



Increasing Performance with MS SQL Server 64



Jason M. Goertz

Performance Engineer

Hewlett-Packard, WIE Performance Group

Redmond, WA

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Agenda



- Differences between 32 and 64 bit SQL
- Usage Scenarios
- Addressing Top Concerns
- The Consolidation Case
- Performance Considerations
- Customer Successes

Differences between 32 and 64 bit SQL Server



Enabling industry-standard servers across the data center with Windows Server 2003



 Microsoft
Windows Server 2003



- 32-bit versions - suited for the majority of today's business needs and applications
- 64-bit versions - appropriate if:
 - You *need* an alternative to RISC or proprietary architectures in your data center
 - You *have* increasingly complex or memory-intensive workloads that are beyond current IA-32 capabilities, such as:
 - Massive databases
 - Decision support systems and data warehousing
 - Line of business applications: enterprise resource planning, supply chain, etc.
 - You *require* maximum performance, scalability, and growth over the long term



HP Integrity Servers: Broadest line of Itanium[®] 2-based systems supporting Windows Server



HP Integrity
Superdome



Up to 64p scalability and hard-partitioning capability for leading consolidation



HP Integrity
rx8620-32 server



32p scalability and hard-partitioning capability for consolidation



HP Integrity
rx7620-16 server



16p flexibility with high-performance, density, and partitioning capabilities



HP Integrity
rx4640-8 server



8p high-performance server in ultra-dense and highly-scalable models



HP Integrity
rx2600-2 server



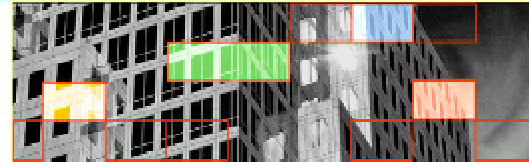
2p ultra-dense, power-packed server redefines entry-level computing



SQL Server Release on Itanium

- **Liberty**

- SQL Server 2000 64-bit edition
- beta version released November 2002
- production version released on April 24, 2003
 - Enterprise and Developer's Edition



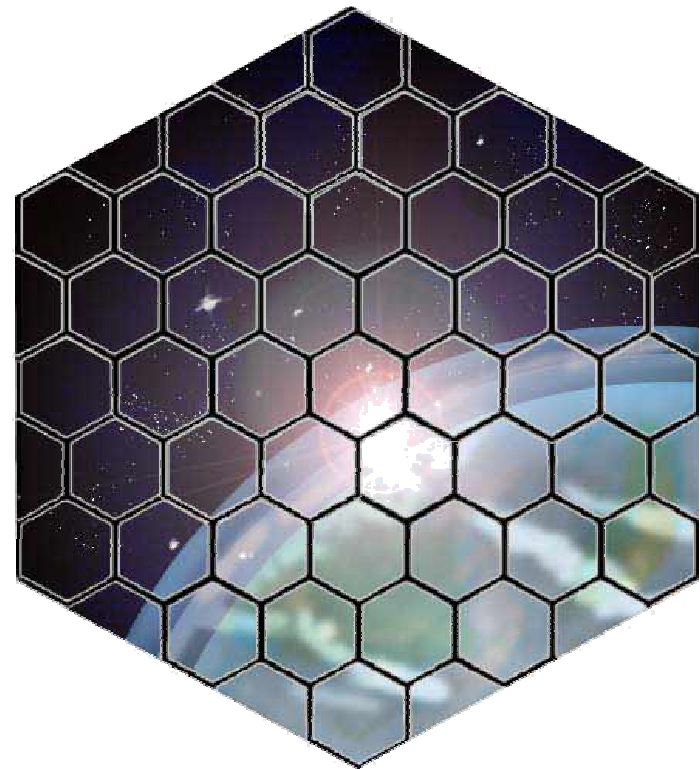
- **Yukon**

- Internal name for “SQL Server 2005” (64-bit and 32-bit)
- Beta-II release now
- Production release 1H of 2005

SQL Server 2000 Enterprise Edition (64-bit)



- Scales up to 512 GB of RAM
(64 in previous version)
- 1TB will be supported in Yukon
- Support up to 64 CPUs (32)



Tested and Certified



What is different from 32-bit

- No upgrades from SQL Server 6.5 and 7.0
- No remote installation
- No English query engine
- No Jet engine
- No 32-bit tools (EM, QA, DTS Designer, Wizards, Development Tools)
 - However, 64-bit SQL Server can be remotely managed from a 32-bit client
- No mixed 64-bit/32-bit processes are allowed
 - 64-bit programs cannot call 32-bit MDAC DLLs (and vice versa)
 - Extended Stored Procedures must be 64-bit (recompilation needed)
- SQL Mail is not supported
 - *But* the SQL Server Agent Mail **is** supported
- Copy Database Wizard (CDW) is not supported



SQL Server 2000 (64-bit)

Other significant changes

- Windows® Installer (Darwin) Setup
 - Single feature tree
 - Easily integrated into ISV application setup
 - Improved reliability
 - Analysis Services integrated into the database installation procedure
- Leverages Windows 2003 64-bit components
 - MDAC 2.7 stack
 - Distributed Transaction Coordinator
 - HTML Help

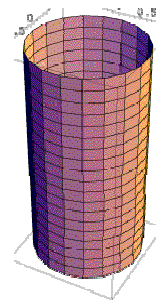
Key Differences of Analysis Services 64-bit

Data sources

- MDAC for 64-bit: only for the SQL Server OLE database provider and SQL Server ODBC driver
- OLE DB provider for ODBC is not supported (non-existent)
- Other DB providers (Oracle) may be available

Repository location

- No Jet means: no MDB storage for repository
- By default, the repository will always use SQL Server



NOTE: SQL Server 2000 Analysis Services 64-bit is aligned to SP3

Key Differences of Analysis Service 64-bit

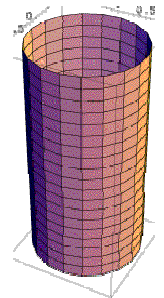
No Analysis Manager tool

- Can be remotely administered from 32-bit Analysis Manager
- SP3-based so Remote Analysis Manager (client) **must** be SP3 also

Memory-related registry settings

HKLM/Software/Microsoft/OLAP Server/Current Version

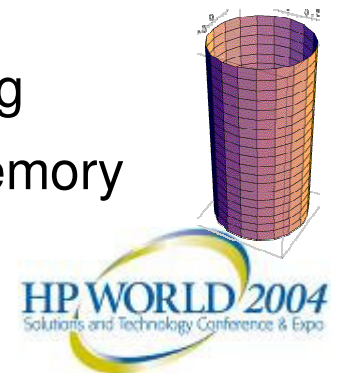
- MemoryAsMB
- HighMemoryLimit
- Other
- Some of them use Mbyte instead of byte as a unit





Advantages of Analysis Services (64-bit)

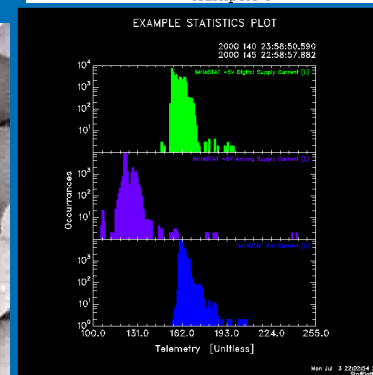
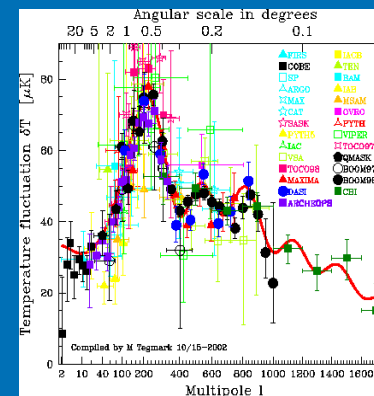
- No more **3GB** Limit
- No VLDM
- **Very large** dimensions supported **in memory** (up to 16TB)
- There can be more **parallelism** in partition processing because of memory advantages
- Analysis Services can use the large memory available for querying and **cube processing**
- Faster aggregation processing
 - Aggregations are built-in memory during cube processing
 - Temporary files are not used if aggregations will fit in memory



SQL 64-bit Caveats

- Extended stored procedures and UDFs must be recompiled for 64-bit
- ODBC Drivers for 3rd party databases
- HW Vendors must provide 64 bit drivers
 - SAN, Networking, etc. is mainly an issue of certification for Windows Datacenter for larger systems

Usage Scenarios



Itanium™ Architecture Benefits for SQL Server



Feature

Large Memory Support

Higher performance – larger buffer
No AWE required
More simultaneous connections

EPIC

Parallel & predictive query execution
More queries
More complex transactions
Faster external stored procedures
Real-time analysis

Large SMP Support

Database consolidation
Lower TCO
Increased headroom & scalability

Benefit

Manage Huge Volumes of Data

Improved Parallel Processing

Scale up & Multi SQL Instances



Consider 64-bit SQL Server 2000 for HP Integrity Servers



When you need to:

- scale beyond 8 processors and 4 GB of memory (IA-32 has a virtual address space limit of 32 GB, but many applications cannot take advantage of more than 4 GB)
- keep procedure/statement cache in the virtual address space
- keep memory associated with a server-side cursor in virtual address space
- speed up hash joins and sort operations within the maximum of the virtual address space
- directly address > 3 GB of memory (eliminate spill-out in TempDB)
- go beyond IA-32's bit limit of 32 GB virtual address space

For SQL Server environments, only the combination of SQL Server 2000 (64-bit) and HP Integrity Superdome server scales up to 64 processors and 512 GB of memory!



64-bit SQL Usage Scenarios

- Workloads leveraging **large SQL Buffer Cache**
 - OLTP with large working sets
 - Relational Data Warehouses
 - 64-bit eliminates performance overhead of AWE, the 32-bit large-memory technology
- Massive **Scale-up** Scenarios
 - More linear scalability beyond 8-way, and especially beyond 16-way
 - Server Consolidation

64-Bit SQL usage scenarios (cont'd.)

Workloads stressing Virtual Memory

- Limited to 3 GB on 32-bit, regardless of AWE
- Applications that stress
 - Procedure cache and cursor memory
 - Sort, index, and hash table memory
 - Connection memory
 - Analysis Services memory
- Examples:
 - Server Consolidation
 - High-Volume, diverse OLTP
 - Large-Scale OLAP
 - Simultaneous queries with large table joins



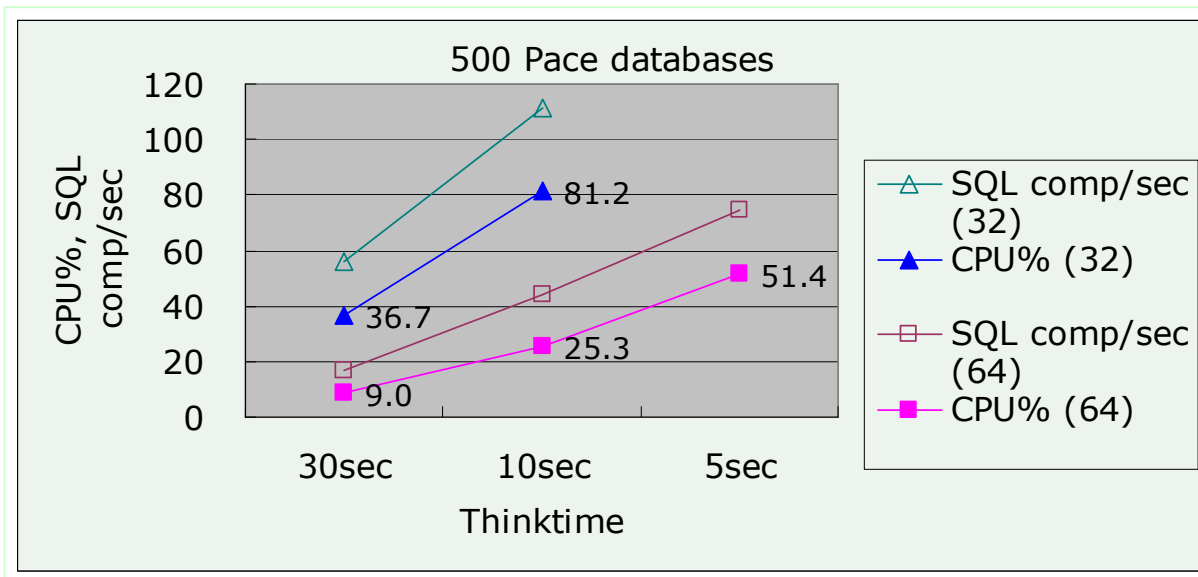
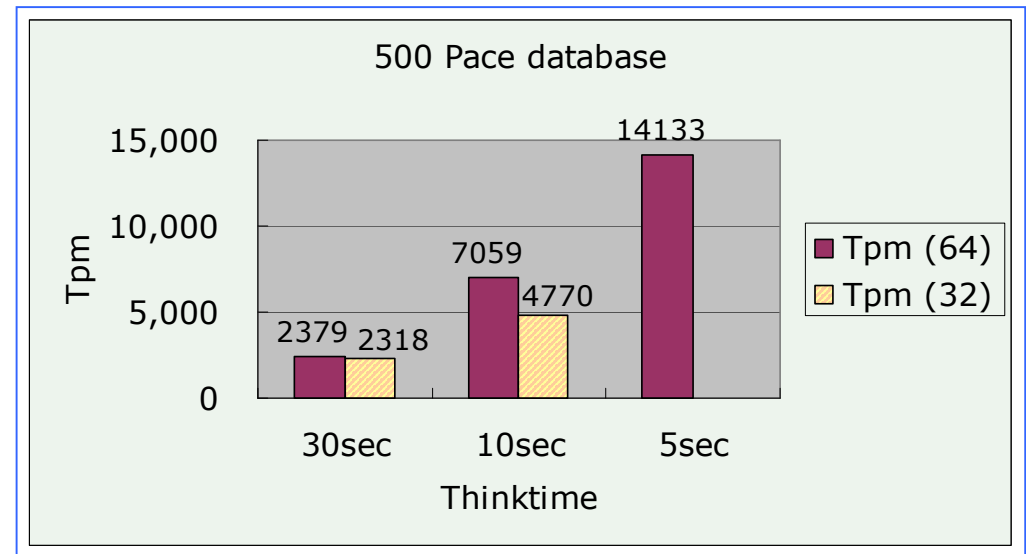
EXAMPLE: Server Consolidation / Larger Procedure Cache

- Internal test of a 500-database consolidation; accounting application
- Scarce resource on 32-bit is **Procedure Cache**
- Migrating to 64-bit and eliminating the bottleneck *reduces CPU* and enables greater throughput

Consolidation / Procedure Cache



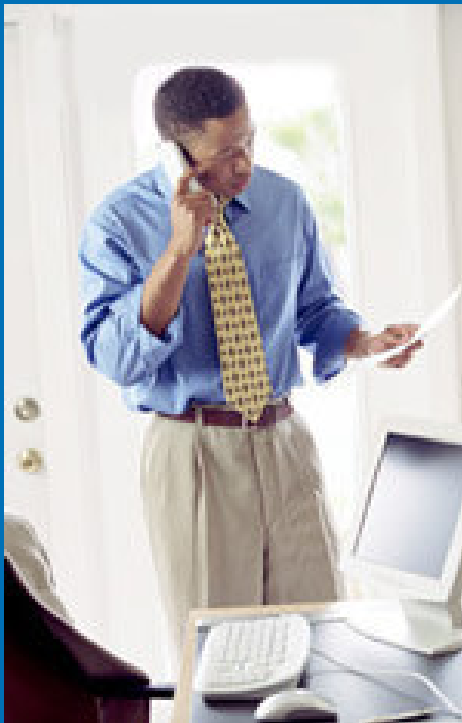
TPM versus Thinktime



CPU% and SQL
compilations/sec
versus
Thinktime



Addressing Top Concerns



SQL Server 2000 64-bit – Concern #1

Concern #1

32bit SQL
or
64bit SQL?

Which one applies to
my business case?

- 32-bit
 - **Scale out** approach: Improve performance by balancing out the workload
- 64-bit
 - **Scale-up** approach: Database that isn't easily partitioned performs better.
 - Quick access to large volumes of data residing in processor cache and main memory
 - I/O intensive
 - Complex queries: Sorts, joins, and workspace that can spill to disk
 - Virtual Memory: Many open cursors
 - Multiple instances of SQL Server
 - Total memory required is > 3GB

SQL Server 2000 64bit – Concern #2

Concern #2

Incompatibility

Will my existing 32-bit applications work with SQL Server 64bit?

- Has the same SQL Server 2000 **code base**
 - Based on SP3
- Same **on-disk format** for both SQL32 and SQL64 databases
- **Interoperability** with other SQL Server installations
- No need to modify middle-tier applications when migrating 32-bit to 64-bit applications
- MS released IA-32 Execution Layer Setup software driver

Transition Seamlessly from 32-bit to 64-bit SQL Server 2000 Enterprise Edition



Networking layer of 64-bit versions of SQL Server 2000 Enterprise Edition accepts input from 32-bit clients, just as with 64-bit clients!

Run your 32-bit application on your x86 server with a 64-bit Itanium-based database server and experience the performance benefits!



Microsoft
SQL Server



Manageability & Backup Software



- Anti-Virus:
 - CA- eTrust AntiVirus v7
 - Symantec- AntiVirus Corporate Edition
 - MicroTrend ServerProtect v5.56
- Backup/Restore:
 - HP OpenView DataProtector
 - Veritas – Netbackup v4.5 FP3 (64-bit client)
 - Veritas- Backup exec (64-bit client)
 - DBassociateIT- SQL LiteSpeed
 - Legato Networker v7.0
- Management and monitoring:
 - BMC Patrol
 - HP Systems Insight Manager
 - HP OpenView
 - NetIQ EndPoints, AppManager, AppManager for SQL, Diagnostic Mgr for SQL
 - Unicenter v3.1 client



SQL Server 2000 64bit – Concern #3

Concern #3 Cost

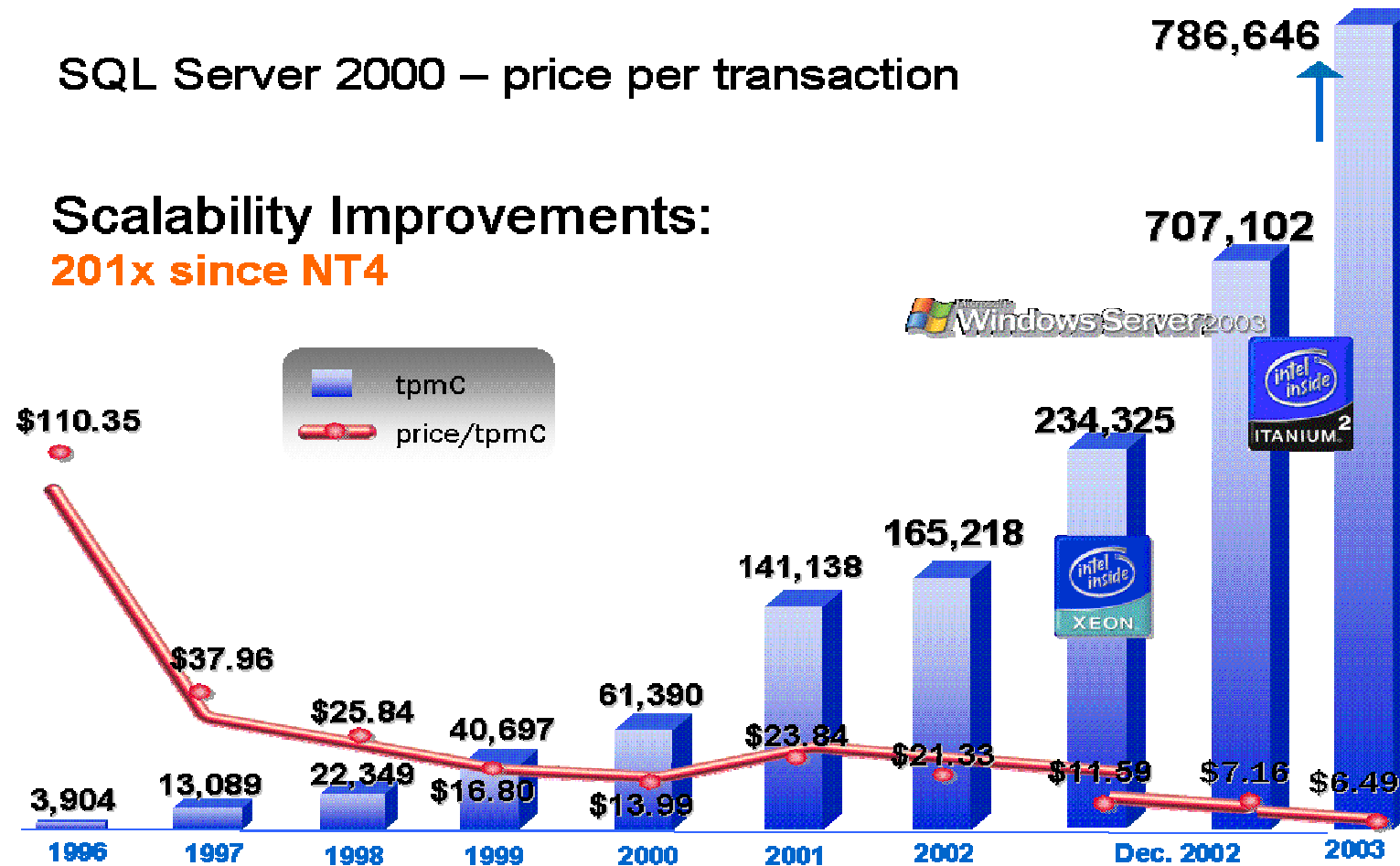
How expensive is SQL
Server 64bit?

Does it cost much **more** to run SQL server 64-bit on
Itanium ® 2 systems?

- Same price and license terms
for Windows Server 2003
32 and 64-bit
- SQL Server 64-bit Products
available:
 - Enterprise Edition (64-bit) &
 - Developer Edition (64-bit)
- SQL Server 2000 licenses
interchangeable for 32/64 bit
 - No need to buy new licenses

SQL Server 2000 – price per transaction

Scalability Improvements:
201x since NT4



Results from www.tpc.org, Dec 2002 – Windows Server, Microsoft SQL Server TPC-C Benchmarks

SQL Server 2000 64bit – Concerns #4

Concern #4

Migration Complexity:

How difficult is it to migrate?

- Same administrative tools
 - for 32-bit/64-bit SQL databases (Enterprise Manager Client installed on a 32-bit server)
- Minimal migration hurdles
 - Scripting languages will work on SQL Server 2000 (64-bit)
 - Extended Stored Procedures need to be recompiled
 - 64-bit compilers ship with Platform SDK
- Procedure to migrate SQL32 to SQL64:
 - Detach database from 32-bit server and reattach on 64-bit server



Database Consolidation

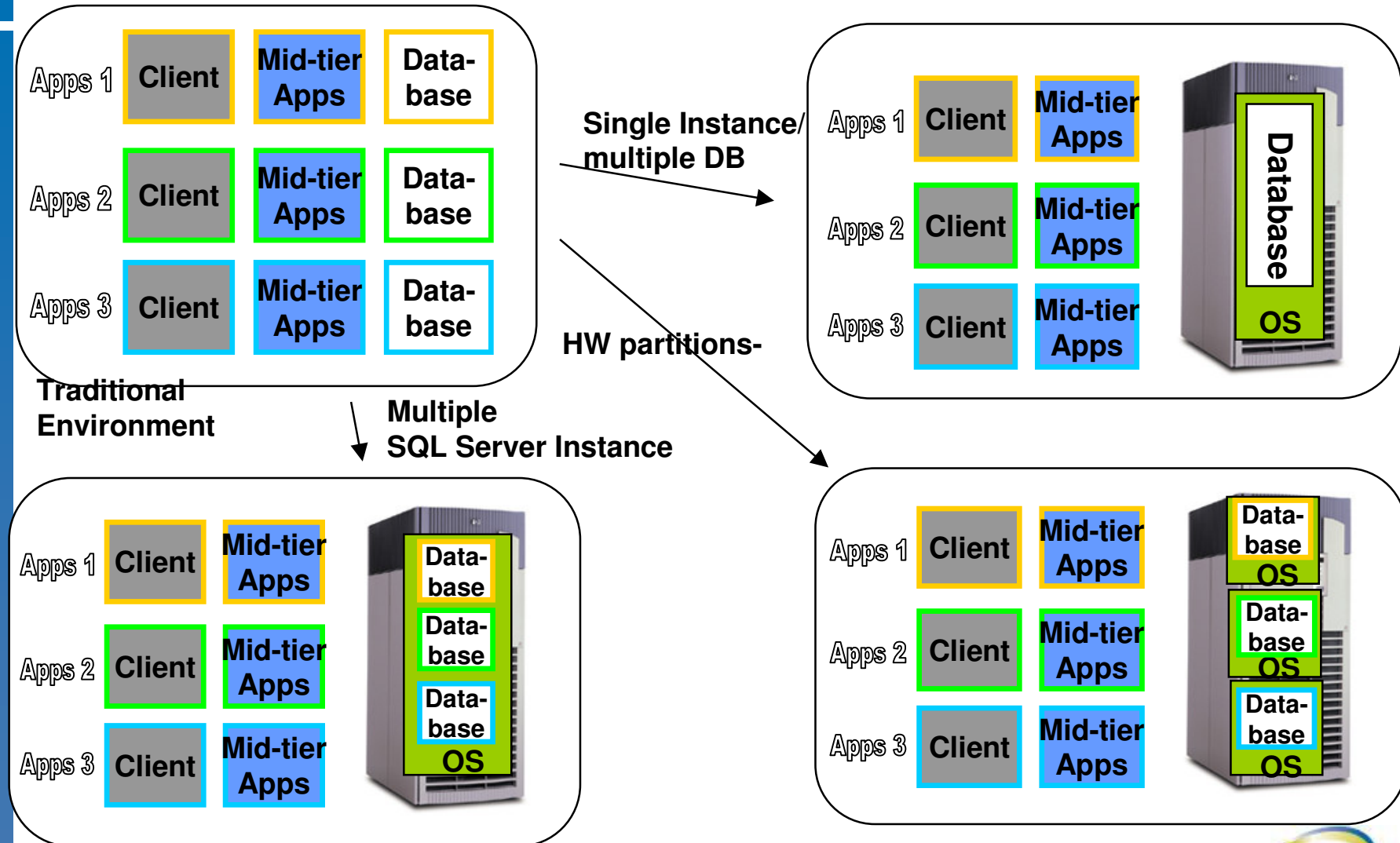
Values of Database Consolidation

- Maximize server resource utilization
- Centralize management of databases
- Increase security of enterprise data
- Simplify database monitoring and management

Potential cost savings in hardware, software, and operation



Three DB Consolidation Options



Four Decisive Factors for Consolidation Design



- System resources
 - Resources usage in database servers to be consolidated
 - Aggregate Resources requirements/availability in new DB server
- Application characterization
 - Criticality of applications that DB supports
 - Type of applications (e.g. Internal vs. external, businesses, etc)
 - Resources requirement and usage pattern
- Technology constraints
 - Network infrastructure
 - OEM alignment
- Business constraints
 - Business alignment
 - Cost/Investment protection



Major Design Decisions for Database Consolidations



- Deployment Models
 - Number of databases to be consolidated
 - Consolidation models
 - Number of instances
 - Clustered or not clustered
- Resource Control
 - SQL 2000 built-in resource management
 - Built-in processor affinity
 - Set maximum server memory limit
 - MS Windows Resource Manager
 - OEM/third party resource management tools

Major Design Decisions for Database Consolidations (continued)



- Hardware/software
 - CPU/Memory/Disk/Memory according to aggregated resources
 - Vendor of choice
 - Meeting SLA
 - 70% resources under normal load
 - Headroom
 - Cost
- Cluster solution
 - Now Windows 2003 supports 8-node clusters
 - No AWE with SQL64 means less failover time
 - Failover configuration options (e.g. N+1)

Major Design Decisions for Database Consolidations (continued)



- Database Layout
 - Placement of data file or data file group critical for performance
 - Each instance assigned to a segregated disk unit
 - Disks assigned to the unit assigned to separate I/O channel
 - Disk assignment and configuration depends on the I/O patterns of each instance
- Database Security
 - Can be segregated by instances
 - Each instance given separate administrative authority
- Management Solutions
 - Meeting the existing enterprise management frameworks
 - MOM, NetIQ, BMC Patrol, HP Openview, CA Unicenter, IBM Tivoli



How Do I Size a System?



- HP Integrity server transactions processing sizer for Microsoft SQL Server 2000 (64-bit) available on HP's ActiveAnswers web site
<http://www.hp.com/solutions/mssql>
- General Rule of Thumb: 4 Itanium2 Procs ~ 8 older Xeon procs (ie, 700-900 Mhz)
- Very workload dependent
- DSS will only be faster if more IO hardware is used
- Call HP for sizing of SQL with other applications such as SAP, PeopleSoft, and Siebel





Performance Considerations

Performance Optimization is Workload Dependent

- Different workloads must be dealt with differently
 - OLTP vs DSS
- Different workloads put stress on different parts of the hardware
- SQL should be tuned differently for different workloads
- If workload is mixed, must decide which has precedence (generally OLTP)

Online Transaction Processing (OLTP) Considerations



- Generates more network traffic, but generally many short packets
- Also generally does smaller storage transfers
- Need to maximize system for quick response time, shorter DB recovery time
- TPC-C standardized benchmark is an example of this workload

Decision Support System (DSS) Considerations



- Usually imposes a large IO load on the system
- Can negatively impact OLTP workload on the same machine
- SQL is pretty good at optimizing this workload
- Sp_configure “Max Degree of Parallelism” is key to tuning this workload
- TPC-H standardized benchmark is an example of this workload

General Hardware Guidelines



- Assuming DB size > memory size, more memory will generally help
- For OLTP with high IO loads, **more spindles** will help; IO rate should be < 100/spindle/sec
- For DSS workloads, more IO bandwidth will generally help; Realistic load through a single fiber is 180 mb /sec

General Guidelines for Storage



- Disk layout

- RAID 0+1 for Log drive, Write Cache **enabled**
- **NO** RAID 5 for Log or TempDB
- RAID 0+1 or RAID 5 for database
- Avoid multiple RAID volumes on same physical disk
(backup volumes OK)
- Optimize stripe size for workload; generally, 8K for OLTP, more for DSS, Store/Restore

General Guidelines for Storage (cont'd.)



- **Connectivity**

- Enough FC cards, bandwidth might not be a problem for DB operation but for Restore (= downtime); DSS will require more bandwidth
- Distribute FC cards over I/O chassis, 5 X 2GB FC per I/O chassis max
- Switch Configuration
 - Verify 2GB mode
 - Avoid Switch-to-Switch Bottlenecks

General Guidelines for Network



- Enough NICs, SQL network traffic packets are typically small, <10,000 packets/sec on a Gigabit NIC
- Enable TCP and IP, Rx and Tx checksum offloading
- Enable coalescing
- Adapter Teaming has additional overhead
- Intel NICs usually faster than Broadcom (less CPU load)

General Guidelines for SQL

- **Do not** assume parameters that worked on small 32-bit systems will work on larger 64-bit systems
- In general, consciously set sp_configure params, including Affinity Masks, Max Server Memory, etc.
- ‘max degree of parallelism’ 1 for OLTP style workloads, higher for DSS style workloads. **Do not leave set to 0 if running mixed OLTP/DSS.**
- ‘max worker threads’ set to total number of DB connections + number of CPUs + 8

General Guidelines for SQL (cont'd.)



- If the application uses TempDB, make sure its on fast disks (write cache on) and large enough (avoid auto-grow)
- Same guidelines for Log, but log **must** have redundant cache

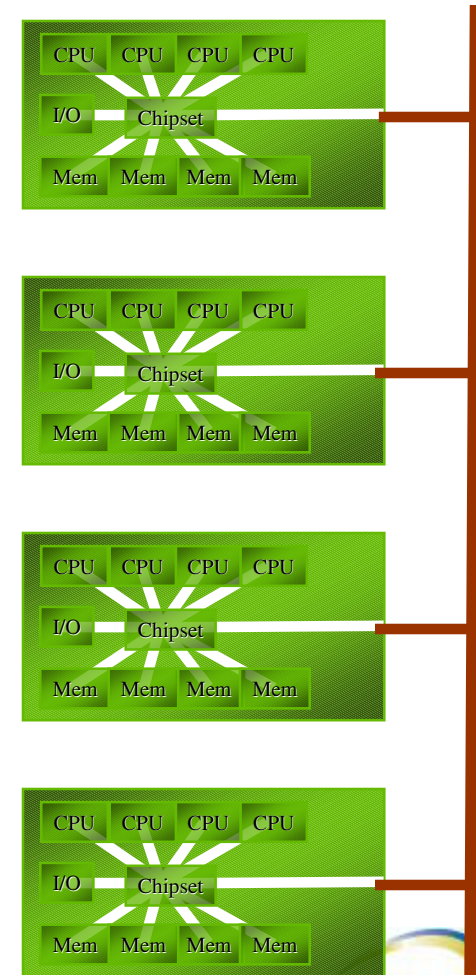
Hardware Suggestions for OLTP



- Need enough NICS to handle packet load; total bandwidth usually not an issue with OLTP
- Optimize disc stripe size for average IO; generally, 8K with SQL. Monitor with Perfmon
- Move NICS to avoid interrupt overhead colliding with lazywriter, log thread
- Use NUMA/Connection Affinity if application can benefit

A Quick Note on NUMA

- Non-uniform Memory Access
- Used by partitionable systems
- Key concept: CPUs and Memory banks are grouped in “cells”
- Intra-cell communication is faster than inter-cell
- Avoid Memory Contention typical of SMP systems
- SQL can be made NUMA aware
- Configure memory all cell local



Caveats of NUMA

- OS will allocate stacks in proper cell
- ALL CLM should be standard configuration
- SQL Liberty QFE is NUMA Aware



Caveats of NUMA (cont'd.)

- Max benefit will be seen from connection affinity, only available with VIA currently
- Yukon NUMA totally re-written from ground up
- Yukon will have connection affinity for TCP

Performance Summary



- Take advantage of hardware offered by Integrity
- Configure disc, network, and storage for optimum access for your workload
- SQL Defaults are not always best choices for larger systems
- Always configure CLM to activate NUMA on mid and large systems





Customer Successes

Customers Benefiting from HP Integrity Servers with Windows



- **Data warehousing**
 - Raymond James Financial
 - CompUSA
 - DenizBank (consolidation)
- **Business intelligence**
 - Banca Popolare di Vicenza
 - ING Commercial America
 - 123Multimedia
- **Enterprise resource planning**
 - The Koehler Group
 - Multiyork
 - VTG-Lehnkering AG (consolidation)
 - ebm-papst Germany (consolidation)
 - KCM
 - realTech AG
 - Electra Sweden AB
- **Database performance**
 - kabu.com Securities
 - Johns Hopkins University
 - Navitaire
 - Shanghai WaiGaoQiao INTER Net & Information Co. Ltd.
 - Exact Software
- **Database consolidation**
 - Nikkei NET
 - The Presidential Administration of Chuvashia
 - Korea Telecom
 - Tielikelaitys: Finnish Road Enterprise
 - Vietnam Incombank

For details on these references go to:

<http://www.hp.com/products1/itanium/testimonials/index.html>



The Business Value of HP Integrity Server—Windows Solutions



Tieliikelaitos/Finnish Road Enterprise Public sector, EMEA	Integrity rx5670 server Windows Server 2003 SQL Server 2000	• Consolidation of 3 DB servers simplified IT and reduced costs • Supports millions of transactions for 3,500 current users and more expected • 3X performance improvement over 32-bit alternative
 VTG-LEHNKERING AG Logistics company, EMEA	32-bit platforms and apps 2 rx5670 servers Windows Server 2003 Enterprise Virtual Array	• Up to 80% performance improvement for significant cost savings; can now support local offices • Scalability for future growth • Tighter control over accounting, faster access to reporting and management information
 CompUSA Retail, North America	Integrity rx2600, Integrity rx5670 servers Windows Server 2003 SQL Server 2000	• OLAP takes 1/60th the time (33 min vs. 33 hrs) of the previous solution • Superb scalability
 DenizBank Financial services	Integrity Superdome Windows Server 2003 SQL Server 2000	• High-performance CRM IT consolidation reduced costs • Exceptional uptime improved profitability and customer loyalty
Raymond James Financial Financial services, North America 	Integrity Superdome Windows Server 2003 SQL Server 2000	• 5X performance improvement over 32-bit alternative • Expects increased profitability by reducing costs and increasing productivity



“The price-performance benefits of 64-bit Windows and SQL Server are obvious.

We can replace all ten 32-bit servers ... with a single 64-bit server that costs roughly 60% as much, yet can support twice the workload.

Our decision to move to the 64-bit environment becomes a no-brainer: we're shifting the performance benefit to where it counts the most - the customer experience.”

**Mark Ellis,
Senior VP, Application Architecture
Information Resources, Inc. (IRI)**



Summary

- SQL Server (64-bit) provides leading enterprise-class performance and availability database service for Windows environments
- HP Integrity servers offer the widest range of product, and the highest level of scalability for 64-bit SQL
- Integrity and 64-bit SQL give maximum options for performance gains. Must be tuned differently than 32 bit in most cases.
- Key focus for Database Applications:
 - ✓ Scale Up OLTP
 - ✓ Large Memory Data Warehousing/OLAP
 - ✓ SQL Server Consolidation



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