmers can use SAS 4GL language statements in custom-coded programs to report on this data.

The enhanced logging features classify messages according to audit, performance, administration, and application namespaces, as well as by diagnostic levels such as trace, information, error, warning, and fatal. SAS and IT administrators now have the power and flexibility to classify these messages according to a well-defined location. In addition, administrators can dynamically enable—and change—diagnostic logging levels without stopping and restarting SAS processes. The logging facility contains a suite of predefined patterns that can be used to customize the output format for diagnostic messages. Through the use of appenders, administrators can direct messages to customized output destinations such as the Windows Event Viewer, UNIX system logs, the z/OS system logger, or an operator's console. In addition, messages can be directed to an external database for real-time analysis of enterprise activity or to perform historical analyses on audit, performance, or diagnostic events. See the paper [SAS 9.2 Enhanced Logging Facilities](#) for more details.

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The SAS Audit, Performance and Measurement package acquires the data collected by the enhanced logging facility and uses it to create predefined sample reports that can help SAS and IT administrators understand how SAS is being used on their various computer hardware systems. Reports such as Most Heavily Used Datasets/Directories, Top 10 Reports/OLAP Cubes/Users, and SAS PROC Usage are just examples of the types of reporting that can be done. This information can easily be expanded to cover the complete set of computer resources being used by SAS. The information can even be used as input to internal chargeback systems. See the paper "Understanding the Audit and Performance Management Artifact Usage and Performance" for more details.

GATHERING DATA FROM SAS ENTERPRISE BI APPLICATIONS

The use of SAS Enterprise Guide as a front-end SAS reporting and analysis tool has empowered end users to implement sophisticated reporting, analytics, and data manipulation with a minimum of programming, using re-usable application code modules. Because the SAS Enterprise Guide interface can connect to established, pooled, back-end SAS sessions that have been started by a general SAS user ID, it became difficult to parse individual user activity and consumption. Early implementations of SAS shared metadata deployments did not provide information that distinguished individual users or processes. For example, it was not possible to identify which users or processes consumed the most hardware resources, which SAS data files were being accessed most frequently, and who read or updated a particular SAS data file.

The SAS Audit, Performance and Measurement package can gather log records and collate the information associated with specific individuals and processes. A sample Web application included with the SAS Audit, Performance and Measurement package reports on the SAS Enterprise BI content (such as reports, data, and projects) that are accessed by individual SAS Enterprise Guide processes. It also reports on the resulting computer resource consumption. These reports are available from the lower right panel of the sample interface, as shown in Figure 1.

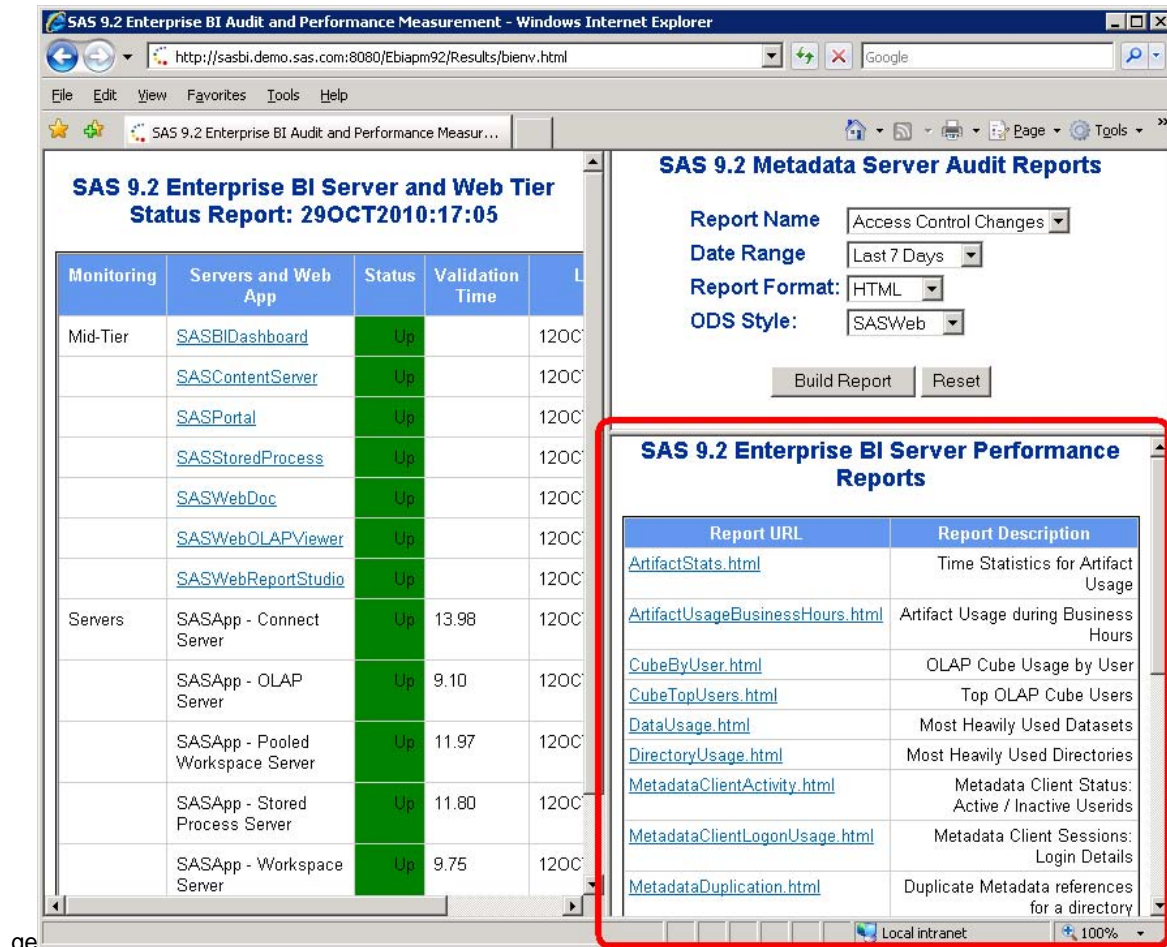


Figure 1. The SAS Audit, Performance and Measurement Package with the Usage Reports Highlighted

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Audit and performance reporting, which is generally scheduled to run as a nightly batch operation, extracts information from the various log files, appends the new day's data to the package's reporting data sets, and generates new reports for SAS and IT administrators to review during the next business day. The package is designed to be extensible. Organizations can easily add new customized reports to the nightly batch processing system.

In addition to performing general usage reporting on data collected from the back-end SAS servers, the SAS Audit, Performance and Measurement package collects and reports data from the SAS Metadata Server and Web application servers. As a result, you can obtain a complete picture of all the SAS Enterprise BI components in your deployment. With this additional data, information about changes to metadata security can now be collected. The metadata security audit information allows organizations to track security changes made to the various objects stored in the SAS metadata repository. For information about producing these reports, see the paper "Extending the Metadata Security Audit Reporting Capabilities of the Audit, Performance and Measurement package."

SAS 9.3 MetadataGetArtifacts Data Source Inventory
as of 01APR2011

type=CUBE

Metadata ID	Name	Metadata Path	Operating System Directory
A5A7RR6G.C700000K	BID_Appalachian_Chocolates	/BIDTesting/DataSources/Cubes/BID_Appalachian_Chocolates	BID_Appalachian_Chocolates
A5A7RR6G.C700000L	BID_MAILORDERINFOCUBE	/BIDTesting/DataSources/Cubes/BID_MAILORDERINFOCUBE	BID_MAILORDERINFOCUBE
A5A7RR6G.C700000M	BID_MDDBCARS	/BIDTesting/DataSources/Cubes/BID_MDDBCARS	BID_MDDBCARS
A5A7RR6G.C700000N	BID_PRDMDDDB	/BIDTesting/DataSources/Cubes/BID_PRDMDDDB	BID_PRDMDDDB
A5A7RR6G.C700000O	BID_VELOCITY	/BIDTesting/DataSources/Cubes/BID_VELOCITY	BID_VELOCITY
A5A7RR6G.C700000P	BasicStar	/OCS Testing/Cubes/BasicStar	BasicStar
A5A7RR6G.C700000G	CAMPAIGN	/SAS Projects/Intelligent Query/Shared/Cubes/CAMPAIGN	CAMPAIGN
A5A7RR6G.C700000H	CAMPAIGN_ALL	/SAS Projects/Intelligent Query/Shared/Cubes/CAMPAIGN_ALL	CAMPAIGN_ALL
A5A7RR6G.C700000I	Copy of DT_MAILORDERINFOCUBE	/WRS Testing/Copy of DT_MAILORDERINFOCUBE	Copy of DT_MAILORDERINFOCUBE
A5A7RR6G.C700000Q	Copy of FullySummarized	/OCS Testing/Cubes/Copy of FullySummarized	Copy of FullySummarized
A5A7RR6G.C7000005	CustomerSummary	/SAS Projects/AMO/Shared Data/SASApp - OLAP Schema/CustomerSummary	CustomerSummary
A5A7RR6G.C7000001	DT_MAILORDERINFOCUBE	/Shared Data/Cubes/DT_MAILORDERINFOCUBE	DT_MAILORDERINFOCUBE
A5A7RR6G.C7000002	DVT_ESRI_USCITIES	/Shared Data/Cubes/DVT_ESRI_USCITIES	DVT_ESRI_USCITIES
A5A7RR6G.C7000004	DVT_MDDBCARS	/Shared Data/Cubes/DVT_MDDBCARS	DVT_MDDBCARS
A5A7RR6G.C7000007	ESRI_MoreHier	/Shared Data/Cubes/ESRI_MoreHier	ESRI_MoreHier
A5A7RR6G.C700000H	Finance_Excel	/Shared Data/GlobalEngineering/AUS/Cubes/Finance_Excel	Finance_Excel
A5A7RR6G.C700000S	FullySummarized	/OCS Testing/From SAX/FullySummarized	FullySummarized
A5A7RR6G.C700000D	IDPPProductSales	/SAS Projects/Portal/IDPPProductSales	IDPPProductSales
A5A7RR6G.C700001E	IDPStudentInformation	/SAS Projects/Portal/IDPStudentInformation	IDPStudentInformation
A5A7RR6G.C700000J	ITEM	/SAS Projects/Intelligent Query/Shared/Cubes/ITEM	ITEM
A5A7RR6G.C700000K	MAILORDERCUBE	/SAS Projects/Intelligent Query/Shared/Cubes/MAILORDERCUBE	MAILORDERCUBE
A5A7RR6G.C7000008	MDDBCARS	/Shared Data/Cubes/MDDBCARS	MDDBCARS
A5A7RR6G.C700000L	ORIONCUBE	/SAS Projects/Intelligent Query/Shared/Cubes/ORIONCUBE	ORIONCUBE

Figure 2. List of SAS Data Files Registered in the SAS Metadata Repository

With SAS 9.3, additional data collection and reports are provided on the Web Application servers that are run in conjunction with SAS Enterprise BI applications. In addition, more reports were added to the SAS Audit, Performance and Measurement package.

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SAS 9.3 Web Application Server Status Report: 01APR2011 23:36

Server Name	Hostname and Port	Status	Used Total Heap	Live Threads Total Started	Contents
RDCESX02066 - Jboss	rdcesx02066.race.sas.com:8080	Up	940349K / 2070976K	654 / 15288	Check
EMIX64S06 - WebSphere	emix64s06.na.sas.com:9080	Up	1344735K / 2097152K	388 / 2302	Check

SAS 9.3 Enterprise BI Server and Web Tier Status Report: 01APR2011:23:35

Monitoring	Server Name	Status	Port	Validated	
Mid-Tier	SASWebReportStudio	Running	8080	01APR2011:23:35:43.60	
	SASAdmin	Running	8080	01APR2011:23:35:44.04	
	SASBIDashboard	Running	8080	01APR2011:23:35:42.84	
	SASBIDashboardEventGen	Running	8080	01APR2011:23:35:42.75	
	SASContentServer	Running	8080	01APR2011:23:35:43.70	
	SASPortal	Running	8080	01APR2011:23:35:43.25	
	SASStoredProcess	Running	8080	01APR2011:23:35:43.73	
	SASWebDoc	Running	8080	01APR2011:23:35:42.68	
	Servers	Object Spawner - rdcesx02066	Running	8581	01APR2011:23:35:41.54
		SASApp - OLAP Server	Running	5451	01APR2011:23:35:42.12
SASApp - Stored Process Server		Running	8601	01APR2011:23:35:42.48	
SASMeta - Metadata Server		Running	8561	01APR2011:23:35:42.60	

SAS 9.3 Enterprise BI Server Reports

Report URL	Report Description
Audit Reports	
Administrators.html	Administrators
AccessControlChanges.html	Access Control Changes
AuthenticationError.html	Authentication Errors
MetadataClientActivity.html	Client Status: Active / Inactive Users
MetadataClientLoginUsage.html	Client Sessions: Login Details
MetadataGroupsRolesUsers.html	Metadata Groups, Roles, and Users
GroupChanges.html	Group Changes
LoginNotAuthorized.html	Login Not Authorized
UseridsAdded.html	Userids Added
UseridsRemoved.html	Userids Removed
Performance Reports	
ArtifactStats.html	Time Statistics for Artifact Usage
ArtifactUsageBusinessHours.html	Artifact Usage during Business Hours
CubeByUser.html	OLAP Cube Usage by User
CubeTopUsers.html	Top OLAP Cube Users
DataUsage.html	Most Heavily Used Datasets
DirectoryUsage.html	Most Heavily Used Directories
MetadataDuplication.html	Duplicate Metadata references for a directory
ProcUsage.html	SAS PROC Usage
ReportUsageTopTen.html	Top 10 Report Usage
ServerElapsedVsCPU.html	Server Comparison of Elapsed versus CPU Time
ServerUsageByUser.html	SAS Server Usage by SAS User
STPReportAveResponse.html	Stored Process Average Response Time
STPReportByDuration.html	Stored Process Consumption by Elapsed Time
UsageInventory_frame.html	Inventory of Metadata Artifacts
UserUsage.html	Artifact Usage by User
WorkspaceTopUsers.html	Top Workspace Users by Sessions
WorkspaceTopMemoryUsers.html	Top Workspace Users by Memory Usage
WorkspaceHourUsage.html	Workspace Server Usage by Hour

Figure 3. SAS 9.3 Additions to the SAS Audit, Performance and Measurement Package

Along with the report features of the SAS Audit, Performance and Measurement package, the SAS enhanced logging facility enables SAS and IT administrators to interact with the Windows Event Viewer, UNIX system logs, the z/OS system logger, third-party monitors, or the operator's console. Through these mechanisms, tracking thresholds can be set so that administrators are alerted when a computer resource is about to exceed its capacity or a crucial SAS server has become inactive.

SOME CASE STUDY EXAMPLES

The following are examples of key areas to monitor for SAS:

- IT administrators should monitor available disk space in the SAS WORK file system (Windows folder or UNIX directory) where the SAS WORK files are assigned. If this file system becomes full or unavailable, then all SAS sessions will terminate and no new SAS sessions can start until space is made available on the file system. Pre-assigned thresholds (for example, reaching 85% full) should be triggered for monitoring and management. Poor performance of SAS jobs has been exhibited when underlying file systems approach this capacity. In addition to affecting performance, the overhead of reading from and writing to highly utilized SAS WORK file systems with large I/O sizes can, in rare instances, cause SAS sessions to behave abnormally—anything from SAS servers failing to SAS jobs terminating prematurely.
- Another item to monitor is the SAS Metadata Server. If the SAS session that contains the metadata server instance becomes unresponsive or terminates, then all SAS Enterprise BI applications that are associated with the server will become unavailable. Monitoring this SAS session is important. The following example from HP's OpenView application reports an ALERT from an inactive SAS Metadata Server to inform the appropriate IT staff member on call that it has failed.

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Severity	Duplicates	S	U	I	A	O	N	Received	Service	Node	Application	Object	Text	Group
Normal	2	-	-	X	-	-	-	2/6/2007 5:41:09 PM	Services & Processes	wtp112	HP Open...	opcmo...	The policy WINO5SPI-DHCPCL_DHCP...	OpC
Normal	2	-	-	X	-	-	-	2/6/2007 5:41:09 PM	Services & Processes	wtp112	HP Open...	opcmo...	The policy WINO5SPI-SpoolerServic...	OpC
Normal	1	-	-	X	-	-	-	2/6/2007 5:41:14 PM	Services & Processes	wtp112	HP Open...	opcmo...	The policy WINO5SPI-MTS20_MSDT...	OpC
Normal	1	-	-	X	-	-	-	2/7/2007 4:23:31 PM	Services & Processes	wtp112	HP Open...	opclde ...	Illegal index: 11431810 (function csm...	OpC
Normal	1	-	-	-	-	-	-	2/15/2007 11:21:48 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server: Log file closing.	
Normal	1	-	-	-	-	-	-	2/15/2007 11:24:48 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server: Log file opened.	
Normal	1	-	-	-	-	-	-	2/15/2007 11:24:48 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server is up.	
Normal	1	-	-	-	-	-	-	2/16/2007 12:44:03 PM	Logical SAS Metadata ...	wtp112	SAS		Monitor SAS\$SPI_MetadataServerPin...	
Normal	5	-	-	-	-	-	-	2/16/2007 5:21:54 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	55	-	-	-	-	-	-	2/19/2007 11:22:03 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	12	-	-	-	-	-	-	2/19/2007 11:27:03 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	630	-	-	-	-	-	-	2/19/2007 2:17:03 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	1	-	-	-	-	-	-	2/19/2007 4:15:08 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server is operating su...	
Normal	1	-	-	-	-	-	-	2/20/2007 5:20:01 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	7	-	-	-	-	-	-	2/20/2007 5:48:01 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	3	-	-	-	-	-	-	2/20/2007 5:48:01 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	38	-	-	-	-	-	-	2/20/2007 6:57:59 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server: SAS Admin us...	
Normal	24	-	-	-	-	-	-	2/20/2007 6:58:01 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	14255	-	-	-	-	-	-	2/21/2007 1:59:01 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	1	-	-	-	-	-	-	3/17/2007 3:34:24 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server is operating su...	
Normal	7	-	-	-	-	-	-	3/19/2007 11:09:08 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Resume: a SAS Meta...	
Normal	31	-	-	-	-	-	-	3/28/2007 10:34:21 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	65	-	-	-	-	-	-	3/28/2007 11:10:21 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	109	-	-	-	-	-	-	4/2/2007 11:48:20 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server: SAS\$Trust use...	
Normal	35	-	-	-	-	-	-	4/2/2007 11:48:22 AM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	654	-	-	-	-	-	-	4/8/2007 10:09:23 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	7874	-	-	-	-	-	-	4/9/2007 12:37:23 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	3912	-	-	-	-	-	-	4/9/2007 12:37:23 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Normal	37457	-	-	-	-	-	-	4/9/2007 12:47:23 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server client connecti...	
Normal	10022	-	-	-	-	-	-	4/9/2007 12:44:22 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Server new client con...	
Critical	1	-	-	X	-	X	-	4/9/2007 12:46:57 PM	Logical SAS Metadata ...	wtp112	SAS	SAS Le...	Service "SAS Lev1 MS - HPOpenView...	
Minor	1	-	-	-	X	-	-	4/9/2007 12:47:19 PM	Logical SAS Metadata ...	wtp112	SAS		SAS Metadata Pause: a SAS Metada...	

Figure 4. HP OpenView Operations Console with Signal from SAS Metadata Server

The preceding examples show how SAS and IT administrators can monitor and manage SAS Enterprise BI applications. However, how can you monitor ad hoc and batch processes that are submitted by SAS users from outside the SAS Enterprise BI facility?

GATHERING DATA FROM SAS BATCH JOBS

The types of information described in the preceding sections can also be gathered from applications other than SAS Enterprise BI applications, such as ad hoc and batch processes. However, the collection of information from these processes requires that the logging facility be turned on globally for all SAS processes. This can be done by placing the appropriate SAS commands in a global AUTOEXEC.SAS file that is used by all SAS sessions. You simply add the logging facility autocall macros to the top of the ad hoc or batch SAS program code for each job. The MAUTOSOURCE system option must be set and the %LOG4SAS autocall macro must be invoked before any other logging facility autocall macros are invoked. Note that the MAUTOSOURCE system option is set by default. Placing this autocall macro within the job automatically creates the appropriate logging information.

If you want to track independent users separately from SAS Enterprise BI users, you can collect this information in a separate location. Given the power-user nature of independent ad hoc and batch jobs, it has been our experience that these jobs tend to use more computer resources than jobs submitted via SAS Enterprise Guide. A better understanding of this heavy component, including the number of processes executed (especially the unpredictable ad hoc ones) and their resource consumption, is crucial to capacity and performance management. Because the ad hoc job set can quickly grow out of control, in some cases it is important to identify individual users so that you can establish limits and curbs if needed.

Power-user, ad hoc, and batch jobs can overwhelm system resources and thereby affect SAS Enterprise BI applications, which tend to be more predictable in usage. Monitoring these jobs separately enables you to either institute appropriate resource constraints or provide additional resources where they are valued most.

GATHERING DATA FROM HARDWARE MONITORS

If you are looking to use the information in the preceding examples to gain a better understanding of utilization, capacity, and application performance, then additional information needs to be gathered from the computer system.

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To obtain a complete picture of what is running on your computer, you need to see what is happening from the computer system's perspective. This information can be derived easily from operating system hardware monitor tools. For example, Performance Monitor (PerfMon) from Microsoft creates a .csv file, and nmon from IBM has an analyzer that produces Excel spreadsheets. Both of these file formats are easily read into SAS data files.

SAS can also read data from iostat, vmstat, sar, mpstat, and other standard OS-provided kernel collectors to create SAS data files for all other operating systems.

All of these collectors include time stamps in the data. These time stamps make it easy to graph computer resource usage over time and identify "hotspots" within the computer resources.

All of these collectors can be scheduled to run for the duration (generally 24 hours), collecting data at the interval (generally every 5 minutes) that best matches the length of your average SAS session. This information can be analyzed periodically (every month or so) to determine if SAS application usage has increased and if the computer resources still have enough headroom to support this growth.

Here is an example of a graph produced with SAS using data from one of these hardware monitor data resources.

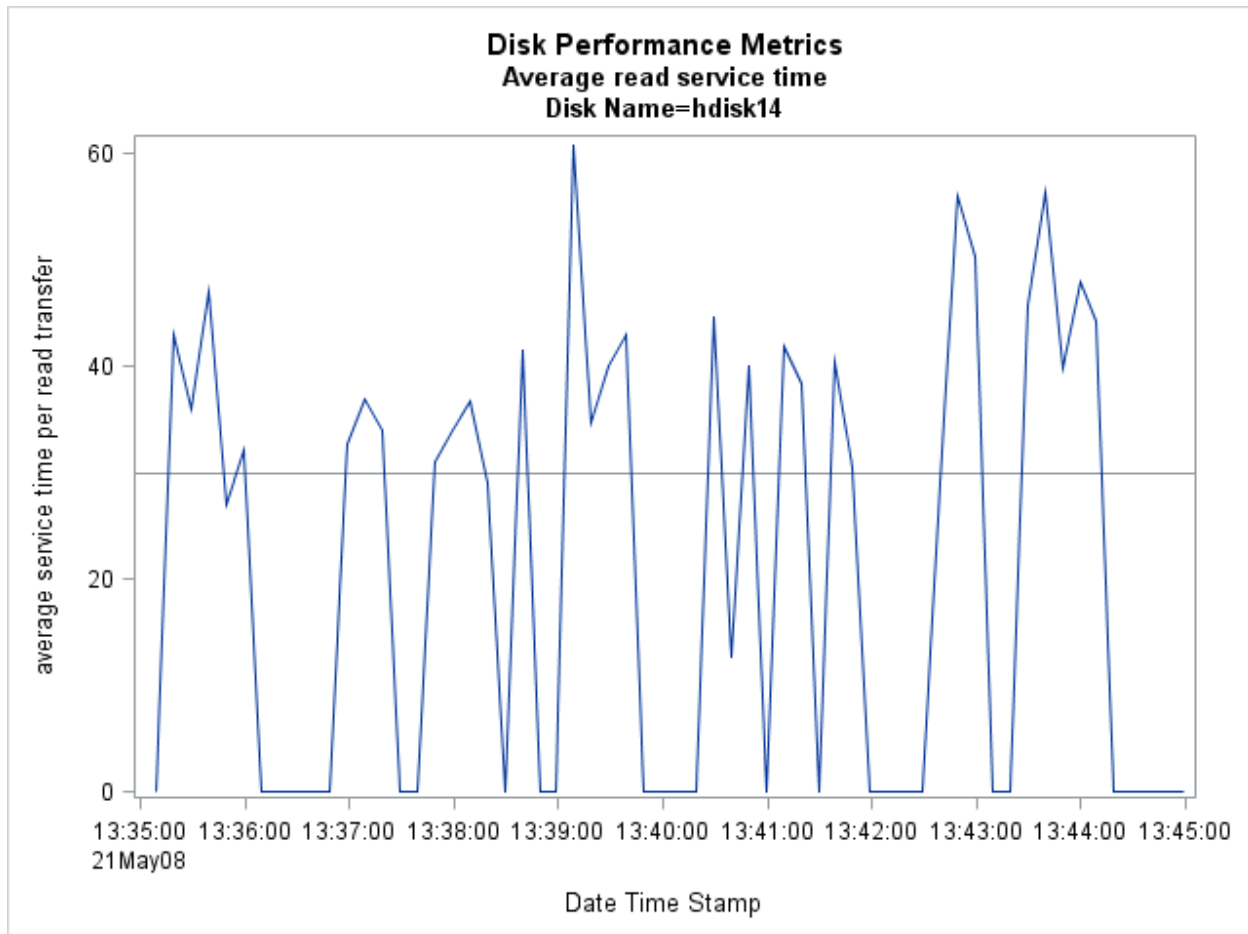


Figure 5. Graph of Average Service Times for Read Transfers from iostat

The preceding example includes a superimposed line that indicates the device maximum service time in milliseconds (30) that we feel should not be exceeded in a sustained fashion. As you can see, the maximum service time was exceeded many times during this short collection time. Because this particular collection was for a very short SAS job exhibiting I/O issues, the short collection period is relevant. For a longer job, we would need to expand the interval. Given the reported device service times, additional monitors must be examined to help determine why maximum service times are being exceeded.

MARRYING ALL THE DATA TOGETHER

Now that you have gathered all of the information about how SAS is being used, along with data from the various

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computer systems on which SAS is run, what can you do with this data? Here are some examples:

- **Peak Load Periods:** You can use the data management facilities within SAS to determine what was happening on your computer resources during peak load times. Generally, peak load times are those periods of time during which application users say that it takes longer for a typical SAS job to finish. Using data from the hardware monitor, you can determine if computer resources are consistently running close to capacity for long periods of time. Having the ability to query the list of SAS jobs running each day during these peak load periods will help you determine next steps.
- **Sluggish SAS Performance:** This can be determined by running a report that compares the real time of various SAS tasks to the combined user and system CPU times. If the delta between these is high (20% or higher), you can match the time stamps in the data gathered from SAS with time stamps in the data from your hardware monitors to see if any computer resources are exhibiting a bottleneck. Please note that there are times when a large delta between real time and combined user and system CPU times is expected. For example, this is expected when you use the SQL procedure to extract data from an external relational database (RDBMS). SAS does not accrue CPU time for the processing done by the RDBMS; it only accrues real time. Therefore, if the SQL statements that you have pushed into the RDBMS require it to do a lot of processing before returning the data to SAS, the real time will be significantly higher than the combined CPU time.
- **Excessive use of External Data Sources:** One of the SAS Audit, Performance and Measurement reports lists the SAS data files that are accessed most frequently by your SAS applications. If the report shows that these SAS data files are links to external RDBMS tables, you can work with the users of these SAS applications to determine how often they pull data from the external RDBMSs. In some customer cases, we have determined that the same 100+ GB of data from an external RDBMS is pulled multiple times each day by one or more SAS users. In one of these cases, we worked with the customer to create a local SAS data mart of this data each night on the back-end SAS compute server to avoid network bottlenecks during the business day.
- **Exceeding Computer Resource Thresholds:** In the various papers on SAS performance monitoring that have been presented at previous SAS Global Forums, lists of general thresholds have been provided that can be used as guidelines to determine if your computer resources are at or above capacity.

FOR WINDOWS, WE ARE FREQUENTLY SEEING ISSUES WITH REAL MEMORY BECOMING EXHAUSTED DURING SAS WORKLOADS. WHEN THIS HAPPENS THE SAS JOBS PERFORMANCE BEGINS TO STALL. THERE ARE SEVERAL HOT FIXES THAT NEED TO BE INSTALLED TO RESOLVE THIS ISSUE AND THESE ARE LISTED IN THE [CONFIGURATION AND TUNING GUIDELINES FOR SAS® 9 IN MICROSOFT WINDOWS SERVER 2008](#) PAPER. THIS IS AN EASY FIX THAT TENDS TO SHOW IMMEDIATE RESULTS.

Very useful capacity, utilization, and performance information can be uncovered and acted upon through the use of the SAS enhanced logging facility and the SAS Audit, Performance and Measurement package. Combining the data collected from these tools with the hardware monitor data from your computer system completes the package.

Some additional items of interest include the following:

- On Windows systems, many SAS users experience the exhaustion of real memory during the processing of SAS workloads. When this occurs, the SAS jobs and the entire Windows server become very slow. Several hot fixes need to be installed to resolve this issue. These are listed in the paper [Configuration and Tuning Guidelines for SAS® 9 in Microsoft Windows Server 2008](#). The fixes are easy to implement and generally resolve most issues with the performance of SAS on Windows.
- On AIX systems, quite a few AIX kernel parameters need to be set to ensure the best performance of SAS. All of these are settings are documented on the IBM Web site at <http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP101529>.
- If the capacity planning aspect of this paper is of interest to you, please note that SAS has a pre-built solution—[SAS IT Resource Management](#)—that does capacity planning for you.

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RECOMMENDED READING

- SAS® 9.2 Audit, Performance and Measurement <http://support.sas.com/rnd/emi/EbiApm92/index.html>
- *SAS® 9.2 Logging: Configuration and Programming Reference* <https://support.sas.com/pubscat/bookdetails.jsp?pc=61514>
- *SAS 9.2 Interface to Application Response Measurement (ARM): Reference* <https://support.sas.com/pubscat/bookdetails.jsp?pc=61526>

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