SQL Server Database File I/O Report

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http://www.databasejournal.com/features/mssql/article.php/3796551/article.htm

A busy SQL Server instance with tens or hundreds of databases, for example, a SharePoint server used by the entire company, often has its database files spread across multiple physical drives to help with the I/O performance. However, as more and more databases are added to the server, the I/O activity among the drives can become unbalanced. One drive could be taking a heavier workload than others and become the performance bottleneck. When this sort of I/O problems occur, you need to monitor the activity of all the drives on Performance Monitor, compare their workloads and identify the bottlenecks.

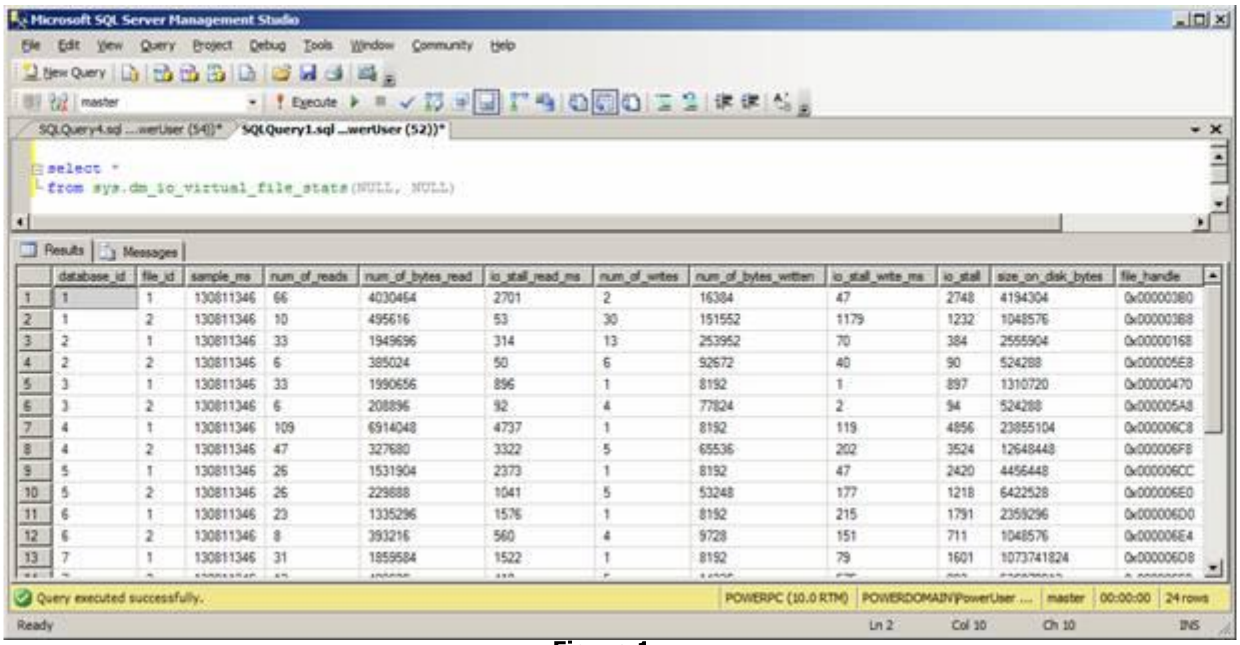
Some of the perfomance counters regarding disk I/O are listed below.

LogicalDisk\% Disk Time
LogicalDisk\% Disk Read Time
LogicalDisk\% Disk Write Time
LogicalDisk\Avg. Disk Queue Length
LogicalDisk\Avg. Disk Read Queue Length
LogicalDisk\Avg. Disk Write Queue Length
LogicalDisk\Disk Bytes/sec
PhysicalDisk\% Disk Time
PhysicalDisk\Avg. Disk Queue Length
PhysicalDisk\Avg. Disk Read Queue Length
PhysicalDisk\Avg. Disk Write Queue Length

From the performance data, if a drive is busy for a much higher percentage of time or its disk queue length is greater than 1.5 * (number of spindles), you might want to move some database files from the drive to other drives with a lighter workload, or get a new drive to alleviate the I/O pressure. To decide which database files to move, you need to examine the activity of each database file so you can make a reasonable estimate on how the drives will perform after the reorganization. Each database gets hit differently. It is not necessary that the bigger or faster-growing databases are busier. In this article, I will show you a simple report for the I/O statistics of each database file, including reads, writes, and time spent waiting for reads and writes.

In **SQL Server 2005** and **SQL Server 2008**, a new dynamic management function sys.dm_io_virtual_file_stats is available. This function accepts two parameters, a database id and a file id. When both parameters are null, then this function returns I/O statistics for all data and log files.

```
select *
from sys.dm_io_virtual_file_stats(NULL, NULL)
```



```
select *
from sys.dm_io_virtual_file_stats(NULL, NULL)
```

	database_id	file_id	sample_ms	num_of_reads	num_of_bytes_read	io_stall_read_ms	num_of_writes	num_of_bytes_written	io_stall_write_ms	io_stall	size_on_disk_bytes	file_handle
1	1	1	130811346	66	4030464	2701	2	16384	47	2748	4194304	0x000003B0
2	1	2	130811346	10	495616	53	30	151552	1179	1232	1048576	0x000003B8
3	2	1	130811346	33	1949696	314	13	253952	70	384	2555904	0x00000168
4	2	2	130811346	6	385024	50	6	92672	40	90	524288	0x000005E8
5	3	1	130811346	33	1990656	896	1	8192	1	897	1310720	0x00000470
6	3	2	130811346	6	208896	92	4	77824	2	94	524288	0x000005A8
7	4	1	130811346	109	6914048	4737	1	8192	119	4856	23855104	0x000006C8
8	4	2	130811346	47	327680	3322	5	65536	202	3524	12648448	0x000006F8
9	5	1	130811346	26	1531904	2373	1	8192	47	2420	4456448	0x000006CC
10	5	2	130811346	26	229888	1041	5	53248	177	1218	6422528	0x000006E0
11	6	1	130811346	23	1335296	1576	1	8192	215	1791	2359296	0x000006D0
12	6	2	130811346	8	393216	560	4	9728	151	711	1048576	0x000006E4
13	7	1	130811346	31	1859584	1522	1	8192	79	1601	1073741824	0x000006D8

Query executed successfully. | POWERPC (10.0 RTM) | POWERDOMAIN\PowerUser ... | master | 00:00:00 | 24 rows

Microsoft SQL Server Management Studio
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New Query
master
Execute
SQLQuery4.sql ...werUser (54))*
SQLQuery1.sql ...werUser (52))*
Results
Messages
Ready
Ln 2
Col 10
Ch 10
INS

Figure 1

As shown in Figure 1, the I/O statistics for all the data and log files has been returned. The columns regarding I/O activity are described as follows.

sample_ms
Number of milliseconds since the computer was started. This column can be used to compare different outputs from this function.

num_of_reads
Number of reads issued on the file.

num_of_bytes_read
Total number of bytes read on this file.

io_stall_read_ms
Total time, in milliseconds, that the users waited for reads issued on the file.

num_of_writes
Number of writes made on this file.

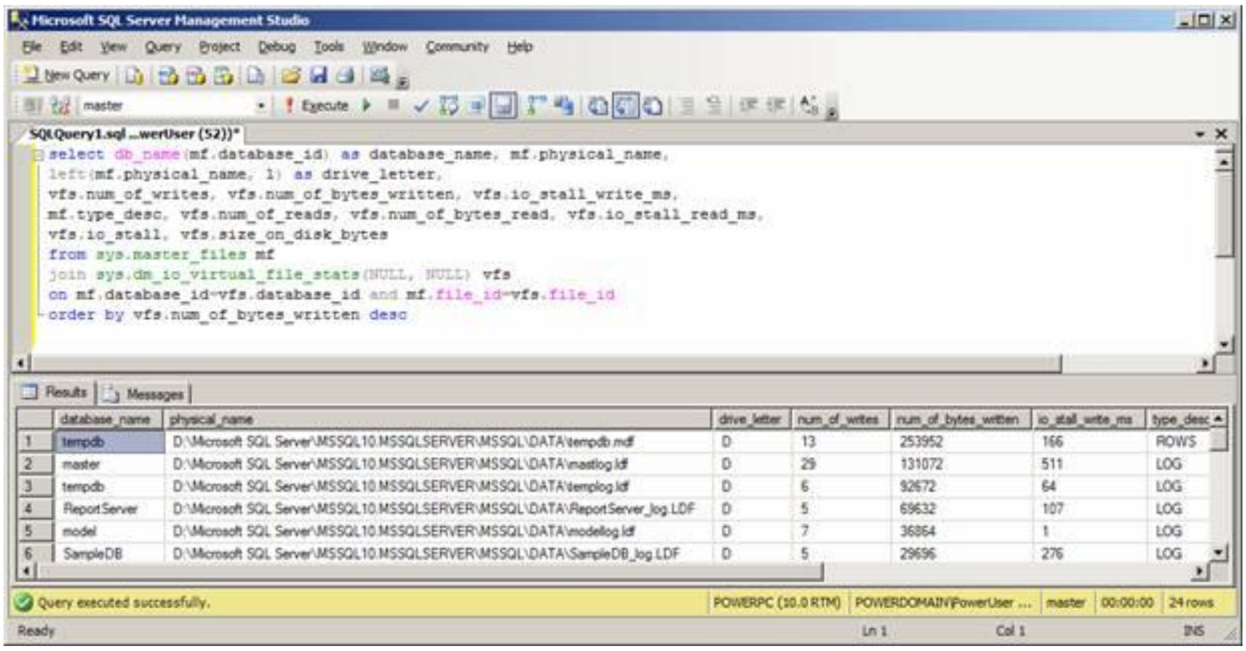
num_of_bytes_written
Total number of bytes written to the file.

io_stall_write_ms
Total time, in milliseconds, that users waited for writes to be completed on the file.

io_stall
Total time, in milliseconds, that users waited for I/O to be completed on the file.

However, the database_id and file_id columns in the result set don't provide a direct link from the I/O statistics to the file name or path. We need to join the table returned by sys.dm_io_virtual_file_stats with the sys.master_files catalog view to find out on which drive the files reside. If you concluded from the performance data that writing causes the bottleneck, you can sort the result set by num_of_bytes_written to find out which file is written the most.

```
select db_name(mf.database_id) as database_name, mf.physical_name,
left(mf.physical_name, 1) as drive_letter,
vfs.num_of_writes, vfs.num_of_bytes_written, vfs.io_stall_write_ms,
mf.type_desc, vfs.num_of_reads, vfs.num_of_bytes_read, vfs.io_stall_read_ms,
vfs.io_stall, vfs.size_on_disk_bytes
from sys.master_files mf
join sys.dm_io_virtual_file_stats(NULL, NULL) vfs
on mf.database_id=vfs.database_id and mf.file_id=vfs.file_id
order by vfs.num_of_bytes_written desc
```



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master
Execute
SQLQuery1.sql ...werUser (52))*
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select db_name(mf.database_id) as database_name, mf.physical_name,
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mf.type_desc, vfs.num_of_reads, vfs.num_of_bytes_read, vfs.io_stall_read_ms,
vfs.io_stall, vfs.size_on_disk_bytes
from sys.master_files mf
join sys.dm_io_virtual_file_stats(NULL, NULL) vfs
on mf.database_id=vfs.database_id and mf.file_id=vfs.file_id
order by vfs.num_of_bytes_written desc
```

	database_name	physical_name	drive_letter	num_of_writes	num_of_bytes_written	io_stall_write_ms	type_desc
1	tempdb	D:\Microsoft SQL Server\MSSQL10.MSSQLSERVER\MSSQL\DATA\tempdb.mdf	D	13	253952	166	ROWS
2	master	D:\Microsoft SQL Server\MSSQL10.MSSQLSERVER\MSSQL\DATA\mastlog.ldf	D	29	131072	511	LOG
3	tempdb	D:\Microsoft SQL Server\MSSQL10.MSSQLSERVER\MSSQL\DATA\templog.ldf	D	6	92672	64	LOG
4	ReportServer	D:\Microsoft SQL Server\MSSQL10.MSSQLSERVER\MSSQL\DATA\ReportServer_log.LDF	D	5	69632	107	LOG
5	model	D:\Microsoft SQL Server\MSSQL10.MSSQLSERVER\MSSQL\DATA\modellog.ldf	D	7	36864	1	LOG
6	SampleDB	D:\Microsoft SQL Server\MSSQL10.MSSQLSERVER\MSSQL\DATA\SampleDB_log.LDF	D	5	29696	276	LOG

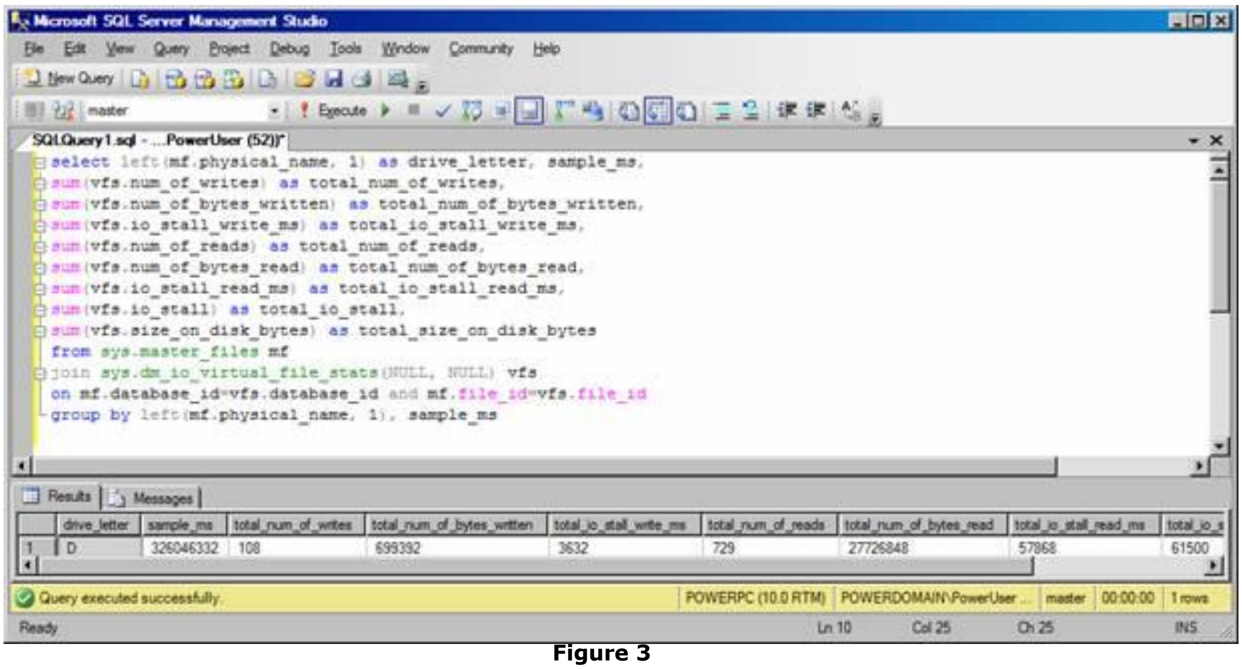
```
Query executed successfully.    POWERPC (10.0 RTM)    POWERDOMAIN\PowerUser ...    master    00:00:00    24 rows
Ready    Ln 1    Col 1    INS
```

Figure 2

As shown in Figure 2, the data file of tempdb is being written to the most. If the performance data showed that the drive D: is the write bottleneck, then we can consider moving tempdb to another drive, or adding a new drive for tempdb (having tempdb on a separate drive is Microsoft recommended).

It would also be helpful to know the total read and write activities of a logical drive by running the following statement.

```
select left(mf.physical_name, 1) as drive_letter, sample_ms,
sum(vfs.num_of_writes) as total_num_of_writes,
sum(vfs.num_of_bytes_written) as total_num_of_bytes_written,
sum(vfs.io_stall_write_ms) as total_io_stall_write_ms,
sum(vfs.num_of_reads) as total_num_of_reads,
sum(vfs.num_of_bytes_read) as total_num_of_bytes_read,
sum(vfs.io_stall_read_ms) as total_io_stall_read_ms,
sum(vfs.io_stall) as total_io_stall,
sum(vfs.size_on_disk_bytes) as total_size_on_disk_bytes
from sys.master_files mf
join sys.dm_io_virtual_file_stats(NULL, NULL) vfs
on mf.database_id=vfs.database_id and mf.file_id=vfs.file_id
group by left(mf.physical_name, 1), sample_ms
```



```
select left(mf.physical_name, 1) as drive_letter, sample_ms,
sum(vfs.num_of_writes) as total_num_of_writes,
sum(vfs.num_of_bytes_written) as total_num_of_bytes_written,
sum(vfs.io_stall_write_ms) as total_io_stall_write_ms,
sum(vfs.num_of_reads) as total_num_of_reads,
sum(vfs.num_of_bytes_read) as total_num_of_bytes_read,
sum(vfs.io_stall_read_ms) as total_io_stall_read_ms,
sum(vfs.io_stall) as total_io_stall,
sum(vfs.size_on_disk_bytes) as total_size_on_disk_bytes
from sys.master_files mf
join sys.dm_io_virtual_file_stats(NULL, NULL) vfs
on mf.database_id=vfs.database_id and mf.file_id=vfs.file_id
group by left(mf.physical_name, 1), sample_ms
```

	drive_letter	sample_ms	total_num_of_writes	total_num_of_bytes_written	total_io_stall_write_ms	total_num_of_reads	total_num_of_bytes_read	total_io_stall_read_ms	total_io_s
1	D	326046332	108	699392	3632	729	27726848	57868	61500

```
Query executed successfully.    POWERPC (10.0 RTM)    POWERDOMAIN\PowerUser ...    master    00:00:00    1 rows
```

Figure 3

The output is shown in Figure 3. You can compare these total values with the performance data to confirm the imbalance of drive workloads. You can also use the total values to estimate how the drives will behave after file moves. For example, in our example, if we decide to move the tempdb data file off the drive D:, we can simply deduct the num_of_bytes_written of the tempdb data file from the total_num_of_bytes_written of drive D:, to estimate the total number of bytes that will be written in the same sampling period after the move.

In **SQL Server 2000**, the sys.dm_io_virtual_file_stats function doesn't exist. You can, however, use the fn_virtualfilestats function. This function doesn't accept NULL as a valid parameter value. Therefore, you have to use a cursor to iterate through all database files.

```
DECLARE @DBID smallint
DECLARE @FILEID smallint
DECLARE @DBNAME sysname
DECLARE @FILENAME nvarchar(260)

CREATE TABLE #FileIOStats
(name sysname,
filename nvarchar(260),
drive_letter char(1),
NumberReads bigint,
NumberWrites bigint,
BytesRead bigint,
BytesWritten bigint,
IoStallMS bigint)

DECLARE ALLFILES CURSOR FOR
SELECT dbid, fileid, [name], [filename] FROM [master].[dbo].[sysaltfiles]

OPEN ALLFILES
FETCH NEXT FROM ALLFILES INTO @DBID, @FILEID, @DBNAME, @FILENAME
```

```
WHILE (@@FETCH_STATUS = 0)
BEGIN

		INSERT INTO #FileIOStats
		SELECT @DBNAME, @FILENAME, left(@FILENAME, 1), NumberReads,
NumberWrites, BytesRead, BytesWritten, IoStallMS
		FROM ::fn_virtualfilestats(@DBID, @FILEID)

		FETCH NEXT FROM ALLFILES INTO @DBID, @FILEID, @DBNAME, @FILENAME
END

CLOSE ALLFILES
DEALLOCATE ALLFILES

SELECT * FROM #FileIOStats
DROP TABLE #FileIOStats
```

As you can see, it is much simpler and easier to retrieve the report in SQL Server 2005 and 2008.

Conclusion

In this article, we have shown you how to produce a simple database file I/O report that helps resolve disk I/O bottleneck. This report can be used to identify the files to move off busy drives and to estimate the I/O activities after file moves.