Understanding Server Hardware

Module 4: Hardware Selection

Glenn Berry
Glenn@SQLskills.com

pluralsight
hardcore developer training

Introduction

- **Choosing a server vendor**
  - Dell, Fujitsu, HP, IBM, NEC, or Unisys
- **Choosing a server form factor**
  - Rack-mount, tower, or blade
- **Choosing a processor vendor**
  - AMD or Intel
- **Choosing a server model**
  - Motherboard, processors, memory, internal storage, etc.
- **Determining the amount of RAM**
  - Workload type, OS and application memory limits
- **Choosing the storage type**
  - Internal drives, PCI-E cards, direct-attached storage, SANs
  - Understanding RAID levels and RAID storage overhead
- **Choosing components for redundancy**
  - Avoiding single points of failure

Choosing a Server Vendor

- **Several "top-tier" server vendors to choose from:**
  - Dell, Fujitsu, HP, IBM, NEC, or Unisys
- **Your organization likely has a preferred server vendor**
  - You are a "Dell shop" or an "IBM shop" for example
    - You can usually get a 15-25% discount from your preferred vendor
    - It is somewhat easier to maintain servers from the same vendor
  - It may be nearly impossible to buy from another vendor
- **Different vendors have different strengths and weaknesses**
  - Some vendors are less expensive than others
  - Some vendors have proprietary technology that can be valuable
- **Try to stay current about what different vendors offer**
  - A competitor may have something truly compelling in a new model
  - You can get competitive bids from several vendors to get best prices

Choosing a Server Form Factor

- **Three main choices**
  - Rack-mounted, tower, or blade server
  - Rack-mounted is the most common form factor
- **May be determined by your existing infrastructure**
  - If your data center or server room uses racks – rack-mounted
  - Tower servers can be less expensive than rack-mounted servers
- **Blade servers are very popular with I.T. departments**
  - They give you much higher server density in the same space
  - They have shared, common infrastructure in the blade chassis
  - The blade chassis is a single point of failure

Common Server Form Factors

- **Rack mount servers**
  - Standardized width and length to fit four post racks
    - Typical chassis is 444mm wide, 684mm long
  - Various standard vertical heights
    - 1U, 2U, 4U are most common sizes
  - Mounting rails for easy servicing

- **Tower servers**
  - Vertical tower with ample space for internal components
    - Some models can be fitted with rails for rack mounting
  - Commonly used for entry level servers

- **Blade servers**
  - Multiple blades in a shared, rack mount chassis
  - Increased server density, possible bottlenecks due to shared chassis

Choosing a Processor Vendor

- **For mainstream Windows-based servers, it is either Intel or AMD**
  - Processor vendor choice determines the available server model choices
- **Vendor choice can have a major effect on several factors**
  - Performance and scalability
  - Hardware cost, electrical power usage
  - Software licensing costs
- **Intel processor advantages:**
  - Better single-threaded performance
  - Lower power usage
- **AMD processor advantages:**
  - Higher physical core counts
  - Lower processor hardware cost

Choosing a Server Model

- **Processor vendor choice must be made first**
  - Restricts your available choices of server models
- **Processor socket count choice must be made next**
  - Restricts your available choices of server models
  - One-socket, two-socket, four-socket, or larger
- **"Bigger" servers are not faster than "smaller" servers**
  - Higher socket count servers have slower Intel processors
  - There are scaling losses as you go from two-sockets to four-sockets
- **What are your total memory and I/O performance requirements?**
  - Higher socket count servers have more memory slots
  - Higher socket count servers have more PCI-E expansion slots
- **What vertical form factor do you want?**
  - 1U, 2U, 4U, or taller
  - Taller servers have more room for internal drive bays

Choosing a Processor Model

- **What type of workload will you have on the server?**
  - Is it a CPU intensive workload?
  - Is it a single-threaded workload or a multi-threaded workload?
  - Consider core counts, clock speed, cache sizes
- **What kind of licensing model does your application have?**
  - May be based on socket count, physical core count, etc.
  - Core-based licensing can be very expensive with high core counts
- **What kind of hardware budget do you have?**
  - High core count, high clock speed processors are expensive
  - Over-provisioning your processor can sometimes save money
- **Choose carefully, since you are unlikely to upgrade processors**
  - Server vendors charge exorbitant prices for processor upgrade kits

Determining the Amount of RAM

- **Several different limits to consider**
  - Physical limits of the server
    - Determined by the server model and processor memory controller
  - License limits of the operating system version and edition
  - License limits of the application version and edition
- **Physical RAM is extremely affordable**
  - Currently $10-15 per GB and falling over time
  - RAM is faster and much less expensive than I/O capacity
  - Populating all memory slots can reduce memory bandwidth
    - This depends on the processor and memory controller
- **Select larger capacity DIMMs**
  - 8GB and 16GB DIMMs are good choices in late 2012
  - Having some empty memory slots lets you easily add more RAM later

Choosing the Storage Type

- **Depends on server usage, performance requirements, budget**
  - Existing infrastructure, employee skillset, and politics also matter
- **Four main storage types**
  - Internal drives - traditional magnetic drives or solid state drives (SSDs)
  - PCI-E storage cards
  - Direct-attached storage (DAS) - traditional magnetic drives or SSDs
  - Storage area networks (SAN) - traditional magnetic drives or SSDs
- **Internal, DAS and SAN can use hybrid or tiered-storage**
  - Mixture of magnetic storage and SSD storage
  - Good compromise between space, performance and cost
- **Storage details can make a huge difference for I/O performance**
  - 10K drives versus 15K drives, 3Gbps SAS versus 6Gbps SAS
  - Bandwidth of RAID controller, HBA or iSCSI NIC is very important

Internal Drives

- **Internal drives can be adequate for some workload types**
  - Web servers, application servers, caching servers
  - Light-duty database servers
- **Server vertical size has effect on number of internal drive bays**
- **Drive size (2.5” or 3.5”) also affects drive density**
  - 1U server might have 8-10 2.5” drive bays
  - 2U server might have 16-26 2.5” drive bays
  - 4U server might have 12-24 2.5” drive bays
- **Use a hardware RAID controller with cache memory**
  - Gives you better performance than software RAID
- **Prefer 15K drives over 10K drives**
  - More drives are better than fewer drives for performance
- **Consider SSDs where appropriate**

PCI-E Storage Cards

- **Flash-based storage on a PCI-E expansion card**
  - Uses very high bandwidth PCI-E slot instead of SAS or SATA port
  - Type and speed of PCI-E slot can be a limiting factor for bandwidth
- **Storage cards can deliver extremely high I/O performance**
  - Very high sequential throughput
  - Extremely high random I/O performance
- **Capital cost ranges from high to extremely high**
  - Anywhere from $2K to $150K for one storage card
- **Storage cards use less electrical power than multiple drives**
  - Can save on operating and maintenance costs
- **Leading vendors**
  - Fusion-io, OCZ, Intel

Direct-Attached Storage (DAS)

- **External storage enclosure with multiple drives**
  - Typically 8 to 24 drives in a storage enclosure
  - Drives can be magnetic hard drives or SSDs or a combination of both
  - Direct cable connection to a hardware RAID controller in one server
  - Can also be daisy-chained to another storage enclosure
    - Daisy-chaining is not a best practice for performance or redundancy
  - Easy to configure and manage
    - Does not require special training or expertise
  - Can provide excellent sequential read and write performance
    - Limited by PCI-E slot bandwidth
  - Much lower initial capital cost than most SANs
    - Incremental cost to add more capacity is also lower
  - Less flexible and feature rich than a SAN
    - No thin provisioning, no snapshots, etc.

Storage Area Network (SAN)

- **External storage enclosure with multiple components**
  - Large number of drives, can usually be expanded
  - Storage processors, large dedicated cache, operating system
  - Very flexible and feature-rich
    - Thin-provisioning, SAN snapshots, easy to change RAID levels
  - Usually much higher initial capital cost than DAS
  - Requires some training and expertise to setup and manage
- **Two main types of SANs**
  - Fiber-channel (FC), using host-bus adapter (HBA)
  - iSCSI, using dedicated Ethernet cards
- **SANs are usually optimized for IOPs**
  - Sequential throughput can be limited by interface and path to servers
    - Example: 1Gbps iSCSI limited to roughly 100MB/second
    - Example: 4Gbps FC HBA limited to roughly 400MB/second

RAID Basics

- **Redundant array of inexpensive disks (RAID)**
  - Standardized method of managing multiple drives with a controller
  - Provides redundancy and higher performance than a single drive
  - Allows higher capacity logical drives than is possible with one drive
- **Hardware RAID controllers manage multiple drives**
  - Server RAID controllers have dedicated cache memory
  - Cache can be used for reads or writes or both
- **Several different RAID levels are commonly used**
  - RAID 1
  - RAID 5
  - RAID 50
  - RAID 10

RAID 1

- **RAID 1 is called mirroring**
  - Requires two physical drives
  - Data is copied to both drives
  - Requires 50% storage space overhead
  - Drive array can survive the loss of one drive
    - You need to replace the failed drive and allow the RAID controller to automatically rebuild the mirror as soon as possible
  - No performance impact after the loss of one drive
- **Very common to install the OS to a RAID 1 volume on a server**
  - Usually done with two internal drives in the server
  - This allows the server to operate normally after losing one drive

RAID 5

- **RAID 5 is called striping with parity**
  - Requires at least three physical drives
  - Data is striped between all drives
  - After data is written to all drives, parity information is calculated and then striped to all of the drives
    - This causes a write performance penalty
  - This allows the array to survive the loss of one drive in the array
    - Performance is severely affected after the loss of one drive
    - Failed drive must be replaced as soon as possible
  - Requires 1/(the number of drives) as storage overhead
- **RAID 5 is very popular with I.T. departments**
  - It is quite economical because of low storage overhead
  - Risk of failure goes up as you add drives to the array

RAID 50

- **RAID 50 is called striping across multiple RAID 5 data sets**
  - Requires at least six physical drives
    - Minimum of two, three-drive RAID 5 arrays
  - Requires 1/(number of drives) in each RAID 5 array for storage overhead
  - Can survive the loss of one drive in each RAID 5 array
  - Performs better than RAID 5 after the loss of one drive
  - Can be a good compromise between RAID 5 and RAID 10
    - Less expensive than RAID 10
    - More expensive than RAID 5, but provides better redundancy
  - Not all RAID controllers support RAID 50

RAID 10

- **RAID 10 is called a striped set of mirrors**
  - Data is mirrored and then striped
    - Possible to survive the loss of more than one drive
  - Requires a minimum of four physical drives
    - Must be an even number of physical drives
  - No write performance penalty
    - Very well-suited to write intensive workloads
  - Requires a 50% storage space overhead
    - More expensive than RAID 5
- **RAID 10 is very popular with database administrators**
  - Provides better write performance and better redundancy than RAID 5

Choosing Components for Redundancy

- **Depending on the intended server usage**
  - You may want to invest in redundant components
    - Database servers should have redundant components
    - Web servers, application servers may not need redundant components
      - Low hardware cost per server may be the over-riding goal
      - You may have redundant servers behind a load balancer instead
- **You want to eliminate single points of failure where possible**
  - Dual power supplies, plugged into separate circuits
  - Multiple network ports, plugged into separate network switches
    - Most new servers have two or four embedded Gigabit Ethernet network ports
  - RAID protection for logical drives
    - RAID 10 gives more redundancy than RAID 5
  - Hot-swappable components
    - Hard drives, fans, power supplies, memory

Summary

- **Many choices must be made**
  - Server vendor
  - Server form-factor
  - Processor vendor
  - Server model
  - Processor model
  - RAM amount
  - Storage type
- **Servers have multiple redundant components**
  - Motherboard, processors, memory
  - Internal storage, power supplies
  - Integrated components

What is Next?

- **Module 5 will cover hardware maintenance**
  - The importance of hardware maintenance
  - Knowing what has to be maintained
  - Discovering when updates are needed
  - Planning and testing hardware updates
  - Using rolling maintenance techniques