StorFacts™ Report

i5 Memory Analysis

Memory

Pronunciation: mĕm'ə-rē

Definition *n. sing.* **mem·o·ry**

1. The mental faculty of retaining and recalling past experience.
2. The act or an instance of remembering; recollection: *spent the afternoon lost in memory.*
3. All that a person can remember: *It hasn't happened in my memory.*
4. Something remembered: *pleasant childhood memories.*
5. The fact of being remembered; remembrance: *dedicated to their parents' memory.*
6. The period of time covered by the remembrance or recollection of a person or group of persons: *within the memory of humankind.*

For more information – http://www.gstinc.com/store/Memory-C145.aspx

WHAT IS MEMORY?

INTRODUCTION

These days, no matter how much memory your server has, it never seems to be quite enough. Not long ago (1989 to be exact), an IBM AS/400 B10 server had a maximum memory capacity of 16MB. Today, the B10's direct decendant, IBM's i5 595 server boasts 2TB (2,097,152MB) of memory.

Price has also substantially changed over the years. Based upon 1989's cost of $130/MB, a 4GB memory upgrade would have cost over $500,000. In contrast, based upon today's cost of less than $1/MB, this same upgrade cost only $4,500.

For some, the memory equation is simple: the more the better. However, for those who want to go deeper, this StorFacts™ report contains answers to some of the most common questions asked.

THE ROLE OF MEMORY IN THE COMPUTER INDUSTRY

People in the industry commonly use the term "memory" to refer to RAM (Random Access Memory). A computer uses RAM to hold temporary instructions and data needed to complete tasks. This enables the computer's processor, to access instructions and data stored in memory very quickly.

A good example of this is when the processor loads the application program into memory -- such as a word processing or page layout program -- thereby enabling the application program to work as quickly and efficiently as possible. Having the program loaded into memory means that you can get work done more quickly with less time spent waiting for the computer to retrieve or execute instructions.

The program execution begins when you enter a command from your workstation. The processor interprets the command and instructs the disk drives to load the command or program into memory. Once needed data is loaded into memory, the processor is able to access it much more quickly than if it had to retrieve it from the disk.

MEMORY AND PERFORMANCE

It's been proven that adding more memory to a computer system increases its performance. If there isn't enough memory to hold all the information the processor needs, the computer has to set up what's known as a **virtual memory** file. In so doing, the processor reserves space on the hard disk to simulate additional RAM. This process, referred to as "swapping", slows the system down. In an average computer, it takes the processor approximately 200**ns (nanoseconds)** to access RAM compared to 12 million nanoseconds to access the hard drive. To put this into perspective, this is equivalent to what's normally a 3 1/2 minute task taking 4 1/2 months to complete!

How Much Memory Do You Need?

Perhaps you already know what it's like to work on a computer that doesn't have quite enough memory. You can hear the hard drive operating more frequently and the "hour glass" or "wrist watch" cursor symbol appears on the screen for longer periods of time. Things will run more slowly at times, memory errors occur more frequently, and sometimes you can't launch an application or a file without first closing or quitting another.

So, how do you determine if you have enough memory, or if you would benefit from more? And if you do need more, how much more? The fact is, the right amount of memory depends on the type of system you have, the type of work you're doing, and the software applications you're using.

SERVER MEMORY REQUIREMENTS

How can you tell when a server requires more memory? Quite often, the users of the network are good indicators. If network-related activity such as email, shared applications, or printing slows down, the users will probably let their Network Administrator know about it. Here are a few proactive strategies that can be used to gauge whether or not a server has sufficient memory:

1. Monitor server disk activity. If disk swapping is detected, it is usually a result of inadequate memory.
2. Most servers have a utility that monitors processor, memory, and disk utilization. Review this at peak usage times to measure the highest spikes in demand.

Once it's determined that a server does need more memory, there are many factors to consider when deciding on how much is enough:

What functions does the server perform (application, remote access, email, Web, file, print, database)?

Some servers hold a large amount of information in memory at once, while others process information sequentially. For example, a typical large database server does a lot of data processing; with more memory, such a server would likely run much faster because more of the records it needs for searches and queries could be held in memory so they are "at the ready." On the other hand, compared to a database server, a typical file server can perform efficiently with less memory because its primary job is simply to transfer information rather than to process it.

What operating system does the server use?

Each server operating system manages memory differently. For example, a **network operating system (NOS)** such as the Novell operating system handles information much differently than an application-oriented operating system such as Windows. Windows richer interface requires more memory, while the traditional Novell functions of file and print serving require less memory.

How many users access the server at one time?

Most servers are designed and configured to support a certain number of users at one time. Recent tests show that this number is directly proportional to the amount of memory in the server. As soon as the number of users exceeds maximum capacity for which the system is designed, the server resorts to using hard disk space as virtual memory and performance drops sharply. In recent studies with Windows NT, additional memory allowed an application server to increase by several times the number of users supported while maintaining the same level of performance.

What kind and how many processors are installed on the server?

Memory and processors affect server performance differently, but they work hand-in-hand. Adding memory allows more information to be handled at one time, while adding processors allows the information to be processed faster. So, if you add processing power to a system, additional memory will enable the processors to perform at their full potential.

How critical is the server's response time?

In some servers, such as Web or e-commerce servers, response time directly affects the customer experience and hence revenue. In these cases, some IT Managers choose to install more memory than they think they would ever need in order to accommodate surprise surges in use. Because server configurations involve so many variables, it's difficult to make precise recommendations with regard to memory.

CACHE MEMORY

Cache memory is high speed memory that resides very close to the processor. It usually exists in relatively small amounts (normally less than 1MB). Cache memory is designed to supply the processor with the most frequently requested data and instructions. Because retrieving data or instructions from cache takes a fraction of the time that it takes to access it from main memory, having cache memory can save a lot of time. If the information is not in cache, it still has to be retrieved from main memory, but checking cache memory takes so little time that it's worth it. This is analogous to checking your refrigerator for the food you need before running to the store to get it: it's likely that what you need is there; if not, it only took a moment to check.

The concept behind caching is the "80/20" rule: of all the programs, information, and data on your computer, about 20% of it is used 80% of the time. This 20% of frequently used data might include the code required for sending or deleting email, saving a file onto your hard drive, or simply recognizing which keys you've touched on your keyboard. Conversely, the remaining 80% of the data in your system gets used about 20% of the time. Cache memory makes sense because there's a good chance that the data and instructions now in the processor will be needed again.

How cache memory works

> Cache memory is like a "hot list" of instructions needed by the processor. The memory controller saves in cache each instruction the processor requests. Each time the processor retrieves an instruction it needs from cache -- called a "cache hit" -- that instruction moves to the top of the "hot list." When cache is full and the processor calls for a new instruction, the system overwrites the data in cache that hasn't been used for the longest period of time. This way, the high priority information that's used continuously stays in cache, while the less frequently used information is replaced.

Levels of Cache

Today, most cache memory is incorporated into the processor chip itself; however, other configurations are possible. In some cases, a system may have cache located inside the processor, just outside the processor on the motherboard, or it may have a memory cache socket near the processor, that can receive a cache memory module. Whatever the configuration, any cache memory component is assigned a "level" according to its proximity to the processor. For example, the cache that is closest to the processor is called **Level 1 (L1) Cache**, the next levels of cache are numbered L2, L3 and so on. Computers often have other types of caching in addition to cache memory. For example, sometimes the system uses main memory as a cache for the hard drive. While we won't discuss these scenarios here, it's important to note that the term cache can refer specifically to memory and to other storage technologies as well.

You might wonder: if having cache memory near the processor is so beneficial, why isn't cache memory used for all of main memory? For one thing, cache memory typically uses a type of memory chip called Static RAM (SRAM), which is more expensive and requires more space per megabyte than the DRAM typically used for main memory. Also, while cache memory does improve overall system performance, it does so up to a point. The real benefit of cache memory is in storing the most frequently-used instructions. A larger cache would hold more data, but if that data isn't needed frequently, there's little benefit to having it near the processor.

It can take as long as 195ns for the slower DRAMs in main memory to satisfy a memory request from the processor. External cache using SRAMs can satisfy a memory request from the PROCESSOR in as little as 45ns.

THE DIFFERENCE BETWEEN DDR1 AND DDR2 MEMORY

IBM i5 servers utilize both DDR1 and DDR2 memory. Cost and performance is significantly different between these two technologies.

DDR1 Memory

DDR1 is a next-generation of Double Data Rate (DDR) SDRAM technology. It allows the memory chip to perform transactions on both the rising and falling edges of the clock cycle. For example, with DDR SDRAM, a 100 or 133MHz memory bus clock rate yields an effective data rate of 200MHz or 266MHz.

DDR2 Memory

DDR2 is the second generation of Double Data Rate (DDR) SDRAM memory. It is an evolution of DDR memory technology that delivers higher speeds (up to 800 MHz), lower power consumption and better heat dissipation. It is an ideal memory solution for bandwidth hungry systems

CONCLUSION

The remainder of this StorFacts™ report will detail IBM eServer memory. Memory descriptions, server rules, and min/max memory requirements will be presented.

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Memory Feature Codes

FC4400	1024MB (2x 512MB) 276-Pin 533MHz DDR-2 SDRAM DIMMs

Configuration

1. 1024MB (2 x 512MB)
2. DDR-2 DIMM 276-Pin 533MHz SDRAM
3. Requires: 2 DIMM slots
4. Must be installed in Pairs or Quads

FC4443	512MB Memory ~ (2x256MB DIMMS)

Configuration

1. 512MB (2 x 256MB)
2. DDR-1 DIMM 208-Pin 266MHz SDRAM
3. Requires: 2 DIMM slots
4. Must be installed in Pairs or Quads

FC4444	1GB Memory ~ (4x256MB DIMMS)

Configuration

1. 1024MB (4 x 256MB)
2. DDR-1 DIMM 208-Pin 266MHz SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4445	4GB Memory ~ (4x1GB DIMMS)

Configuration

1. 4096MB (4 x 1024MB)
2. DDR-1 DIMM 208-Pin 266MHz SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4447	2GB Memory ~ (4x512MB DIMMS)

Configuration

1. 2048MB (4 x 512MB)
2. DDR-1 DIMM 208-Pin 266MHz SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4449	8GB Memory ~ (4x2GB DIMMS)

Configuration

1. 8192MB (4 x 2048MB)
2. DDR-1 DIMM 208-Pin 266MHz Stacked DRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4450	16GB Memory ~ (4x4GB DIMMS)

Configuration

1. 16384MB (4 x 4096MB)
2. DDR-1 DIMM 208-Pin 266MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4452	2GB Memory ~ (4x512MB DIMMS)

Configuration

1. 2048MB (4 x 512MB)
2. DDR-1 DIMM 208-Pin 8NS SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4454	8GB Memory ~ (4x2GB DIMMS)

Configuration

1. 8192MB (4 x 512MB)
2. DDR-1 DIMM 208-Pin 8NS SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4474	2048MB (2x 1024MB) 276-Pin 533MHz DDR-2 SDRAM DIMMs

Configuration

1. 2048MB (2 x 1024MB)
2. DDR-2 DIMM 276-Pin 533MHz SDRAM
3. Requires: 2 DIMM slots
4. Must be installed in Pairs or Quads

FC4475	4096MB (2x 2048MB) 276-Pin 533MHz DDR-2 SDRAM DIMMs

Configuration

1. 4096MB (2 x 2048MB)
2. DDR-2 DIMM 276-Pin 533MHz SDRAM
3. Requires: 2 DIMM slots
4. Must be installed in Pairs or Quads

FC4477	8192MB (2x 4096MB) 276-Pin 533MHz DDR-2 SDRAM DIMMs

Configuration

1. 8192MB (2 x 4096MB)
2. DDR-2 DIMM 276-Pin 533MHz SDRAM
3. Requires: 2 DIMM slots
4. Must be installed in Pairs or Quads

FC4490	4GB Memory ~ (4x1GB DIMMS)

Configuration

1. 4096MB (4 x 1024MB)
2. DDR-1 DIMM 208-Pin 250MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4491	16GB Memory ~ (4x4GB DIMMS)

Configuration

1. 16384MB (4 x 4096MB)
2. DDR-1 DIMM 208-Pin 250MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4492	32GB Memory ~ (4x8GB DIMMS)

Configuration

1. 32768MB (4 x 8192MB)
2. DDR-1 DIMM 208-Pin 250MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4497	16GB (4X4GB) DIMMs, 276 PIN, 533 MHz, DDR2 SDRAM

Configuration

1. 16384MB (4 x 4096MB)
2. DDR-2 DIMM 276-Pin 533MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC4498	32GB (4X8GB) DIMMs, 276 pin, 400MHz DDR2 SDRAM

Configuration

1. 32768MB (4 x 8192MB)
2. DDR-2 DIMM 276-Pin 400MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC7892	2GB Memory ~ (4 x 512MB DIMMS)

Configuration

1. 2048MB (4 x 512MB)
2. DDR-2 DIMM 276-Pin 533MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC7893	4GB Memory ~ (4x1GB DIMMS)

Configuration

1. 4096MB (4 x 1024MB)
2. DDR-2 DIMM 276-Pin 533MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads

FC7894	8GB Memory ~ (4 x 2GB DIMMS)

Configuration

1. 8192MB (4 x 2048MB)
2. DDR-2 DIMM 276-Pin 533MHz Stacked SDRAM
3. Requires: 4 DIMM slots
4. Must be installed in Quads