SYBASE®

Performance and Tuning Series: Monitoring Adaptive Server with sp_sysmon

Adaptive Server® Enterprise

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Contents

About This Book

Audience

This manual is intended for database administrators, database designers, developers and system administrators.

How to use this book

- Introduction to sp_sysmon – discusses how to use and invoke sp_sysmon
- Monitoring Performance with sp_sysmon – describes sp_sysmon output, including suggestions for interpreting sp_sysmon output and deducing possible implications

Related documents

The Adaptive Server® Enterprise documentation set consists of the following:

- The release bulletin for your platform – contains last-minute information that was too late to be included in the books.

  A more recent version of the release bulletin may be available on the World Wide Web. To check for critical product or document information that was added after the release of the product CD, use the Sybase Technical Library.
- The *Installation Guide* for your platform – describes installation, upgrade, and configuration procedures for all Adaptive Server and related Sybase products.
- *What's New in Adaptive Server Enterprise?* – describes the new features in Adaptive Server version 15.0, the system changes added to support those features, and changes that may affect your existing applications.
- *ASE Replicator User's Guide* – describes how to use the Adaptive Server Replicator feature of Adaptive Server to implement basic replication from a primary server to one or more remote Adaptive Servers.
- *Component Integration Services User's Guide* – explains how to use the Adaptive Server Component Integration Services feature to connect remote Sybase and non-Sybase databases.
- The *Configuration Guide* for your platform – provides instructions for performing specific configuration tasks for Adaptive Server.

- *Enhanced Full-Text Search Specialty Data Store User's Guide* – describes how to use the Full-Text Search feature with Verity to search Adaptive Server Enterprise data.
- *Glossary* – defines technical terms used in the Adaptive Server documentation.
- *Historical Server User's Guide* – describes how to use Historical Server to obtain performance information for SQL Server® and Adaptive Server.
- *Java in Adaptive Server Enterprise* – describes how to install and use Java classes as datatypes, functions, and stored procedures in the Adaptive Server database.
- *Job Scheduler User's Guide* – provides instructions on how to install and configure, and create and schedule jobs on a local or remote Adaptive Server using the command line or a graphical user interface (GUI).
- *Messaging Service User's Guide* – describes how to useReal Time Messaging Services to integrate TIBCO Java Message Service and IBM WebSphere MQ messaging services with all Adaptive Server database applications.
- *Monitor Client Library Programmer's Guide* – describes how to write Monitor Client Library applications that access Adaptive Server performance data.
- *Monitor Server User's Guide* – describes how to use Monitor Server to obtain performance statistics from SQL Server and Adaptive Server.
- *Performance and Tuning Series* – a series of books that explain how to tune Adaptive Server for maximum performance:
  - *Basics* – the basics for understanding and investigating performance questions in Adaptive Server.
  - *Locking and Concurrency Control* – describes how the various locking schemas can be used for improving performance in Adaptive Server, and how to select indexes to minimize concurrency.
  - *Query Processing and Abstract Plans* – describes how the optimizer processes queries and how abstract plans can be used to change some of the optimizer plans.
  - *Physical Database Tuning* – describes how to manage physical data placement, space allocated for data, and the temporary databases.
  - *Monitoring Adaptive Server with sp_sysmon* – describes how to monitor Adaptive Server's performance with sp_sysmon.

    - *Improving Performance with Statistical Analysis* – describes how Adaptive Server stores and displays statistics, and how to use the set statistics command to analyze server statistics.
    - *Using the Monitoring Tables* – describes how to query Adaptive Server's monitoring tables for statistical and diagnostic information.
- *Quick Reference Guide* – provides a comprehensive listing of the names and syntax for commands, functions, system procedures, extended system procedures, data types, and utilities in a pocket-sized book (regular size when viewed in PDF format).
- *Reference Manual* – is a series of four books that contains the following detailed Transact-SQL information:
    - *Building Blocks* – Transact-SQL datatypes, functions, global variables, expressions, identifiers and wildcards, and reserved words.
    - *Commands* – Transact-SQL commands.
    - *Procedures* – Transact-SQL system procedures, catalog stored procedures, system extended stored procedures, and dbcc stored procedures.
    - *Tables* – Transact-SQL system tables and dbcc tables.
- *System Administration Guide*
    - *Volume 1* – provides an introduction to the basics of system administration, including a description of configuration parameters, resource issues, character sets, sort orders, and diagnosing system problems. The second part of this book is an in-depth description of security administration.
    - *Volume 2* – includes instructions and guidelines for managing physical resources, mirroring devices, configuring memory and data caches, managing multiprocessor servers and user databases, mounting and unmounting databases, creating and using segments, using the reorg command, and checking database consistency. The second half of this book describes how to back up and restore system and user databases.
- *System Tables Diagram* – illustrates system tables and their entity relationships in a poster format. Full-size available only in print version; a compact version is available in PDF format.

- *Transact-SQL User's Guide* – documents Transact-SQL, the Sybase enhanced version of the relational database language. This manual serves as a textbook for beginning users of the database management system. This manual also contains descriptions of the pubs2 and pubs3 sample databases.
- *User Guide for Encrypted Columns* – describes how configure and use encrypted columns with Adaptive Server
- *Using Adaptive Server Distributed Transaction Management Features* – explains how to configure, use, and troubleshoot Adaptive Server DTM features in distributed transaction processing environments.
- *Using Sybase Failover in a High Availability System* – provides instructions for using Sybase Failover to configure an Adaptive Server as a companion server in a high availability system.
- *Unified Agent and Agent Management Console* – describes the Unified Agent, which provides runtime services to manage, monitor and control distributed Sybase resources.
- *Utility Guide* – documents the Adaptive Server utility programs, such as isql and bcp, which are executed at the operating system level.
- *Web Services User's Guide* – explains how to configure, use, and troubleshoot Web Services for Adaptive Server.
- *XA Interface Integration Guide for CICS, Encina, and TUXEDO* – provides instructions for using the Sybase DTM XA interface with X/Open XA transaction managers.
- *XML Services in Adaptive Server Enterprise* – describes the Sybase native XML processor and the Sybase Java-based XML support, introduces XML in the database, and documents the query and mapping functions that comprise XML Services.

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Use the Sybase Getting Started CD, the SyBooks CD, and the Sybase Product Manuals Web site to learn more about your product:

- The Getting Started CD contains release bulletins and installation guides in PDF format, and may also contain other documents or updated information not included on the SyBooks CD. It is included with your software. To read or print documents on the Getting Started CD, you need Adobe Acrobat Reader, which you can download at no charge from the Adobe Web site using a link provided on the CD.

- The SyBooks CD contains product manuals and is included with your software. The Eclipse-based SyBooks browser allows you to access the manuals in an easy-to-use, HTML-based format.

  Some documentation may be provided in PDF format, which you can access through the PDF directory on the SyBooks CD. To read or print the PDF files, you need Adobe Acrobat Reader.

  Refer to the *SyBooks Installation Guide* on the Getting Started CD, or the *README.txt* file on the SyBooks CD for instructions on installing and starting SyBooks.

- The Sybase Product Manuals Web site is an online version of the SyBooks CD that you can access using a standard Web browser. In addition to product manuals, you will find links to EBFs/Maintenance, Technical Documents, Case Management, Solved Cases, newsgroups, and the Sybase Developer Network.

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  3. Select a product.
  4. Specify a time frame and click Go. A list of EBF/Maintenance releases is displayed.

     Padlock icons indicate that you do not have download authorization for certain EBF/Maintenance releases because you are not registered as a Technical Support Contact. If you have not registered, but have valid information provided by your Sybase representative or through your support contract, click Edit Roles to add the "Technical Support Contact" role to your MySybase profile.
  5. Click the Info icon to display the EBF/Maintenance report, or click the product description to download the software.

Conventions

The following sections describe conventions used in this manual.

SQL is a free-form language. There are no rules about the number of words you can put on a line or where you must break a line. However, for readability, all examples and most syntax statements in this manual are formatted so that each clause of a statement begins on a new line. Clauses that have more than one part extend to additional lines, which are indented. Complex commands are formatted using modified Backus Naur Form (BNF) notation.

Table 1 shows the conventions for syntax statements that appear in this manual:

Table 1: Font and syntax conventions for this manual

Element	Example
Command names,procedure names, utility names, and other keywords display in sans serif font.	select sp_configure
Database names and datatypes are in sans serif font.	master database
Book names, file names, variables, and path names are in italics.	*System Administration Guide* *sql.ini* file *column_name* *$SYBASE/ASE* directory

Variables—or words that stand for values that you fill in—when they are part of a query or statement, are in italics in Courier font.	`select column_name`
	`from table_name`
	`where search_conditions`

Type parentheses as part of the command.	compute *row_aggregate* (*column_name*)
Double colon, equals sign indicates that the syntax is written in BNF notation. Do not type this symbol. Indicates “is defined as”.	`::=`
Curly braces mean that you must choose at least one of the enclosed options. Do not type the braces.	`{cash, check, credit}`
Brackets mean that to choose one or more of the enclosed options is optional. Do not type the brackets.	`[cash | check | credit]`
The comma means you may choose as many of the options shown as you want. Separate your choices with commas as part of the command.	`cash, check, credit`
The pipe or vertical bar(|) means you may select only one of the options shown.	`cash | check | credit`

An ellipsis (...) means that you can *repeat* the last unit as many times as you like.	`buy thing = price [cash | check | credit]`
	`[, thing = price [cash | check | credit]]...`
	You must buy at least one thing and give its price. You may choose a method of payment: one of the items enclosed in square brackets. You may also choose to buy additional things: as many of them as you like. For each thing you buy, give its name, its price, and (optionally) a method of payment.

- Syntax statements (displaying the syntax and all options for a command) appear as follows:

  sp_dropdevice [*device_name*]

  For a command with more options:

  select *column_name*
  from *table_name*
  where *search_conditions*

In syntax statements, keywords (commands) are in normal font and identifiers are in lowercase. Italic font shows user-supplied words.

- Examples showing the use of Transact-SQL commands are printed like this:

```
select * from publishers
```

- Examples of output from the computer appear as follows:

```
pub_id    pub_name                city          state
------    --------------------    -----------   -----
0736      New Age Books           Boston        MA
0877      Binnet & Hardley        Washington    DC
1389      Algodata Infosystems    Berkeley      CA

(3 rows affected)
```

In this manual, most of the examples are in lowercase. However, you can disregard case when typing Transact-SQL keywords. For example, SELECT, Select, and select are the same.

Adaptive Server's sensitivity to the case of database objects, such as table names, depends on the sort order installed on Adaptive Server. You can change case sensitivity for single-byte character sets by reconfiguring the Adaptive Server sort order. For more information, see the *System Administration Guide*.

Accessibility features

This document is available in an HTML version that is specialized for accessibility. You can navigate the HTML with an adaptive technology such as a screen reader, or view it with a screen enlarger.

Adaptive Server HTML documentation has been tested for compliance with U.S. government Section 508 Accessibility requirements. Documents that comply with Section 508 generally also meet non-U.S. accessibility guidelines, such as the World Wide Web Consortium (W3C) guidelines for Web sites.

Note You might need to configure your accessibility tool for optimal use. Some screen readers pronounce text based on its case; for example, they pronounce ALL UPPERCASE TEXT as initials, and MixedCase Text as words. You might find it helpful to configure your tool to announce syntax conventions. Consult the documentation for your tool.

For information about how Sybase supports accessibility, see Sybase Accessibility at http://www.sybase.com/accessibility. The Sybase Accessibility site includes links to information on Section 508 and W3C standards.

If you need help

Each Sybase installation that has purchased a support contract has one or more designated people who are authorized to contact Sybase Technical Support. If you cannot resolve a problem using the manuals or online help, please have the designated person contact Sybase Technical Support or the Sybase subsidiary in your area.

CHAPTER 1

Introduction to sp_sysmon

This chapter discusses how to use and invoke sp_sysmon.

Using sp_sysmon

sp_sysmon provides a detailed report of the activity on your system, and provides you with a number of ways to specify the type of information you want to receive, the time interval during which data for the report will be collected, and other options that determine how the report is generated.

The sp_sysmon report consists of a number of separate sections. You can run sp_sysmon to generate the complete report or only one of the individual sections. You can also specify a time interval over which the report should run or execute the stored procedure yourself at the beginning and end of the desired time period.

sp_sysmon reports monitoring data only from the sample period. Make sure you make decisions about tuning based on representative data. For example, to tune spinlocks, base decisions on data from a peak utilization report. However, base a decision to decrease the number of engines on a number of samples representing typical and peak workloads.

The data for the report is collected from a set of monitor counters that are maintained by Adaptive Server. These counters are also used by other applications such as Monitor Server. By default, the sp_sysmon report clears these counters when it is invoked. Clearing the counters can interfere with other applications using the counters, causing the data they report to be invalid.

Warning! To control whether sp_sysmon clears the counters, specify the `noclear` option. When you specify the `noclear` option, sp_sysmon does not clear the counters, which allows sp_sysmon to run at the same time as Monitor Server and other sp_sysmon sessions. By default, noclear is enabled when you run sp_sysmon using a sample interval, and disabled when you run sp_sysmon using the *begin_* and *end_sample* parameters. See "Using the noclear option" on page 7 for more information.

sp_sysmon contributes approximately 5 to 7% overhead while it runs on a single CPU server, and more on multiprocessor servers (the percentages may be different for your site). The amount of overhead increases with the number of CPUs.sp_sysmon `noclear` and Monitor Server use the same internal counters. When not run with the option, sp_sysmon resets these counters to 0, producing erroneous output for Monitor Server when it is used with sp_sysmon.

There are counters shared between sp_sysmon and the monitoring tables. Starting a second execution of sp_sysmon while an earlier execution is running can clear all the counters, so the reports generated by the first sp_sysmon session are inaccurate.

For information on running sp_sysmon with other applications see "Using the noclear option" on page 7.

The performance tuning tips for sp_sysmon are based on the sampling interval you supply with sp_sysmon. Review the recommendations thoroughly, based on your system requirements, before you incorporate them in your production system. Sybase strongly recommends that you set up a test area with your data, and test any changes before you implement any of the recommendations.

Since sp_sysmon provides a snapshot view of the system, you may need to reconsider recommendations when the workload changes.

Note You cannot run sp_sysmon on an Adaptive Server with a tempdb that is the default size. Increase the size of tempdb by at least 2MB so that Adaptive Server does not run out of log space on the temporary databases.

When to run sp_sysmon

You can run sp_sysmon before and after tuning Adaptive Server configuration parameters to gather data for comparison. This data gives you a basis for performance tuning and lets you observe the results of configuration changes.

Use sp_sysmon when the system exhibits behavior you want to investigate. For example, to find out how the system behaves under typically loaded conditions, run sp_sysmon when conditions are normal and typically loaded. For example, consider whether it makes sense to run sp_sysmon for 10 minutes starting at 7:00 p.m., which is before batch jobs begin and after most of the day's OLTP users have left the site. Instead, run sp_sysmon during the normal OLTP load and during batch jobs.

In many tests, it is best to start the applications first, and start sp_sysmon when the caches are likely to have reached a steady state. If you are trying to measure capacity, be sure that the amount of work you give the server keeps it busy for the duration of the test.

Many of the statistics, especially those that measure data per second, can look extremely low if the server is idle during part of the sample interval.

In general, sp_sysmon produces valuable information when you use it:

- Before and after cache or pool configuration changes
- Before and after any sp_configure changes that may effect performance (for example, changes to memory sizes, caches, or disk I/O related options)
- Before and after the addition of new queries to your application mix
- Before and after an increase or decrease in the number of Adaptive Server engines
- When adding new disk devices and assigning objects
- During peak periods, to look for contention or bottlenecks
- During stress tests, to evaluate an Adaptive Server configuration for a maximum expected application load
- When performance seems slow or behaves abnormally

You may also find sp_sysmon to be helpful during query or application development. For example, when you are:

- Working with indexes and updates to see if certain updates reported as deferred_varcol are resulting in direct versus deferred updates

- Checking the caching behavior of particular queries or a mix of queries
- Tuning the parameters and cache configuration for parallel index creation

Invoking sp_sysmon

Use sp_sysmon:

- With a fixed time interval to provide a sample for a specified number of minutes
- With the begin_sample and end_sample parameters to start and stop sampling

You can also tailor the output to provide the information you need:

- You can print the entire report.
- You can print just one section of the report, such as “Cache Management” or “Lock Management.”

Note The Cache Wizard section is a special section of the report. You need to specify the section for Cache Wizard to get output on it. See “Sample output” on page 23.

- You can include application-level detailed reporting for named applications (such as isql, bcp, or any named application) and for combinations of named applications and user names. The default is to omit this section.

Fixed time intervals

To invoke sp_sysmon, use isql to execute:

```
sp_sysmon interval [, section  [, applmon]]
```

interval must be in the form “hh:mm:ss”. For example, to run sp_sysmon for 10 minutes, use:

```
sp_sysmon "00:10:00"
```

To print only the “Data Cache Management” section of the report, use:

```
sp_sysmon "00:10:00", dcache
```

For information on the *applmon* parameter, see "Specifying the application detail parameter" on page 6.

Using *begin_sample* and *end_sample*

Use the begin_sample and end_sample parameters to invoke sp_sysmon to start sampling, issue queries, and end the sample and print the results at any point in time. For example:

```
sp_sysmon begin_sample
execute proc1
execute proc2
select sum(total_sales) from titles
sp_sysmon end_sample
```

Note On systems with many CPUs and high activity, counters can overflow if the sample period is too long.

If you see results that include negative numbers in sp_sysmon output, reduce the sample time.

Specifying report sections for output

To print a single section of the report, use one of the values listed in Table 1-1 for the *section* parameter.

Table 1-1: sp_sysmon report sections

Report section	Parameter
Application Management	appmgmt
Cache Wizard	cache wizard
Data Cache Management	dcache
Disk I/O Management	diskio
ESP Management	esp
Housekeeper Task Activity	housekeeper
Index Management	indexmgmt
Kernel Utilization	kernel
Lock Management	locks
Memory Management	memory
Metadata Cache Management	mdcache*
Monitor Access to Executing SQL	monaccess
Network I/O Management	netio
Parallel Query Management	parallel
Procedure Cache Management	pcache
Recovery Management	recovery
RepAgent	repagent
Task Management	taskmgmt
Transaction Management	xactmgmt
Transaction Profile	xactsum
Worker Process Management	wpm

You can also obtain most of the information available through sp_sysmon_mdcache using sp_monitorconfig.

Specifying the application detail parameter

If you specify the *applmon* parameter to sp_sysmon, the report includes detailed information by application or by application and login name. This parameter is valid only when you print the entire report or when you specify appmgmt for the section parameter. If you specify the application detail parameter and request any other section of the report, the application detail parameter is ignored.

The third parameter must be one of the following:

Parameter	Information reported
appl_only	CPU, I/O, priority changes, and resource limit violations by application name.
appl_and_login	CPU, I/O, priority changes, and resource limit violations by application name and login name. Can be used with all sections.
no_appl	Skips the application and login section of the report. This is the default.

This example runs sp_sysmon for 5 minutes and prints the "Application Management" section, including the application and login detail report:

```
sp_sysmon "00:05:00", appmgmt, appl_and_login
```

See "Per Application Or Per Application And Login" on page 48 for sample output.

Using the *noclear* option

By default, sp_sysmon does not clear the monitor counters that are used as source data for the report. If other applications or instances of the sp_sysmon report are running when this is done, clearing the counters may cause the data that they report to be invalid.

Use the optional noclear parameter with sp_sysmon to not clear the monitor counters. For example:

sp_sysmon "00:15:00", noclear

This example runs the sp_sysmon report for a 15-minute sample interval without clearing the monitor counters. You can use the value of `noclear` for any of these parameters which lets you specify noclear in combination with other parameter values:

```
@section
@applmon
@filter
@dumpcounters
```

For example, to create the report for kernel resource use while using the `noclear` option, issue:

sp_sysmon "00:15:00", kernel, noclear

When you run sp_sysmon with the `noclear` option, you may detect a slight increase in the amount of I/O activity at the beginning of the sample period. The report must create a temporary table in which to store initial counter values. The impact of this activity on the data reported by sp_sysmon should be negligible on any but the most quiescent systems.

Because Monitor Server uses the same monitor counters that the sp_sysmon report does, Sybase recommends that you use the `noclear` option when running sp_sysmon at the same time that Monitor Server is running. You can also run multiple concurrent sessions of sp_sysmon reports by using the `noclear` option. Consider whether other system monitoring applications that you are running use the monitor counters. If they do, use the `noclear` option when running sp_sysmon.

When you execute sp_sysmon 'end_sample' from a session that is different from the one on which you executed 'begin_sample', sp_sysmon does not decrement the monitor counters and Adaptive Server returns error message number 19374 to the client. This means that, if an application enables the monitor counters and does not disable them before logging out, the usage count continues to reflect the same number of users as it did before the application logged out.

Redirecting output to a file

A full sp_sysmon report contains hundreds of lines of output. Use isql input and output redirect flags to save the output to a file.

See *Utility Programs Guide* for more information on isql.

CHAPTER 2

Monitoring Performance with *sp_sysmon*

This chapter describes sp_sysmon output, including suggestions for interpreting sp_sysmon output and deducing possible implications.

sp_sysmon output is most valuable when you understand your Adaptive Server environment and its applications.

How to use the reports

sp_sysmon can give you information about Adaptive Server system behavior before and after tuning. Study the entire report to understand the full impact of the changes you make. Sometimes removing one performance bottleneck reveals another. Similarly, tuning efforts might improve performance in one area while actually causing performance degradation in another area.

In addition to pointing out areas for tuning work, sp_sysmon output is valuable in determining when further tuning will not pay off in additional performance gains. It is just as important to know when to stop tuning Adaptive Server, or when the problem resides elsewhere, as it is to know what to tune.

A single sp_sysmon run presents resource utilization during the specific time interval. Make sure that the time intervals you use clearly represent the workload and situation for which you are tuning Adaptive Server.

Other information can contribute to interpreting sp_sysmon output:

- Information on the configuration parameters in use, from sp_configure or the configuration file
- Information on the cache configuration and cache bindings, from sp_cacheconfig and sp_helpcache
- Information on disk devices, segments, and the objects stored on them

Reading output

sp_sysmon displays performance statistics in a consistent tabular format. For example, in an SMP environment running 7 Adaptive Server engines, the output typically looks like this:

```
Engine Busy Utilization          CPU Busy   I/O Busy         Idle
------------------------         --------   --------     --------
Engine 0                           68.7 %      2.5 %       28.8 %
Engine 1                           61.9 %      3.3 %       34.8 %
Engine 2                           67.0 %      2.4 %       30.6 %
Engine 3                           69.0 %      3.8 %       27.2 %
Engine 4                           60.2 %      2.7 %       37.2 %
Engine 5                           55.7 %      3.2 %       41.1 %
Engine 6                           53.8 %      3.2 %       43.0 %
------------------------         --------   --------     --------
Summary          Total            436.3 %     21.1 %      242.6 %
Average                            62.3 %      3.0 %       34.7 %
```

Rows

Most rows represent a specific type of activity or event, such as acquiring a lock or executing a stored procedure. When the data is related to CPUs, the rows show performance information for each Adaptive Server engine in the SMP environment. Often, when there are groups of related rows, the last row is a summary of totals and an average.

The sp_sysmon report indents some rows to show that one category is a subcategory of another. In the following example, "Found in Wash" is a subcategory of "Cache Hits", which is a subcategory of "Cache Searches":

```
Cache Searches                per sec        per xact     count    % of total
                          ----------      ---------   -------    ---------
   Cache Hits                32731.6      153429.6     9819492      100.0 %
     Found in Wash             288.4        1351.7       86508        0.9 %
Cache Misses                    10.9          50.9        3257        0.0 %
--------------------      ------------     ---------   ---------
Total Cache Searches          32742.5      153480.5     9822749
```

Many rows are not printed when the "count" value is 0.

Columns in output

Unless otherwise stated in this chapter, the columns in the examples in this chapter represent these performance statistics:

- "per sec"– average per second during sampling interval.
- "per xact" – average per committed transaction during sampling interval.
- "count" – total number during the sample interval.
- "% of total" – varies, depending on context, as explained for each occurrence.

Interpreting the data

When tuning Adaptive Server, the fundamental measures of success appear as increases in throughput and reductions in application response time. Unfortunately, tuning Adaptive Server cannot be reduced to printing these two values.

In most cases, your tuning efforts must take an iterative approach, involving a comprehensive overview of Adaptive Server activity, careful tuning and analysis of queries and applications, and monitoring locking and access on an object-by-object basis.

Per-second and per-transaction data

Weigh the importance of per second and per transaction data on the environment and the category you are measuring. The per transaction data is generally more meaningful in benchmarks or in test environments where the workload is well defined.

It is likely that you will find per transaction data more meaningful for comparing test data than per second data alone because, in a benchmark test environment, there is usually a well-defined number of transactions, making comparison straightforward. Per transaction data is also useful for determining the validity of percentage results.

You may find it more useful to look at the per-second averages when you analyze workloads involving a large number of queries not executed inside a transaction (for example, select statements). The per-second analysis allows you to compare the tuning that affects these queries.

Percent of total and count data

The meaning of the "% of total" data varies, depending on the context of the event and the totals for the category. When interpreting percentages, keep in mind that they are often useful for understanding general trends, but can be misleading when taken in isolation.

For example, 50% of 200 events is much more meaningful than 50% of 2 events.

The "count" data is the total number of events that occurred during the sample interval. You can use count data to determine the validity of percentage results.

Per engine data

In most cases, per engine data for a category shows a fairly even balance of activity across all engines. Two exceptions are:

- If you have fewer processes than CPUs, some of the engines will show no activity.

- If most processes are performing fairly uniform activity, such as simple inserts and short selects, and one process performs some I/O-intensive operation such as a large bulk copy, you will see unbalanced network and disk I/O.

Total or summary data

Summary rows provide an overview of Adaptive Server engine activity by reporting totals and averages.

Be careful when interpreting averages because they can give false impressions of true results when the data is skewed. For example, if one Adaptive Server engine is working 98% of the time and another is working 2% of the time, a 49% average is misleading.

Sample interval and time reporting

The heading of an sp_sysmon report includes the software version, server name, run date, the date and time the sample interval started, the time it completed, and the duration of the sample interval.

```
===============================================================================
Sybase Adaptive Server Enterprise System Performance Report
===============================================================================
Server Version:       Adaptive Server Enterprise/12.5.3/EBF 12868 ESD#4/P/Sun_
Server Name:           SYB5D3B
Run Date:              May 15, 2008
Sampling Started at:   May 15, 2008 12:20:05
Sampling Ended at:     May 15, 2008 12:23:33
Sample Interval:       00:03:28
Sample Mode:           No Clear
Counters Last Cleared: May 11, 2008 08:09:20
===============================================================================
```

Kernel Utilization

"Kernel Utilization" reports Adaptive Server activities. It tells you how busy Adaptive Server engines were during the time the CPU was available to Adaptive Server, how often the CPU yielded to the operating system, the number of times that the engines checked for network and disk I/O, and the average number of I/Os the engines found waiting at each check.

Sample output

The following sample shows sp_sysmon output for "Kernel Utilization" in an environment with eight Adaptive Server engines.

```
Kernel Utilization
------------------

Your Runnable Process Search Count is set to 2000
and I/O Polling Process Count is set to 10

Engine Busy Utilization       CPU Busy    I/O Busy      Idle
------------------------      --------    --------  --------
Engine 0                         3.3 %      13.7 %     83.0 %
Engine 1                         2.4 %       9.2 %     88.4 %
Engine 2                         4.9 %      19.9 %     75.2 %
Engine 3                          .8 %      19.1 %     76.1 %
Engine 4                         2.8 %       7.0 %     90.2 %
Engine 5                         1.9 %       7.3 %     90.8 %
Engine 6                         2.5 %       7.6 %     89.9 %
Engine 7                         2.0 %       8.1 %     89.9 %
------------------------      --------    --------   --------
Summary              Total      24.6 %      91.9 %    683.5 %
Average                          3.1 %      11.5 %     85.4 %

CPU Yields by Engine           per sec      per xact       count   % of total
-------------------------  -----------   -----------   ---------   ---------
Engine 0                          31.5           0.0        2802      11.6 %
Engine 1                          38.1           0.0        3388      14.0 %
Engine 2                          21.8           0.0        1936       8.0 %
Engine 3                          30.2           0.0        2689      11.1 %
Engine 4                          37.9           0.0        3372      13.9 %
Engine 5                          38.4           0.0        3421      14.1 %
Engine 6                          36.1           0.0        3217      13.3 %
Engine 7                          38.4           0.0        3420      14.1 %
-------------------------   ----------   -----------    --------
```

```
Total CPU Yields                272.4           0.2       24245

Network Checks
Non-Blocking                 434722.4         366.8    38690292       99.9 %
Blocking                        272.4           0.2       24247        0.1 %
-------------------------   ----------   -----------    --------
Total Network I/O Checks     434994.8         367.1    38714539
Avg Net I/Os per Check            n/a           n/a     0.00003         n/a

Disk I/O Checks
Total Disk I/O Checks        435855.6         367.8    38791149         n/a
Checks Returning I/O         125358.1         105.8    11156875      28.8 %
Avg Disk I/Os Returned            n/a           n/a      0.00313         n/a
```

Engine Busy Utilization

"Engine Busy Utilization" reports the percentage of time the Adaptive Server kernel is busy executing tasks on each Adaptive Server engine (rather than time spent idle). The summary row gives the total and the average active time for all engines combined.

The values reported on the Engine Busy Utilization report may differ from the CPU usage values reported by operating system tools. When Adaptive Server has no tasks to process, it enters a loop that regularly checks for network I/O, completed disk I/Os, and tasks in the run queue.

One measurement that cannot be made from inside Adaptive Server is the percentage of time that Adaptive Server had control of the CPU versus the time the CPU was in use by the operating system. The operating system provides CPU time to Adaptive Server. sp_sysmon reports how Adaptive Server uses the time the operating system provides. You should always use sp_sysmon in conjunction with the operating system's monitoring tools to get readings for both systems.

Check your operating system documentation for the correct commands.

To reduce the time that Adaptive Server spends checking for I/O while idle, lower the sp_configure parameter runnable process search count. This parameter specifies the number of times an Adaptive Server engine loops looking for a runnable task before yielding the CPU. However, decreasing the value for runnable process search count can increase latency, decreasing performance.

"Engine Busy Utilization" measures how busy Adaptive Server engines were during the CPU time they were given. If the engine is available to Adaptive Server for 80% of a 10-minute sample interval, and "Engine Busy Utilization" was 90%, it means that Adaptive Server was busy for 7 minutes and 12 seconds and was idle for 48 seconds.

When sp_sysmon samples the counters (by default, every 100 milliseconds), each engine indicates what it is currently doing. For example, if it is executing a task, it reports that it is `"CPU Busy,"`; if it is idling, it reports that it is `"Idle"`; if it is idling and has at least one pending asynchronous disk IO, it reports `"IO Busy."`

"Engine Busy Utilization" can help you decide whether there are too many or too few Adaptive Server engines. Adaptive Server high scalability is due to tunable mechanisms that avoid resource contention.

By checking sp_sysmon output for problems and tuning to alleviate contention, response time can remain high even at "Engine Busy" values in the 80 to 90% range. If values are consistently very high (more than 90%), it is likely that response time and throughput could benefit from an additional engine.

The "Engine Busy Utilization" values are averages over the sample interval, so very high averages indicate that engines may be 80% busy during part of the interval. Spinlock contention increases CPU usage, and should be checked if the server experiences high CPU utilization. In-memory table scans also increase CPU usage, which you can decrease by tuning queries appropriately.

When engine utilization is extremely high, the housekeeper wash task writes few or no pages out to disk (since it runs only during idle CPU cycles.) This means that a checkpoint finds many pages that need to be written to disk, and the checkpoint process, a large batch job, or a database dump is likely to send CPU usage to 100% for a period of time, causing a perceptible dip in response time.

If the "Engine Busy Utilization" percentages are consistently high, and you want to improve response time and throughput by adding Adaptive Server engines, check for increased resource contention in other areas after adding each engine.

In an environment where Adaptive Server is serving a large number of users, performance is usually fairly evenly distributed across engines. However, when there are more engines than tasks, you may see some engines with a large percentage of utilization, and other engines may be idle. For example:

```
Engine Busy Utilization          CPU Busy       I/O Busy        Idle
------------------------         ---------       -------     --------
Engine 0                            68.7 %           2.5 %     28.8 %
```

```
Engine 1                              61.9 %          3.3 %      34.8 %
Engine 2                              67.0 %          2.4 %      30.6 %
Engine 3                              69.0 %          3.8 %      27.2 %
Engine 4                              60.2 %          2.7 %      37.2 %
Engine 5                              55.7 %          3.2 %      41.1 %
Engine 6                              53.8 %          3.2 %      43.0 %
------------------------            --------        --------   --------
Summary                  Total       436.3 %         21.1 %     242.6 %
Average                               62.3 %          3.0 %      34.7 %
```

In an SMP environment, tasks have soft affinity to engines. Without other activity (such as lock contention) that could cause a task to be placed in the global run cue, the task continues to run on the same engine.

CPU Yields by Engine

"CPU Yields by Engine" reports the number of times each Adaptive Server engine yielded to the operating system. "% of total" data is the percentage of times an engine yielded as a percentage of the combined yields for all engines.

"Total CPU Yields" reports the combined data over all engines. However, an engine with one or more pending asynchronous disk IOs does not yield, even when runnable process search count is exhausted.

If the "Engine Busy Utilization" data indicates low engine utilization, use "CPU Yields by Engine" to determine whether the "Engine Busy Utilization" data reflects a truly inactive engine or one that is frequently starved out of the CPU by the operating system.

When an engine is not busy, it yields to the CPU after a period of time related to the runnable process search count parameter. A high value for "CPU Yields by Engine" indicates that the engine yielded voluntarily.

- Engine Busy Low/CPU Yields Low – a higher value for the I/O Busy% column than for the CPU Busy% column indicates a large amount of pending I/O. Look for changes you can make at the operating system level to solve bottlenecks in I/O processing. If the Adaptive Server system CPU time is too high (based on operating system output), decrease the value for runnable process search count.
- Engine Busy Low/CPU Yields High – engine is inactive.
- Engine Busy High/CPU Yields Low – Adaptive Server is very busy and has jobs to run. Adding engines will probably help performance.

- Engine Busy High/CPU Yields High – this should be the case when a normal number of user connections running simple queries. It is likely that lowering runnable process search count will have little or no effect. Adding engines is also unlikely to help, unless ‘Engine Busy Utilization” is very high.

For more information about configuration parameters, see Chapter 5, “Setting Configuration Parameters,” in the *System Administration Guide, Volume 1*.

```
CPU Yields by Engine            per sec      per xact      count   % of total
------------------------   ------------   -----------   --------    ---------
Engine 0                          73.5           1.8      44087      26.2 %
Engine 1                          40.4           1.0      24224      14.4 %
Engine 2                          23.7           0.6      14208       8.4 %
Engine 3                          36.2           0.9      21746      12.9 %
Engine 4                          38.7           1.0      23207      13.8 %
Engine 5                          41.3           1.0      24760      14.7 %
Engine 6                          26.8           0.7      16108       9.6 %
----------------------     ------------    ----------   --------
Total CPU Yields                 280.6           6.9     168340
```

Network Checks

“Network Checks” includes information about blocking and non-blocking network I/O checks, the total number of I/O checks for the interval, and the average number of network I/Os per network check.

Adaptive Server has two ways to check for network I/O: blocking and non-blocking modes.

```
Network Checks
Non-Blocking                166371.5        4098.3    99822899      99.8 %
Blocking                       279.0           6.9      167388       0.2 %
-------------------------   ---------      --------   ---------
Total Network I/O Checks    166650.5        4105.2    99990287
Avg Net I/Os per Check           n/a           n/a     0.00476        n/a
```

Non-Blocking

“Non-Blocking” reports the number of times Adaptive Server performed non-blocking network checks. With non-blocking network I/O checks, an engine checks the network for I/O and continues processing, whether or not it found I/O waiting (this is how an engine typically checks for network I/O.)

Blocking

"Blocking" reports the number of times Adaptive Server performed blocking network checks. This is how an engine yields CPU to the operating system, and should be equal to the number of yields (it may differ because of timing issues).

After an engine completes all runnable tasks in the queue, the engine loops for a short time, polling the network and checking for the next client request. If after a certain number of loops (determined by the sp_configure parameter, runnable process search count) the engine finds no runnable tasks, and there is no pending asynchronous disk I/O, the engine performs a blocking network I/O poll, yielding its CPU to the operating system. At this point, the engine is said to be sleeping.

A sleeping engine wakes up once per clock tick to perform routine housekeeping tasks and check for runnable tasks. If there are no runnable tasks, the engine performs another blocking network check and goes back to sleep.

Adaptive Server may wake a sleeping engine before the next clock tick if a different engine completes some network I/O. Once awake, the engine performs post-processing I/O work, typically resulting in a task becoming runnable (this task is unlikely to yield again until the I/O work has been processed).

Total Network I/O Checks

"Total Network I/O Checks" reports the number of times an engine polls for incoming and outgoing packets. This category is helpful when you use it with "CPU Yields by Engine."

When an engine is idle, it loops while checking for network packets. If "Network Checks" is low and "CPU Yields by Engine" is high, the engine could be yielding too often and not checking the network frequently enough. If the system can afford the overhead, it might be acceptable to yield less often.

An engine loops the number of times you have defined with runnable process search count times before yielding (unless the engine has at least one pending disk I/O). Consequently, an engine that yields too often may indicate that performance is suffering because runnable process search count is set too low.

Average Network I/Os per Check

"Avg Net I/Os per Check" reports the average number of network I/Os (sends and receives) per check for all Adaptive Server engine checks that took place during the sample interval.

The sp_configure parameter i/o polling process count specifies the maximum number of processes that Adaptive Server runs before the scheduler checks for disk and network I/O completions. Tuning i/o polling process count affects both the response time and throughput of Adaptive Server.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

If Adaptive Server engines check frequently, but retrieve network I/O infrequently, you can try reducing the frequency for network I/O checking.

Disk I/O Checks

"Disk I/O Checks" reports the total number of disk I/O checks and the number of checks returning I/O.

```
Disk I/O Checks
Total Disk I/O Checks        171839.7        4233.0    103103833      n/a
Checks Returning I/O          31783.1         782.9     19069887   18.5 %
Avg Disk I/Os Returned             n/a           n/a       0.01722      n/a
```

- `Checks Returning I/O` – number of actual checks.
- `Avg Disk I/Os Returned` – percentage of `Checks Returning I/O` that resulted in one or more completed IOs.

Total Disk I/O Checks

"Total Disk I/O Checks" reports the number of times engines entered a routine to check for disk I/O. The io polling process count configuration parameter controls the frequency of this check.

When a task needs to perform I/O, the Adaptive Server engine running the task immediately issues an I/O request and puts the task to sleep, waiting for the I/O to complete. The engine may process other tasks, but continues to check for completed I/Os. When the engine finds completed I/Os, it moves the task from the sleep queue to the run queue.

Checks Returning I/O

"Checks Returning I/O" reports the number of times an I/O was outstanding when the disk check routine was entered.

Adaptive Server engines poll for network I/O when the value for `"io polling process count"` tasks have been run within one tick of the server or during the `"idle loops"`. However, the engine does not poll for Disk IO unless there is at least one pending Disk IO. `"Checks Returning IO"` indicates the number of times the engine intends to check for a disk IO and the number of times Adaptive Server intended to check and there was at least one pending disk IO.

For example, if an engine checks for expected I/O 100,000 times, this average indicates the percentage of time that there actually was I/O pending. If, of those 100,000 checks, I/O was completed 10,000 times, then 10% of the checks were effective, and the other 90% were overhead.

However, you should also check the average number of I/Os returned per check, and how busy the engines were during the sample interval. If the sample includes idle time, or the I/O traffic is sporadic, it is possible that a high percentage of the checks were returning I/O during the busy period.

If the results in this category seem low or high, you can configure i/o polling process count to increase or decrease the frequency of the checks.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Average Disk I/Os Returned

"Average disk I/Os returned" reports the percentage of "Checks Returning I/O" that result in one or more completed I/Os.

Increasing the amount of time that Adaptive Server engines wait between checks may result in better throughput because Adaptive Server engines can spend more time processing if they spend less time checking for I/O. However, you should verify this for your environment. If the value for I/O Busy% is high, then Adaptive Server should perform more frequent checks to pick up I/Os as soon as they are completed. The i/o polling process count configuration parameter controls how often Adaptive Server performs this check.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Cache Wizard

The “Cache Wizard” section can help you monitor and configure caches for optimal performance.

Cache Wizard allows you to identify:

- Hot objects (objects that are often accessed). The output is ranked by the number of logical reads in a named cache or default data cache.
- Spinlock contention on the cache.
- The usage of the cache and buffer pools.
- The percentage of hits at a cache, buffer pool, and object level.
- The effectiveness of large I/O.
- The effectiveness of asynchronous prefetch (APF).
- The cache occupancy by the various objects.

The Cache Wizard section appears in sp_sysmon output only when you specify the cache wizard in sp_sysmon syntax. You can include two parameters with Cache Wizard, topN and filter.

A recommendation section prints at the end.

Before you run sp_sysmon cache wizard, you must first install the monitoring tables.

Cache wizard syntax

To obtain output from the cache wizard, use:

```
sp_sysmon begin_sample
sp_sysmon { end_sample | interval }
[, 'cache wizard'  [, top_N [, filter] ] ]
```

Parameters

- top_N – varchar datatype that limits the list of objects reported in the Object Section based on the ranking criteria for the number of logical reads in the specified interval (as displayed in the LR/sec column).

  The order of ranking is ascending or descending, based on whether the specified value is a positive or negative integer. Obtain the entire list of objects occupying the cache at the end of the interval by specifying a value of 0 (zero). The default value is 10.

- filter – varchar datatype that allows you to specify a pattern for the caches included in the report.

  For example, if you specify filter as default data cache, the report will contain only information about the default data cache. If you specify a filter value of emp%, the output includes information on all caches with a name matching this pattern.

  To display output for all caches, leave filter blank. The default data cache appears first, and is followed by the other caches in alphabetical order.

For more information, see "Sample output" on page 23.

Example

This example runs the Cache wizard against the default data cache for a 5-minute interval, showing the top 15 objects in the cache:

```
sp_sysmon '00:05:00','cache wizard','15','default data
cache'
```

Preparing to run the cache wizard

sp_sysmon retrieves the information for the Cache Wizard from monitoring tables and monitor counters.

See *Performance and Tuning Series: Monitoring Tables* for more information.

The Cache Wizard report requires the following configuration parameters to be enabled. If these configuration parameters are not enabled, sp_sysmon automatically enables them at the beginning of the interval and disables them at the end.

enable monitoring – set to 1. This option is dynamic.
per object statistics active – set to 1. This option is dynamic.
object lockwait timing – set to 1. This option is dynamic.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume One*.

Sample output

The Cache Wizard section output contains three main sections for each cache. This is followed by a recommendation section and a legend section at the end of the report.:

- Cache section – provides summary statistics for a specific cache:

```
default data cache
------------------
Run Size:               100.00 Mb   Usage%:              2.86
LR/sec:         41.10 PR/sec:    22.57    Hit%:          45.09
Cache Partitions:        4       Spinlock Contention%:    0.00
```

Usage% – each time a set of pages is brought into the cache, Adaptive Server tracks whether that page is referenced (used). When the page is removed from the cache, this count is reduced. Usage% is the current usage of the cache as a percentage of the cache size.

LR/sec – a logical read is any read from the cache (a hit) or a disk read (a miss). LR/sec is the number of logical reads in the cache during the interval divided by the length of the sample interval.

PR/sec – a physical read is a read from disk (miss). PR/sec is the number of physical reads in the cache during the interval divided by the sample interval.

Hit% – ratio of hits to total cache reads, such as the ratio of (LR/sec minus PR/sec) to LR/sec.

- Buffer pool section – breaks down the cache section statistics into the various buffer pools in the cache.

```
Buffer Pool Information
-------------------------------------------------------------------------
IO Size Wash Size Run Size APF%   LR/sec   PR/sec   Hit%   APF-Eff% Usage%
------- ---------- ------- ------ ------- -------- ------ -------- ------
4 Kb     3276 Kb    16.00 Mb  10.00     0.47     0.13  71.43    n/a     0.20
2 Kb    17200 Kb    84.00 Mb  10.00    40.63    22.43  44.79    n/a     3.37
```

APF-Eff% – number of pages asynchronous prefetch uses, and the total number of pages asynchronous prefetch brings in.

Usage% tracks whether a page brought into the buffer pool is referenced or not, providing the ratio of the pages referenced in the buffer pool to the run size of the buffer pool.

- Object section – reports statistics on the objects occupying the cache at the end of the interval. Use the topN parameter to limit the size of this section. Objects display in the ascending order of PR/sec.

```
Object Statistics
-------------------------------------------------------------------------
Object                      LR/sec  PR/sec   Hit%  Obj_Cached% Cache_Occp%
------------------------------ ------- ------- ------ ----------- -----
empdb.dbo.t1                  0.57    0.30  47.06       56.25        0.02
empdb.dbo.t2                  0.30    0.30   0.00       56.25        0.02
```

```
empdb.dbo.t3                0.30    0.30   0.00      56.25        0.02

Object                                Obj Size  Size in Cache
------------------------------ -----------   ------------
empdb.dbo.t1                            32 Kb          18 Kb
empdb.dbo.t2                            32 Kb          18 Kb
empdb.dbo.t3                            32 Kb          18 Kb
```

- Recommendations section – gives a set of recommendations, where applicable, based on the data collected in the sample interval:

```
The various recommendations are as follows:
Usage% for 'default data cache' is low (< 5%)
Usage% for  4k buffer pool in cache:default data cache is low (< 5%)
Consider using Named Caches or creating more cache partitions for
'default data cache' or both
Consider increasing the 'wash size' of the 2k pool for 'default data
cache'
Consider adding a large I/O pool for 'default data cache'
```

- Legend – explains the various terms used in the output. Some of the terms from the output are explained here in greater detail.

Sample output for Cache Wizard

```
sp_sysmon '00:00:30', 'cache wizard'

================================================================================
Cache Wizard
================================================================================

------------------
default data cache
------------------
Run Size        :   100.00 Mb   Usage%              :      2.86
LR/sec          :    41.10      PR/sec             :     22.57   Hit%:  45.09
Cache Partitions:        4      Spinlock Contention%:      0.00

Buffer Pool Information
--------------------------------------------------------------------------------
IO Size Wash Size  Run Size    APF%   LR/sec   PR/sec   Hit%   APF-Eff% Usage%
------- ---------- ----------- ------ -------- -------- ------ -------- ------
4 Kb     3276 Kb    16.00 Mb  10.00     0.47     0.13  71.43    n/a      0.20
2 Kb    17200 Kb    84.00 Mb  10.00    40.63    22.43  44.79    n/a      3.37
```

```
(1 row affected)

Object Statistics

--------------------------------------------------------------------------------
Object                          LR/sec  PR/sec  Hit%   Obj_Cached% Cache_Occp%
------------------------------- ------- ------- ------ ----------- -----------
tempdb.dbo.t1                     0.57    0.30  47.06       56.25        0.02
tempdb.dbo.t2                     0.30    0.30   0.00       56.25        0.02
tempdb.dbo.t3                     0.30    0.30   0.00       56.25        0.02
tempdb.dbo.t4                     0.30    0.30   0.00       56.25        0.02
tempdb.dbo.t5                     0.30    0.30   0.00       56.25        0.02
tempdb.dbo.t6                     0.30    0.30   0.00       56.25        0.02
tempdb.dbo.t8                     0.30    0.30   0.00       56.25        0.02
tempdb.dbo.t7                     0.57    0.20  64.71       62.50        0.02
tempdb.dbo.tempcachedobjstats     3.63    0.00 100.00       50.00        0.01
tempdb.dbo.tempobjstats           0.47    0.00 100.00       25.00        0.00

Object                          Obj Size    Size in Cache
------------------------------- ----------- -------------
tempdb.dbo.t1                         32 Kb        18 Kb
tempdb.dbo.t2                         32 Kb        18 Kb
tempdb.dbo.t3                         32 Kb        18 Kb
tempdb.dbo.t4                         32 Kb        18 Kb
tempdb.dbo.t5                         32 Kb        18 Kb
tempdb.dbo.t6                         32 Kb        18 Kb
tempdb.dbo.t8                         32 Kb        18 Kb
tempdb.dbo.t7                         32 Kb        20 Kb
tempdb.dbo.tempcachedobjstats         16 Kb         8 Kb
tempdb.dbo.tempobjstats               16 Kb         4 Kb

---------
company_cache
---------
Run Size        :     1.00 Mb   Usage%              :      0.39
LR/sec          :     0.07      PR/sec             :      0.07   Hit%:   0.00
Cache Partitions:        1      Spinlock Contention%:      0.00

Buffer Pool Information
--------------------------------------------------------------------------------
IO Size Wash Size  Run Size    APF%   LR/sec   PR/sec   Hit%   APF-Eff% Usage%
------- ---------- ----------- ------ -------- -------- ------ -------- ------
2 Kb      204 Kb     1.00 Mb  10.00     0.07     0.07   0.00    n/a     0.39

Object Statistics
--------------------------------------------------------------------------------
```

```
Object                LR/sec  PR/sec  Hit%   Obj_Cached% Cache_Occp%
--------------------- ------- ------- ------ ----------- -----------
empdb.dbo.history       0.07    0.07   0.00       25.00        0.39

Object                Obj Size    Size in Cache
--------------------- ----------- -------------
empdb.dbo.history         16 Kb        4 Kb

-------------
companydb_cache
-------------
Run Size        :     5.00 Mb   Usage%              :    100.00
LR/sec          :   380.97      PR/sec              :     56.67   Hit%:  85.13
Cache Partitions:        1      Spinlock Contention%:      0.00

Buffer Pool Information
-------------------------------------------------------------------------------
IO Size Wash Size  Run Size    APF%   LR/sec   PR/sec   Hit%   APF-Eff% Usage%
------- ---------- ----------- ------ -------- -------- ------ -------- ------
2 Kb     1024 Kb     5.00 Mb  10.00   380.97    56.67  85.13  98.42   100.00


Object Statistics
-------------------------------------------------------------------------------

Object                          LR/sec  PR/sec  Hit%   Obj_Cached% Cache_Occp%
------------------------------ ------- ------- ------ ----------- -----------
company_db.dbo.emp_projects     41.07   22.80  44.48       19.64        9.45
company_db.dbo.dept_det         93.03   20.67  77.79       99.08       54.53
company_db.dbo.emp_perf        116.70    2.63  97.74       97.77       34.18
company_db.dbo.dept_locs         0.43    0.17  61.54       50.00        0.16

Object                          Obj Size    Size in Cache
------------------------------ ----------- -------------
company_db.dbo.emp_projects       2464 Kb      484 Kb
company_db.dbo.dept_det           2818 Kb     2792 Kb
company_db.dbo.emp_perf           1790 Kb     1750 Kb
company_db.dbo.dept_locs            16 Kb        8 Kb

TUNING RECOMMENDATIONS
-------------------------------------------------------------------
Usage% for 'default data cache' is low (< 5%)
Usage% for  4k buffer pool in cache:default data cache is low (< 5%)
Usage% for  2k buffer pool in cache:default data cache is low (< 5%)
```

```
Usage% for 'company_cache' is low (< 5%)
 Usage% for  2k buffer pool in cache:company_cache is low (< 5%)

 Consider adding a large I/O pool for 'companydb_cache'


LEGEND
------
LR/sec    - number of logical reads per second, i.e. sum of cache & disk reads
PR/sec    - number of physical reads per second i.e. disk reads
Run Size- size of cache or buffer pool in Kilobytes
Cache Partitions- number of cache partitions
Spinlock Contention%- Percentage spinlock contention for the cache
Hit%      - ratio of hits to total searches
Usage%    - ratio of pages referenced to Run Size

Wash Size- wash size of buffer pool in Kilobytes
APF%      - asynchronous prefetch % for this buffer pool
APF-Eff%- Ratio of buffers found in cache and brought in because
               of APF to the number of APF disk reads performed

Object    - combination of db, owner, object and index name
Obj Size- size of the object in Kilobytes
Size in Cache- size occupied in cache in Kilobytes at the end of sample
Obj_Cached%- Ratio of 'Size in Cache' to 'Obj Size'
Cache_Occp%- Ratio of 'Size in Cache' to 'Run Size' of cache
```

Worker Process Management

"Worker Process Management" reports the use of worker processes, including the number of worker process requests that were granted and denied and the success and failure of memory requests for worker processes.

Analyze this output with that of "Parallel Query Management" on page 31.

Sample output

```
Worker Process Management
-------------------------
                                per sec      per xact      count    % of total
                             -----------  ------------  --------    ---------
Worker Process Requests
Requests Granted                     0.1           0.4        23      100.0 %
Requests Denied                      0.0           0.0         0        0.0 %
------------------------     -----------  ------------    ------
Total Requests                       0.1           0.4        23

Requests Terminated                  0.0           0.0         0        0.0 %

Worker Process Usage
Total Used                           0.2           1.1        69        n/a
Max Ever Used During Sample          0.0           0.1         9        n/a

Memory Requests for Worker Processes
Succeeded                            2.2          10.1       646      100.0 %
Failed                               0.0           0.0         0        0.0 %
------------------------      ----------  ------------   -------
Total Requests                       2.2          10.1       646

Avg Mem Ever Used by a WP (in bytes)  n/a           n/a     1208.9        n/a
```

Worker Process Requests

"Worker Process Requests" reports requests for worker processes and worker process memory. A parallel query may make multiple requests for worker processes. For example, a parallel query that requires a sort may make one request for accessing data and a second for parallel sort.

The “Requests Granted” and “Requests Denied” rows show how many requests were granted and how many requests were denied due to a lack of available worker processes at execution time.

To see the number of adjustments made to the number of worker processes, see “Parallel Query Usage” on page 32.

“Requests Terminated” reports the number of times a request was terminated by user action, such as pressing Ctrl+c, that cancelled the query.

Worker Process Usage

In this section, “Total Used” reports the total number of worker processes used during the sample interval. “Max Ever Used During Sample” reports the highest number in use at any time during sp_sysmon’s sampling period. You can use “Max Ever Used During Sample” to set the configuration parameter number of worker processes.

Memory Requests for Worker Processes

This section reports the number of requests made for memory allocations for worker processes, how many of those requests succeeded and how many failed. Memory for worker processes is allocated from a memory pool configured with the parameter memory per worker process.

If “Failed” is a nonzero value, you may need to increase the value of memory per worker process.

Avg Mem Ever Used By a WP

This row reports the maximum average memory used by all active worker processes at any time during the sample interval. Each worker process requires memory, principally for exchanging coordination messages. This memory is allocated by Adaptive Server from the global memory pool.

The size of the pool is determined by multiplying the two configuration parameters, number of worker processes and memory per worker process.

If number of worker processes is set to 50, and memory per worker process is set to the default value of 1024 bytes, 50K is available in the pool. Increasing memory for worker process to 2048 bytes would require 50K of additional memory.

At start-up, static structures are created for each worker process. While worker processes are in use, additional memory is allocated from the pool as needed, and deallocated when not needed. The average value printed is the average for all static and dynamically memory allocated for all worker processes, divided by the number of worker processes actually in use during the sample interval.

If a large number of worker processes are configured, but only a few are in use during the sample interval, the value printed may be inflated, due to averaging in the static memory for unused processes.

If "Avg Mem" is close to the value set by memory per worker process and the number of worker processes in "Max Ever Used During Sample" is close to the number configured, you may want to increase the value of the parameter.

If a worker process needs memory from the pool, and no memory is available, the process prints an error message and exits.

Note For most parallel query processing, the default value of 1024 is more than adequate.

The exception is dbcc checkstorage, which can use up 1792 bytes if only one worker process is configured. If you are using dbcc checkstorage, and number of worker processes is set to 1, you may want to increase memory per worker process.

Parallel Query Management

"Parallel Query Management" reports the execution of parallel queries. It reports the total number of parallel queries, the number of times the number of worker processes was adjusted at runtime, and the granting of locks during merges and sorts.

Sample output

```
Parallel Query Management
```

```
-------------------------

Parallel Query Usage            per sec     per xact      count   % of total
-----------------------   ------------   ----------  ---------   ----------
Total Parallel Queries             0.1          0.3         19          n/a
WP Adjustments Made
Due to WP Limit                    0.0          0.0          0        0.0 %
Due to No WPs                      0.0          0.0          0        0.0 %

Merge Lock Requests             per sec     per xact      count   % of total
-----------------------   ------------   ----------  ---------    ----------
Network Buffer Merge Locks
Granted with no wait               1.1          5.0        320       21.3 %
Granted after wait                 3.9         18.4       1179       78.7 %

Result Buffer Merge Locks
Granted with no wait               0.0          0.0          0        0.0 %
Granted after wait                 0.0          0.0          0        0.0 %

Work Table Merge Locks
    Granted with no wait           0.0          0.0          0        0.0 %
    Granted after wait             0.0          0.0          0        0.0 %
-----------------------   ------------   ----------  ---------    ----------
Total # of Requests                5.0         23.4       1499

Sort Buffer Waits               per sec     per xact      count   % of total
-----------------------   ------------   ----------  ---------   ----------
Producer Waits                     0.0          0.1          8      100.0 %
Consumer Waits                     0.0          0.0          0        0.0 %
-----------------------   ------------   ----------  ---------    ----------
Total # of Waits                    0.0          0.1          8
```

Parallel Query Usage

"Total Parallel Queries" reports the total number of queries eligible to be run in parallel. The optimizer determines the best plan, deciding whether a query should be run serially or in parallel and how many worker processes should be used for parallel queries.

"WP Adjustments Made" reports how many times the number of worker processes recommended by the optimizer had to be adjusted at runtime. Two possible causes are reported:

- "Due to WP Limit" – indicates the number of times the number of worker processes for a cached query plan was adjusted due to a session-level limit set with set parallel_degree or set scan_parallel_degree.

  If "Due to WP Limit" is a nonzero value, look for applications that set session-level limits.

- "Due to No WPs" – indicates the number of requests for which the number of worker processes was reduced due to lack of available worker processes. These queries may run in serial, or they may run in parallel with fewer worker processes than recommended by the optimizer. It could mean that queries are running with poorly optimized plans.

  If "Due to No WPs" is a nonzero value, and the sample was taken at a time of typical load on your system, you may want to increase the number of worker processes configuration parameter or set session-level limits for some queries.

  Running sp_showplan on the fid (family ID) of a login using an adjusted plan shows only the cached plan, not the adjusted plan.

  If the login is running an adjusted plan, sp_who shows a different number of worker processes for the fid than the number indicated by sp_showplan results.

Merge Lock Requests

"Merge Lock Requests" reports the number of parallel merge lock requests that were made, how many were granted immediately, and how many had to wait for each type of merge. The three merge types are:

- "Network Buffer Merge Locks"– reports contention for the network buffers that return results to clients.
- "Result Buffer Merge Locks"– reports contention for the result buffers used to process results for ungrouped aggregates and nonsorted, nonaggregate variable assignment results.
- "Work Table Merge Locks"– reports contention for locks while results from worktables were being merged.

"Total # of Requests" prints the total of the three types of merge requests.

Sort Buffer Waits

This section reports contention for the sort buffers used for parallel sorts. Parallel sort buffers are used by:

- Producers – the worker processes returning rows from parallel scans.
- Consumers – the worker processes performing the parallel sort.

If the number of waits is high, you can configure number of sort buffers to a higher value.

See Chapter 10, "Using Statistics to Improve Performance," in *Performance and Tuning: Query Processing and Abstract Plans* for guidelines.

Task Management

"Task Management" provides information on opened connections, task context switches by engine, and task context switches by cause. `Task Management` identifies why a task stopped running (that is, the report highlights resource shortages and contention).

Sample output

```
Task Management                per sec      per xact      count   % of total
-------------------------  ------------    ----------   --------  ----------

Connections Opened                  0.2           0.0        154         n/a

Task Context Switches by Engine
Engine 0                          269.9           3.4     240477       7.3 %
Engine 1                          209.4           2.7     186574       5.7 %
Engine 2                          198.4           2.5     176730       5.4 %
Engine 3                          198.5           2.5     176859       5.4 %
Engine 4                          278.4           3.5     248054       7.5 %
Engine 5                          187.1           2.4     166697       5.1 %
Engine 6                          202.7           2.6     180640       5.5 %
Engine 7                          312.2           4.0     278129       8.5 %
Engine 8                          215.7           2.7     192198       5.8 %
Engine 9                          260.3           3.3     231940       7.1 %
Engine 10                         235.1           3.0     209447       6.4 %
Engine 11                         409.2           5.2     364604      11.1 %
```

```
Engine 12                          225.8           2.9      201166       6.1 %
Engine 13                          484.9           6.1      432020      13.1 %
-------------------------   ------------  ------------  -----------
Total Task Switches:              3687.5          46.7     3285535

Task Context Switches Due To:
Voluntary Yields                   860.8          10.9      766929      23.3 %
Cache Search Misses                852.0          10.8      759122      23.1 %
System Disk Writes                  12.7           0.2       11353       0.3 %
Exceeding I/O batch size           184.7           2.3      164550       5.0 %
Logical Lock Contention              0.3           0.0         258       0.0 %
Address Lock Contention              0.0           0.0          12       0.0 %
Latch Contention                     0.7           0.0         587       0.0 %
Log Semaphore Contention            31.1           0.4       27737       0.8 %
PLC Lock Contention                  0.6           0.0         577       0.0 %
Group Commit Sleeps                  6.9           0.1        6122       0.2 %
Last Log Page Writes                71.4           0.9       63619       1.9 %
Modify Conflicts                    19.9           0.3       17728       0.5 %
I/O Device Contention                0.0           0.0           0       0.0 %
Network Packet Received            152.1           1.9      135483       4.1 %
Network Packet Sent                643.7           8.1      573528      17.5 %
Network services                   127.8           2.3        7564       8.9 %
Other Causes                        850.7          10.8      757930      23.1%
```

Connections Opened

"Connections Opened" reports the number of connections opened to Adaptive Server. It includes any type of connection, such as client connections and remote procedure calls. It counts only connections started during the sample interval; connections established before the interval started are not counted, although they may be active and using resources.

"Connections Opened" provides a general understanding of the Adaptive Server environment and the workload during the interval. This data can also be useful for understanding application behavior—it can help determine if applications repeatedly open and close connections or perform multiple transactions per connection.

See "Transaction Profile" on page 54 for information about committed transactions.

Task Context Switches by Engine

Each process running on Adaptive Server has its own "context," or environment, which includes information about the current database, client character set, currently running query, and so on. A "context switch" occurs when Adaptive Server is running one client or system process, but must switch to a different client or system process, and this switch involves changing the context under which the engine is running.

"Task Context Switches by Engine" reports the number of times each Adaptive Server engine switched context from one user task to another. "% of total" reports the percentage of engine task switches for each Adaptive Server engine as a percentage of the total number of task switches for all Adaptive Server engines combined.

"Total Task Switches" summarizes task-switch activity for all engines on SMP servers. You can use "Total Task Switches" to observe the effect of reconfigurations. You might reconfigure a cache or add memory if tasks appear to block on cache search misses and to be switched out often. Then, check the data to see if tasks tend to be switched out more or less often.

Task Context Switches Due To

"Task Context Switches Due To" reports the number of times that Adaptive Server switched context for a number of common reasons. "% of total" reports the percentage of times the context switch was due to each specific cause as a percentage of the total number of task context switches for all Adaptive Server engines combined.

"Task Context Switches Due To" provides an overview of the reasons that tasks were switched off engines. You can investigate he possible performance problems shown in this section by checking other sp_sysmon output, as indicated in the sections that describe the causes.

For example, if most of the task switches are caused by physical I/O, try minimizing physical I/O by adding more memory or reconfiguring caches. However, if lock contention causes most of the task switches, check the locking section of your report.

See "Lock Management" on page 80 for more information.

Voluntary Yields

"Voluntary Yields" reports the number of times a task completed without yielding. A task that completes yields is indicated in the `Network Packet Sent` column. A high number of voluntary yields indicates that there is little contention.

The configuration parameter time slice sets the amount of time that a process can run. A CPU-intensive task that does not switch out due to other causes yields the CPU at certain "yield points" in the code, to allow other processes a turn on the CPU. See "Allotted Slices Exhausted" on page 48 to identify whether tasks are exhausting their time quota.

See "Using Engines and CPUs," in *Performance and Tuning Series: Basics* for more information.

Cache Search Misses

"Cache Search Misses" reports the number of times a task was switched out because a needed page was not in cache and had to be read from disk. For data and index pages, the task is switched out while the physical read is performed.

See "Data Cache Management" on page 89 for information about the cache-related parts of the sp_sysmon output.

System Disk Writes

"System Disk Writes" reports the number of times a task was switched out because it needed to perform a disk write or because it needed to access a page that was being written by another process, such as the housekeeper or the checkpoint process.

Most Adaptive Server writes happen asynchronously, but processes sleep during writes for page splits, recovery, and OAM page writes.

If "System Disk Writes" seems high, check the value for page splits to see if the problem is caused by data page and index page splits.

See "Page Splits" on page 71.

If the high value for system disk writes is not caused by page splitting, you cannot affect this value by tuning Adaptive Server.

Exceeding I/O Batch Size

"Exceeding I/O batch size" reports how many times an I/O-intensive task was switched from an engine because of exceeding a I/O batch limit. However, "Exceeding I/O batch size" reports only the context switches from nonlog I/O batches. Adaptive Server paces disk writes to keep from flooding the disk I/O subsystems during operations that perform large amounts of I/O. For example, the checkpoint task writes a large number of data pages to the disk. Adaptive Server switches off the checkpoint task so it sleeps until the batch of writes completes. Checkpoint then wakes and issues another batch.

Configure batch sizes—both nonlog I/O and log I/O—using the i/o batch size parameter.

By default, the number of writes per batch is set to 100. You may want to increase the number of writes per batch if:

- You have a high-throughput, high-transaction environment with a large data cache.
- Your system is not I/O bound.

Logical Lock Contention

"Logical Lock Contention" reports the number of times a task was switched out due to contention for locks on tables, data pages, or data rows.

Investigate lock contention problems by checking the transaction detail and lock management sections of the report.

- See "Transaction Detail" on page 57 and "Lock Management" on page 80.
- Check to see if your queries are performing deferred and direct expensive updates, which can cause additional index locks. See "Updates" on page 59.
- Use sp_object_stats to report information on a per-object basis.

  See Chapter 3, "Locking Reports," of *Performance and Tuning Series: Locking* for more information.

For additional help on locks and lock contention, check the following sources:

- "Types of Locks," in the *Performance and Tuning Series: Locking and Concurrency Control* provides information about types of locks to use at server or query level.

- See chapter 2, "Locking Configuration and Tuning," of *Performance and Tuning Series: Locking* for information about reducing lock contention.
- Chapter 1, "Introduction to Locking," in *Performance and Tuning Series: Locking* provides information on indexes and query tuning. In particular, use indexes to ensure that updates and deletes do not lead to table scans and exclusive table locks.

Address Lock Contention

"Address Lock Contention" reports the number of times a task was switched out because of address locks. Adaptive Server acquires address locks on the index pages of allpages-locked tables. These locks block access to data pages. For example, an exclusive address lock on an index page blocks another system process ID (spid) from reading that page and following that index to the data. However, tasks can still use other access methods to the data.) Also, when a leaf-level index page is exclusively locked, no modifications can be done to any data pointed to by the index rows on the locked page, since the index rows may need to be modified as well.

Latch Contention

"Latch Contention" reports the number of times a task was switched out because it needed to wait for a latch.

If your user tables use only allpages-locking, latch contention is taking place either on a data-only-locked system table or on allocation pages.

If your applications use data-only-locking, the contention reported here includes all waits for latches, including those on index pages and OAM pages as well as allocation pages.

Reducing contention during page allocation

In SMP environments where inserts and expanding updates are extremely high, so that page allocations take place very frequently, contention for the allocation page latch can reduce performance. Normally, Adaptive Server allocates new pages for an object on an allocation unit that is already in use by the object and is known to have free space.

For each object, Adaptive Server tracks this allocation page number as a hint for any tasks that need to allocate a page for that object. When more than one task at a time needs to allocate a page on the same allocation unit, the second and subsequent tasks block on the latch on the allocation page.

You can specify a “greedy allocation” scheme, so that Adaptive Server keeps a list of eight allocation hints for page allocations for a table.

This command enables greedy allocation for the salesdetail table in database 6:

```
dbcc tune(des_greedyalloc, 6, salesdetail, "on")
```

To turn it off, use:

```
dbcc tune(des_greedyalloc, 6, salesdetail, "off")
```

The effects of dbcc tune(des_greedyalloc) are not persistent, so you must reissue the commands after you restart Adaptive Server.

Use dbcc tune(des_greedyalloc) only if all of the following are true:

- You have multiple engines. This command is rarely useful with fewer than four engines.
- A large number of pages are being allocated for the object. You can use sp_spaceused or optdiag to track the number of pages.
- The latch contention counter shows contention.

Greedy allocation is more useful when tables are assigned to their own segments. If you enable greedy allocation for several tables on the same segment, the same allocation hint could be used for more than one table.

Greedy allocation is not allowed in the master and tempdb databases, and is not allowed on system tables. Greedy page allocation is not applicable to partitioned tables.

The hints are allocation pages which potentially have free space. The maximum number of hints maintained is 16.

Log Semaphore Contention

A semaphore is a simple internal locking mechanism that prevents a second task from accessing the data structure currently in use. Adaptive Server uses semaphores to protect the user log caches, since more than one process can access the records of a ULC and force a flush.

“Log Semaphore Contention” reports the number of times a task was switched out because it needed to acquire the transaction log semaphore held by another task. This applies to SMP systems only.

If log semaphore contention is high, see “Transaction Management” on page 61.

Check disk queuing on the disk used by the transaction log. See "Disk I/O Management" on page 114.

Also see "Engine Busy Utilization" on page 15. If engine utilization reports a low value, and response time is within acceptable limits, consider reducing the number of engines. Running with fewer engines reduces contention by decreasing the number of tasks trying to access the log simultaneously.

High log semaphore contention usually points to issues with logging or the I/O subsystem. However, even a well-tuned system can have high contention on the log semaphore in a OLTP environment that uses high throughput.

User Log Cache Lock Contention

"PLC Lock Contention" reports contention for a lock on a user log cache.

Group Commit Sleeps

"Group Commit Sleeps" reports the number of times a task performed a transaction commit and was put to sleep until the log was written to disk by another task.

When a task commits, its log records are flushed from its user log cache to the current page of the transaction log in cache. If the log page (or pages, if a large log I/O size is configured) is not full, the task is switched out and placed on the end of the run queue. The log write for the page is performed when:

- Another process fills the log pages, and flushes the log. This is presented as a Group Commit Sleep or as I/O Pacing.
- When the task reaches the head of the run queue, and no other process has flushed the log page. This is presented as a Last Log Page Write.

In high throughput environments, a large log I/O size helps prevent problems in disk queuing on the log device. A high percentage of group commit sleeps should not be regarded as a problem.

Last Log Page Writes

"Last Log Page Writes" reports the number of times a task was switched out because it was put to sleep while writing the last log page.

The task switched out because it was responsible for writing the last log page, as opposed to sleeping while waiting for some other task to write the log page, as described in "Group Commit Sleeps" on page 41.

If this value is high, review "Avg # Writes per Log Page" on page 67 to determine whether Adaptive Server is repeatedly writing the same last page to the log. If the log I/O size is greater than 2K, reducing the log I/O size might reduce the number of unneeded log writes.

For more information, see the "Optimizing Transaction Performance in Adaptive Server Enterprise 12.5" white paper at www.sybase.com (enter "Optimizing Transaction Performance" in the search field on the Sybase home page).

Modify Conflicts

"Modify Conflicts" reports the number of times that a task tried to get exclusive access to a page that was held by another task under a special lightweight protection mechanism. For certain operations, Adaptive Server uses a lightweight protection mechanism to gain exclusive access to a page without using actual page locks. Examples are access to some system tables and dirty reads. These processes require exclusive access to the page, even though they do not modify it.

I/O Device Contention

"I/O Device Contention" reports the number of times a task was put to sleep while waiting for a semaphore for a particular device.

When a task needs to perform physical I/O, Adaptive Server fills out the I/O structure and links it to a per-engine I/O queue. If two Adaptive Server engines request an I/O structure from the same device at the same time, one of them sleeps while it waits for the semaphore.

Device contention occurs only when you have enabled disk mirroring (the default is "disabled") or when I/Os are delayed. For more information about delayed I/Os, see "Disk I/O Management" on page 114.

If there is significant contention for I/O device semaphores, try reducing it by redistributing the tables across devices or by adding devices and moving tables and indexes to them.

Network Packet Received

When task switching is reported by "Network Packet Received," the task switch is due to one of these causes:

- A task received part of a multipacket batch and was switched out waiting for the client to send the next packet of the batch, or
- A task completely finished processing the current batch and was put into a receive sleep state while waiting to receive the next command or packet from the client. This is the most common reason for task context switches due to "Network Packet Received."

If "Network Packet Received" is high, see "Network I/O Management" on page 120. You can configure the network packet size for all connections or allow certain connections, to log in using larger packet sizes.

See Chapter 1, "Introduction to the Basics," in *Performance and Tuning Series: Basics* for more information about network packet sizes.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume One*.

Network Packet Sent

"Network Packet Sent" reports the number of times a task went into a send sleep state while waiting for the network to send each packet to the client. The network model determines that there can be only one outstanding packet per connection at any point in time. A task can send a network packet without posting a send request to the network IO task, avoiding a task context switch.

If there is a lot of data to send, and the task is sending many small packets (512 bytes per packet), the task could end up sleeping a number of times. The data packet size is configurable, and different clients can request different packet sizes. When a query completes, this action is included in the `Network Packet Send` column.

See Chapter 2, "Networks and Performance," in *Performance and Tuning Series: Basics* for more information about network packets.

If "Network Packet Sent" is a major cause of task switching, see "Network I/O Management" on page 120.

Network Services

Measures the number of context switches that are caused by sleeping on network operations (other than the send and receive operations).

Other Causes

"Other Causes" reports the number of tasks switched out for any reasons not described above. In a well-tuned server, this value may rise as tunable sources of task switching are reduced.

Application Management

"Application Management" reports execution statistics for user tasks. This section is useful if you use resource limits, or if you plan to tune applications by setting execution attributes and assigning engine affinity. Before making any adjustments to applications, logins, or stored procedures, run sp_sysmon during periods of typical load, and familiarize yourself with the statistics in this section.

For related background information, see *Performance and Tuning Series: Basics.*

Requesting detailed application information

If you request information about specific tasks using the third sp_sysmon parameter (*applmon*) sp_sysmon output gives statistics specific to each application individually, in addition to summary information. You can choose to display the detailed application information in one of two ways:

- Application and login information (using the sp_sysmon parameter appl_and_login) – sp_sysmon prints a separate section for each login and the applications it is executing.
- Application information only (using the sp_sysmon parameter, appl_only) – sp_sysmon prints a section for each application, which combines data for all of the logins that are executing it.

For example, if 10 users are logged in with isql, and 5 users are logged in with an application called sales_reports, requesting "application and login" information prints 15 detail sections. Requesting "application only" information prints 2 detail sections, one summarizing the activity of all isql users, and the other summarizing the activity of the sales_reports users.

The appl_and_login can be used with all sections of sp_sysmon. This is an example of the syntax:

```
sp_sysmon "00:05:00", @applmon=appl_and_login
```

See "Specifying the application detail parameter" on page 6.

Sample output

```
Application Management
----------------------

Application Statistics Summary (All Applications)
-------------------------------------------------
Priority Changes                  per sec      per xact      count   % of total
--------------------------  ------------  ----------  --------  ----------
To High Priority                      3.4           0.1      2058       18.6 %
To Medium Priority                    9.6           0.2      5774       52.3 %
To Low Priority                       5.4           0.1      3217       29.1 %
----------------------   ------------  ----------  --------
Total Priority Changes               18.4           0.5     11049

Allotted Slices Exhausted         per sec      per xact      count   % of total
--------------------------  ------------  ----------  --------  ----------
High Priority                         0.0           0.0         0        0.0 %
Medium Priority                      13.8           0.3      8251      100.0 %
Low Priority                          0.0           0.0         0        0.0 %
--------------------------  ------------  ----------  --------  ----------
Total Slices Exhausted               13.8           0.3      8251

Skipped Tasks By Engine           per sec      per xact      count   % of total
--------------------------  ------------  ----------  --------  ----------
Total Engine Skips                    0.0           0.0         0         n/a

Engine Scope Changes                  0.0           0.0         0         n/a
```

The following example shows output for application and login; only the information for one application and login is included. The first line identifies the application name (before the arrow) and the login name (after the arrow).

```
---------------------------------------------------------------------
  Application->Login:   ctisql->adonis

  Application Activity            per sec      per xact      count   % of total
--------------------------  ------------  ----------  --------  ----------
CPU Busy                              0.1           0.0        27        2.8 %
    I/O Busy                          1.3           0.1       461       47.3 %
    Idle                              1.4           0.2       486       49.9 %
```

```
Number of Times Scheduled              1.7            0.2          597          n/a

 Application Priority Changes      per sec       per xact       count   % of total
--------------------------  ------------  ----------  --------  ----------
To High Priority                      0.2           0.0         72       50.0 %
    To Medium Priority                0.2           0.0         72       50.0 %
    To Low Priority                   0.0           0.0          0        0.0 %
--------------------------  ------------  ----------  --------  ----------
Total Priority Changes                0.4           0.0        144

  Application I/Os Completed      per sec       per xact       count   % of total
--------------------------  ------------  ----------  --------  ----------
Disk I/Os Completed                   0.6           0.1        220       53.9 %
    Network I/Os Completed            0.5           0.1        188       46.1 %
--------------------------   ------------       -------   --------
    Total I/Os Completed              1.1           0.1        408

 Resource Limits Violated         per sec       per xact       count   % of total
--------------------------  ------------  ----------  --------  ----------
IO Limit Violations
    Estimated                        0.0           0.0          0        0.0 %
    Actual                           0.1           4.0          4       50.0 %
  Time Limit Violations
    Batch                            0.0           0.0          0        0.0 %
    Xact                             0.0           0.0          0        0.0 %
  RowCount Limit Violations          0.1           4.0          4       50.0 %

--------------------------   -----------       -------   --------
Total Limits Violated                 0.1           8.0           8
```

Application Statistics Summary (All Applications)

The sp_sysmon statistics in the summary section can help you determine whether there are any anomalies in resource utilization. If there are, you can investigate further using the detailed report.

Applications statistics show:

- Whether tasks are switching back and forth between different priority levels
- Whether the assigned time that tasks are allowed to run is appropriate
- Whether tasks to which you have assigned low priority are starved for CPU time

- Whether engine bindings with respect to load balancing is correct

"Application Statistics Summary" includes data for system tasks as well as for user tasks. If the summary report indicates a resource issue, but you do not see supporting evidence in the application or application and login information, investigate the sp_sysmon kernel section of the report ("Kernel Utilization" on page 14).

Priority Changes

"Priority Changes" reports the priority changes that took place for all user tasks in each priority run queue during the sample interval. It is normal to see some priority switching due to system-related activity. For example, such priority switching occurs when:

- A task sleeps while waiting on a lock – Adaptive Server temporarily raises the task's priority.
- A housekeeper task sleeps – Adaptive Server raises the priority to medium when the housekeeper wash and housekeeper chores task wake up, and changes them back to low priority when they go back to sleep.
- A task executes a stored procedure – the task assumes the priority of the stored procedure and resumes its previous priority level after executing the procedure.

If you are using logical process management and there are a high number of priority changes compared to steady state values, it may indicate that an application, or a user task related to that application, is changing priorities frequently. Check priority change data for individual applications. Verify that applications and logins are behaving as you expect.

If you determine that a high-priority change rate is not due to an application or to related tasks, then it is likely due to system activity.

Total Priority Changes

"Total Priority Changes" reports the total number of priority changes during the sample period. This section gives you a quick way to determine if there are a high number of run queue priority changes occurring.

Allotted Slices Exhausted

"Allotted Slices Exhausted" reports the number of times user tasks in each run queue exceeded the time allotted for execution. Once a user task gains access to an engine, the task is allowed to execute for a given period of time. If the task has not yielded the engine before the time is exhausted, Adaptive Server requires it to yield as soon as possible without holding critical resources. After yielding, the task is returned to the run queue.

"Allocated Slices Exhausted" helps you to determine whether there are CPU-intensive applications for which you should tune execution attributes or engine associations. If these numbers are high, it indicates that an application is CPU intensive. Application-level information can help you figure out which application to tune. Some tasks, especially those which perform large sort operations, are CPU intensive.

Use "Alloted slices exhausted" to assess new hardware requirements. Faster CPUs are typically beneficial, and the more exhausted timeslices you encounter, the more your site will benefit from upgrading to faster CPUs.

Skipped Tasks By Engine

"Skipped Tasks By Engine" reports the number of times engines skipped a user task at the head of a run queue. This happens when the task at the head of the run queue has affinity to an engine group and was bypassed in the queue by an engine that is not part of the engine group.

The value is affected by configuring engine groups and engine group bindings. A high number in this category might be acceptable if low priority tasks are bypassed for more critical tasks. It is possible that an engine group is bound so that a task that is ready to run might not be able to find a compatible engine. In this case, a task might wait to execute while an engine sits idle. Investigate engine groups and how they are bound, and check load balancing.

Engine Scope Changes

"Engine Scope Changes" reports the number of times a user changed the engine group binding of any user task during the sample interval.

Per Application Or Per Application And Login

This section gives detailed information about system resources used by particular application and login tasks, or by all users of each application.

Application Activity

"Application Activity" helps you to determine whether an application is I/O intensive or CPU intensive. It reports how much time all user tasks in the application spend executing, doing I/O, or being idle. It also reports the number of times a task is scheduled and chosen to run.

CPU Busy

"CPU Busy" reports the number of clock ticks during which the user task was executing during the sample interval. When the numbers in this category are high, it indicates a CPU-bound application. If this is a problem, you may want to consider engine binding.

I/O Busy

"I/O Busy" reports the number of clock ticks during which the user task was performing I/O during the sample interval. If the numbers in this category are high, it indicates an I/O-intensive process. If idle time is also high, the application could be I/O bound.

The application might achieve better throughput if you assign it a higher priority, bind it to a lightly loaded engine or engine group, or partition the application's data onto multiple devices.

Idle

"Idle" reports the number of clock ticks during which the user task was idle during the sample interval.

Number of Times Scheduled

"Number of Times Scheduled" reports the number of times a user task is scheduled and chosen to run on an engine. This data can help you determine whether an application has sufficient resources. If this number is low for a task that normally requires substantial CPU time, it may indicate insufficient resources. Consider changing priority in a loaded system with sufficient engine resources.

Application Priority Changes

"Application Priority Changes" reports the number of times this application had its priority changed during the sample interval.

When the “Application Management” category indicates a problem, use this section to pinpoint the source.

Application I/Os Completed

“Application I/Os Completed” reports the disk and network I/Os completed by this application during the sample interval.

This category indicates the total number of disk and network I/Os completed.

If you suspect a problem with I/O completion, see “Disk I/O Management” on page 114 and “Network I/O Management” on page 120.

Resource Limits Violated

“Resource Limits Violated” reports the number and types of violations for:

- I/O Limit Violations—Estimated and Actual
- Time Limits—Batch and Transaction
- RowCount Limit Violations
- Total Limits Violated

If no limits are exceeded during the sample period, only the total line is printed.

ESP Management

This section reports on the use of extended stored procedures.

Sample output

```
================================================================================

ESP Management                    per sec     per xact       count   % of total
--------------------------  ------------  -----------  ----------   ---------
ESP Requests                         0.0          0.0           0         n/a
```

ESP Requests

"ESP Requests" reports the number of extended stored procedure calls during the sample interval.

Avg. Time to Execute an ESP

"Avg. Time to Execute an ESP" reports the average length of time for all extended stored procedures executed during the sample interval.

Housekeeper Task Activity

The "Housekeeper Tasks Activity" section reports on housekeeper tasks. If the configuration parameter housekeeper free write percent is set to 0, the housekeeper task HK WASH does not run. Enable space reclamation by setting enable housekeeper GC to a value between 1 and 5. Disable space reclamation by setting enable housekeeper GC to 0.

For more information, see:

- *Performance and Tuning: Basics*, Chapter 3, "Using Engines and CPUs
- "Diagnosing System Problems," in *System Administration Guide, Volume One*

Sample output

```
===============================================================================

Housekeeper Task Activity
-------------------------
                        per sec    per xact     count        % of total
                        ---------  --------  --------        -----------
Buffer Cache Washes
   Clean                    228.0       5.6    136828            100.0 %
   Dirty                      0.0       0.0        12              0.0 %
                        ---------  --------  --------
Total Washes                228.1       5.6    136840
Garbage Collections           1.3       0.0       791               n/a
Pages Processed in GC         0.0       0.0         0               n/a
Statistics Updates           12.0       0.3      7196                 n/a
```

Buffer Cache Washes

This section reports:

- The number of buffers examined by the housekeeper wash task
- The number that were found clean
- The number that were found dirty

A buffer is considered “dirty” when the data page it represents in a data cache includes changes that Adaptive Server has not written to disk. A buffer is considered “clean” when the data page it represents it is a copy of the data on disk.

The number of dirty buffers includes those already in I/O due to writes being started at the wash marker.

The “Recovery Management” section of sp_sysmon reports how many times the housekeeper wash task was able to write all dirty buffers for a database. See“Recovery Management” on page 111.

Garbage Collections

This section reports the number of times the housekeeper garbage collection task checked to determine whether there were committed deletes that indicated that there was space that could be reclaimed on data pages.

“Pages Processed in GC” reports the number of pages where the housekeeper garbage collection task succeeded in reclaiming unused space on a page of a data-only-locked table.

Statistics Updates

“Statistics Updates” reports on the number of times the housekeeper chores task checked to see if statistics needed to be written.

Monitor Access to Executing SQL

“Monitor Access to Executing SQL” reports:

- Contention that occurs when sp_showplan or Monitor Server accesses query plans.

  Note Querying monitoring tables (for example, monProcessSQLText and monSysSQLText) does not update these counters

- The number of overflows in SQL batch text buffers and the maximum size of SQL batch text sent during the sample interval

Sample output

```
Monitor Access to Executing SQL
-------------------------------
                                  per sec    per xact     count    % of total
                               -----------  ----------   -------    ----------
Waits on Execution Plans              0.0         0.0         0         n/a
Number of SQL Text Overflows          8.6          .2      5138         n/a
Maximum SQL Text Requested            n/a         n/a    588307         n/a
(since beginning of sample)
```

Waits on Execution Plans

"Waits on Execution Plans" reports the number of times that a process attempting to use sp_showplan had to wait to acquire read access to the query plan. Query plans may be unavailable if sp_showplan is run before the compiled plan is completed or after the query plan finished executing. In these cases, Adaptive Server tries to access the plan three times and then returns a message to the user.

Number of SQL Text Overflows

"Number of SQL Text Overflows" reports the number of times that SQL batch text exceeded the text buffer size.

Maximum SQL Text Requested

"Maximum SQL Text Requested" reports the maximum size of a batch of SQL text since the sample interval began. You can use this value to set the configuration parameter max SQL text monitored.

See “Diagnosing System Problems,” in *System Administration Guide: Volume 1*.

Transaction Profile

The “Transaction Profile” section reports on data modifications by type of command and table locking scheme.

Sample output

```
================================================================================
Transaction Profile
-------------------

Transaction Summary             per sec    per xact     count        % of total
--------------------           --------    --------   -------       ---------
Committed Xacts                   40.6         n/a     24357             n/a

Transaction Detail              per sec    per xact     count        % of total
--------------------           --------    --------   -------       ---------
Inserts
APL Heap Table                   799.4        19.7    479637           28.5 %
APL Clustered Table             2003.0        49.3   1201819           71.3 %
Data Only Lock Table               6.7         0.2      4047            0.2 %
Fast Bulk Insert                   0.0         0.0         0            0.0 %
-------------------------  -----------   ---------   -------       ---------
Total Rows Inserted             2809.2        69.2   1685503           98.7 %

Updates
APL Deferred                       1.3         0.0       771           19.3 %
APL Direct In-place                2.0         0.0      1176           29.5 %
APL Direct Cheap                   0.2         0.0       127            3.2 %
APL Direct Expensive               3.2         0.1      1905           47.8 %
DOL Deferred                       0.0         0.0         1            0.0 %
DOL Direct                         0.0         0.0         7            0.2 %
-------------------------  -----------  ----------  --------       ----------
Total Rows Updated                 6.6         0.2      3987            0.2 %

Data Only Locked Updates
DOL Replace                        0.0         0.0         3           37.5 %
DOL Shrink                         0.0         0.0         0            0.0 %
```

```
DOL Cheap Expand                    0.0          0.0          0             0.0 %
DOL Expensive Expand                0.0          0.0          5            62.5 %
DOL Expand & Forward                0.0          0.0          0             0.0 %
DOL Fwd Row Returned                0.0          0.0          0             0.0 %
------------------------  ------------  ----------  --------  ----------
Total DOL Rows Updated              0.0          0.0          8             0.0 %

Deletes
APL Deferred                        1.3          0.0        771             4.1 %
APL Direct                         24.1          0.6      14462            77.5 %
DOL                                 5.7          0.1       3432            18.4 %
------------------------  ------------  ----------  -------       ----------
Total Rows Deleted                  1.1          0.8      18665             1.1 %
========================  ============  ==========  ========
Total Rows Affected              2846.9         70.1     1708155
```

Transaction Summary

"Transaction Summary" reports committed transactions. "Committed Xacts" reports the number of transactions committed during the sample interval.

The transactions counted include implicit and explicit, chained (ANSI-style), or unchained:

- An implicit transaction executes data modification commands such as insert, update, or delete. If you do not specify a begin transaction statement, Adaptive Server interprets every operation as a separate transaction; an explicit commit transaction statement is not required. For example, the following is counted as three transactions.

  ```
  1> insert …
  2> go
  1> insert …
  2> go
  1> insert …
  2> go
  ```

- An explicit transaction encloses data modification commands within begin transaction and commit transaction statements and counts the number of transactions by the number of commit statements. For example, the following set of statements is counted as one transaction:

  ```
  1> begin transaction
  2> insert …
  3> insert …
  4> insert …
  ```

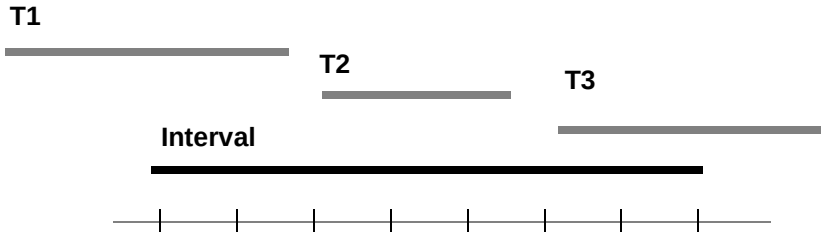
```
5> commit transaction
6> go
```

- In the ANSI transaction model, any select or data modification command starts a transaction, but a commit transaction statement must complete the transaction. sp_sysmon counts the number of transactions by the number of commit transaction statements. For example, the following set of statements is counted as one transaction:

```
1> insert …
2> insert …
3> insert …
4> commit transaction
5> go
```

If there were transactions that started before the sample interval began and completed during the interval, "Committed Xacts" reports a larger number of transactions than the number that started and completed during the sample interval. If transactions do not complete during the interval, "Total # of Xacts" does not include them. In Figure 2-1, both T1 and T2 are counted, but T3 is not.

Figure 2-1: How transactions are counted



How to count multidatabase transactions

Multidatabase transactions are also counted. For example, a transaction that modifies three databases counts as three transactions.

Multidatabase transactions incur more overhead than single database transactions: they require more log records and more user log cache (ULC) flushes, and they involve two-phase commit between the databases.

You can improve performance by reducing the number of multidatabase transactions whenever possible.

Transaction Detail

"Transaction Detail" gives statistical detail about data modification operations by type. The work performed by rolled back transactions is included in the output below, although the transaction is not counted in the number of transactions.

For the "Total Rows" for inserts, updates, and deletes, the "% of total" column reports the percentage of the transaction type as a percentage of all transactions.

See "How updates are performed in Performance" in *Performance and Tuning Series: Query Processing and Abstract Plans* for more information on deferred and direct inserts, updates, and deletes.

In the output for this section, APL indicates allpages-locked tables and DOL indicates data-only-locked tables.

Inserts

The "Inserts" section provides detailed information about the types of inserts taking place on heap tables (including partitioned heap tables), clustered tables, and all inserts as a percentage of all insert, update, and delete operations. "Inserts" displays the number of inserts performed on:

- Allpages-locked heap tables
- Allpages-locked tables with clustered indexes
- Data-only locked tables

Insert statistics do not include fast bulk copy inserts, because those are written directly to the data pages and to disk without the normal insert and logging mechanisms.

APL Heap Tables

"APL Heap Tables" reports the number of row inserts that took place on allpages-locked heap tables—all tables that do not have a clustered index. This includes:

- Partitioned heap tables
- Unpartitioned heap tables
- Slow bulk copy inserts into heap tables

- select into commands
- Inserts into worktables. This is the most common case unless the application heavily uses APL tables without clustered indexes.

The "% of total" column shows the percentage of row inserts into heap tables as a percentage of the total number of inserts.

If there are a large number of inserts to heap tables, determine if these inserts are generating contention.

Check the sp_sysmon report for data on last page locks on heaps in "Lock Detail" on page 83. If there appears to be a contention problem, you can view Monitor Server or query the monitoring tables to determine which tables are involved.

In many cases, creating a clustered index that randomizes insert activity solves the performance problems for heaps. In other cases, you might need to establish partitions on an unpartitioned table or increase the number of partitions on a partitioned table.

APL Clustered Table

"APL Clustered Table" reports the number of row inserts to allpages-locked tables with clustered indexes. The "% of total" column shows the percentage of row inserts to tables with clustered indexes as a percentage of the total number of rows inserted.

Inserts into allpages-locked clustered tables can lead to page splitting.

Adaptive Server may use worktables with clustered indexes to perform vector aggregates (for example, group by), although a hash-based algorithm is more common for Adaptive Server release 15.0 and later.

See "Row ID Updates from Clustered Split" on page 70 and "Page Splits" on page 71.

Data Only Lock Table

"Data Only Lock Table" reports the number of inserts for all data-only-locked tables. The "% of total" column shows the percentage of inserts to data-only-locked tables as a percentage of all inserts.

Total Rows Inserted

"Total Rows Inserted" reports all row inserts to all tables. It gives the average number of all inserts per second, the average number of all inserts per transaction, and the total number of inserts. "% of total" shows the percentage of rows inserted compared to the total number of rows affected by data modification operations.

Updates and update detail sections

The "Updates" report has two sections, "Updates" and "Data Only Locked Updates."

Updates

"Updates" reports the number of deferred and direct row updates. The "% of total" column reports the percentage of each type of update as a percentage of the total number of row updates. sp_sysmon reports the following types of updates:

- APL Deferred
- APL Direct In-place
- APL Direct Cheap
- APL Direct Expensive
- DOL Deferred
- DOL Direct

Direct updates incur less overhead than deferred updates and are generally faster because they limit the number of log scans, reduce locking, save traversal of index B-trees (reducing lock contention), and can save I/O because Adaptive Server does not have to prefetch pages to perform modification based on log records.

For a description of update types, see Chapter 1, "Understanding Query Processing," in *Performance and Tuning Series: Query Processing and Abstract Plans.*

Total Rows Updated

"Total Rows Updated" reports all deferred and direct updates combined. The "% of total" columns shows the percentage of rows updated, based on all rows modified.

Data-Only-Locked Updates

This section reports more detail on updates to data-only-locked tables:

- DOL Replace – the update did not change the length of the row; some or all of the row was changed, resulting in the same row length.
- DOL Shrink – the update shortened the row, leaving noncontiguous empty space on the page to be collected during space reclamation.
- DOL Cheap Expand – the row grew in length; it was the last row on the page, so expanding the length of the row did not require moving other rows on the page.
- DOL Expensive Expand – the row grew in length and required movement of other rows on the page.
- DOL Expand and Forward – the row grew in length, and did not fit on the page. The row was forwarded to a new location.
- DOL Fwd Row Returned – the update affected a forwarded row; the row fit on the page at its original location and was returned to that page.

The total reported in "Total DOL Rows Updated" is not included in the "Total Rows Affected" sum at the end of the section, since the updates in this group provide a different breakdown of the updates already reported in "DOL Deferred" and "DOL Direct."

Deletes

"Deletes" reports the number of deferred and direct row deletes from allpages-locked tables. All deletes on data-only-locked tables are performed by marking the row as deleted on the page, so the categories "direct" and "deferred" do not apply. The "% of total" column reports the percentage of each type of delete as a percentage of the total number of deletes.

Total Rows Deleted

"Total Rows Deleted" reports all deferred and direct deletes combined. The "% of total" column reports the percentage of deleted rows as compared to all rows inserted, updated, or deleted.

Transaction Management

"Transaction Management" reports transaction management activities, including user log cache (ULC) flushes to transaction logs, ULC log records, ULC semaphore requests, log semaphore requests, transaction log writes, and transaction log allocations.

Sample output

```
Transaction Management
----------------------

ULC Flushes to Xact Log        per sec       per xact       count   % of total
-------------------------  ------------  ------------  ----------  ----------
by Full ULC                     1589.5          20.1     1416238      61.0 %
by End Transaction                80.0           1.0       71259       3.1 %
by Change of Database             20.3           0.3       18070       0.8 %
by Single Log Record             805.7          10.2      717844      30.9 %
by Unpin                          88.0           1.1       78390       3.4 %
by Other                          22.6           0.3       20149       0.9 %
-------------------------  ------------  ------------  ----------
Total ULC Flushes               2606.0          33.0     2321950

ULC Log Records                34824.5         440.9    31028656         n/a
Max ULC Size During Sample         n/a           n/a        2048         n/a

ULC Semaphore Requests
Granted                        62902.7         796.4    56046303      100.0 %
Waited                             0.6           0.0         577        0.0 %
-------------------------  ------------  ------------  ----------
Total ULC Semaphore Req        62903.3         796.4    56046880

Log Semaphore Requests
Granted                         2951.1          37.4     2629390       99.0 %
Waited                            31.1           0.4       27737        1.0 %
```

```
------------------------   ------------  ------------  ----------
Total Log Semaphore Req          2982.2          37.8     2657127

Transaction Log Writes            1296.5         16.4     1155198          n/a
Transaction Log Alloc            2379.7          30.1     2120319           n/a
Avg # Writes per Log Page           n/a           n/a      0.54482          n/a
```

ULC Flushes to Xact Log

"ULC Flushes to Xact Log" reports the total number of times that user log caches (ULCs) were flushed to a transaction log. The "% of total" column reports the percentage of times the type of flush took place, for each category, as a percentage of the total number of ULC flushes. This category can help you identify areas in the application that cause problems with ULC flushes.

There is one ULC for each configured user connection. Adaptive Server uses ULCs to buffer transaction log records. On both SMP and single-processor systems, this helps reduce transaction log I/O. For SMP systems, it reduces the contention on the current page of the transaction log.

You can configure ULC size with the configuration parameter user log cache size.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

ULC flushes are caused by the following activities:

- "by Full ULC" – a process's ULC becomes full.
- "by End Transaction" – a transaction ended (rollback or commit, either implicit or explicit).
- "by Change of Database" – a transaction modified an object in a different database (a multidatabase transaction).
- "by System Log Record" – a system transaction (such as an OAM page allocation) occurred within the user transaction.
- "by Unpin" – two transactions are trying to update the same page of a DOL table.
- "by Other" – any other reason, including needing to write to disk.

When one of these activities causes a ULC flush, Adaptive Server copies all log records from the user log cache to the database transaction log.

"Total ULC Flushes" reports the total number of all ULC flushes that took place during the sample interval.

Note In databases with mixed data and log segments, the user log cache is flushed after each record is added.

by Full ULC

A high value for "by Full ULC" indicates that Adaptive Server is flushing the ULCs more than once per transaction, negating some performance benefits of user log caches. If the "% of total" value for "by Full ULC" is greater than 20%, consider increasing the size of the user log cache size parameter.

Increasing the ULC size increases the amount of memory required for each user connection, so you do not want to configure the ULC size to suit a small percentage of large transactions.

by End Transaction

A high value for "by End Transaction" indicates a healthy number of short, simple transactions.

by Change of Database

The ULC is flushed every time there is a database change. If this value is high, consider decreasing the size of the ULC if it is greater than 2K.

by System Log Record and By Other

If either of these values is higher than approximately 20%, and the size of your ULC is more than 2048, consider reducing the ULC size.

Check sections of your sp_sysmon report that relate to log activity:

- Contention for semaphore on the user log caches (SMP only); see "ULC Semaphore Requests" on page 65
- Contention for the log semaphore. (SMP only); see "Log Semaphore Requests" on page 66
- The number of transaction log writes; see "Transaction Log Writes" on page 67

by Unpin

"Unpinning" occurs when two transactions attempt to update the same data page, causing the second transaction to flush the first transaction's user log cache, unpinning the data page from the first transaction's ULC.

Adaptive Server typically uses row-level locking for increased concurrency, since both transactions are trying to update the same page.

Unpinning occurs when:

1 Transaction T1 updates row R1.

2 Adaptive Server logs the update in P1's ULC, ensuring that this data page is pinned to T1's ULC.

3 When T2 tries to update a different row on page P1, it finds that this page is pinned to T1's ULC.

4 To update the page, T2 flushes T1's ULC, unpinning the data page.

To reduce the number of unpins:

- If possible, redesign the application so that it directly requests different data pages.
- If row locking is inevitable, spread the data to more data pages with sp_chgattribute max_rows_per_page.

Total ULC Flushes

"Total ULC Flushes" reports the total number of ULC flushes during the sample interval.

ULC Log Records

This row provides an average number of log records per transaction. It is useful in benchmarking or in controlled development environments to determine the number of log records written to ULCs per transaction.

Many transactions, such as those that affect several indexes or deferred updates or deletes, require several log records for a single data modification. Queries that modify a large number of rows use one or more records for each row.

If this data is unusual, study the data in the next section, Maximum ULC Size, and look at your application for long-running transactions and for transactions that modify large numbers of rows.

Maximum ULC Size

The value in the "count" column is the maximum number of bytes used in any ULC, across all ULCs. This data can help you determine if ULC size is correctly configured.

Since Adaptive Server flushes the ULC when a transaction completes, any unused memory allocated to the ULCs is wasted. If the value in the "count" column is consistently less than the defined value for the user log cache size configuration parameter, reduce user log cache size to the value in the "count" column (but no smaller than 2048 bytes).

When "Max ULC Size" equals the user log cache size, check the number of flushes due to transactions that fill the user log cache (see "by Full ULC" on page 63). If the number of times that logs were flushed due to a full ULC is more than 20%, consider increasing the user log cache size configuration parameter.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

ULC Semaphore Requests

"ULC Semaphore Requests" reports the number of times a user task was immediately granted a semaphore or had to wait for it. "% of total" shows the percentage of tasks granted semaphores and the percentage of tasks that waited for semaphores as a percentage of the total number of ULC semaphore requests. This is relevant only in SMP environments.

"ULC Semaphore Requests" provides the following information:

- Granted – the number of times a task was granted a ULC semaphore immediately upon request. There was no contention for the ULC.
- Waited – the number of times a task tried to write to ULCs and encountered semaphore contention.

- Total ULC Semaphore Requests – the total number of ULC semaphore requests that took place during the interval, including requests that were granted or had to wait.

Log Semaphore Requests

"Log Semaphore Requests" reports of contention for the log semaphore that protects the current page of the transaction log in cache. This data is meaningful for SMP environments only.

This category provides the following information:

- Granted – the number of times a task was granted a log semaphore immediately after it requested one. "% of total" reports the percentage of immediately granted requests as a percentage of the total number of log semaphore requests.
- Waited – the number of times two tasks tried to flush ULC pages to the log simultaneously and one task had to wait for the log semaphore. "% of total" reports the percentage of tasks that had to wait for a log semaphore as a percentage of the total number of log semaphore requests.
- Total Log Semaphore Requests – the total number of times tasks requested a log semaphore including those granted immediately and those for which the task had to wait.

Log Semaphore Contention and User Log Caches

In high throughput environments with a large number of concurrent users committing transactions, a certain amount of contention for the log semaphore is expected. In some tests, very high throughput is maintained, even though log semaphore contention is in the range of 20 to 30%.

High contention is not normal. If you see high contention in your server, perform all the regular tuning procedures, including making sure the storage is properly configured and performing adequately.

Asynchronous Log Service

In high throughput environments that include a large number of concurrent users committing transactions, you can expect contention for the log semaphore.

For more information, see "Asynchronous log service," in *Performance and Tuning Series: Query Processing*.

Transaction Log Writes

"Transaction Log Writes" reports the total number of times Adaptive Server wrote a transaction log page to disk. Transaction log pages are written to disk when a transaction commits (after a wait for a group commit sleep) or when the current log pages become full.

Transaction Log Allocations

"Transaction Log Alloc" reports the number of times additional pages were allocated to the transaction log. This data is useful for comparing to other data in this section and for tracking the rate of transaction log growth.

Avg # Writes per Log Page

"Avg # Writes per Log Page" reports the average number of times each log page was written to disk. The value is reported in the "count" column.

In high throughput applications, this number should be as low as possible. If the transaction log uses 2K I/O, the lowest possible value is 1; with 4K log I/O, the lowest possible value is .5, since one log I/O can write 2 log pages.

In low throughput applications, the number will be significantly higher. In very low throughput environments, it may be as high as one write per completed transaction.

Index Management

"Index Management reports index management activity, including nonclustered maintenance, page splits, and index shrinks.

Sample output

```
Index Management
----------------

Nonclustered Maintenance        per sec      per xact       count   % of total
-------------------------  ------------  ------------  ----------  ----------
Ins/Upd Requiring Maint         1996.3          25.3     1778674      n/a
# of NC Ndx Maint                694.9           8.8      619122      n/a
Avg NC Ndx Maint / Op              n/a           n/a     0.34808      n/a

Deletes Requiring Maint         1922.5          24.3     1712946      n/a
# of NC Ndx Maint                621.1           7.9      553387      n/a
Avg NC Ndx Maint / Op              n/a           n/a     0.32306      n/a

RID Upd from Clust Split           0.0           0.0           0      n/a
# of NC Ndx Maint                  0.0           0.0           0      n/a

Upd/Del DOL Req Maint              9.0           0.1        7989      n/a
# of DOL Ndx Maint                 9.2           0.1        8238      n/a
Avg DOL Ndx Maint / Op             n/a           n/a     1.03117      n/a

Page Splits                       11.7           0.1       10452      n/a
Retries                            0.0           0.0           0      0.0 %
Deadlocks                          0.0           0.0           0      0.0 %
Add Index Level                    0.0           0.0           0      0.0 %

Page Shrinks                       0.1           0.0         124      n/a
Deadlocks                            %
Deadlock Retries Exceeded          0.0           0.0           0      0.0 %

Index Scans                     per sec       per xact      count   % of total
-------------------------  ------------  ------------  ----------  ----------
Ascending Scans                69751.6         883.1    62148709      29.3 %
DOL Ascending Scans           168653.5        2135.3   150270303      70.7 %
Descending Scans                   8.8           0.1        7884       0.0 %
DOL Descending Scans              23.9           0.3       21271       0.0 %
                             -----------   ------------  ----------
Total Scans                    238437.9        3018.8    212448167
```

Nonclustered Maintenance

This category reports the number of operations that required, or potentially required, maintenance to one or more indexes; that is, it reports the number of operations for which Adaptive Server had to at least check to determine whether it was necessary to update the index. The output also gives the number of indexes that were updated and the average number of indexes maintained per operation.

In tables with clustered indexes and one or more nonclustered indexes, all inserts, all deletes, some update operations, and any data page splits require changes to the nonclustered indexes. High values for index maintenance indicate that you should assess the impact of maintaining indexes on Adaptive Server performance. While indexes speed the retrieval of data, maintaining indexes slows data modification. Maintenance requires additional processing, additional I/O, and additional locking of index pages.

Other sp_sysmon output that is relevant to assessing nonclustered indexes is:

- Information on total updates, inserts and deletes, and the number and type of page splits. See "Transaction Detail" on page 57, and "Page Splits" on page 71.
- Information on lock contention. See "Lock Detail" on page 83.
- Information on address lock contention. See "Address Lock Contention" on page 39 and "Exclusive Address and Shared Address" on page 85.

For example, you can compare the number of inserts that took place with the number of maintenance operations that resulted. If a relatively high number of maintenance operations, page splits, and retries occurred, consider the usefulness of indexes in your applications.

See Chapter 5, "Indexes," in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

Ins/Upd Requiring Maint

The data in this section gives information about how insert and update operations affect indexes on allpages-locked tables. For example, an insert to a clustered table with three nonclustered indexes requires updates to all three indexes, so the average number of operations that resulted in maintenance to nonclustered indexes is three.

However, an update to the same table may require only one maintenance operation—to the index for which key value was changed.

- Ins/Upd Requiring Maint – reports the number of insert and update operations to a table with indexes that potentially required modifications to one or more indexes.
- # of NC Ndx Maint – reports the number of nonclustered indexes that required maintenance as a result of insert and update operations.
- Avg NC Ndx Maint/Op – reports the average number of nonclustered indexes per insert or update operation that required maintenance.

For data-only-locked tables, inserts are reported in "Ins/Upd Requiring Maint," and deletes and inserts are reported in "Upd/Del DOL Req Maint."

Deletes Requiring Maintenance

The data in this section gives information about how delete operations affected indexes on allpages-locked tables:

- Deletes Requiring Maint – reports the number of delete operations that potentially required modification to one or more indexes.
- # of NC Ndx Maint – reports the number of nonclustered indexes that required maintenance as a result of delete operations.
- Avg NC Ndx Maint/Op – reports the average number of nonclustered indexes per delete operation that required maintenance.

See "Deletes" on page 60.

Row ID Updates from Clustered Split

This section reports index maintenance activity caused by page splits in allpages-locked tables with clustered indexes. These splits require updating the nonclustered indexes for all of the rows that move to the new data page.

- RID Upd from Clust Split – reports the total number of page splits that required maintenance of a nonclustered index.
- # of NC Ndx Maint – reports the number of nonclustered rows that required maintenance as a result of row ID update operations.
- Avg NC Ndx Maint/Op – reports the average number of nonclustered indexes entries that were updated for each page split.

Upd/Del DOL Req Maint (Data-Only-Locked updates and deletes requiring maintenance)

The data in this section gives information about how updates and deletes affected indexes on data-only-locked tables:

- "Upd/Del DOL Req Maint" reports the number of update and delete operations that potentially required modification to one or more indexes.
- "# of DOL Ndx Main" reports the number of indexes that required maintenance as a result of update or delete operations.
- "Avg DOL Ndx Maint/Op" reports the average number of indexes per update or delete operation that required maintenance.

Page Splits

"Page Splits" reports the number of page splits for data pages, clustered index pages, or nonclustered index pages that occurred because there was not enough room for a new row.

When a data row is inserted into an allpages-locked table with a clustered index, the row must be placed in physical order according to the key value. Index rows must also be placed in physical order on the pages. If there is not enough room on a page for a new row, Adaptive Server splits the page, allocates a new page, and moves some rows to the new page. Page splitting incurs overhead because it updates the parent index page and the page pointers on the adjoining pages and adds lock contention. For clustered indexes, page splitting also updates all nonclustered indexes that point to the rows on the new page.

See Chapter 5, "Indexes," in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

Reducing page splits for ascending key inserts

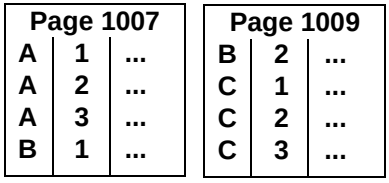
If "Page Splits" is high and your application is inserting values into an allpages-locked table with a clustered index on a compound key, you may be able to reduce the number of page splits through a special optimization that changes the page split point for these indexes.

The special optimization is designed to reduce page splitting and to result in more completely filled data pages. This affects only clustered indexes with compound keys, where the first key is already in use in the table, and the second column is based on an increasing value.

Default data page splitting

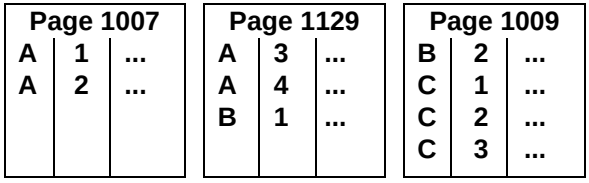
The table sales has a clustered index on store_id, customer_id. There are three stores (A, B, and C). Each store adds customer records in ascending numerical order. The table contains rows for the key values A,1; A,2; A,3; B,1; B,2; C,1; C,2; and C,3, and each page holds four rows, as shown in Figure 2-2.

Figure 2-2: Clustered table before inserts



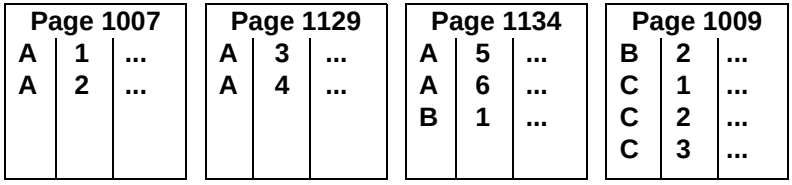
Using the normal page-splitting mechanism, inserting "A,4" results in allocating a new page and moving half of the rows to it, and inserting the new row in place, as shown in Figure 2-3.

Figure 2-3: Insert causes a page split



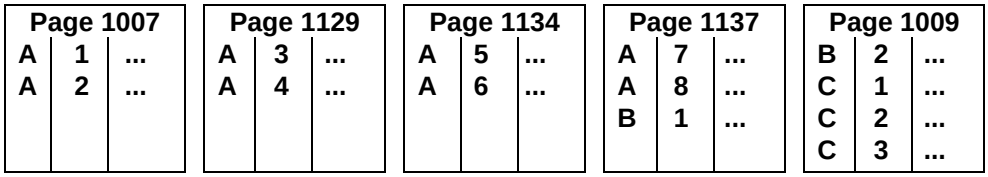
When "A,5" is inserted, no split is needed, but when "A,6" is inserted, another split takes place, as shown in Figure 2-4.

Figure 2-4: Another insert causes another page split



Adding "A,7" and "A,8" results in yet another page split, as shown in Figure 2-5.

Figure 2-5: Page splitting continues

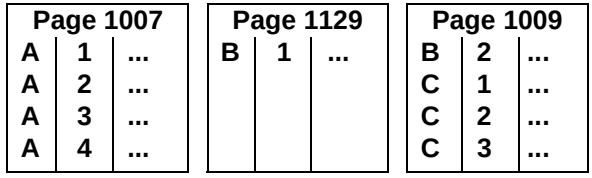


For more information about data page splits, see Chapter 12, "How Indexes Work," in the *Performance and Tuning: Basics*

Effects of ascending inserts

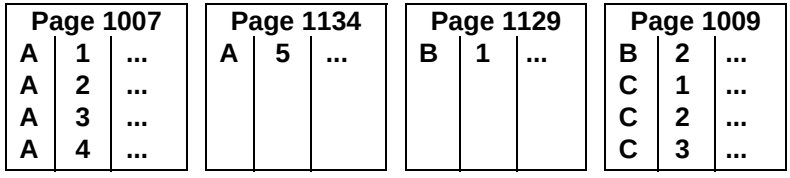
You can set ascending inserts mode for a table, so that pages are split at the point of the inserted row rather than in the middle of the page. Starting from the original table shown in Figure 2-2 on page 72, the insertion of "A,4" results in a split at the insertion point, with the remaining rows on the page moving to a newly allocated page, as shown in Figure 2-6.

Figure 2-6: First insert with ascending inserts mode



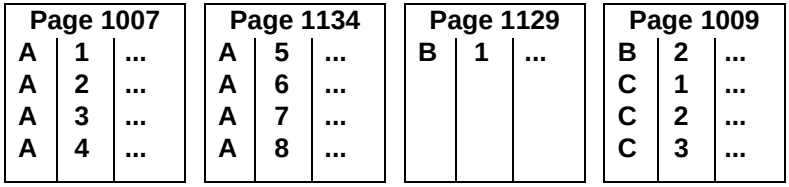
Inserting "A,5" causes a new page to be allocated, as shown in Figure 2-7.

Figure 2-7: Additional ascending insert causes a page allocation



Adding "A,6", "A,7", and "A,8" fills the new page, as shown in Figure 2-8.

Figure 2-8: Additional inserts fill the new page



Setting ascending inserts mode for a table

To turn on ascending insert mode for the sales table, use:

```
dbcc tune (ascinserts, 1, "sales")
```

To turn ascending insert mode off, use:

```
dbcc tune (ascinserts, 0, "sales")
```

These commands update the status2 bit of sysindexes.

If tables sometimes experience random inserts and have more ordered inserts during batch jobs, enable dbcc tune (ascinserts) only for the period during which the batch job runs.

Retries and Deadlocks

"Deadlocks" reports the number of index page splits and shrinks that resulted in deadlocks. Adaptive Server has a mechanism called deadlock retries that attempts to avoid transaction rollbacks caused by index page deadlocks. "Retries" reports the number of times Adaptive Server used this mechanism.

Deadlocks on index pages take place when each of two transactions needs to acquire locks held by the other transaction. On data pages, deadlocks result in choosing one process (the one with the least accumulated CPU time) as a deadlock victim and rolling back the process.

By the time an index deadlock takes place, the transaction has already updated the data page and is holding data page locks, so rolling back the transaction causes overhead.

In a large percentage of index deadlocks caused by page splits and shrinks, both transactions can succeed by dropping one set of index locks, and restarting the index scan. The index locks for one of the processes are released (locks on the data pages are still held), and Adaptive Server tries the index scan again, traversing the index from the root page of the index.

Usually, by the time the scan reaches the index page that needs to be split, the other transaction has completed, and no deadlock takes place. By default, any index deadlock that is due to a page split or shrink is retried up to five times before the transaction is considered deadlocked and is rolled back.

For information on changing the default value for the number of deadlock retries with sp_configure "deadlock retries", see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

The deadlock retries mechanism causes the locks on data pages to be held slightly longer than usual and causes increased locking and overhead. However, the mechanism reduces the number of transactions that are rolled back due to deadlocks. The default setting provides a reasonable compromise between the overhead of holding data page locks longer and the overhead of rolling back transactions that have to be reissued.

A high number of index deadlocks and deadlock retries indicates high contention in a small area of the index B-tree.

If your application encounters a high number of deadlock retries, reduce page splits using fillfactor when you re-create the index.

See Chapter 5, "Indexes," in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

Add Index Level

"Add Index Level" reports the number of times a new index level was added. This happens infrequently, so expect to see result values of 0 most of the time. The count could have a value of 1 or 2 if your sample includes inserts into an empty table or into a small table with indexes.

Page Shrinks

"Page Shrinks" reports the number of times that deleting index rows caused the index to shrink off a page. Shrinks incur overhead due to locking in the index and the need to update pointers on adjacent pages. Repeated "count" values greater than 0 indicate there may be many pages in the index with fairly small numbers of rows per page due to delete and update operations. If there are a high number of shrinks, consider rebuilding the indexes.

Index Scans

"Index Scans" reports forward and backward scans by lock scheme:

- Ascending Scans – reports the number of forward scans on allpages-locked tables.
- DOL Ascending Scans – reports the number of forward scans on data-only-locked tables.
- Descending Scans – reports the number of backward scans on allpages-locked tables.
- DOL Descending Scans – reports the number of backward scans on data-only-locked tables.

For more information on forward and backward scans, see "Indexes" in *Performance and Tuning Series: Locking and Concurrency Control*.

Metadata Cache Management

"Metadata Cache Management" reports the use of the metadata caches that store information about the three types of metadata: objects, indexes, and databases. This section also reports the number of object, index, and database descriptors that were active during the sample interval, and the maximum number of descriptors used since the server was last started. It also reports spinlock contention for the object and index metadata caches.

Sample output

```
Metadata Cache Management
-------------------------

Metadata Cache Summary              per sec   per xact     count    % of total
-------------------------          ---------  --------  --------    ---------

Open Object Usage
Active                                 n/a         n/a       4604       n/a
Max Ever Used Since Boot               n/a         n/a       4612       n/a
Free                                   n/a         n/a      25396       n/a
Reuse Requests
Succeeded                              n/a         n/a          0       n/a
```

```
Failed                                  n/a          n/a            0        n/a

Open Index Usage
Active                                  n/a          n/a         2747        n/a
Max Ever Used Since Boot                n/a          n/a         2753        n/a
Free                                    n/a          n/a         2253        n/a
Reuse Requests
Succeeded                               n/a          n/a            0        n/a
Failed                                  n/a          n/a            0        n/a

Open Partition Usage
Active                                  n/a          n/a         2747        n/a
Max Ever Used Since Boot                n/a          n/a         2753        n/a
Free                                    n/a          n/a         2253        n/a
Reuse Requests
Succeeded                               n/a          n/a            0        n/a
Failed                                  n/a          n/a            0        n/a

Open Database Usage
Active                                  n/a          n/a           32        n/a
Max Ever Used Since Boot                n/a          n/a           32        n/a
Free                                    n/a          n/a           18        n/a
Reuse Requests
Succeeded                               n/a          n/a            0        n/a
Failed                                  n/a          n/a            0        n/a

Object Manager Spinlock Contention      n/a          n/a          n/a        1.3 %

Object Spinlock Contention              n/a          n/a          n/a        0.0 %

Index Spinlock Contention               n/a          n/a          n/a        0.0 %

Index Hash Spinlock Contention          n/a          n/a          n/a        0.0 %

Partition Spinlock Contention           n/a          n/a          n/a        0.0 %

Partition Hash Spinlock Contention      n/a          n/a          n/a        0.0 %
```

Open Object, Index, and Database Usage

Each of these sections contains the same information for the three types of metadata caches. The output provides this information:

- "Active" reports the number of objects, indexes, or databases that were active during the sample interval.

- "Max Ever Used Since Boot" reports the maximum number of descriptors used since the last restart of Adaptive Server.
- "Free" reports the number of free descriptors in the cache.
- "Reuse Requests" reports the number of times that the cache had to be searched for reusable descriptors:
  - "Failed" means that all descriptors in cache were in use and that the client issuing the request received an error message.
  - "Succeeded" means the request found a reusable descriptor in cache. Even though "Succeeded" means that the client did not get an error message, Adaptive Server is doing extra work to locate reusable descriptors in the cache and to read metadata information from disk.

You can use this information to set the configuration parameters number of open indexes, number of open objects, and number of open databases, as shown in Table 2-1.

Table 2-1: Action to take based on metadata cache usage statistics

***sp_sysmon* output**	**Action**
Large number of "Free" descriptors	Set parameter lower
Very few "Free" descriptors	Set parameter higher
"Reuse Requests Succeeded" nonzero	Set parameter higher
"Reuse Requests Failed" nonzero	Set parameter higher

Object Manager Spinlock Contention

This is a server-wide spinlock used to manage internal states of the object descriptor.

If the contention on this spinlock is greater than 10%, use dbcc tune(des_bind) to reduce contention and improve the server's scalability. See dbcc tune(des_bind) in the *Adaptive Server Enterprise Reference Manual*.

Object and Index Spinlock Contention

These sections report on spinlock contention on the object descriptor and index descriptor caches. Use this information to tune the configuration parameters open object spinlock ratio and open index spinlock ratio. If the reported contention is more than 3%, decrease the value of the corresponding parameter to lower the number of objects or indexes protected by a single spinlock.

Hash Spinlock Contention

This section reports contention for the spinlock on the index metadata cache hash table. You can use this information to tune the open index hash spinlock ratio configuration parameter. If the reported contention is greater than 3%, decrease the value of the parameter.

Using *sp_monitorconfig* to find metadata cache usage statistics

sp_monitorconfig displays metadata cache usage statistics on certain shared server resources, including:

- The number of databases, objects, and indexes that can be open at any one time
- The number of auxiliary scan descriptors used by referential integrity queries
- The number of free and active descriptors
- The percentage of active descriptors
- The maximum number of descriptors used since the server was last started
- The current size of the procedure cache and the amount actually used

For example, suppose the number of open indexes configuration parameter is 500. During a peak period, you can run sp_monitorconfig to get an accurate reading of the actual metadata cache usage for index descriptors:

```
1> sp_monitorconfig "number of open indexes"

Usage information at date and time: Apr 22 2002  2:49PM.
Name             num_free  num_active  pct_act  Max_Used  Reused
--------------   --------  ----------  -------  --------  ------
number of open        217         283    56.60       300  No
```

In this report, the maximum number of open indexes used since the server was last started is 300, even though Adaptive Server is configured for 500. Therefore, you can reset the number of open indexes configuration parameter to 330, to accommodate the 300 maximum used index descriptors, plus space for 10 percent more.

You can also determine the current size of the procedure cache with sp_monitorconfig 'procedure cache size,' which describes the amount of space in the procedure cache and the most space it has ever actually used. For example, the procedure cache in the following server is configured for 20,000 pages:

```
1> sp_configure "procedure cache size"

option_name                    config_value run_value
------------------------------ ------------ ---------
procedure cache size                  20000      3271
```

However, when you run sp_montorconfig “procedure cache size”, you find that the most the procedure cache has ever used is 14241 pages, which means you can save memory by lowering the run value of the procedure cache:

```
1> sp_monitorconfig "procedure cache size"

Usage information at date and time: Apr 22 2002  2:49PM.
Name                num_free  num_active  pct_act  Max_Used  Reused
--------------      --------  ----------  -------  --------  ------
procedure cache         5878       14122    70.61     14241  No
```

Lock Management

“Lock Management” reports locks, deadlocks, lock promotions, and lock contention.

Sample output

```
Lock Management
---------------

Lock Summary                    per sec      per xact       count   % of total
------------------------   ------------   -----------   ---------   ---------
Total Lock Requests          279236.5        6878.6   167541893         n/a
Avg Lock Contention               1.2           0.0         691       0.0 %
Deadlock Percentage               0.0           0.0           0       0.0 %

Lock Detail                    per sec      per xact       count   % of total
------------------------   ------------   -----------   ---------   ---------

Table Lock Hashtable
  Lookups                       9571.4         235.8     5742818         n/a
  Avg Chain Length                 n/a           n/a     0.00981         n/a
  Spinlock Contention              n/a           n/a         n/a        0.2 %

Exclusive Table
  Granted                         14.3           0.4        8580      100.0 %
```

```
  Waited                        0.0           0.0           0         0.0 %
------------------------  ------------  ------------  ----------  ----------
Total EX-Table Requests          14.3           0.4        8580         0.0 %

Shared Table
  Total SH-Table Requests         0.0           0.0           0          n/a

Exclusive Intent
  Granted                       139.7           3.4       83793       100.0 %
  Waited                          0.0           0.0           0         0.% 
------------------------  ------------  ------------  ----------  ----------
Total EX-Intent Requests        139.7           3.4       83793         0.1 %

Shared Intent
  Granted                      9412.9         231.9     5647759       100.0 %
  Waited                          0.0           0.0           0         0.0 %
------------------------  ------------  ------------  ----------  ----------
Total SH-Intent Requests        9412.9         231.9     5647759         3.4 %

Page & Row Lock HashTable
  Lookups                     173637.2        4277.3   104182335          n/a
  Avg Chain Length                n/a           n/a     0.01387          n/a
  Spinlock Contention             n/a           n/a         n/a         0.4 %

Exclusive Page
  Granted                       306.5           7.6      183911       100.0 %
  Waited                          0.0           0.0           2         0.0 %
------------------------  ------------  ------------  ----------  ----------
Total EX-Page Requests          306.5           7.6      183913         0.1 %

Update Page
  Granted                     19052.6         469.3    11431583       100.0 %
  Waited                          0.1           0.0          60         0.0 %
------------------------  ------------  ------------  ----------  ----------
Total UP-Page Requests        19052.7         469.3    11431643         6.8 %

Shared Page
  Granted                     63587.2        1566.4    38152347       100.0 %
  Waited                          0.0           0.0           0         0.0 %
------------------------  ------------  ------------  ----------  ----------
Total SH-Page Requests        63587.2        1566.4    38152347        22.8 %

Exclusive Row
  Granted                       33.9           0.8       20326       100.0 %
  Waited                          0.0           0.0           0         0.0 %
------------------------  ------------  ------------  ----------  ----------
```

```
Total EX-Row Requests              33.9           0.8       20326        0.0 %

Update Row
  Granted                          10.1           0.2        6030       98.2 %
  Waited                            0.2           0.0         108        1.8 %
------------------------  ------------  ------------  ----------  ----------
Total UP-Row Requests              10.2           0.3        6138        0.0 %

Shared Row
  Granted                       88431.3        2178.4    53058781      100.0 %
  Waited                            0.0           0.0           0        0.0 %
------------------------  ------------  ------------  ----------  ----------
Total SH-Row Requests          88431.3        2178.4    53058781       31.7 %

Next-Key
  Total Next-Key Requests           0.0           0.0           0         n/a

Address Lock Hashtable
  Lookups                       98247.7        2420.2    58948613         n/a
  Avg Chain Length                  n/a           n/a     0.00019         n/a
  Spinlock Contention               n/a           n/a         n/a        0.5 %

Exclusive Address
  Granted                        2758.9          68.0     1655359      100.0 %
  Waited                            0.6           0.0         380        0.0 %
------------------------  ------------  ------------  ----------  ----------
Total EX-Address Requests        2759.6          68.0     1655739        1.0 %

Shared Address
  Granted                       95487.9        2352.2    57292733      100.0 %
  Waited                            0.2           0.0         141        0.0 %
------------------------  ------------  ------------  ----------  ----------
Total SH-Address Requests       95488.1        2352.2    57292874       34.2 %

Last Page Locks on Heaps
  Granted                         799.4          19.7      479637      100.0 %
  Waited                            0.0           0.0           0        0.0 %
------------------------  ------------  ------------  ----------  ----------
Total Last Pg Locks               799.4          19.7      479637      100.0 %

Deadlocks by Lock Type           per sec      per xact       count   % of total
------------------------  ------------  ------------  ----------  ----------
Total Deadlocks                   0.0           0.0           0         n/a

Deadlock Detection
  Deadlock Searches               0.0           0.0          19         n/a
```

```
  Searches Skipped                    0.0           0.0            0         0.0 %
  Avg Deadlocks per Search            n/a           n/a      0.00000           n/a

Lock Promotions
  Total Lock Promotions             0.0             0.0            0           n/a
Lock Timeouts by Lock Type        per sec       per xact        count    % of total
------------------------    ------------    -----------    ---------    ---------
Total Timeouts                       0.0            0.0            0           n/a
```

"Lock Promotions" reports detail rows even if there were no occurrences of them during the sample interval; for example, "Deadlocks by Lock Type" in the above sample output.

Lock Summary

"Lock Summary" provides overview statistics about lock activity that took place during the sample interval.

- "Total Lock Requests" reports the total number of lock requests.
- "Avg Lock Contention" reports the average number of times there was lock contention as a percentage of the total number of lock requests.

  If the value is insufficient in determining how severe the lock contention is. To determine the severity of the lock contention, query the monSysWaits, monProcessWaits, and monLocks monitoring tables, or use sp_object_stats. For more information, see *Performance and Tuning Series: Monitoring Tables*. See the *Adaptive Server Reference Manual: Procedures* for more information about sp_object_stats. See *Performance and Tuning Series: Locking and Concurrency Control* for more information on tuning locking behavior.
- "Deadlock Percentage" reports the percentage of deadlocks as a percentage of the total number lock requests. If this value is high, see "Deadlocks by Lock Type" on page 86.

Lock Detail

"Lock Detail" provides information that you can use to determine whether the application is causing a lock contention or deadlock-related problem.

This output reports locks by type, displaying the number of times that each lock type was immediately granted and the number of times a task had to wait for a particular type of lock. The "% of total" is the percentage of the specific lock type that was granted or had to wait with respect to the total number of lock requests.

"Lock Detail" reports these types of locks:

- Exclusive Table
- Shared Table
- Exclusive Intent
- Shared Intent
- Exclusive Page
- Update Page
- Shared Page
- Exclusive Row
- Update Row
- Shared Row
- Exclusive Address
- Shared Address
- Last Page Locks on Heaps

Lock contention can have a large impact on Adaptive Server performance. Table locks generate more lock contention than page or row locks because no other tasks can access a table while there is an exclusive table lock on it, and, if a task requires an exclusive table lock, it must wait until all shared locks are released. If lock contention is high, run sp_object_stats to help pinpoint the tables involved.

"Avg Hash Chain Length" reports the average number of locks per hash bucket during the sample interval. You can configure the size of the lock hash table with the configuration parameter lock hashtable size. If the average number of locks per hash chain is more than four, consider increasing the size of the hash table.

Large inserts with bulk copy are an exception to this guideline. Lock hash chain lengths may be longer during large bulk copies.

See Chapter 2, "Locking Configuration and Tuning," in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Exclusive Address and Shared Address

"Exclusive Address" and "Shared Address" report the number of times address locks were immediately granted or the number of times the task had to wait for the lock. Address locks are held on index pages of allpages-locked tables. Address locks can have serious impact, since a lock on an index page blocks access to all data pages pointed to by the index page.

Last Page Locks on Heaps

"Last Page Locks on Heaps" reports locking attempts on the last page of a partitioned or unpartitioned heap table. It only reports on allpages-locked tables.

This information can indicate whether there are tables in the system that would benefit from using data-only-locking from partitioning, or from increasing the number of partitions. Adding a clustered index that distributes inserts randomly across the data pages may also help. If you know that one or more tables is experiencing a problem with contention for the last page, Monitor Server or the monitoring tables can help determine which table is experiencing the problem. See the *Monitor Server User's Guide* and the *Performance and Tuning Series: Monitoring Tables* for more information.

See Chapter 1, "Controlling Physical Data Placement," in *Performance and Tuning Series: Physical Database Tuning* for information on how partitions can help solve the problem of last-page locking on unpartitioned heap tables.

Table Lock Hashtable

"Lock Hashtable Lookups" reports the number of times the lock hash table was searched for a lock on a page, row, or table.

You can configure the size of the lock hash table with the configuration parameter lock hashtable size. If the average number of locks per hash chain is more than four, consider increasing the size of the hash table.

See Chapter 2, “Locking Configuration and Tuning,” in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

Deadlocks by Lock Type

“Deadlocks by Lock Type” reports the number of specific types of deadlocks. “% of total” gives the number of each deadlock type as a percentage of the total number of deadlocks.

Deadlocks may occur when many transactions execute at the same time in the same database. They become more common as the lock contention increases between the transactions.

This category reports data for these deadlock types:

- Exclusive Table
- Shared Table
- Exclusive Intent
- Shared Intent
- Exclusive Page
- Update Page
- Shared Page
- Exclusive Row
- Update Row
- Shared Row
- Shared Next-Key
- Exclusive Address
- Shared Address
- Others

“Total Deadlocks” summarizes the data for all lock types.

As in the example for this section, if there are no deadlocks, sp_sysmon does not display any detail information, it only prints the “Total Deadlocks” row with zero values.

To pinpoint where deadlocks occur, do one or both of:

- Use sp_object_stats.

  See Chapter 2, "Locking Configuration and Tuning," in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

- Enable printing of detailed deadl,ock information to the log.

  See Chapter 3, "Locking Reports" in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

Deadlock Detection

"Deadlock Detection" reports the number of deadlock searches that found deadlocks and the number of deadlock searches that were skipped during the sample interval.

See Chapter 3, "Locking Reports," in *Performance and Tuning Series: Locking and Concurrency Control* for more information.

Deadlock Searches

"Deadlock Searches" reports the number of times that Adaptive Server initiated a deadlock search during the sample interval. Deadlock checking is time-consuming overhead for applications that experience no deadlocks or very low levels of deadlocking. You can use this data with "Average Deadlocks per Search" on page 88 to determine if Adaptive Server is checking for deadlocks too frequently.

Searches Skipped

"Searches Skipped" reports the number of times that a task started to perform deadlock checking, but found deadlock checking in progress and skipped its check. "% of total" reports the percentage of deadlock searches that were skipped as a percentage of the total number of searches.

When a process is blocked by lock contention, it waits for an interval of time set by the configuration parameter deadlock checking period. When this period elapses, the process starts deadlock checking. If a search is already in progress, the process skips the search.

If you see some number of searches skipped, but some of the searches are finding deadlocks, increase the parameter slightly. If you see a lot of searches skipped, and no deadlocks, or very few, increase the parameter by a larger amount.

For more information about configuration parameters, see Chapter 5, “Setting Configuration Parameters, in the *System Administration Guide, Volume 1*.

Average Deadlocks per Search

“Avg Deadlocks per Search” reports the average number of deadlocks found per search.

This category measures whether Adaptive Server is checking for deadlocks too frequently. If your applications rarely deadlock, adjust the frequency with which tasks search for deadlocks by increasing the value of the deadlock checking period configuration parameter.

For more information about configuration parameters, see Chapter 5, “Setting Configuration Parameters,” in the *System Administration Guide, Volume 1*.

Lock Promotions

“Lock Promotions” reports the number of times that the following escalations took place:

- “Ex-Page to Ex-Table” – exclusive page to exclusive table.
- “Sh-Page to Sh-Table” – shared page to shared table.
- “Ex-Row to Ex-Table” – exclusive row to exclusive table.
- “Sh-Row to Sh-Table – shared row to shared table.
- “Sh-Next-Key to Sh-Table” – shared next-key to shared table.

“Total Lock Promotions” reports the average number of lock promotion types combined per second and per transaction.

If no lock promotions took place during the sample interval, only the total row is printed.

If there are no lock promotions, sp_sysmon does not display the detail information.

“Lock Promotions” data can:

- Help you to detect whether lock promotion in your application is a cause of lock contention and deadlocks
- Be used before and after tuning lock promotion variables to determine the effectiveness of the values.

Look at the "Granted" and "Waited" data for signs of contention. If lock contention is high and lock promotion is frequent, consider changing the lock promotion thresholds for the tables involved.

You can configure the lock promotion threshold either server-wide or for individual tables.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Lock Time-out Information

"Lock Time-outs by Lock Type" reports on the number of times a task was waiting for a lock and the transaction was rolled back due to a session-level or server-level lock timeout. The detail rows that show the lock types are printed only if lock timeouts occurred during the sample period. If no lock time-outs occurred, "Total Lock Time-outs" is displayed with all values equal to 0.

For more information on lock time-outs, see Chapter 4, "Using Locking Commands," in *Performance and Tuning Series: Locking and Concurrency Control*.

Data Cache Management

sp_sysmon reports summary statistics for all caches, followed by statistics for each named cache.

sp_sysmon reports the following activities for the default data cache and for each named cache:

- Spinlock contention
- Utilization
- Cache searches, including hits and misses
- Pool turnover for all configured pools
- Buffer wash behavior, including buffers passed clean, buffers already in I/O, and buffers washed dirty
- Prefetch requests performed and denied
- Dirty read page requests

Use sp_cacheconfig and sp_helpcache output to help analyze the data from this section of the report. sp_cacheconfig provides information about caches and pools, and sp_helpcache provides information about objects bound to caches.

See Chapter 4, "Configuring Data Caches," in *System Administration Guide: Volume 2* for information on how to use these system procedures.

See Chapter 5, "Memory Use and Performance," in *Performance and Tuning Series: Basics* for more information on performance issues and named caches.

Sample output

The following sample shows sp_sysmon output for the "Data Cache Management" categories. The first block of data, "Cache Statistics Summary," includes information for all caches. sp_sysmon reports a separate block of data for each cache. These blocks are identified by the cache name. The sample output shown here includes only the default data cache, although there were more caches configured during the interval.

```
Data Cache Management
---------------------

Cache Statistics Summary (All Caches)
-------------------------------------
                              per sec       per xact       count   % of total
                            ----------     -----------    -------    --------
Cache Search Summary
  Total Cache Hits             39472.3        185026.5   11841696     99.9 %
  Total Cache Misses              33.8           158.4      10139      0.1 %
-----------------------   ------------    ------------   --------
Total Cache Searches           39506.1        185184.9   11851835

Cache Turnover
  Buffers Grabbed                177.0           829.6      53097        n/a
  Buffers Grabbed Dirty            0.0             0.0          0      0.0 %

Cache Strategy Summary
  Cached (LRU) Buffers         35931.1        168427.1   10779332     98.6 %
  Discarded (MRU) Buffers        511.7          2398.4     153500      1.4 %

Large I/O Usage
  Large I/Os Performed            46.9           219.9      14071     94.5 %

Large I/Os Denied due to
  Pool < Prefetch Size             2.5            11.6        745      5.0 %
```

```
  Pages Requested
  Reside in Another
  Buffer Pool                      0.3             1.3          80       0.5 %
----------------------   ------------    ------------   --------
Total Large I/O Requests          49.7           232.8       14896

Large I/O Effectiveness
  Pages by Lrg I/O Cached        171.3           803.1       51398         n/a
  Pages by Lrg I/O Used          567.2          2658.7      170157     331.1 %

Asynchronous Prefetch Activity
  APFs Issued                      9.6            45.0        2878       1.2 %
  APFs Denied Due To
    APF I/O Overloads              0.0             0.0           0       0.0 %
    APF Limit Overloads            0.0             0.0           0       0.0 %
    APF Reused Overloads           0.0             0.0           0       0.0 %
    APF Buffers Found in Cache
      With Spinlock Hel            1.7             7.8         501       0.2 %
      W/o Spinlock Held          787.1          3689.5      236128      98.6 %
----------------------   ------------    ------------   --------
Total APFs Requested             798.4          3742.3      239507

  Other Asynchronous Prefetch Statistics
    APFs Used                      9.4            43.9        2808         n/a
    APF Waits for I/O              6.8            31.8        2034         n/a
    APF Discards                   0.0             0.0           0         n/a

Dirty Read Behavior
    Page Requests                  0.0             0.0           0         n/a

-------------------------------------------------------------------------------
Cache: default data cache
                               per sec       per xact       count   % of total
                          ----------     -----------    -------    --------
  Spinlock Contention             n/a             n/a         n/a       2.8 %

  Utilization                     n/a             n/a         n/a      82.9 %

  Cache Searches
    Cache Hits                32731.6        153429.6     9819492     100.0 %
      Found in Wash             288.4          1351.7       86508       0.9 %
    Cache Misses                 10.9            50.9        3257       0.0 %
----------------------   ------------    ------------   ----------
Total Cache Searches          32742.5        153480.5     9822749

Pool Turnover
```

```
  2  Kb Pool
    LRU Buffer Grab              123.0           576.7         36908     92.5 %
      Grabbed Dirty                0.0             0.0             0      0.0 %
  16 Kb Pool
    LRU Buffer Grab               10.0            47.1          3012      7.5 %
      Grabbed Dirty                0.0             0.0             0      0.0 %
----------------------   ------------    ------------    ----------
Total Cache Turnover             133.1           623.8         39920

Buffer Wash Behavior
  Statistics Not Available - No Buffers Entered Wash Section Yet

Cache Strategy
  Cached (LRU) Buffers         30012.1        140681.9       9003640    98.3 %
  Discarded (MRU) Buffers        511.7          2398.4        153500     1.7 %

Large I/O Usage
  Large I/Os Performed            10.0            47.1          3012    80.2 %

  Large I/Os Denied due to
    Pool < Prefetch Size           0.8             3.9           247     6.6 %
    Pages Requested
    Reside in Another
    Buffer Pool                    1.7             7.8           498    13.3 %
----------------------   ------------    ------------    ----------
Total Large I/O Requests          12.5            58.7          3757

Large I/O Detail
  4   Kb Pool
    Pages Cached                   0.0             0.0             0       n/a
    Pages Used                     0.0             0.0             0       n/a
  16  Kb Pool
    Pages Cached                  80.3           376.5         24096       n/a
    Pages Used                    76.1           356.5         22817    94.7 %




Dirty Read Behavior
      Page Requests                0.0             0.0             0       n/a


--------------------------------------------------------------------------------
Cache: pub_log_cache
                                per sec        per xact      count  % of total
                           ----------     -----------    ----------  -------
```

```
  Spinlock Contention                n/a             n/a           n/a    0.2 %

  Utilization                        n/a             n/a           n/a    9.1 %

  Cache Searches
    Cache Hits                    3591.9         16837.1       1077574  100.0 %
      Found in Wash                  0.0             0.0             0    0.0 %
    Cache Misses                     0.0             0.0             0    0.0 %
-----------------------   ------------    ------------    ----------
Total Cache Searches              3591.9         16837.1       1077574

Pool Turnover
  2  Kb Pool
L    RU Buffer Grab                 0.3             1.3            80    0.8 %
      Grabbed Dirty                 0.0             0.0             0     0.0 %
  4  Kb Pool
    LRU Buffer Grab                33.9           158.9         10171   99.2 %
      Grabbed Dirty                 0.0             0.0             0    0.0 %
-----------------------   ------------    ------------    ----------
Total Cache Turnover              34.2           160.2         10251

Buffer Wash Behavior
  Statistics Not Available - No Buffers Entered Wash Section Yet

Cache Strategy
  Cached (LRU) Buffers          2872.7         13465.9        861817  100.0 %
  Discarded (MRU) Buffers          0.0             0.0             0    0.0 %

Large I/O Usage
Large I/Os Performed              33.9           158.9         10171   99.2 %

Large I/Os Denied due to
  Pool < Prefetch Size             0.0             0.0             0    0.0 %
  Pages Requested
  Reside in Another
  Buffer Pool                      0.3             1.3            80    0.8 %
-----------------------   ------------    ------------    ----------
Total Large I/O Requests          34.2           160.2         10251

Large I/O Detail
  4   Kb Pool
    Pages Cached                  67.8           317.8         20342       n/a
    Pages Used                    67.8           317.8         20342   100.0 %

Dirty Read Behavior
    Page Requests                  0.0             0.0             0      n/a
```

```
---------------------------------------------------------------------------
Cache: tempdb_data_cache
                              per sec        per xact      count  % of total
                           ----------     -----------    ----------  -------
  Spinlock Contention             n/a             n/a          n/a      0.0 %

  Utilization                     n/a             n/a          n/a      8.0 %

Cache Searches
  Cache Hits                  3148.8         14759.8       944630     99.3 %
    Found in Wash                7.9            37.0         2365      0.3 %
Cache Misses                    22.9           107.5         6882      0.7 %
-----------------------   ------------    ------------   ----------
Total Cache Searches            3171.7         14867.4       951512

Pool Turnover
  2  Kb Pool
    LRU Buffer Grab              6.8            31.8         2038     69.7 %
      Grabbed Dirty              0.0             0.0            0      0.0 %
  4  Kb Pool
    LRU Buffer Grab              0.1             0.4           24      0.8 %
      Grabbed Dirty              0.0             0.0            0      0.0 %
  16 Kb Pool
    LRU Buffer Grab              2.9            13.5          864     29.5 %
      Grabbed Dirty              0.0             0.0            0       0.0%
-----------------------   ------------    ------------   ----------
Total Cache Turnover             9.8            45.7         2926

Buffer Wash Behavior
  Statistics Not Available - No Buffers Entered Wash Section Yet


Cache Strategy
  Cached (LRU) Buffers        3046.3         14279.3       913875    100.0 %
  Discarded (MRU) Buffers        0.0             0.0            0      0.0 %

Large I/O Usage
  Large I/Os Performed            3.0            13.9          888    100.0 %

  Large I/Os Denied due to
    Pool < Prefetch Size          0.0             0.0            0      0.0 %
    Pages Requested
    Reside in Another
    Buffer Pool                   0.0             0.0            0      0.0 %
-----------------------   ------------    ------------   ----------
Total Large I/O Requests          3.0            13.9          888
```

```
  Large I/O Detail
    4   Kb Pool
      Pages Cached                0.2              0.8              48         n/a
      Pages Used                  0.2              0.7              47      97.9 %
    16  Kb Pool
      Pages Cached               23.0            108.0            6912         n/a
      Pages Used                  2.9             13.5             864      12.5 %

Dirty Read Behavior
      Page Requests               0.0              0.0               0         n/a
```

Cache Statistics Summary (All Caches)

This section summarizes behavior for the default data cache and all named data caches combined. Corresponding information is printed for each data cache. See “Cache Management by Cache” on page 100.

Cache Search Summary

This section provides summary information about cache hits and misses. Use this data as an overview of how effective cache design is. A high number of cache misses indicates that you should investigate statistics for each cache.

- “Total Cache Hits” reports the number of times that a needed page was found in any cache. “% of total” reports the percentage of cache hits as a percentage of the total number of cache searches.
- “Total Cache Misses” reports the number of times that a needed page was not found in a cache and had to be read from disk. “% of total” reports the percentage of times that the buffer was not found in the cache as a percentage of all cache searches.
- “Total Cache Searches” reports the total number of cache searches, including hits and misses for all caches combined.

Cache Turnover

This section provides a summary of cache turnover:

- "Buffers Grabbed" reports the number of buffers that were replaced in all of the caches. The "count" column represents the number of times that Adaptive Server fetched a buffer from the LRU end of the cache, replacing a database page. If the server was recently restarted, so that the buffers are empty, reading a page into an empty buffer is not counted here.
- "Buffers Grabbed Dirty" reports the number of times that fetching a buffer found a dirty page at the LRU end of the cache and had to wait while the buffer was written to disk. If this value is nonzero, find out which caches are affected and disk IO are performing adequately and increase the pool wash size. This represents a serious performance hit.

Cache Strategy Summary

This section provides a summary of the caching strategy used.

- "Cached (LRU) Buffers" reports the total number of buffers placed at the head of the most-recently used and last-recently used (MRU, LRU) chain in all caches.
- "Discarded (MRU) Buffers" reports the total number of buffers in all caches following the fetch-and-discard strategy—the buffers placed at the wash marker.

Large I/O Usage

This section provides summary information about the large I/O requests in all caches. If "Large I/Os Denied" is high, investigate individual caches to determine the cause.

- "Large I/Os Performed" measures the number of times that the requested large I/O was performed. "% of total" is the percentage of large I/O requests performed as a percentage of the total number of I/O requests made.
- "Large I/Os Denied" reports the number of times that large I/O could not be performed. "% of total" reports the percentage of large I/O requests denied as a percentage of the total number of requests made.
- "Total Large I/O Requests" reports the number of all large I/O requests (both granted and denied) for all caches.

Large I/O Effectiveness

"Large I/O Effectiveness" helps determine the performance benefits of large I/O. It compares the number of pages that were brought into cache by a large I/O to the number of pages actually referenced while in the cache. If the percentage for "Pages by Lrg I/O Used" is low, few of the pages brought into cache are being accessed by queries. Investigate the individual caches to determine the source of the problem. Use optdiag to check the value for "Large I/O Efficiency" for each table and index.

- "Pages by Lrg I/O Cached" reports the number of pages brought into all caches by all large I/O operations that took place during the sample interval. Low percentages could indicate one of:
  - Allocation fragmentation in the table's storage
  - Inappropriate caching strategy
- "Pages by Lrg I/O Used" reports the total number of pages that were used after being brought into cache by large I/O. sp_sysmon does not print output for this category if there were no "Pages by Lrg I/O Cached."

Asynchronous Prefetch Activity Report

This section reports asynchronous prefetch activity for all caches.

For information on asynchronous prefetch for each database device, see "Disk I/O Management" on page 114. For information about asynchronous prefetch, see Chapter 6, "Tuning Asynchronous Prefetch," in *Performance and Tuning Series: Basics*.

"Total APFs Requested" reports the total number of pages eligible to be prefetched, that is, the sum of the look-ahead set sizes of all queries issued during the sample interval. Other rows in "Asynchronous Prefetch Activity" provide detailed information about:

- The pages that were prefetched ("APFs Issued")
- The reasons that prefetch was denied
- The page was found in the cache

APFs Issued

"APFs Issued" reports the number of asynchronous prefetch requests issued by the system during the sample interval.

APFs Denied Due To

This section reports the reasons that APFs were not issued:

- "APF I/O Overloads" reports the number of times APF usage was denied because of a lack of disk I/O structures or because of disk semaphore contention.

  If this number is high, check the following information in "Disk I/O Management:"

  - The value of the disk i/o structures configuration parameter. See "Disk I/O Structures" on page 116.
  - Values for contention for device semaphores for each database device to determine the source of the problem. See "Mirror Semaphore Granted and Waited" on page 119.

  If the problem is due to a shortage of disk I/O structures, set the configuration parameter higher, and repeat your tests. If the problem is due to high disk semaphore contention, examine the physical placement of the objects where high I/O takes place.

- "APF Limit Overloads" indicates that the percentage of buffer pools that can be used for asynchronous prefetch was exceeded. This limit is set for the server as a whole by the global async prefetch limit configuration parameter. Use sp_poolconfig to tune each pool individually.

- "APF Reused Overloads" indicates that APF usage was denied due to a kinked page chain or because the buffers brought in by APF were swapped out before they could be accessed.

  Ideally, consecutive pages contain consecutive rows. However, if the page chain jumped from its present position to a distant piece of disk for a few pages then jumped back to its original position, the page is considered "kinked". For example, a page chain that uses pages 1, 2, 396, 397, 3, 4 is kinked.

APF Buffers Found in Cache

This section reports how many buffers from APF **look-ahead sets** were found in the data cache during the sample interval. Asynchronous prefetch tries to find a page to read in the data cache using a quick scan, without holding the cache spinlock. If that does not succeed, APF then performs a thorough scan holding the spinlock.

Other Asynchronous Prefetch Statistics

Three additional asynchronous prefetch statistics are reported in this section:

- "APFs Used" reports the number of pages that were brought into the cache by asynchronous prefetch and used during the sample interval. The pages counted for this report may have been brought into cache during the sample interval or by asynchronous prefetch requests that were issued before the sample interval started.
- "APF Waits for I/O" reports the number of times a process had to wait for an asynchronous prefetch to complete. This indicates that the prefetch was not issued early enough for the pages to be in cache before the query needed them. It is reasonable to expect some percentage of "APF Waits." Some reasons that tasks may have to wait are:
  - The first asynchronous prefetch request for a query is generally included in "APF Waits."
  - Each time a sequential scan moves to a new allocation unit and issues prefetch requests, the query must wait until the first I/O completes.
  - Each time a nonclustered index scan finds a set of qualified rows and issues prefetch requests for the pages, it must wait for the first pages to be returned.

  Other factors that can affect "APF Waits for I/O" are the amount of processing that needs to be done on each page, and the speed of the I/O subsystem.
- "APF Discards" indicates the number of pages that were read in by asynchronous prefetch and discarded before they were used. A high value for "APFs Discards" may indicate that increasing the size of the buffer pools could help performance, or it may indicate that APF is bringing pages into cache that are not needed by the query.

Dirty Read Behavior

This section provides information to help you analyze how dirty reads (isolation level 0 reads) affect the system.

Page Requests

"Page Requests" reports the average number of pages that were requested at isolation level 0. The "% of total" column reports the percentage of dirty reads with respect to the total number of page reads.

Dirty read page requests incur high overhead if they lead to many dirty read restarts.

Dirty Read Re-starts

"Re-Starts" reports the number of dirty read restarts that took place. This category is reported only for the server as a whole, and not for individual caches. sp_sysmon does not print output for this category if there were no "Dirty Read Page Requests."

A dirty read restart occurs when a dirty read is active on a page and another process makes changes to the page that cause the page to be deallocated. The scan for the level 0 must be restarted.

The "% of total" output is the percentage of dirty read restarts done with isolation level 0 as a percentage of the total number of page reads.

If these values are high, you might take steps to reduce them through application modifications, because overhead associated with dirty reads and resulting restarts is very expensive. Most applications should avoid restarts because of the large overhead they incur.

Cache Management by Cache

This section reports cache utilization for each active cache on the server. The sample output shows results for the default data cache.

Cache Spinlock Contention

"Spinlock Contention" reports the number of times an engine encountered spinlock contention on the cache, and had to wait, as a percentage of the total spinlock requests for that cache. This is meaningful only in SMP environments.

When a user task makes any changes to a cache, a spinlock denies all other tasks access to the cache while the changes are being made. Although spinlocks are held for extremely brief durations, they can slow performance in multiprocessor systems with high transaction rates. If spinlock contention is more than 10%, consider using named caches or adding cache partitions.

See Chapter 5, "Memory Use and Performance," in *Performance and Tuning: Basics* for information on adding caches.

Utilization

"Utilization" reports the percentage of searches using this cache as a percentage of searches across all caches.You can compare this value for each cache to determine if there are caches that are over- or under-utilized. If you decide that a cache is not well utilized, you can:

- Change the cache bindings to balance utilization. For more information, see Chapter 5, "Memory Use and Performance," in *Performance and Tuning: Basics*.
- Resize the cache to correspond more appropriately to its utilization.

  For more information, see Chapter 4, "Configuring Data Caches," in *System Administration Guide: Volume 2*.

Cache Search, Hit, and Miss Information

This section displays the number of hits and misses and the total number of searches for this cache. Cache hits are roughly comparable to the logical reads values reported by statistics io; cache misses are roughly equivalent to physical reads. sp_sysmon always reports values that are higher than those shown by statistics io, since sp_sysmon also reports the I/O for system tables, log pages, OAM pages, and other system overhead.

Interpreting cache hit data requires that you understand how applications use each cache. In caches that are created to hold specific objects such as indexes or lookup tables, cache hit ratios may reach 100%. In caches used for random point queries on huge tables, cache hit ratios may be quite low but still represent effective cache use.

Cache hits and misses can also help you to determine if adding more memory would improve performance. For example, if "Cache Hits" is high, adding memory probably would not help much.

Cache Hits

"Cache Hits" reports the number of times that a needed page was found in the data cache. "% of total" reports the percentage of cache hits compared to the total number of cache searches.

Found in Wash

"Found in Wash" reports the number of times that the needed page was found in the wash section of the cache. "% of total" reports the percentage of times that the buffer was found in the wash area as a percentage of the total number of hits. If the data indicates a large percentage of cache hits found in the wash section, it may mean the wash area is too big. However, a large number of hits is not a problem for caches that are read-only or that have a low number of writes.

A large wash section might lead to increased physical I/O because Adaptive Server initiates a write on all dirty pages as they cross the wash marker. If a page in the wash area is written to disk, and is then updated a second time, I/O has been wasted. Check to see whether a large number of buffers are being written at the wash marker.

See "Buffer Wash Behavior" on page 104 for more information.

If queries on tables in the cache use a "fetch-and-discard" strategy for a non-APF I/O, the first cache hit for a page finds it in the wash. The buffer is moved to the MRU end of the chain, so a second cache hit soon after the first cache hit will find the buffer still outside the wash area.

See "Cache Strategy" on page 105 for information.

You can change the wash size. If you make the wash size smaller, run sp_sysmon again under fully loaded conditions and check the output for "Grabbed Dirty" values greater than 0

See "Cache Turnover" on page 95.

Cache Misses

"Cache Misses" reports the number of times that a needed page was not found in the cache and had to be read from disk. "% of total" is the percentage of times that the buffer was not found in the cache as a percentage of the total searches.

Total Cache Searches

This row summarizes cache search activity. The "Found in Wash" data is a subcategory of the "Cache Hits" number and is not used in the summary calculation.

Pool Turnover

"Pool Turnover" reports the number of times that a buffer was replaced from each pool in a cache. Each cache can have up to 4 pools, with I/O sizes of 2K, 4K, 8K, and 16K. If there is any "Pool Turnover," sp_sysmon prints the "LRU Buffer Grab" and "Grabbed Dirty" information for each pool that is configured and a total turnover figure for the entire cache. If there is no "Pool Turnover," sp_sysmon prints zeros for "Total Cache Turnover."

This information helps you to determine if the pools and cache are the right size.

LRU Buffer Grab

"LRU Buffer Grab" is incremented only when a page is replaced by another page. If you have recently restarted Adaptive Server, or if you have just unbound and rebound the object or database to the cache, turnover does not count reading pages into empty buffers.

If memory pools are too small for the throughput, you may see high turnover in the pools, reduced cache hit rates, and increased I/O rates. If turnover is high in some pools and low in other pools, you might want to move space from the less active pool to the more active pool, especially if it can improve the cache-hit ratio.

If the pool has 1000 buffers, and Adaptive Server is replacing 100 buffers every second, 10% of the buffers are being turned over every second. This might be an indication that the buffers do not remain in cache for long enough for the objects using that cache.

Grabbed Dirty

"Grabbed Dirty" gives statistics for the number of dirty buffers that reached the LRU before they could be written to disk. When Adaptive Server needs to grab a buffer from the LRU end of the cache to fetch a page from disk, and finds a dirty buffer instead of a clean one, it must wait for I/O on the dirty buffer to complete. "% of total" reports the percentage of buffers grabbed dirty as a percentage of the total number of buffers grabbed.

A nonzero value for "Grabbed Dirty" indicates that the wash area of the pool is too small for the throughput in the pool. Remedial actions depend on the pool configuration and usage:

- If the pool is very small and has high turnover, consider increasing the size of the pool and the wash area.

- If the pool is large, and it is used for a large number of data modification operations, increase the size of the wash area.
- If several objects use the cache, moving some of them to another cache could help.
- If the cache is being used by create index, the high I/O rate can cause dirty buffer grabs, especially in a small (16K) pool. In these cases, set the wash size for the pool as high as possible, to 80% of the buffers in the pool.
- If the cache is partitioned, reduce the number of partitions.
- Check query plans and I/O statistics for objects that use the cache for queries that perform a lot of physical I/O in the pool. Tune queries, if possible, by adding indexes.

Check the "per second" values for "Buffers Already in I/O" and "Buffers Washed Dirty" in "Buffer Wash Behavior" on page 104. The wash area should be large enough to allow I/O to be completed on dirty buffers before they reach the LRU. The time required to complete the I/O depends on the actual number of physical writes per second achieved by your disk drives.

Also check "Disk I/O Management" on page 114 to see if I/O contention is slowing disk writes.

Also, it might help to increase the value of the housekeeper free write percent configuration parameter. See Chapter 5 in *System Administration Guide: Volume 1*.

Total Cache Turnover

This summary line provides the total number of buffers grabbed in all pools in the cache.

Buffer Wash Behavior

This category reports information about the state of buffers when they reach the pool's wash marker. When a buffer reaches the wash marker, it is in one of three states:

- "Buffers Passed Clean" reports the number of buffers that were clean when they passed the wash marker. The buffer was not changed while it was in the cache, or it was changed, and has already been written to disk by the housekeeper or a checkpoint. "% of total" reports the percentage of buffers passed clean as a percentage of the total number of buffers that passed the wash marker.

- "Buffers Already in I/O" reports the number of times that I/O was already active on a buffer when it entered the wash area. The page was modified while in the cache. The housekeeper or a checkpoint has started I/O on the page, but the I/O has not completed. "% of total" reports the percentage of buffers already in I/O as a percentage of the total number of buffers that entered the wash area.
- "Buffers Washed Dirty" reports the number of times that a buffer entered the wash area dirty and not already in I/O. The buffer was changed while in the cache and has not been written to disk. An asynchronous I/O is started on the page as it passes the wash marker. "% of total" reports the percentage of buffers washed dirty as a percentage of the total number of buffers that entered the wash area.

If no buffers pass the wash marker during the sample interval, sp_sysmon prints:

```
Statistics Not Available - No Buffers Entered Wash Section Yet!
```

Cache Strategy

This section reports the number of buffers placed in cache following the fetch-and-discard (MRU) or normal (LRU) caching strategies:

- Cached (LRU) Buffers – reports the number of buffers that used normal cache strategy and were placed at the MRU end of the cache. This includes all buffers read directly from disk and placed at the MRU end, and all buffers that were found in cache. At the completion of the logical I/O, the buffer was placed at the MRU end of the cache.
- Discarded (MRU) Buffers – reports the number of buffers that were placed at the wash marker, using the fetch-and-discard strategy.

  If you expect an entire table to be cached, but you see a high value for "Discarded Buffers," use showplan to see if the optimizer is generating the fetch-and-discard strategy when it should be using the normal cache strategy.

  See Chapter 2, "Using showplan," in *Performance and Tuning Series: Query Processing and Abstract Plans* for more information.

Large I/O Usage

This section provides data about Adaptive Server prefetch requests for large I/O. It reports statistics on the numbers of large I/O requests performed and denied.

Large I/Os Performed

"Large I/Os Performed" measures the number of times that a requested large I/O was performed. "% of total" reports the percentage of large I/O requests performed as a percentage of the total number of requests made.

Large I/Os Denied

"Large I/Os Denied" reports the number of times that large I/O could not be performed. "% of total" reports the percentage of large I/O requests denied as a percentage of the total number of requests made.

Adaptive Server cannot perform large I/O:

- If any page in a buffer already resides in another pool.
- When there are no buffers available in the requested pool.
- On the first extent of an allocation unit, since it contains the allocation page, which is always read into the 2K pool.

If a high percentage of large I/Os were denied, the use of the larger pools might not be as effective as it could be. If a cache contains a large I/O pool, and queries perform both 2K and 16K I/O on the same objects, there will always be some percentage of large I/Os that cannot be performed because pages are in the 2K pool.

If more than half of the large I/Os were denied, and you are using 16K I/O, try moving all of the space from the 16K pool to the 8K pool. Re-run the test to see if total I/O is reduced. When a 16K I/O is denied, Adaptive Server does not check for 8K or 4K pools, but uses the 2K pool.

Use information from this category and "Pool Turnover" to help judge the correct size for pools.

Total large I/O Requests

"Total Large I/O Requests" provides summary statistics for large I/Os performed and denied.

Large I/O Detail

This section provides summary information for each pool individually. It contains a block of information for each 4K, 8K, or 16K pool configured in cache. It prints the pages brought in ("Pages Cached") and pages referenced ("Pages Used") for each I/O size that is configured.

For example, if a query performs a 16K I/O and reads a single data page, the "Pages Cached" value is 8, and "Pages Used" value is 1.

- "Pages by Lrg I/O Cached" prints the total number of pages read into the cache.
- "Pages by Lrg I/O Used" reports the number of pages used by a query while in cache.

Dirty Read Behavior

"Page Requests" reports the average number of pages requested at isolation level 0.

The "% of total" output for "Dirty Read Page Requests" shows the percentage of dirty reads with respect to the total number of page reads.

Procedure Cache Management

"Procedure Cache Management" shows:

- The number of times stored procedures are recompiled.
- The phase that triggered the recompilations: execution time, recompilation, and so on.
- The cause of recompilation: table missing, permissions change, and so on.

Sample output

```
Procedure Cache Management       per sec      per xact       count   % of total
-------------------------  ------------   -----------  ---------   ---------
Procedure Requests                 14.2           0.3        8499         n/a
Procedure Reads from Disk           0.0           0.0          27        0.6%
Procedure Writes to Disk            0.0           0.0           0        0.0%
Procedure Removals                  0.0           0.0           0         n/a
Procedure Recompilations            0.0           0.0           0         n/a

SQL Statement Cache:
Statements Cached                   0.6           2.7         171         n/a
Statements Found in Cache           2.0           9.5        1529         n/a
Statements Not Found                0.6           2.7         171         n/a
```

```
Statements Dropped                0.2             0.8          52          n/a
Statements Restored               0.0             0.0           0          n/a
Statements Not Cached             0.0             0.0           0          n/a
```

The procedure cache contains most execution plans for requested procedures. In this example, the procedure cache reads only 0.6 percent from disk.

This system's statement cache is effective, since the value for Statements Found in Cache is 611. This value is much higher than the values for Statements Not Found and Statements Cached, so the reuse rate of statements is high.

Procedure Requests

"Procedure Requests" reports the number of times stored procedures were executed.

When a procedure is executed, either:

- An idle copy of the query plan is in memory, so it is copied and used or,
- No copy of the procedure is in memory, or all copies of the plan in memory are in use, so the procedure must be read from disk.

Procedure Reads from Disk

"Procedure Reads from Disk" reports the number of times idle copies were not available and Adaptive Server had to read procedures from disk (that is, Adaptive Server could not copy what was already in cache).

"% of total" reports the percentage of procedure reads from disk as a percentage of the total number of procedure requests. A relatively high percentage may indicate that the procedure cache is too small.

Procedure Writes to Disk

"Procedure Writes to Disk" reports the number of procedures created during the interval. This can be significant if application programs generate stored procedures.

Procedure Removals

"Procedure Removals" reports the number of times that a procedure aged out of cache.

Procedure Recompilations

"Procedure Recompilations" reports the number of times stored procedures were recompiled.

SQL Statement Cache

"SQL Statement Cache" reports on the number of statements during the interval that were cached, found in cache, not found, dropped, restored, and not cached.

Sample output

```
SQL Statement Cache:
Statements Cached                 0.6            2.7          171        n/a
Statements Found in Cache         2.0            9.5          611        n/a
Statements Not Found              0.6            2.7          171        n/a
Statements Dropped                0.2            0.8           52        n/a
Statements Restored               0.0            0.0            0        n/a
Statements Not Cached              0.0            0.0            0        n/a
```

- Statements Cached – number of statements added to the statement cache during the sample period.
- Statements Found in Cache – number of statements found in the statement cache. This value represents the number of times Adaptive Server used the statement cache to avoid recompiling a statement.
- Statements Not Found – number of times Adaptive Server looked for, but did not find, a statement in the statement cache.
- Statements Dropped – number of times Adaptive Server removed a statement already in the statement cache to make room for a new statement being cached.
- Statements Restored – number of query plans restored after an existing plan was invalidated by a schema change to an object referenced by the statement.

- Statements Not Cached – number of statements Adaptive Server compiled, but did not enter, into the statement cache. If you have set statement cache size to 0 (disabling the statement cache), Statements Not Cached is the number of statements that Adaptive Server could have cached.

Memory Management

"Memory Management" reports the number of pages allocated and deallocated during the sample interval.

Sample output

```
Memory Management              per sec       per xact       count   % of total
-------------------------   ------------   -----------    --------    --------
Pages Allocated                 2565.7          63.2      1539423       n/a
Pages Released                   2565.7          63.2       1539423      n/a
```

Pages Allocated

"Pages Allocated" reports the number of times that a new page was allocated in memory.

Pages Released

"Pages Released" reports the number of times that a page was freed.

Recovery Management

This data indicates the number of checkpoints caused by the normal checkpoint process, the number of checkpoints initiated by the housekeeper task, and the average length of time for each type. Use information to correctly set the recovery and housekeeper parameters.

Note If you are using Adaptive Server 12.5.3 or later, internal benchmarks indicate that the checkpoint task executes up to 200% faster than formerly, causing significant gains in database recovery speeds. This increase in speed requires no action on your part.

However, performance improvements depend on the effectiveness of your I/O subsystem. You may not see these gains until the IO bandwidth is available.

Sample output

```
===============================================================================

Recovery Management
-------------------
Checkpoints                      per sec     per xact    count    % of total
-------------------------    -----------   ----------  -------      --------
# of Normal Checkpoints              0.2          0.0      106        100.0 %
# of Free Checkpoints                0.0          0.0        0          0.0 %
-------------------------  ------------   ----------  -------
Total Checkpoints                    0.2          0.0      106
```

Checkpoints

Checkpoints write dirty pages (pages that have been modified in memory, but not written to disk) to the database device. The Adaptive Server automatic (normal) checkpoint mechanism works to maintain a minimum recovery interval. By tracking the number of log records in the transaction log since the last checkpoint was performed, the mechanism estimates whether the time required to recover the transactions exceeds the recovery interval. If so, the checkpoint process scans all data caches and writes out all changed data pages.

When Adaptive Server has no user tasks to process, the housekeeper wash task begins writing dirty buffers to disk. These writes are done during the server's idle cycles, so they are known as "free writes." They result in improved CPU usage and a decreased need for buffer washing during transaction processing.

of Normal Checkpoints

"# of Normal Checkpoints" reports the number of checkpoints performed by the normal checkpoint process.

If the normal checkpoint is doing most of the work, especially if the time required for the checkout is lengthy, it might make sense to increase the number of writes performed by the housekeeper wash task.

For more information about configuration parameters, see Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

of Free Checkpoints

"# of Free Checkpoints" reports the number of checkpoints performed by the housekeeper wash task. The housekeeper wash task performs checkpoints only when it has cleared all dirty pages from all configured caches.

If the housekeeper wash task finishes writing all dirty pages in all caches to disk, it checks the number of rows in the transaction log since the last checkpoint. If there are more than 100 log records, it issues a checkpoint. This is called a "free checkpoint" because it requires very little overhead. In addition, it reduces future overhead for normal checkpoints.

You can use the housekeeper free write percent parameter to configure the maximum percentage by which the housekeeper wash task can increase database writes. See Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Total Checkpoints

"Total Checkpoints" reports the combined number of normal and free checkpoints that occurred during the sample interval.

Average Time per Normal Checkpoint

"Avg Time per Normal Chkpt" reports the average time that normal checkpoints lasted.

Average Time per Free Checkpoint

"Avg Time per Free Chkpt" reports the average time that free (or housekeeper) checkpoints lasted.

Increasing the Housekeeper Batch Limit

The housekeeper wash task has a built-in batch limit to avoid overloading disk I/O for individual devices. By default, the batch size for housekeeper writes is 3. As soon as the housekeeper detects that it has issued 3 I/Os to a single device, it stops processing in the current buffer pool and begins checking for dirty pages in another pool. If the writes from the next pool are assigned to the same device, it moves on to another pool. Once the housekeeper has checked all of the pools, the housekeeper waits until the last I/O it has issued has completed, and then begins the cycle again.

The default batch limit is designed to provide good device I/O characteristics for slow disks. You may get better performance by increasing the batch size for fast disk drives. Set this limit globally for all devices on the server or to different values for disks with different speeds. You must reset the limits each time Adaptive Server is restarted.

This command sets the batch size to 10 for a single device, using the virtual device number from sysdevices:

```
dbcc tune(deviochar, 8, "10")
```

To see the device number, use sp_helpdevice, or:

```
select name, vdevno
from sysdevices
```

To change the housekeeper's batch size for all devices on the server, use -1 in place of a device number:

```
dbcc tune(deviochar, -1, "5")
```

For very fast drives, setting the batch size as high as 50 has yielded performance improvements during testing.

You may want to try setting the batch size higher if:

- The average time for normal checkpoints is high.
- There are no problems with exceeding I/O configuration limits or contention on the semaphores for the devices.

Disk I/O Management

This section reports on disk I/O. It provides an overview of disk I/O activity for the server as a whole and reports on reads, writes, and semaphore contention for each logical device.

Sample output

```
Disk I/O Management
-------------------

Max Outstanding I/Os            per sec      per xact       count   % of total
------------------------    -----------   -----------   ---------   ---------
  Server                             n/a           n/a         527         n/a
  Engine 0                           n/a           n/a         429         n/a
  Engine 1                           n/a           n/a         448         n/a
  Engine 2                           n/a           n/a         457         n/a
  Engine 3                           n/a           n/a         508         n/a
  Engine 4                           n/a           n/a         526         n/a
  Engine 5                           n/a           n/a         416         n/a
  Engine 6                           n/a           n/a         425         n/a


I/Os Delayed by
  Disk I/O   Structures              n/a           n/a           0         n/a
  Server Config   Limit              n/a           n/a           0         n/a
  Engine Config Limit                n/a           n/a           0         n/a
  Operating System Limit             n/a           n/a           0         n/a


Total Requested Disk I/Os         547.2          13.5      328339

Completed Disk I/O's
Asynchronous I/O's
```

```
  Engine 0                        135.0           3.3       81017       24.7 %
  Engine 1                         70.3           1.7       42172       12.8 %
  Engine 2                         50.1           1.2       30083        9.2 %
  Engine 3                         68.0           1.7       40789       12.4 %
  Engine 4                         72.5           1.8       43473       13.2 %
  Engine 5                         81.2           2.0       48749       14.8 %
  Engine 6                         70.1           1.7       42070       12.8 %
Synchronous I/O's
  Total Completed I/Os              0.0           0.0           0          n/a
------------------------   ------------   -----------   ---------
Total Completed I/Os              547.3          13.5      328353


Device Activity Detail
----------------------

Device:
  /dev/sybase/c1t0d0s0r
  master                          per sec      per xact       count   % of total
------------------------    -----------   -----------   ---------   ---------
  Reads
    APF                             0.0           0.0           2        0.2 %
    Non-APF                         0.3           0.0         154       17.5 %
  Writes                            1.2           0.0         723       82.3 %
-------------------------    ----------   -----------   ---------   ---------
Total I/Os                        1.5           0.0         879        0.3 %


------------------------------------------------------------------------------

Device:
  /dev/sybase/c1t0d0s1r
  dev01                           per sec      per xact       count   % of total
------------------------    -----------   -----------   ---------   ---------
Reads
  APF                               1.0           0.0         584        0.5 %
    Non-APF                         8.5           0.2        5075        4.3 %
    Writes                        185.6           4.6      111355       95.2 %
-------------------------   -----------   -----------   ---------   ---------
Total I/Os                        195.0           4.8      117014       35.6 %


------------------------------------------------------------------------------

Device:
  /dev/sybase/c1t0d0s3r
```

```
  dev02                          per sec      per xact       count   % of total
------------------------    -----------   -----------   ---------   ---------
  Reads
    APF                             0.0           0.0           1        0.5 %
    Non-APF                         0.0           0.0           5        2.4 %
  Writes                            0.3           0.0         204       97.1 %
-------------------------   -----------   -----------   ---------   ---------
Total I/Os                         0.4           0.0         210        0.1%
```

Maximum Outstanding I/Os

"Max Outstanding I/Os" reports the maximum number of I/Os pending for Adaptive Server as a whole (the first line), and for each Adaptive Server engine at any point during the sample interval.

This information can help configure I/O parameters at the server or operating system level if any of the "I/Os Delayed By" values are nonzero.

I/Os Delayed by

When the system experiences an I/O delay problem, it is likely that I/O is blocked by one or more Adaptive Server or operating system limits.

Most operating systems have a kernel parameter that limits the number of asynchronous I/Os that can take place.

Disk I/O Structures

"Disk I/O Structures" reports the number of I/Os delayed by reaching the limit on disk I/O structures. When Adaptive Server exceeds the number of available disk I/O control blocks, I/O is delayed because Adaptive Server requires that tasks get a disk I/O control block before initiating an I/O request.

If the result is a nonzero value, try increasing the number of available disk I/O control blocks by increasing the configuration parameter disk i/o structures. See Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Server Configuration Limit

Adaptive Server can exceed its limit for the number of asynchronous disk I/O requests that can be outstanding for the entire Adaptive Server at one time. You can raise this limit using the max async i/os per server configuration parameter. See Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Engine Configuration Limit

An engine can exceed its limit for outstanding asynchronous disk I/O requests. You can change this limit with the max async i/os per engine configuration parameter. See Chapter 5, "Setting Configuration Parameters," in the *System Administration Guide, Volume 1*.

Operating System Limit

"Operating System Limit" reports the number of times the operating system limit on outstanding asynchronous I/Os was exceeded during the sample interval. The operating system kernel limits the maximum number of asynchronous I/Os that either a process or the entire system can have pending at any one time. See the *System Administration Guide*; also see your operating system documentation.

Requested and Completed Disk I/Os

This data shows the total number of disk I/Os requested and the number and percentage of I/Os completed by each Adaptive Server engine.

"Total Requested Disk I/Os" and "Total Completed I/Os" should be the same or very close. These values will be very different if requested I/Os are not completing due to saturation.

The value for requested I/Os includes all requests initiated during the sample interval, and it is possible that some of them completed after the sample interval ended. These I/Os are not included in "Total Completed I/Os", and cause the percentage to be less than 100, when there are no saturation problems.

The reverse is also true. If I/O requests were made before the sample interval began and they completed during the period, you see a value for "% of total" for "Total Completed I/Os" that is more than 100%.

If the data indicates a large number of requested disk I/Os and a smaller number of completed disk I/Os, there could be a bottleneck in the operating system that is delaying I/Os.

Total Requested Disk I/Os

"Total Requested Disk I/Os" reports the number of times that Adaptive Server requested disk I/Os.

Completed Disk I/Os

"Total Completed Disk I/Os" reports the number of times that each engine completed I/O. "% of total" reports the percentage of times each engine completed I/Os as a percentage of the total number of I/Os completed by all Adaptive Server engines combined.

You can also use this information to determine whether the operating system can keep pace with the disk I/O requests made by all of the engines.

Device Activity Detail

"Device Activity Detail" reports activity on each logical device. It is useful for checking that I/O is well balanced across the database devices and for finding a device that might be delaying I/O. For example, if the "Task Context Switches Due To" data indicates a heavy amount of device contention, use "Device Activity Detail" to figure out which devices are causing the problem.

This section prints the following information about I/O for each data device on the server:

- The logical and physical device names
- The number of reads and writes and the total number of I/Os
- The number of device semaphore requests immediately granted on the device and the number of times a process had to wait for a device semaphore

Reads and Writes

"Reads" and "Writes" report the number of times that reads or writes to a device took place. "Reads" reports the number of pages that were read by asynchronous prefetch and those brought into cache by other I/O activity. The "% of total" column reports the percentage of reads or writes as a percentage of the total number of I/Os to the device.

Total I/Os

"Total I/Os" reports the combined number of reads and writes to a device. The "% of total" column is the percentage of combined reads and writes for each named device as a percentage of the number of reads and writes that went to all devices.

You can use this information to check I/O distribution patterns over the disks and to make object placement decisions that can help balance disk I/O across devices. For example, the data may indicate some disks are more heavily used than others. If you see that a large percentage of all I/O went to a specific named device, you can investigate the tables residing on the device and then determine how to remedy the problem.

See Chapter 1, "Controlling Physical Data Placement," in *Performance and Tuning Series: Physical Database Tuning*.

Mirror Semaphore Granted and Waited

The "Mirror Semaphore Granted" and "Mirror Semaphore Waited" categories report the number of times that a request for a mirror semaphore was granted immediately and the number of times the semaphore was busy and the task had to wait for the semaphore to be released. The "% of total" column is the percentage of times the device the semaphore was granted (or the task had to wait) as a percentage of the total number of mirror semaphores requested. This data is meaningful only in SMP environments.

Adaptive Server uses the semaphore only when either disk mirroring is enabled or when disk IOs are delayed. Disk mirroring is enabled when you change the configuration parameter from is "disabled" default.

A large percentage of I/O requests that waited could indicate a semaphore contention issue. You may want to try redistributing the data on the physical devices.

Network I/O Management

"Network I/O Management" reports the following network activities for each Adaptive Server engine:

- Total requested network I/Os
- Network I/Os delayed
- Total tabular data stream (TDS) packets and bytes received and sent
- Average size of packets received and sent

This data is broken down by engine, because each engine does its own network I/O. Imbalances are usually caused by one of the following condition:

- There are more engines than tasks, so the engines with no work to perform report no I/O, or
- Most tasks are sending and receiving short packets, but another task is performing heavy I/O, such as a bulk copy.

Sample output

```
Network I/O Management
----------------------

Total Network I/O Requests       703.2           17.3     421908           n/a
Network I/Os Delayed               0.0            0.0          0         0.0 %


Total TDS Packets Received      per sec      per xact      count   % of total
-------------------------   -----------   -----------   --------    ---------
  Engine 0                         173.6           4.3     104168       28.3 %
  Engine 1                          76.0           1.9      45580       12.4 %
  Engine 2                          61.9           1.5      37148       10.1 %
  Engine 3                         253.8           6.3     152275       41.4 %
  Engine 4                           3.7           0.1       2227        0.6 %
  Engine 5                          17.2           0.4      10294        2.8 %
  Engine 6                          26.4           0.6      15818        4.3 %
-------------------------    ----------   -----------  ---------
Total TDS Packets Rec'd           612.5          15.1     367510

Total Bytes Received            per sec      per xact      count   % of total
-------------------------   -----------   -----------   --------    ---------
  Engine 0                       83707.9        2062.0   50224763       32.0 %
  Engine 1                       31420.0         774.0   18851993       12.0 %
```

```
  Engine 2                      29113.2         717.2   17467946        11.1 %
  Engine 3                     110841.3        2730.4   66504800        42.4 %
  Engine 4                        589.8          14.5     353880         0.2 %
  Engine 5                       2329.6          57.4    1397760         0.9 %
  Engine 6                       3419.2          84.2    2051507         1.3 %
-------------------------    ----------   -----------   --------
Total Bytes Rec'd             261421.1         6439.7  156852649

Avg Bytes Rec'd per Packet         n/a            n/a        426           n/a

-------------------------------------------------------------------------------

Total TDS Packets Sent           per sec      per xact      count   % of total
-------------------------    ----------   -----------   --------    ---------
  Engine 0                          23.1            0.6      13875        12.8 %
  Engine 1                          26.1            0.6      15651        14.4 %
  Engine 2                          23.0            0.6      13815        12.7 %
  Engine 3                          61.9            1.5      37155        34.2 %
  Engine 4                           5.8            0.1       3472         3.2 %
  Engine 5                          16.3            0.4       9805         9.0 %
  Engine 6                          25.0            0.6      15018        13.8 %
-------------------------    ----------   -----------   --------
Total TDS Packets Sent             181.3            4.5     108791

Total Bytes Sent                 per sec      per xact      count   % of total
-------------------------    ----------   -----------   --------    ---------
  Engine 0                         6821.7          168.0    4093015        22.4 %
  Engine 1                         4911.3          121.0    2946770        16.1 %
  Engine 2                         5690.2          140.2    3414092        18.7 %
  Engine 3                         8400.2          206.9    5040148        27.6 %
  Engine 4                         1689.3           41.6    1013552         5.5 %
  Engine 5                         1375.8           33.9     825481         4.5 %
  Engine 6                         1564.0           38.5     938377         5.1 %
-------------------------    ----------   -----------   ---------
Total Bytes Sent                  30452.4          750.2   18271435

Avg Bytes Sent per Packet             n/a            n/a        167           n/a
```

Total Network I/Os Requests

"Total Network I/O Requests" reports the total number of packets received and sent.

If you know how many packets per second the network can handle, you can determine whether Adaptive Server is challenging the network bandwidth.

The issues are the same whether the I/O is inbound or outbound. If Adaptive Server receives a command that is larger than the packet size, it waits to begin processing until it receives the full command. Therefore, commands that require more than one packet are slower to execute and take up more I/O resources.

If the average bytes per packet is near the default packet size configured for your server, you may want to configure larger packet sizes for some connections. You can configure the network packet size for all connections or allow certain connections to log in using larger packet sizes.

See Chapter 2, "Networks and Performance," in the *Performance and Tuning Series: Basics*.

Network I/Os Delayed

"Network I/Os Delayed" reports the number of times I/O was delayed. If this number is consistently nonzero, consult with your network administrator.

Total TDS Packets Received

"Total TDS Packets Received" reports the number of TDS packets received per engine. "Total TDS Packets Rec'd" reports the number of packets received during the sample interval.

Total Bytes Received

"Total Bytes Received" reports the number of bytes received per engine. "Total Bytes Rec'd" reports the total number of bytes received during the sample interval.

Average Bytes Received per Packet

"Average Bytes Rec'd per Packet" reports the average number of bytes for all packets received during the sample interval.

Total TDS Packets Sent

"Total TDS Packets Sent" reports the number of packets sent by each engine, and a total for the server as a whole.

Total Bytes Sent

"Total Bytes Sent" reports the number of bytes sent by each Adaptive Server engine, and by the server as a whole, during the sample interval.

Average Bytes Sent per Packet

"Average Bytes Sent per Packet" reports the average number of bytes for all packets sent during the sample interval.

Replication Agent

The Replication Agent group displays Replication Agent-specific activity for all databases configured to use a Replication Agent.

Sample output

```
Replication Agent
-----------------

Replication Agent: pubs2
Replication Server: SOROLLA_RS2

                          per sec    per xact   count     % of total
                          -------    --------   -----     ----------
Log Scan Summary
Log Records Scanned           n/a         n/a    1028           n/a
Log Records Processed         n/a         n/a     282           n/a

Log Scan Activity

Updates                       n/a         n/a       5           n/a
Inserts                       n/a         n/a       6           n/a
```

```
Deletes                          n/a          n/a          9          n/a
Store Procedures                 n/a          n/a          2          n/a
DDL Log Records                  n/a          n/a          6          n/a
Writetext Log Records            n/a          n/a          1          n/a
Text/Image Log Records           n/a          n/a         12          n/a
CLRs                             n/a          n/a          2          n/a

Transaction Activity
Opened                           n/a          n/a         61          n/a
Commited                         n/a          n/a         60          n/a
Aborted                          n/a          n/a          1          n/a
Prepared                         n/a          n/a          1          n/a
Maintenance User                 n/a          n/a          0          n/a

Log Extension Wait
Count                          n/a          n/a          3          n/a
Amount of time (ms)            n/a          n/a      17109          n/a
Longest Wait (ms)              n/a          n/a       8866          n/a
Average Time (ms)              n/a          n/a     5703.0          n/a

Schema Cache Lookups
Forward Schema
Count                            n/a          n/a          2          n/a
Total Wait (ms)                  n/a          n/a          3          n/a
Longest Wait (ms)                n/a          n/a          3          n/a
Average Time (ms)                n/a          n/a        1.5          n/a
Backward Schema
Count                            n/a          n/a          3          n/a
Total Wait (ms)                  n/a          n/a          0          n/a
Longest Wait (ms)                n/a          n/a          0          n/a
Average Time (ms)                n/a          n/a        0.0          n/a

Truncation Point Movement
Moved                            n/a          n/a          0          n/a
Gotten from RS                   n/a          n/a          2          n/a

Connections to Replication Server
Success                          n/a          n/a          2          n/a
Failed                           n/a          n/a          0          n/a

Network Packet Information
Packets Sent                     n/a          n/a         21          n/a
Full Packets Sent                n/a          n/a         12          n/a
Largest Packet                   n/a          n/a       2048          n/a
Amount of Bytes Sent             n/a          n/a      28926          n/a
Average Packet                   n/a          n/a     1377.4          n/a
```

```
I/O Wait from RS
Count                          n/a          n/a       26           n/a
Amount of Time (ms)            n/a          n/a     1681           n/a
Longest Wait (ms)              n/a          n/a      373           n/a
Average Wait (ms)              n/a          n/a     64.7           n/a
```

Log Scan Summary

"Log Scan Summary" reports a summary of the log activity to Replication Server. Replication Agent scans the transaction log of the database in which it is running, and sends the scanned information to Replication Server.

The transaction log of the primary database contains modifications that Replication Agent does not process because they belong to objects not marked for replication.

Log Records Scanned

"Log Records Scanned" reports the total number of log records the Replication Agent scanned.

Log Records Processed

"Log Records Processed" reports the total number of log records sent to the Replication Server because they contained objects marked for replication.

Log Scan Activity

"Log Scan Activity" reports these activities from the log:

- Updates – number of updates processed.
- Inserts – number of inserts processed.
- Deletes – number of deletes processed.
- Store Procedures – number of executed stored procedures marked for replication.

- DDL Log Records – number of log records containing Data Definition Language (DDL) to be replicated. This value may not correspond to the number of DDL commands executed in the primary database because a single DDL command executed on the primary database may result in more than one DDL command log record.
- Writetext Log Records – number of log records processed that were generated by writetext.
- Text/Image Log Records – number of Data Manipulation Language (DML) log records for a table with text or image data marked for replication.
- CLRs – number of Compensation Log Records (CLRs) processed.

Transaction Activity

"Transaction Activity" reports these activities:

- Opened – number of begin transaction commands found in the primary log.
- Committed – number of committed transactions.
- Aborted – number of aborted transactions.
- Prepared – number of transactions in the "prepare" state.
- Maintenance User – number of transactions the Maintenance user opened.

Log Extension Wait

When the Replication Agent reaches the end of the transaction log during normal processing, it must wait for Adaptive Server to extend the log (so the primary database resumes activity).

"Log Extension Wait" reports on these activities:

- Count – number of times Replication Agent waited for Adaptive Server to extend the log.
- Amount of time – length of time, in milliseconds, Replication Agent waited for Adaptive Server to extend the log.
- Longest Wait – longest length of time, in milliseconds, Replication Agent had to wait for Adaptive Server to extend the log.
- Average Time – average length of time, in milliseconds, Replication Agent waited for Adaptive Server to extend the log.

Schema Cache Lookups

"Schema Cache Lookups" reports these activities:

- Forward Schema – occasionally, Replication Agent must perform a forward scan on the primary transaction log looking for object schema changes.
- Count – number of times Replication Agent performed a forward scan.
- Total Wait – length of time, in milliseconds, Replication Agent spent performing forward scans.
- Longest Wait – longest length of time, in milliseconds, Replication Agent spent performing a forward scan.
- Average Time – average length of time, in milliseconds, Replication Agent spent performing forward scans.

Backward Schema

When Adaptive Server performs DDL inside a transaction, Replication Agent must perform a backward scan in the primary transaction log. "Backward Schema" reports on these activities:

- Count – number of times Replication Agent performed a backward scan.
- Total Wait – length of time, in milliseconds, Replication Agent spent performing backward scans.
- Longest Wait – longest length of time, in milliseconds, Replication Agent spent performing a backward scan.
- Average Time – average length of time, in milliseconds, Replication Agent spent performing backward scans.

Truncation Point Movement

"Truncation Point Movement" reports on these activities:

- Moved – number of times Replication Agent moved the secondary truncation point on the primary database.
- Gotten from RS – number of times Replication Agent queried Replication Server for a new secondary truncation point.

Connections to Replication Server

"Connections to Replication Server" reports on these activities:

- Success – number of successful connections to Replication Server.
- Failed – number of failed connections to Replication Server.

Network Packet Information

"Network Packet Information" reports on these activities:

- Packets Sent – number of packets sent to Replication Server.
- Full Packets Sent – number of full packets sent to Replication Server.
- Largest Packet – largest packet sent to Replication Server.
- Amount of Bytes Sent – number of bytes sent to Replication Server.
- Average Packet – average packet size.

I/O Wait from RS

"I/O Wait from RS" reports:

- Count – number of times Replication Agent issued a ct_sendpassthru to Replication Server.
- Amount of Time – length of time, in milliseconds, Replication Agent spent processing results from Replication Server.
- Longest Wait – longest elapsed time, in milliseconds, the Replication Agent spent processing results.
- Average Wait – average length of time, in milliseconds, Replication Agent spent processing results

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