Hewlett Packard Enterprise

HPE Reference Architecture for Microsoft SQL Server 2016 on HPE Integrity Superdome X and HPE 3PAR StoreServ 8450

Optimizing performance for operational analytics workloads

Technical white paper

Contents

Executive summary

Efficiently managing large volumes of data is a big challenge for enterprise IT departments. Operational data warehousing environments, such as ad-hoc, decision support environments (commonly referred to as data warehouses), must provide the scalability required for the largest, most demanding query workloads to answer complex business questions. Reporting and operational analytics are frequently managed using historical data from that same data warehouse, and increasingly from real-time data sources streaming through the same operational systems. As these environments grow and include additional operational systems, as well as increasing volumes of historical data (much of it online), lack of scalability may become a bottleneck to success. The ability to scale up these environments, to provide the level of performance required by demanding operational analytics customers, presents a significant challenge.

Additionally, many enterprise customers are now requiring real time analysis of business opportunities without waiting for the processing of data into the data warehousing environment. This transformation is known as operational analytics, also called Hybrid Transactional / Analytical Processing (HTAP). Traditional operational environments have not been able to address these real time analytics needs while still providing optimal performance for the ongoing online transaction processing (OLTP) work directly serving customers and applications. To address these challenges, Hewlett Packard Enterprise developed a solution utilizing the HPE Integrity Superdome X platform and HPE 3PAR StoreServ 8450 storage; ideally suited for solving the scalability and performance needs of these demanding data warehousing and analytics workload environments.

The HPE Integrity Superdome X platform can scale from a single blade solution to solutions encompassing 8 server blades, with up to 48 CPU cores and 3 TB of memory per server blade. This environment also allows a single hardware platform to be logically and physically partitioned to support multiple environments and workloads adjusting resources such as processor, memory, and storage over time as required by the business. In addition, the HPE 3PAR StoreServ enables an all-flash array configuration that can support multiple types of workloads; from heavy I/O transactional applications to large sequential access data warehouse workloads to a combination of both in a mixed workload, multi-application scenario. The HPE 3PAR StoreServ array provides advanced service level management and quality of service for Microsoft® SQL Server workloads with capabilities such as Priority Optimization that can reduce performance contention and guarantee reliable storage performance and scalability.

This reference architecture (RA) provides configuration guidance and performance baseline information for a mixed operational analytics workload, using a transaction driven environment, which has also been optimized via columnstore indexes to support an ad-hoc, decision support workload on the same database platform. The solution is running Microsoft SQL Server 2016 and Microsoft Windows Server® 2016 using an HPE Integrity Superdome X platform with an HPE 3PAR StoreServ 8450 storage array. Prior to SQL Server 2016, most analytics queries were not reasonable to run against the OLTP system, and were therefore deferred until after the data had been processed and added to the enterprise data warehouse. The testing done for this reference architecture showed that using operational analytics with SQL Server 2016 resulted in a 5 minute response time for a series of decision support queries versus up to a 28 hour response time running the same queries without the new style of columnstore indexes. Transactional performance on the operational analytics queries was not negatively impacted due to the use of resource governor.

This reference architecture builds upon earlier technical white papers on the HPE Integrity Superdome X and HPE 3PAR StoreServ platforms, including the reference configuration white paper found at http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA6-5205ENW that compares data warehousing environments running Microsoft Windows Server 2016 and SQL Server 2016 on two generations of the HPE Integrity Superdome X and HPE 3PAR StoreServ platforms. Additionally, earlier reference architecture papers with a similar solution have been published leveraging Microsoft Windows Server 2012 R2 and SQL Server 2014. The first reference architecture, http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA6-1676ENW, provides detailed instructions, guidance, and performance results when running a scale-up OLTP solution alongside a consolidation solution using Hyper-V virtualization. The second reference architecture, found at http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA6-3436ENW, covers mixed data warehousing and OLTP workloads running on the HPE Integrity Superdome X and HPE 3PAR storage array platform. As shown in these earlier reference architectures, each workload runs in complete isolation and is able to maximize hardware investment, scalability, and reliability with the innovative HPE Integrity Superdome X and HPE 3PAR StoreServ platforms. All of these earlier workloads are completely compatible and can run side by side with the operational analytics workload described in this reference architecture, using the available remaining blades in the HPE Integrity Superdome X solution.

Target audience: Chief information officers (CIOs), chief technology officers (CTOs), line of business managers, data center managers, database administrators, enterprise architects, database architects, storage administrators and others wishing to learn more about scaling up Microsoft SQL Server 2016 with HPE Integrity Superdome X and HPE 3PAR platforms. A working knowledge of server architecture, networking architecture, storage design, Microsoft Windows Server, and Microsoft SQL Server is recommended.

Introduction

The strong desire for operational flexibility, well informed by real time analytics, is driving changes in the way database vendors are extending the capabilities of their platforms. Additionally, to provide these capabilities, these changes require additional memory and processing power. The HPE Integrity Superdome X platform, when running Microsoft Windows Server 2016 and SQL Server 2016, is a scalable single system platform suitable for these challenging workloads.

Microsoft Windows Server 2016 provides key private cloud capabilities and features, supporting hybrid data center solutions, along with significant improvements in scalability, resilience, flexibility, and high availability. In particular, Windows Server 2016 is fully capable of taking advantage of the large amount of both processor and memory capacity of the HPE Integrity Superdome X platform, including support for up to 12 TB of addressable memory.

Microsoft SQL Server 2016 includes increased performance for data warehousing and business intelligence, as well as key advances in advanced analytics, in-memory workloads, and big data support. Enhanced columnstore indexing technologies and techniques have greatly enriched the operational analytics capabilities of the platform. These capabilities include updateable secondary columnstore indexes and filtered columnstore indexes. Prior to SQL Server 2016, secondary supporting indexes were used. While this works, in the sense that the queries could run, the performance was such that it wasn't practical to run the analytics queries on the production server and get timely results. Because of this lack of performance, it's much more common to find these analytics questions answered against the enterprise data warehouse, after the data has been extracted, cleansed, and uploaded into that data warehouse. This process prevented the real time analytics questions that business analysts wish to run, to support the increasingly agile business needs.

The HPE Integrity Superdome X system provides a powerful architecture with up to 384 cores and 24 TB of memory that can deliver high performance and low latency for your decision support and business processing workloads.

Note
While the total hardware memory of the HPE Integrity Superdome X is 24 TB, Microsoft Windows Server 2012 R2 supports up to 4 TB of RAM per server, and Microsoft Windows Server 2016 supports up to 12 TB of RAM per server.

This platform provides support for hard partitions, which allows deploying many workloads within a single HPE Integrity Superdome X enclosure, with each partition/system having dedicated resources and complete logical and electrical isolation from other solutions running on the same platform. This gives incredible flexibility and growth opportunities for SQL Server deployments.

HPE Integrity Superdome X is an x86-based server, purposefully and exceptionally well-designed to support the largest scale-up database workloads with up to 384 cores (768 with Hyper-Threading), 24 TB of memory (12 TB per Windows Server 2016 instance), and close to 1 TB/sec of I/O bandwidth. Whether you have a large number of concurrent, short-lived, or large complex queries—the powerful architecture of an HPE Integrity Superdome X combined with an HPE 3PAR StoreServ 8450 storage array will deliver high performance and low latency for your transactional and data warehousing workloads.

Featuring a modular and well-balanced architecture, HPE Integrity Superdome X provides the ultimate flexibility for your mission critical environment. An efficient bladed form factor allows you to start small and grow as your business demands increase. As your databases grow or you need to support new applications, or when your application usage increases, you can efficiently scale up your environment by adding blades. You can start as small as a 2-socket configuration and scale up all the way to 16 sockets, to support applications expanding beyond the limits of standard x86 server offerings. Additionally, the HPE hard partitioning technology, HPE nPars, enables you to deploy different workloads in different partitions that are secure and electrically isolated from one another—an ideal environment to consolidate multiple applications.

Featuring a comprehensive set of reliability, availability and serviceability (RAS) capabilities traditionally offered only on proprietary servers, HPE Integrity Superdome X provides the ideal foundation to run your mission critical applications on standard x86 operating systems.

The HPE 3PAR StoreServ 8450 storage array allows you to store all your data on a single system that supports advanced features including storage federation and automated tiering, enabling you to start small and grow without disruption. The HPE 3PAR StoreServ 8450 makes storage effortless with a range of options that support true convergence of block and file protocols, all-flash array performance, and the use of solid-state drives (SSDs) tiered with spinning media.

This solution is the result of the long-standing relationship and technical collaboration between HPE and Microsoft, delivering the scalability and reliability necessary to address the most demanding mission-critical requirements of your enterprise applications.

Solution overview

This reference architecture is a mixed environment of at least two hard partitions (nPars) of the HPE Integrity Superdome X. The first nPar, and the focus of this reference architecture is an operational analytics platform supporting both OLTP and large analytical queries using the same database. The second nPar, for the purposes of the reference architecture, is an enterprise data warehouse as documented and referenced in the earlier reference configuration white paper. Both nPars use an HPE 3PAR StoreServ 8450 storage array for all storage needs, including the operating system, database and transaction log files, and temporary files. The operational analytics database server is a relatively small database, with details below, in the paper. The data warehousing portion of the server can take up a considerable amount of disk space, and will scale based upon the amount of history preserved in the database.

One of the benefits of the HPE Integrity Superdome X platform is the ability to define electrically isolated partitions, acting as distinctly separate servers, with independent operating systems, as well as processor, memory, networking, and I/O resources. Each nPar can be adjusted to add or remove blades, as well as to reduce or expand available memory to the operating system of each nPar. For this RA, the data warehousing nPar uses 4 blades, 288 logical cores (Hyper-Threading enabled), and 6 TB of memory. The operational analytics nPar will be scaled using 1, 2, or 4 blades as the workload and usage patterns dictate. Because of the relative efficiency of the columnstore indexing technology, including significant compression capabilities, the data size will not grow dramatically in the operational system. Therefore, the complexity of the queries and the throughput requirements of the OLTP workload will typically form the decision points for scaling this server workload.

It should be noted that although for the purposes of this reference architecture the second nPar is an enterprise data warehouse, there is nothing specific about the operational analytics workload that dictates the use of the rest of the blades in the HPE Integrity Superdome X enclosure for any workload supported by the platform. As noted in earlier reference architectures and reference configuration papers in this series, the HPE Integrity Superdome X along with the HPE 3PAR StoreServ platform are excellent choices not just for large relational data warehousing workloads, but also as a consolidation environment for SQL Server, including as a Hyper-V platform for consolidation as well. Additionally, the second nPar could be used, using the same operational analytics techniques discussed in this paper, as a readable secondary server in an AlwaysOn availability group, rerouting these read-only queries to a secondary server to reduce the workload on the OLTP system, but still taking full advantage of the new columnstore enhancements to dramatically improve query performance for these challenging analytical queries.

The reference architecture consists of both HPE hardware and software, as well as software from Microsoft and consists of the following components.

Note
A detailed BOM is provided in Appendix A.

Hardware configuration:

- HPE Integrity Superdome X
  - 8x HPE BL920s Gen9 server blades (only 4 used for the reference architecture)
  - 6 TB of total memory (4 blades), 1.5 TB per server blade
- 2x HPE 6125XLG Ethernet switches (blade Ethernet connectivity)
- 2x Brocade 16 Gb/28c PP+ embedded SAN switch
- HPE 3PAR StoreServ 8450 storage array
  - 192 SSD drives (480 GB/drive)
- HPE SN6000B Fibre Channel switch
- HPE 5900AF-48XG-4QSFP+ Ethernet switch (client connectivity)

Gen9 software configuration:

- Microsoft Windows Server 2016 Technical Preview 5
- Microsoft SQL Server 2016 (RTM + Cumulative Update 1)
- HPE BL920s Gen9 Windows® Driver Bundle (November 2015 Edition)

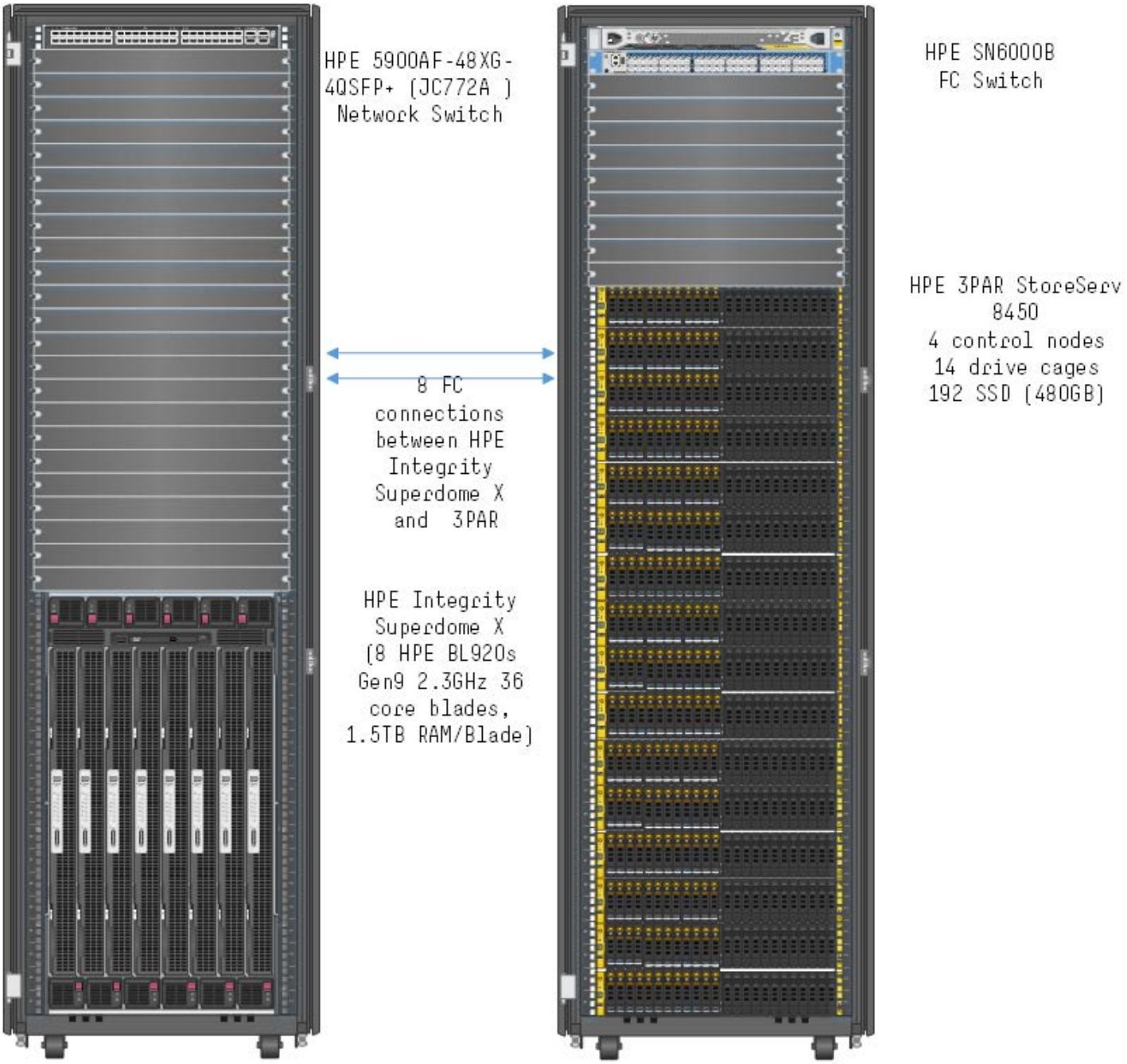

Figure 1. Reference architecture solution for HPE Integrity Superdome X Gen9 solution

Note
This paper assumes that Windows Server 2016 has been installed and configured. HPE strongly recommends that you use the HPE white paper, Running Microsoft Windows Server on HPE Integrity Superdome X, at http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA5-7519ENW, for configuration and guidance, and with the understanding that the white paper still references Windows Server 2012 R2 at this time. It is strongly recommended that the reader be familiar with the content of this previous white paper, before implementing the systems as documented in this guide.

Solution components

The following components make up the reference architecture presented in this paper.

HPE Integrity Superdome X hardware overview

The HPE Integrity Superdome X product consists of two main components: the HPE BladeSystem Superdome enclosure and the HPE BL920s Gen9 server blades. The enclosure has the capacity to accommodate eight HPE BL920s Gen9 server blades each with two sockets containing Intel® Xeon® E7 (v3 or v4) processors. The eight server blades can be part of a single hardware partition (nPar), or optionally carved into smaller HPE nPars of one, two, three, or four server blades each. The nPars are logically and electrically isolated from each other, so they can function independently. Flexibility in configuration of an nPar allows the server to be appropriately sized for any workload.

Note
See the HPE Integrity Superdome X QuickSpecs for more detailed information about hardware configurations and specifications.

Server blade building block

The conceptual block diagram of the computing resources in the HPE BL920s Gen9 server blade is shown in Figure 2.

This simplified diagram shows the server blade I/O (two flexible LAN on motherboard [FlexLOMs] and three mezzanine slots), two processor sockets, and the memory associated with each processor.

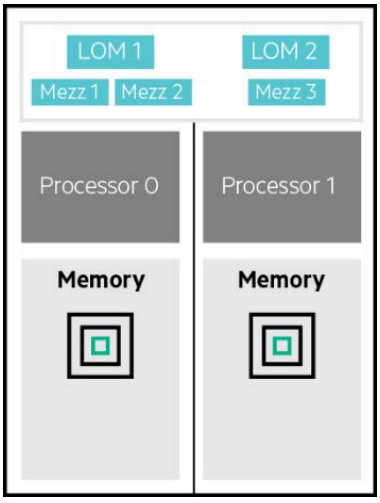

Figure 2. Conceptual block diagram of the HPE BL920s server blade

HPE Integrity Superdome X blade configuration

Eight server blades installed into an HPE Integrity Superdome X enclosure will result in the server structure shown in Figure 3. Each component of this reference architecture will use at most 4 blades, but multiple independent workloads are supported and encouraged within a single HPE Integrity Superdome X enclosure.

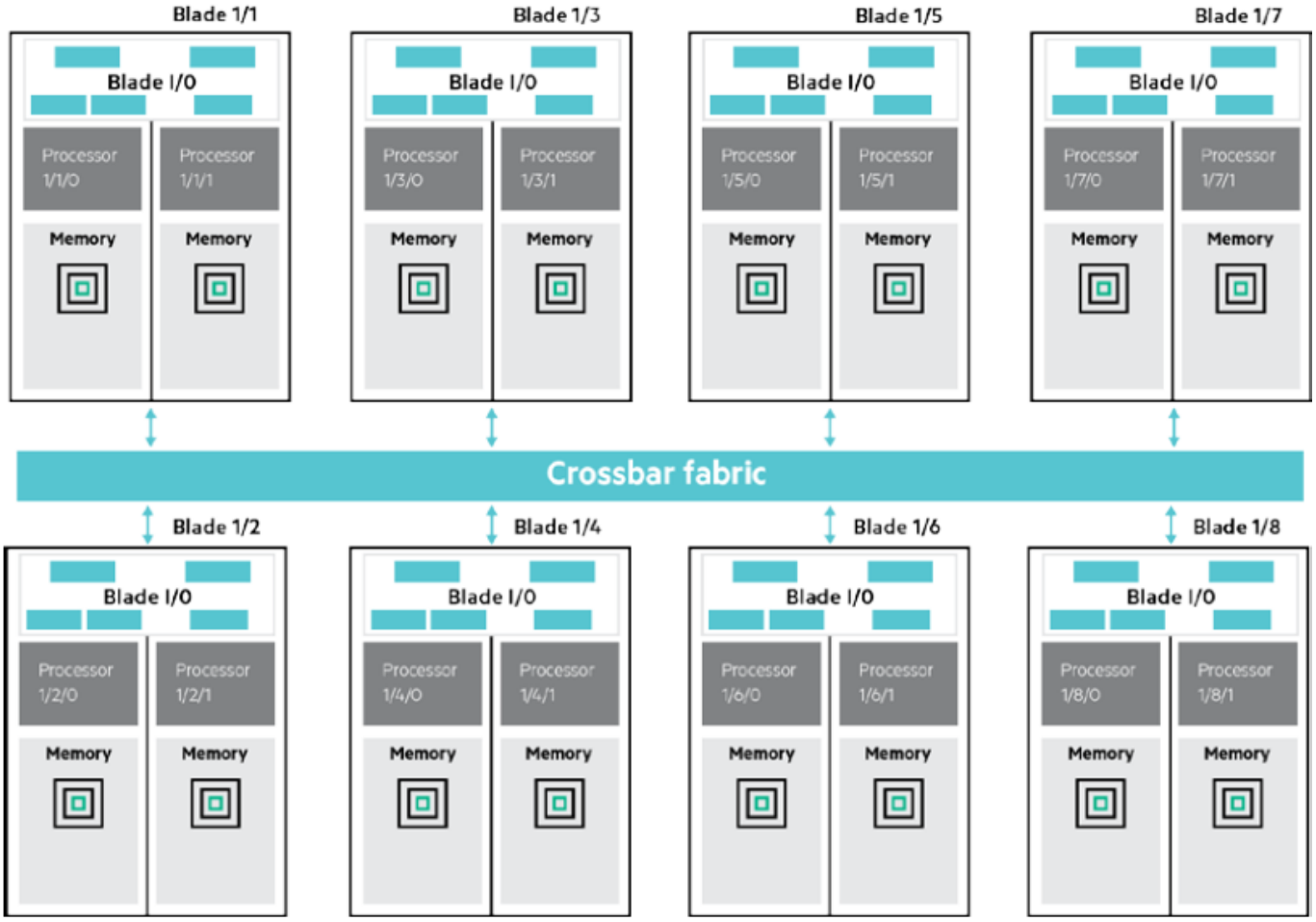

Figure 3. Conceptual block diagram of eight HPE BL920s server blades

You can see that the HPE Integrity Superdome X has a modular structure. The most basic building block is the processor and its associated socket local memory. Each processor has an embedded memory controller, through which it has extremely fast access to its local memory. The processors are combined in pairs, connected by Intel QuickPath Interconnect (QPI) links. Communication among server blades is facilitated through the HPE crossbar fabric. The fabric is built upon the HPE sx3000 chipset.

This structure gives the HPE Integrity Superdome X a non-uniform memory access (NUMA) architecture—the latency time for any given processor to access memory depends on the relative positioning of the processor socket and the memory DIMM. The time it takes for a memory transaction to traverse through the interconnect fabric is somewhat longer than the faster access to socket local memory.

HPE 3PAR StoreServ 8450 overview and configuration

The HPE 3PAR StoreServ 8000 storage (including the 8450 model) offers enterprise Tier 1 storage at a midrange price. HPE 3PAR StoreServ 8000 storage delivers the performance advantages of a purpose-built, flash-optimized architecture without compromising resiliency, efficiency, or data mobility. The new HPE 3PAR Gen5 Thin Express ASIC provides silicon-based hardware acceleration of thin technologies, including inline deduplication, to reduce acquisition and operational costs by up to 75% without compromising performance. With unmatched versatility, performance, and density, HPE 3PAR StoreServ 8000 storage gives you a range of options that support true convergence of block and file protocols, all-flash array performance, and the use of spinning media to further optimize costs. HPE 3PAR StoreServ 8000 storage offers rich, Tier 1 data services, quad-node resiliency, seamless data mobility between systems, high availability through a complete set of persistent technologies, and simple and efficient data protection with a flat backup to HPE StoreOnce Backup appliances.

The HPE Integrity Superdome X Gen9 solution used in this reference architecture is connected with 8 separate connections between the HPE 3PAR StoreServ 8450 storage array and the HPE Integrity Superdome X. Physically, there are two SAN switches on the HPE Integrity Superdome X chassis, and four controllers on the HPE 3PAR 8450 StoreServ storage array. Each of the switches on the HPE Integrity Superdome X has 4 wired connections to the switches on the storage array. The switch wiring is made completely redundant to provide double the storage bandwidth between the HPE Integrity Superdome X chassis and the storage array, and also to provide for high availability for both the HPE Integrity Superdome X and the array switches. All eight connections are 16 Gb rated.

Each switch port on the HPE Integrity Superdome X is physically connected, as well as logically mapped back to a single port on the storage array.

Storage within the storage array is logically created under the functional access of a controller within the storage array itself. When a file is logically created within the storage array, the file is allocated and assigned to one of these four controllers. The storage array is logically divided in half, with half of the immediate storage access available directly from the 0, 1 controllers and half available directly from the 2, 3 controllers. There is of course a high speed interconnect between the two sets of switches with the HPE 3PAR storage array.

Best practices and configuration guidance for the solution

The reference architecture is centered on the HPE Integrity Superdome X and the HPE 3PAR 8450 StoreServ storage array. The HPE Integrity Superdome X does not have any local storage; operating system and other storage is delivered via the Fibre Channel attached storage. An HPE 3PAR StoreServ storage array was selected for both excellent storage capacity and scalable performance capabilities. The HPE 3PAR StoreServ and the HPE Integrity Superdome X are connected via Fibre Channel, and both are on a shared 10 Gb Ethernet network for end user and administrative connectivity. Best practices from the HPE 3PAR StoreServ storage best practices guide at http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA4-4524ENW were implemented, in particular with reference to zoning and redundancy of connections.

Data is spread across as many disks as possible by specifying the recommended configuration parameters when creating CPGs on the HPE 3PAR to host the virtual volumes. Additionally, data volume ownership is spread across the storage controllers to provide locality of data storage on the HPE 3PAR StoreServ and provide redundant access to the storage from the HPE Integrity Superdome X solution. The operating system is stored using RAID 1 (mirroring), while data files are stored using RAID 5 (striped with parity). The transaction log is stored using RAID 1. Thin provisioning is used for all volumes. The operating system is hosted on a single 1 TB OS drive, and the data files for the database are spread across all available data file drives using RAID 5, and a single log file drive (RAID 1), with backups being stored separately on a RAID 1 drive. Both the RAID 1 and RAID 5 CPGs are configured to use as many physical drives as possible within the HPE 3PAR, as testing showed this to provide optimal performance.

For the operational analytics platform, it is strongly recommended that the columnstore indexes be isolated from the SQL Server data files in terms of logical file storage (i.e., operating system files) in a different filegroup or set of filegroups. However, sharing the same CPGs for the virtual volumes is appropriate.

Microsoft SQL Server and Windows Server configuration

The reference architecture solution is running Windows Server 2016 (Technical Preview 5) and SQL Server 2016 CU1. The setup was performed following the recommended configuration in the Running Microsoft Windows Server on HPE Integrity Superdome X white paper. Hyper-Threading is enabled on all blades.

The SQL Server 2016 setup is a default installation/configuration with the exception of the changes noted in the list below:

- Allow Instant File Initialization (service account given “Perform Volume Maintenance Tasks”)
  - To allow faster database file creation
- Increase Maximum worker threads to 4000
  - A larger number of CPUs combined with the large workload use more threads than are configured by default
- Set Max Server Memory to 80% of available operating system memory

- Resource Governor was configured to ensure that the data warehousing query workloads and the OLTP workloads were each allowed 50% of the CPUs
  - This ensures that both workloads have the desired amount of CPU resources to complete their work without negatively impacting the other workload.
- The following trace flags are enabled to scale performance with large numbers of processor and large amounts of memory:
  - -T834 (use large page allocations in Windows)

Note
For further information and recommendations about SQL Server trace flags, review the knowledge base article: Recommended updates and configuration options for SQL Server 2012 and later versions with high-performance workloads, at https://support.microsoft.com/en-us/kb/2964518

Capacity and sizing

The operational analytics workload used for this reference architecture uses an OLTP database that simulates a supply company with warehouses, orders, parts, customers, and payments. A mix of simple and complex transactions are run from hundreds to thousands of simulated users ordering from thousands of warehouses. Additionally, a series of columnstore indexes have been added to the tables to support the ability to ask complex real-time data analytics queries that would normally need to be run against a corporate data warehouse. This is possible due to the enhancements to columnstore indexes in SQL Server 2016.

In SQL Server 2014, since non-clustered columnstore indexes were not updateable, the secondary indexes to support the analytics query patterns are traditional row-based b-tree indexes, and the performance of the queries using these indexing strategies are simply not adequate to allow complex query options using the OLTP database in a timely fashion.

The ability of the database to simultaneously support the transactional and the analytics workload using the optimizations in SQL Server 2016 show great promise for speeding up analytics and reducing the necessity of having to wait until production data has been moved into an enterprise data warehouse environment to answer complex business analysis questions. This greatly improves the velocity of the business analysts in knowing the state of the business, customer trends, and thereby improves the ability of the business to react and profit from these trends in a real-time fashion.

Each blade in the configuration used around 2000 warehouses, with a core SQL Server database of about 1 TB of data, 500 GB of secondary indexes, and 500 GB allowed for the transaction log. Tempdb is isolated on its own RAID 1 drive. Each columnstore index is stored in a separate filegroup and set of database files. As the solution is scaled up, an additional blade is added to the configuration. Each time a blade is added, the sizes double for the database workloads, as does the number of warehouses.

Table 1. Database sizes used

NUMBER OF BLADES	WAREHOUSES	DATA FILE SIZE	INDEX FILE SIZE
1	2000	1 TB	500 GB
2	4000	2 TB	1 TB
4	8000	4 TB	2 TB

The other 4 blades of the HPE Integrity Superdome X in this configuration are running a standard enterprise data warehouse with a data warehousing workload, as described in the earlier reference configuration white paper at http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA6-5205ENW

Workload description

The workload used scales based upon the number of warehouses, with each warehouse attempting to keep inventory in stock and support the many customer requests. The Data Warehouse query workload, as mentioned above, is running simultaneously with the OLTP read-write workload, separated by using a unique login to the SQL Server database, with resource governor keying off the login ID to restrict the CPU cores used. The resource governor configuration can be changed to add or remove available threads for each workload depending upon the needs of

each workload. For example, if a customer mix is very few analytics queries and mostly OLTP workload, then perhaps a 75/25 split of CPU resources would be a much better fit than a 50/50 CPU core split between the two workloads. A simple configuration change implements this either via a Transact-SQL script, or an administrator can make the change using SQL Server Management Studio.

Analysis and recommendations

The solution leveraging an HPE Integrity Superdome X Gen9 and HPE 3PAR StoreServ 8450 storage array, combined with the significantly improved columnstore indexing and query optimization features of Microsoft SQL Server 2016 provide the ability to have a combined operational analytics environment and traditional OLTP transactional system using the same database, leveraging the significant amount of memory and high-speed storage capacity of this reference architecture. While this reference architecture had a data warehousing environment for the other four blades of the HPE Integrity Superdome X, there is no limitation nor interaction needed to validate the configuration of the operational analytics environment. Each nPar within the HPE Integrity Superdome X environment is completely independent and electrically isolated, so the workload on the blades not needed/used for the operational analytics workload can be used for any purpose, and that usage would not change in any way the recommendations for the operational analytics workload.

The testing showed that when we ran analytical queries using the new non-clustered columnstore indexes performance improved quite dramatically (from 28 hours down to 5 minutes in our best case run). This performance testing was isolated, meaning this performance was measured without the OLTP workload so that we could get the best measurement of relative performance of the two workloads. Resource governor isolation of the two workloads was used, so CPU limitations still applied to the analytics queries (i.e., restricted to half the CPUs on the system). The OLTP workload used the other half of the CPUs as allocated in resource governor. This was achieved by having each use a different SQL Server login assigned to different groups in resource governor.

Summary

Demand for a Tier 1 mission critical environment that provides the high availability, reliability, and capacity needed to address challenging enterprise workloads running Microsoft Windows Server 2016 and Microsoft SQL Server 2016 continues to grow. The HPE Integrity Superdome X and HPE 3PAR StoreServ platform provides an optimal environment for supporting mixed workloads to meet these needs. The HPE Integrity Superdome X provides excellent CPU and memory capacity and resources to support workloads ranging from high-end OLTP CPU-intensive transaction processing to I/O and memory-intensive data warehousing environments, or a shared operational analytics environment as shown in this paper. The platform is flexible enough to support other workloads, including as a consolidation platform. The HPE 3PAR StoreServ platform capabilities, as shown in this reference architecture, easily support the mixed operational analytics workload as well as the data warehousing workloads of the secondary nPar.

As shown in both the results of the testing for this reference architecture as well as the earlier mentioned data warehousing tests, the combination of HPE Integrity Superdome X and Microsoft SQL Server 2016 provides an excellent operational analytics environment, with the performance and flexibility of the HPE 3PAR StoreServ array providing the scalability needed for the most challenging multi-use workloads on the Microsoft SQL Server platform. The ability of Windows Server 2016 to take advantage of greater than 4 TB of memory makes the platform ideal for the HPE Integrity Superdome X environment.

This reference architecture demonstrates that the combination of the latest generation of HPE server and storage technologies, along with Microsoft's latest Windows Server and SQL Server platforms, provide dramatic improvements in flexibility and performance that will greatly improve business flexibility and velocity.

Offering high performance, built-in reliability, and streamlined manageability—delivered in a standards-based package—the HPE Integrity Superdome X and Microsoft Windows Server 2016/ SQL Server 2016 solution is a performance winner for both operational analytics and data warehousing workloads. HPE and Microsoft solutions excel at handling OLTP, data warehousing, and business intelligence workloads, and for companies using memory-intensive applications, the HPE Integrity Superdome X server has the balanced scaling required for highly efficient processing. With up to 384 cores and the ability to handle up to 24 TB of memory, you can trust the joint HPE and Microsoft solution to scale right along with your growing business.

This reference architecture describes solution testing performed in May and June 2016.

Implementing a proof-of-concept

As a matter of best practice for all deployments, HPE recommends implementing a proof-of-concept using a test environment that matches as closely as possible the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with a proof-of-concept, contact an HPE Services representative (hpe.com/us/en/services/consulting.html) or your HPE partner.

Appendix A: Bill of materials

Note
Part numbers are at time of publication and subject to change. The bill of materials does not include complete support options or other rack and power requirements. If you have questions regarding ordering, please consult with your HPE Reseller or HPE Sales Representative for more details. hpe.com/us/en/services/consulting.html

Table 2. Bill of materials

QTY	PART NUMBER	DESCRIPTION
		Rack and Network Infrastructure – HPE Integrity Superdome X
1	H6J66A	HPE 42U 600x1075mm Advanced Shock Rack (with Factory Express)
1	H6J85A	HPE Rack Hardware Kit
1	BW906A	HPE 42U 1075mm Side Panel Kit
1	JC772A	HPE 5900AF-48XG-4QSFP+ Switch
1	JC681A	HPE A58x0AF 650W DC Power Supply
1	JC682A	HPE 58x0AF Bck(pwr) Frt(prt) Fan Tray
16	JD092B	HPE X130 10G SFP+ LC SR Transceiver
4	JC682A	HPE 58x0AF Bck(pwr) Frt(prt) Fan Tray
		HPE Integrity Superdome X
1	AT147A	HPE Superdome X Base Enclosure (with 3 Phase PDU, Factory Integrated)
1	AT152A	HPE Superdome X Advanced Par LTU, Factory Integrated
2	711307-B21	HPE 6125XLG Blade Switch, Factory Integrated
2	C8S47A	Brocade 16Gb/28c PP+ Embedded SAN Switch, Factory Integrated
8	H7B40A	HPE BL920s Gen9 2.3GHz 36c Svr Blade, Factory Integrated
96	H7B38A	HPE DDR4 128GB (4x32GB) Mem Module, Factory Integrated
16	710608-B21	HPE QMH2672 16Gb FC HBA, Factory Integrated
8	700065-B21	HPE FlexFabric 20Gb 2P 630FLB Adptr
8	BD505A	HPE iLO Adv incl 3yr TS U 1-Svr Lic, Factory Integrated
48	QK734A	HPE Premier Flex LC/LC OM4 2f 5m Cbl
48	QK724A	HPE B-Series 16Gb SFP+SW XCVR
		Rack and Network Infrastructure – HPE 3PAR StoreServ 8450
1	BW904A	HPE 42U 600x1075mm Enterprise Shock Rack
1	TK808A	HPE Rack Front Door Cover Kit
4	H5M58A	HPE Basic 4.9kVA/L6-30P/C13/NA/J PDU
1	BW906A	HPE 42U 1075mm Side Panel Kit
1	TC472A	HPE Intelligent Inft Analyzer SW v2 LTU
1	TK808A	HPE Rack Front Door Cover Kit
1	BW906A	HPE 42U 1075mm Side Panel Kit
1	QR481B	HPE SN6000B 16Gb 48/48 Pwr Pk+ FC Swch

QTY	PART NUMBER	DESCRIPTION
		HPE 3PAR StoreServ 8450 storage
1	H6Z25A	HPE 3PAR StoreServ 8450 4N Stor Cent Base
4	H6Z00A	HPE 3PAR 8000 4-pt 16Gb FC Adapter
14	H6Z26A	HPE 3PAR 8000 SFF(2.5in) SAS Drive Encl
192	K2Q95A	HPE 3PAR 8000 480GB SFF SSD
1	L7C17A	HPE 3PAR 8450 OS Suite Base LTU
168	L7C18A	HPE 3PAR 8450 OS Suite Drive LTU
1	BD362A	HPE 3PAR StoreServ Mgmt/Core SW Media
1	BD363A	HPE 3PAR OS Suite Latest Media
72	QK734A	HPE Premier Flex LC/LC OM4 2f 5m Cbl
48	QK724A	HPE B-series 16Gb SFP+SW XCVR

Resources and additional links

HPE Integrity Superdome X server documentation is accessible through the "manuals" tab under the following URL, http://h20564.www2.hpe.com/portal/site/hpsc/public/psi/home/?sp4ts.oid=7161269

Information about the HPE Integrity Superdome X

- hpe.com/servers/superdomex
- hpe.com/info/superdomex

HPE Integrity Superdome X Onboard Administrator documentation

- HPE Integrity Superdome X and Superdome 2 Onboard Administrator User Guide, http://h20564.www2.hpe.com/hpsc/doc/public/display?docId=c04389052
- HPE Integrity Superdome X and Superdome 2 Onboard Administrator Command Line Interface User Guide, http://h20565.www2.hpe.com/hpsc/doc/public/display?docId=c04389088

HPE 3PAR information

- HPE 3PAR StoreServ architecture, http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA3-3516ENW
- HPE 3PAR StoreServ 8000 product information, hpe.com/storage/storeserv8000
- HPE 3PAR StoreServ all flash and Microsoft SQL Server brochure, http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA6-3248ENW

Other useful resources

HPE 3PAR Windows Server 2012 and Windows Server 2008 Implementation Guide, http://h20628.www2.hpe.com/km-ext/kmcsdirect/emr_na-c03290621-14.pdf

Implementing Microsoft Windows Server 2016 Technical Preview 5 on HPE ProLiant servers, http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA5-5841ENW

HPE Converged Infrastructure Library, hpe.com/info/convergedinfrastructure

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