SQL Server 2012: Evaluating and Sizing Hardware

Module 3: Choosing the Correct Processor for SQL Server 2012

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Introduction

- Workload type and size considerations
- Determining your server form factor
- Overall budget considerations
- SQL Server 2012 licensing considerations
- The importance of single-threaded processor performance
- The importance of total core counts for scalability
- Using TPC-E benchmark results to compare processor performance
- Using Geekbench to compare processor performance
- Processor power efficiency considerations

Workload Type and Size Considerations

- **SQL Server can have several different workload types**
- **Three most common types:**
  - Online Transaction Processing (OLTP)
  - Relational Data Warehouse (DW)
  - Online Analytical Processing (OLAP)
- **These workload types have different processor requirements**
  - OLTP workload is very dependent on single-threaded performance
  - DW workload is very dependent on the total number of processor cores
  - OLAP workload is dependent on single-threaded performance and the total number of processor cores
- **Total number of cores is correlated to capacity and scalability**
  - Single-threaded processor performance is very important

Determining Your Server Form Factor

- **How many processor sockets are needed?**
  - How much performance and scalability do you need?
- **Bigger servers are not faster servers**
  - Two-socket servers have newer, faster processors
  - Two-socket servers are much faster than higher socket count servers
- **Try to select a two-socket server if possible**
  - They have low hardware costs and adequate capacity for most workloads
  - Two, two-socket servers are better than one, four-socket server
    - Unless you absolutely cannot partition your workload
- **Jumping to four or more sockets gets increasingly expensive**
  - Hardware costs rise in a non-linear fashion
  - Scalability does not rise in a linear fashion
  - Four-socket and larger servers use older, slower processors

Overall Budget Considerations

- **Hardware cost of the server itself**
  - Cost increase is not linear as the socket count increases
- **Storage cost for your databases and database backups**
  - This can be a major source of expense
  - Data compression and backup compression can reduce storage needs
- **SQL Server 2012 license costs**
  - This depends on the SQL Server edition you will be using
    - Enterprise Edition is expensive but required in many scenarios
  - Possible to spend more on SQL Server 2012 licenses than on the hardware and storage subsystem
- **Picking the "right" processor can save on license costs**
  - A bad choice can be very expensive

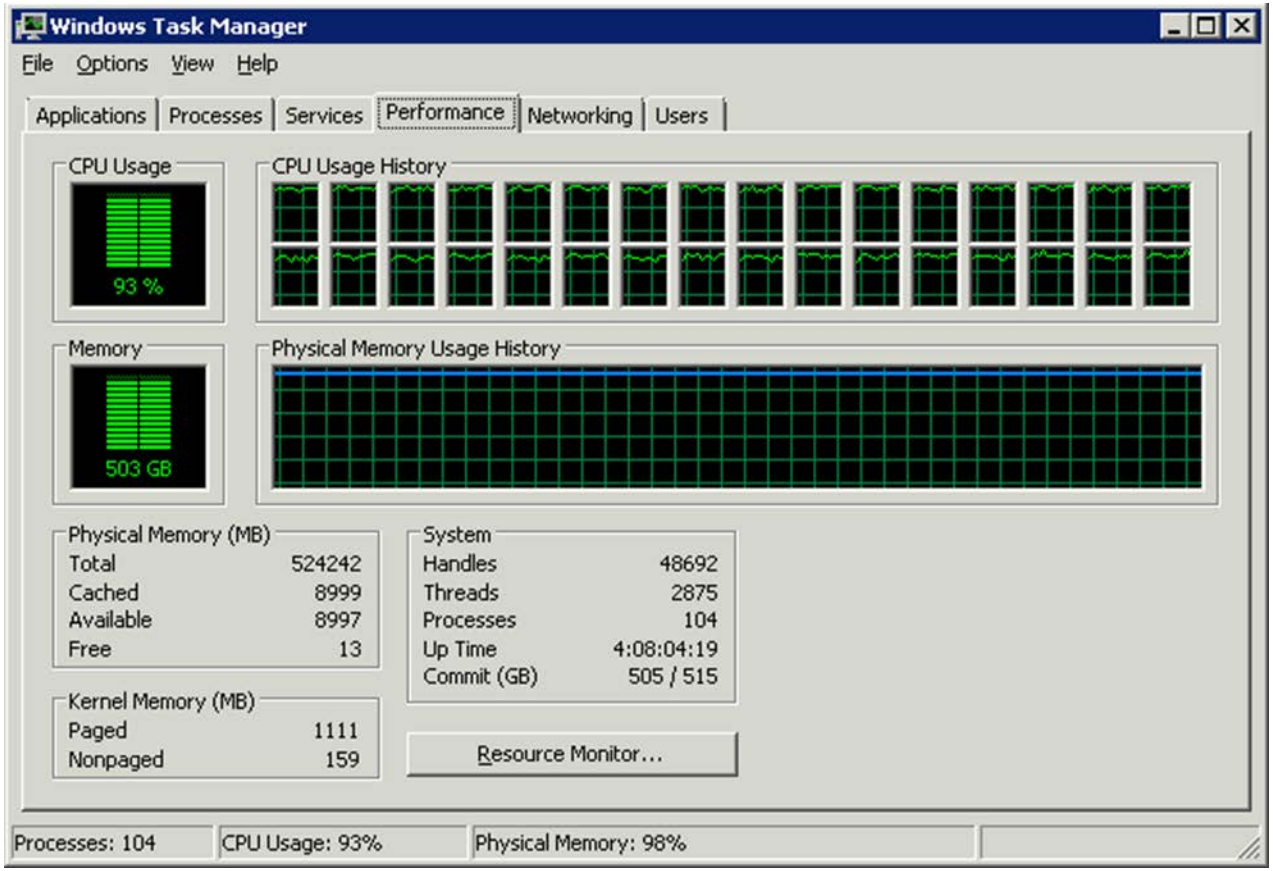
SQL Server 2012 Licensing Considerations

- **Enterprise Edition uses core-based licensing**
  - Physical core counts directly related to SQL Server 2012 licensing costs
- **Business Intelligence Edition uses server-based licensing**
  - Physical core counts not relevant for SQL Server 2012 licensing costs
    - You can use higher core count processors without license cost penalty
- **Standard Edition lets you choose licensing method**
  - Core-based or server-based licensing
  - Limited to lesser of four sockets or sixteen logical cores
  - Also limited to 64GB of RAM
- **Don't choose a four-socket server with high core counts if you will be using SQL Server 2012 Standard Edition**
  - You will not be able to use all of its resources

The Importance of Single-Threaded Performance

- **Extremely important for OLTP workloads**
  - Most OLTP queries run on one processor core
- **With adequate memory and I/O, CPU is the final bottleneck**
  - It is common to not have adequate memory and I/O performance
- **With core-based licensing, you pay the same for each core**
  - You want the best single-threaded performance possible
- **Unused CPU cycles can be used for compression**
  - Data compression with Enterprise Edition
  - Backup compression with Standard and Enterprise Edition

You Want to Avoid Ever Seeing This…



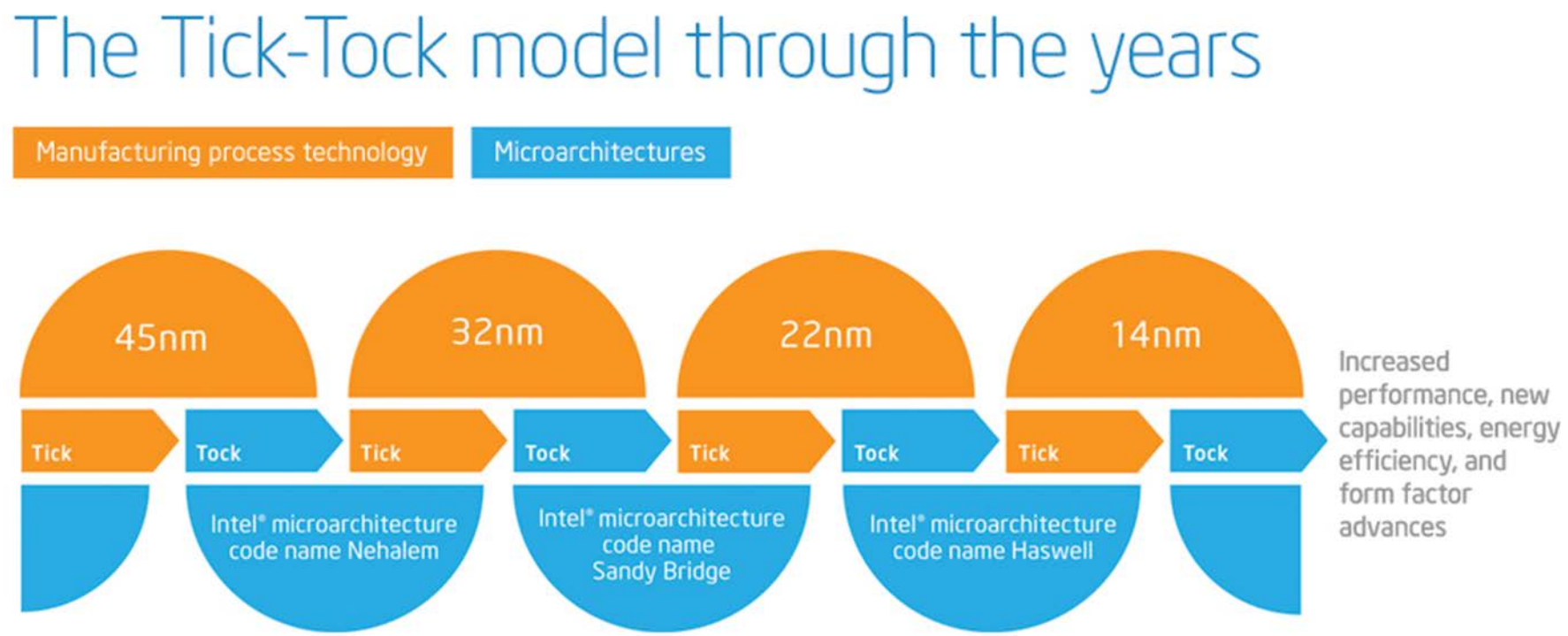
The Importance of Total Core Counts

- **The total number of physical cores affects the total CPU capacity**
  - It also affects the scalability of the system
  - Has a major effect on the SQL Server 2012 license costs
    - Only when you use core-based licensing
- **Logical cores are not counted for licensing purposes**
  - This makes Intel hyper-threading a free feature
  - This can give you a 20-30% boost in capacity for many workloads
- **You can choose specific models with lower core counts**
  - "Frequency optimized" models have higher base clock speeds
  - Four-core Intel Xeon E5-2643 vs. eight-core Intel Xeon E5-2690
  - This will reduce your SQL Server 2012 license costs
  - You will lose capacity, but gain some single-threaded performance

Intel or AMD Processors?

- **Intel is absolutely dominant for single-threaded performance**
  - Two-socket space since December 2008 (Xeon 5500 series)
  - Four-socket space since April 2010 (Xeon 7500 series)
  - Nehalem architecture was a game-changer for Intel
- **AMD processors are less expensive (hardware cost only)**
  - Processor cost is a very small component of the total cost of the server
    - Not a compelling reason to pick an AMD processor
  - Modern AMD processors have high physical core counts
    - This makes them more expensive for SQL Server 2012 core-based licensing
    - SQL Server 2012 Core Factor table gives a 25% discount to some AMD CPUs
    - Even with this discount, AMD licensing costs are still higher than Intel
    - AMD processors make some sense for use with Business Intelligence edition

Intel Tick Tock Release Strategy



Intel Processor Family Tree

Year	Process	Model Families	Code Name
2006	65nm	3000, 3200, 5100, 5300, 7300	Woodcrest, Clovertown
2007	45nm	3100, 3300, 5200, 5400, 7400	Wolfdale, Harpertown
2008	45nm	3400, 3500, 5500, 6500, 7500	Nehalem-EP, EX (2010)
2010	32nm	3600, 5600, E7-8800/4800/2800	Westmere-EP, EX (2011)
2011	32nm	E3-1200, E5-2600	Sandy Bridge, Sandy Bridge-EP
2012	22nm	E3-1200 v2, E5-2600v2 ?	Ivy Bridge, Ivy Bridge-EP
2013	22nm	E3-1200 v3 ?	Haswell-EP, Haswell-EX
2014	14nm		Rockwell
2015	14nm		Skylake
2016	10nm		Skymont

Current Intel Server Processor Series

- **Xeon E3 Family (Ivy Bridge)**
  - E3-1200 v2 Series (Value/mainstream uniprocessor)
- **Xeon E5 Family (Sandy Bridge-EN and EP)**
  - E5-1600 Series (Socket R, uniprocessor)
  - E5-2400 Series (Socket B2, dual-processor, Sandy Bridge-EN)
    - Not a good choice for SQL Server 2012
  - E5-2600 Series (Socket R, dual-processor, Sandy Bridge-EP)
  - E5-4600 Series (Socket R, quad-processor, Sandy Bridge-EP)
- **Xeon E7 Family (Westmere-EX)**
  - E7-2800 Series (dual-processor)
  - E7-4800 Series (quad-processor)
  - E7-8800 Series (eight or more sockets)
    - Westmere-EX is older and more expensive than Sandy Bridge-EP
    - Has much lower single-threaded performance than Sandy Bridge-EP

Recommended Intel Two-Socket Processors

- **Two-socket server (OLTP)**
  - Xeon E5-2690 (32nm Sandy Bridge-EP)
  - 2.9GHz, 20MB L3 cache, 8.0GT/s Intel QPI 1.1
  - Eight cores plus hyper-threading, Turbo Boost 2.0 (3.8GHz)
  - Four memory channels, 384GB max memory capacity (16GB DIMMs)
- **Two-socket server (DW/DSS)**
  - Xeon E7-2870 (32nm Westmere-EX)
  - 2.4GHz, 30MB L3 cache, 6.4GT/s Intel QPI 1.0
  - Ten cores plus hyper-threading, Turbo Boost 2.0 (2.8GHz)
  - Four memory channels, 512GB max memory capacity (16GB DIMMs)

Recommended Intel Four-Socket Processors

- **Four-socket server (OLTP)**
  - Xeon E5-4650 (32nm Sandy Bridge-EP)
  - 2.7GHz, 20MB L3 cache, 8.0GT/s Intel QPI 1.1
  - Eight cores plus hyper-threading, Turbo Boost 2.0 (3.3GHz)
  - Four memory channels, 768GB max memory capacity (16GB DIMMs)
- **Four-socket server (DW/DSS)**
  - Xeon E7-4870 (32nm Westmere-EX)
  - 2.4GHz, 30MB L3 cache, 6.4GT/s Intel QPI 1.0
  - Ten cores plus hyper-threading, Turbo Boost 2.0 (2.8GHz)
  - Four memory channels, 1TB max memory capacity (16GB DIMMs)

TPC-E Benchmark Introduction

- **TPC-E OLTP benchmark available since 2007**
  - http://bit.ly/UGs2Pm
  - Much more realistic than old TPC-C OLTP benchmark
    - More realistic data model, uses data from 2000 U.S. Census
    - Less dependency on I/O subsystem performance, requires fault-tolerance
  - Only SQL Server systems have been submitted so far
    - 60 official submissions as of March 2013
  - Benchmark is CPU-bound with adequate I/O capacity
    - Look at Executive Summary and Full Disclosure Report for details
  - TPC-E terminology translation
    - Processors = sockets
    - Cores = physical cores
    - Threads = logical cores

Using TPC-E Benchmarks to Evaluate Processors

- **Hardware vendors only use the top-tier processors**
  - This gives you a pretty good idea of the best processor at the time
  - You will have to make adjustments for lower-tier processors
- **Find the nearest equivalent processor from the official results**
  - Make sure you are aware of the generation of a processor
  - It is more difficult to compare different generation processors
- **For the same generation processor it is easier to compare results**
  - Make adjustments for number of cores, base clock speed, and cache size

TPC-E Score Analysis Examples

- **Divide tpsE score by number of processors**
  - Indicator of scalability
    - Intel Xeon E7-8870
      - 4614.22 tpsE divided by 8 processors = 576.78/processor
    - Intel Xeon E5-4650
      - 2651.27 tpsE divided by 4 processors = 662.82/processor
    - Intel Xeon E5-2690
      - 1881.76 tpsE divided by 2 processors = 940.88/processor
- **Divide tpsE score by number of threads**
  - Indicator of single-threaded performance
    - Intel Xeon E7-4870
      - 3218.46 tpsE divided by 80 threads = 40.23/thread
    - Intel Xeon E5-2690
      - 1881.76 tpsE divided by 32 threads = 58.81/thread

Geekbench Benchmark Introduction

- **Geekbench is a CPU/memory benchmark**
  - Quick assessment of CPU/memory performance
  - No configuration required, takes a couple of minutes to run
- **Correlates reasonably well with TPC-E scores**
  - Can be used to help “adjust” TPC-E score for slightly different CPU
- **Online database of Geekbench scores**
  - http://browse.geekbench.ca/
  - Search for most similar system by server model number
    - Make sure to compare 32-bit scores to 32-bit scores
    - Make sure to compare 64-bit scores to 64-bit scores
    - 64-bit scores will be 20-30% higher

Using Geekbench to Compare Processors

- **Not as many server system results are available**
  - This makes it harder to find comparable systems
- **Anyone can submit results to the online database**
  - This reduces the reliability of the results
- **Find the nearest equivalent processor from the available results**
  - Make sure you are aware of the generation of a processor
  - It is more difficult to compare different generation processors
- **For the same generation processor it is easier to compare results**
  - Make adjustments for number of cores, base clock speed, and cache size

Selected Geekbench Scores

Processor	Speed	Sockets	Cores	Threads	Geekbench Score
Xeon E7-4870	2.4GHz	4	40	80	38076
Xeon E5-2690	2.9GHz	2	16	32	28964
Xeon X7560	2.26GHz	4	32	64	31008
Xeon X5690	3.46GHz	2	12	24	23693
Opteron 6174	2.2GHz	4	48	48	21132
Xeon X7460	2.66GHz	4	24	24	16632
Opteron 6174	2.2GHz	2	24	24	16046
Xeon X5570	2.93GHz	2	8	16	15228
Xeon X7350	2.93GHz	4	16	16	9724
Xeon E5440	2.83GHz	2	8	8	7953
Xeon 7140	3.4GHz	4	8	8	5282

Processor Power Efficiency Considerations

- **Increased emphasis on power efficiency by Intel and AMD**
  - Power costs can be very significant in large data centers
- **Newer generations of processors use less electrical power**
  - They also handle power management more effectively
- **Hardware power management hurts database server performance**
  - Windows Power plan can also affect database server performance
- **Intel processors have better performance/watt than AMD**
- **Do not choose power-optimized processor models**
  - Large impact on server performance for marginal power savings
  - High performance processor models can be more efficient
    - They can return to idle state more quickly after finishing workload

Summary

- **Keep your workload in mind as you select a processor**
- **Try to use a two-socket processor if possible**
  - Two-socket servers have newer, faster processors
- **Be aware of your overall budget limitations**
  - A poor processor choice will increase SQL Server 2012 license costs
- **Know what edition of SQL Server 2012 you will be using**
  - This affects the licensing model and license limits
- **Single-threaded processor performance is very important**
- **Total core counts affect capacity and license costs**
- **Use benchmark results to help compare different processors**
- **Be aware of processor power efficiency factors**
  - Avoid power-optimized models for database server use

What is Next?

- **Module 4 will cover SQL Server 2012 editions and license limits**
  - SQL Server 2012 Standard Edition
  - SQL Server 2012 Web Edition
  - SQL Server 2012 Business Intelligence Edition
  - SQL Server 2012 Enterprise Edition
  - SQL Server 2012 Developer Edition
  - SQL Server 2012 licensing for virtualization