SOLUTION BRIEF

PLiOPS
EXTREME DATA PROCESSOR

Microsoft
SQL Server 2022 Tested and Validated

Database Consolidation of SQL Server Databases

EXECUTIVE SUMMARY

Growing enterprise data continues to drive the need for higher capacity, higher performance, and easier manageability. However, many organizations in this economy are optimizing hardware resource consumption to meet business and budget goals. This is especially true for organizations to drive higher performance and higher capacity which are utilizing SQL Server Standard that's confined to 24 cores and 128GB of server memory allocation for SQL buffers. The limited hardware resources restrict the size of the database and the number of databases that can be supported for the performance needs of the enterprise. Given this system limitation selecting the proper configuration for data storage is one of the critical tasks when planning MS SQL Server standard deployment. SQL Server powers many business-critical applications across several industries, including E-commerce, banking, insurance, retail, travel, and financial services.

SQL Server 2022 is loaded with most Azure Cloud-enabled features such as Azure Synapse analytics capabilities that connect with on-prem database, and Link to Azure SQL-managed instances to offload read-only workloads. This, plus continued performance, and security innovations are expected to make SQL 2022 especially appealing to DBA & IT teams, driving the on-premises refresh of their most important transactional and analytical databases. This solution brief focuses on the database capacity expansion, performance scaling, database backup offloading, and overall financial benefits of deploying SQL Server 2022 standard with Pliops Extreme Data Processor (XDP) over traditional deployments.

Performance Scaling with Pliops

Pliops XDP is a breakthrough data accelerator that delivers performance acceleration, capacity expansion & reliability benefits while reducing the total cost of SQL Server deployment & its overall operations. It simplifies the set-up, configuration, and administration of infrastructure for SQL Server, enabling a faster refresh of legacy data storage infrastructure.

As shown in Figure 1 HammerDB4.3 was employed to evaluate the performance scaling of SQL Server databases with Pliops setup. A SQL Server standard testing environment is configured with Server Dell PowerEdge R7525 servers. The servers are set up with Intel 6338 32-Core processor and 512GB of Memory and storage is configured with 4 Gen4 3.84TB NVMe SSDs (Samsung PM9A3)that are directly managed by Pliops XDP. To ensure SQL Server standard hardware requirements were satisfied only 24 cores were enabled at the system bios level and 128GB of memory is configured for SQL buffer pool and Red Hat operating system 8.5 is used to deploy SQL Server standard.

Pliops–SQL Server Solution Benefits

- Linear Scaling of SQL Server databases without performance loss.
- Provides high performance data and backup volumes with built in resiliency equivalent to Azure locally redundant storage benefits.
- 70% to 370% database capacity gains compared to RAID10 & RAID 5 storage configurations.
- 1.85 to 1.9X SQL server performance scaling independent of IO workloads.
- Faster database backup and recovery benefits to meet service level objectives using HW offload benefits.
- Higher reliability and resiliency of SQL Server to tolerate multiple SSD failures.
- Reduce the SSD $/TB cost with capacity and Endurance benefits.

SQL Server: HammerDB Performance Testing

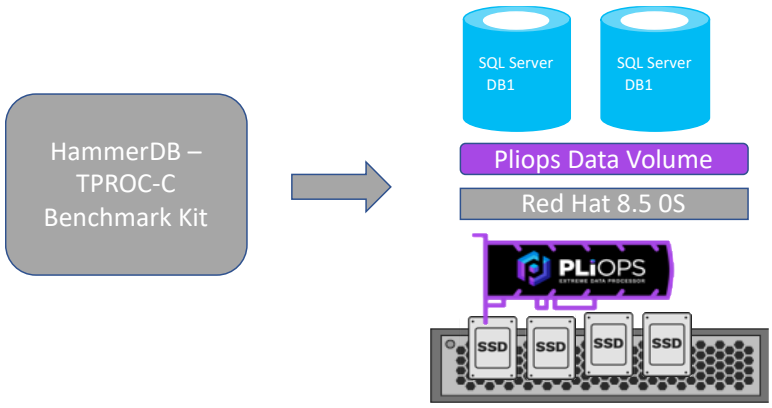

Figure1: SQL Server Performance Setup with Pliops XDP

Pliops XDP exposes high-performance data storage volume with built-in data protection to tolerate any SSD failures. To execute OLTP workload on SQL Server HammerDB TPROC benchmark configured with 25,000 warehouses, which translates into 2.5 TB of database size. Our benchmark testing included both Use All Warehouses option enabled and disabled to evaluate benefits in both customer scenarios. Enabling the Use All-Warehouses option will increase the I/O load on the storage system significantly by accessing all 25K warehouses and simulating highly random access to the dataset. The second identical 2.5TB database is configured to evaluate the performance scaling of Plops XDP.

SQL Server Capacity Savings:

As shown in Table 1 and Figure 2 Pliops accelerated and protected volume has provided 9TB free space even after loading two SQL server databases of 2.5TB each. Pliops XDP in-line data compression and capacity expansion benefits enabled the provision of 14TB fully protected data volume over 14.8 TB of raw storage with no capacity overhead for redundancy. Traditionally It's an established practice to configure either RAID 5 or RAID 10 or a combination of RAID 5 for data and RAID 1/10 for Logfiles to optimize for capacity, performance, and database protection. Employing Pliops XDP for SQL server enterprises simplifies deployment with no need to compromise on these three design principles. Data protection with Pliops XDP is equal to a locally redundant storage option of SQL SERVER configuration on Azure. As shown in the table below, an SQL Server powered by Pliops XDP provides 380% & 70% capacity savings over traditional RAID10 or RAID 5 setups, respectively.

Storage Setup	Raw Capacity (TB)	Usable Capacity with RAID (TB)	Database Capacity Used (TB)	Available capacity (TB)	Pliops XDP Gain %
RAID 10	14.8	7.4	5	2.4	380%
RAID 5	14.8	11.1	5	6.1	70%
Pliops Protected Data Storage	14.8	14	5	9.1	

Table 1: SQL Server Capacity savings comparison with Data storage setup options

```
[pliops@lab4039 ~]$ sudo df -h | grep 'File\|pliops-bd0'
Filesystem                                      Size  Used Avail Use% Mounted on
/dev/pliops-bd0                                  14T  5.0T  9.1T  36% /media/pliops/xdp
```

Figure 2: SQL Server Capacity savings comparison with Data storage setup options

1.95X Performance Scaling with Pliops

With the database capacity expansion benefits realized using Pliops XDP, the next objective was to assess the performance scaling benefits. The Transactions per Minute (TPM) metric was captured after executing HammerDB TPROC benchmark for a 60-minute duration with a single database instance. The Virtual file systems stats were also captured to assess the read and write latency and CPU, IO information, and write amplification were also captured to assess overall system usage.

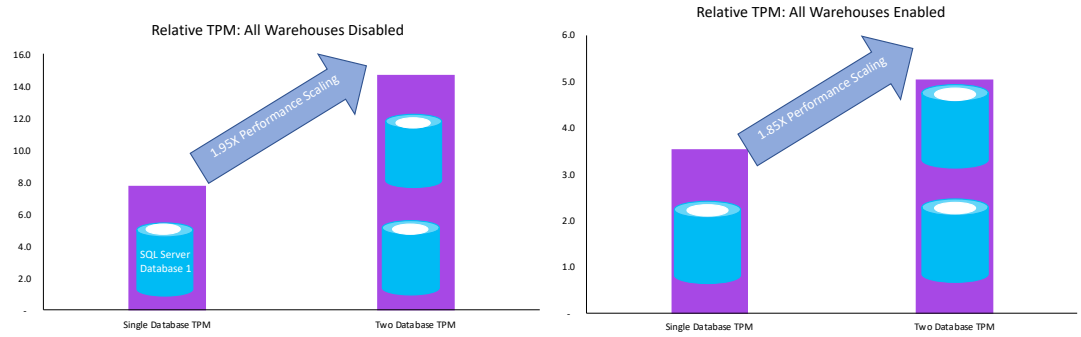

Chart 1: 1.95X Performance scaling with All Warehouses Disabled and 1.85X Scaling with All warehouses enabled.

To assess the database performance scaling we executed the HammerDB workload concurrently against two SQL server databases and captured similar TPM per database and system usage details compared with a single database. As depicted in Chart 1 disabling the Use All Warehouses option provides 1.95X TPM performance scaling and 1.85X performance scaling compared to the same setup with Use All Warehouses enabled. The marginal performance drop is due to a 4 to 5X IO increase by accessing all warehouses of the TPROC schema resulting in a marginal latency overhead.

It was evident from the performance scaling benchmark as the SQL server database increased from one to two databases to support multiple applications customers will not incur performance loss even with limited hardware resources on CPU or Memory. It is all the more important for enterprises to design and build such an optimized infrastructure that provides higher databases and user density per a given data center footprint, while meeting desired service level objectives.

Database Backup Offloading with Pliops

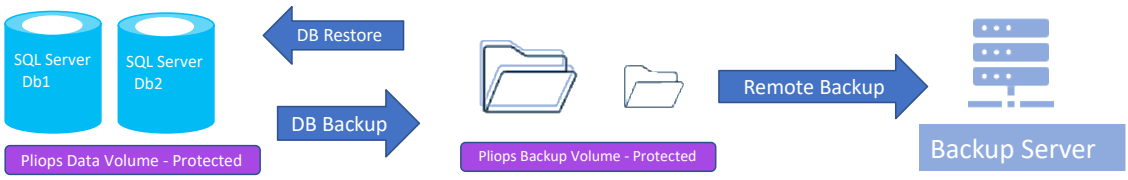

Figure 3: SQL Server Database Backup & Recover Testing with Pliops XDP

Database backup and restore is one of the main responsibilities of SQL server database administrators to ensure the databases are fully protected against media corruption or accidental drop of business-critical tables. SQL Server 2022 introduced database backup offloading to minimize CPU utilization and reduce the backup duration. We wanted to explore how Pliops XDP can be utilized not only as a database accelerator but also for database backup offload.

The test metrics of duration, storage IO, capacity & CPU utilization were captured during full database backup, differential backup, and restore operations. As shown in the table below 2.5TB TPROC database is backed up within 6.1 minutes and the size of the backup file is reduced by 3.8X with 20% CPU utilization. Based on additional experiments the CPU utilization can be considerably reduced if Pliops XDP is exclusively utilized for offloading the SQL backup and data volume is served from traditional RAID10 configuration. The goal of the testing is to obtain the out-of-the-box SQL database backup and recovery operations metrics and this can be further improved with additional optimization.

```
BACKUP DATABASE tpcc
TO DISK = '/media/pliops/xdp/var1/bckupfiles/tpcc1.bak'
GO
BACKUP DATABASE tpcc2
TO DISK = '/media/pliops/xdp/var1/bckupfiles/tpcc2.bak'
GO
```

```
BACKUP DATABASE tpcc
TO DISK =
'/media/pliops/xdp/var1/bckupfiles/tpcc1.dif'
WITH DIFFERENTIAL
GO
BACKUP DATABASE tpcc2
TO DISK =
'/media/pliops/xdp/var1/bckupfiles/tpcc2.dif'
WITH DIFFERENTIAL
GO
```

Figure 4: SQL Server Full Database Backup & Differential backup testing with Pliops XDP

Backup Operation	Database Size (GB)	Duration (Minutes)	Backup Size (GB)	Backup Size Reduction	Throughput (MB/s)	CPU Utilization
Full Database Backup	2500	6.18	655 GB -	3.8X Reduction	5183	20%
Full Database Restore	2500	7.58			4227	19%
Differential Backup	290	5.48	95 GB	3.2X Reduction	870	10%
Full Database Restore	2500	7.65			4187	19%
Differential Restore	290	1.21			3890	19%

Table 2: SQL Server Backup and Recovery Operation Test Results with Pliops XDP

SSD Write Amplification Benefits

Chart 2: Mixed workload performance benefits of Pliops XDP

The primary challenges with traditional NVMe SSD storage configuration with RAID10 or RAID 5 are the write and read amplification overhead that not only limits the SQL server performance but also reduces the longevity of SSD usage. Write amplification increases the amount of data that's written to SSDs compared what's SQL server transactional data. Since SSDs have a limited number of write cycles, write amplification results in shortening SSDs' durability.

Pliops XDP mitigates the SSDs durability issue significantly by providing the in-line compression of SQL server data and then data shaping activities that include packing and merging the variable length data and finally converting random writes to sequential writes. This process minimizes the write amplification to a significant level and thereby increasing the SQL server performance and SSD durability.

As shown in chart 2 during SQL server transactional workload testing the Pliops XDP provides a high write throughput of 836 MB/s to SQL Server. However, the number of disk writes per SSD is only 91 MB/s, that is disk writes are reduced by 9X and all 4 SSDs incur an aggregate disk write of 360 MB/s which is reduced by 2.3X. Data protection along with write amplification at speed is essential for high-performance databases like SQL Server applications.

Conclusion

Microsoft SQL Server 2022 Standard with Pliops XDP provides excellent performance scaling, database capacity expansion, and backup offload benefits to consolidate databases and simplify overall IT operations. The built-in performance acceleration, capacity expansion, and data protection features enable enterprises to efficiently manage data growth challenges without performance and reliability impacts for SQL Server databases. The built-in data protection enables enterprises to increase database uptime and resiliency. This solution also significantly improves the system & storage utilization by offloading database backups and provides a faster recovery to meet or enhance availability service level objectives for critical applications.

About Pliops

Pliops multiplies the effectiveness of organizations' infrastructure investments by exponentially increasing data center performance, reliability, capacity, and efficiency. Founded in 2017 and named as one of the 10 hottest semiconductor startups by CRN in 2020 and 2021. Pliops global investors include NVIDIA, Intel Capital, SoftBank, Western Digital, KDT, and Xilinx. **Learn more at www.pliops.com**.