Excelero NVMesh - Enabling Database and DBaaS Productivity

Server StorageIO® Industry Trends Perspectives Report

Database and DBaaS Performance Productivity Scaling

INTRODUCTION

This Server StorageIO® Industry Trends Perspective report looks at common issues, trends, and how to address various database (DB) and DB as a service (DBaaS) storage performance challenges. Continued growth with new (and existing) applications and workloads including IoT, Artificial Intelligence (AI), Machine Learning (ML), cognitive computing, as well as analytics require scalable, high-performance database instances for their data repositories.

In this report, we look at Excelero NVMesh, a next-generation low-latency, software-defined storage solution that provides "local-like" performance of shared Non-Volatile Memory (NVM) at scale including Solid State Devices (SSD[1]) for DBaaS accessed via NVM Express (NVMe[2]).

NVMesh is a new storage solution that:

- Elastically scales in performance and capacity
- Remove bottlenecks, complexity, and costs
- Is flexible adapting to your needs
- Increases your hardware and software ROI
- Improves database user productivity

Who This Applies To

Cloud Service Providers or CSP, Managed Service Providers or MSP, and DBaaS providers. This report also applies to IT environments that are facing performance, consolidation and other scaling challenges for their database environments. Others that this report applies to includes those with roles of database Administrator (aka DBA), designer, architect, engineers, or those responsible for data platforms or data infrastructures decisions.

INDUSTRY TRENDS AND CHALLENGES

There are many storage challenges facing database and DBaaS environments. Keep in mind that there is no such thing as an information recession. More data is being generated (volume driving bandwidth), processed (driving velocity and activity), and stored every day.

I/O performance activity includes small and large transactions or other I/O operations. In addition to volume and activity, data is also getting larger in size in support of applications and workloads.

Common Database Challenges

Database environment problems include:

- The need for speed and productivity
- Fast applications need fast databases
- Resources consumed as a service
- Public, private and hybrid cloud
- Stretched budgets and staffing
- Database software license costs
- Boost database user productivity
- Reduce database optimization time

[1] In addition to Solid State Device, SSD can also refer to solid state disk or drive Learn more at www.thessdplace.com

[2] Learn more about NVMe for server, rack and fabric deployments at www.thenvmeplace.com

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DBaaS Solution Requirements

Building on previously mentioned database challenges. DBaaS considerations center around flexibility, scalability, ease of use and deployment options along with performance.

DBaaS based database instances need to be able to run from anywhere within the data infrastructure environment. Being able to run anywhere also means the ability to access database data regardless of where stored, while maintaining "local-like" performance (eliminate I/O bottlenecks).

DBaaS enabled Benefits

DBaaS enabled benefits include:

- Derive more value from software licenses
- Enhanced database user experience
- Faster database operations
- Flexibility to adapt to changing workloads
- Improve user productivity, ROI and TCO
- Reduce hardware and software overhead
- Scale to meet your application needs
- Streamline storage management tasks

Database instances need the flexibility to scale dynamically to meet changing workloads. Flexible scaling means not dedicating extra hardware (server, storage, networking) and associated software to database instances. In other words, DBaaS based data infrastructures[3] enable database instances to increase dynamically or reduce their resource needs to what is required at a given point in time.

Scaling up includes adding more storage performance and capacity including volumes. Another aspect of scaling DBaaS storage capacity is non-disruptively expanding existing volumes independent of server CPU needs and vice versa.

DBaaS environments also need the flexibility to scale resources independent of each other. For example, add more CPU independent of storage capacity or vice versa to meet different needs. Performance scaling means boosting bandwidth and activity rates (transactions, IOPs) while reducing response time (latency and queues).

Scaling Up, Out, and Down

Scaling up: Moving from smaller slower servers or storage to more powerful systems to boost performance or capacity.

Scaling out: Adding more nodes to support performance or capacity needs.

Scaling down: Dynamically reducing resources no longer being used to lower excess hardware or other overhead costs.

Scaling applies across different granularity from number and size of nodes, to storage devices, volumes along with other units of resource workload allocation consumption.

Business and database benefits of a DBaaS enabled environment include cloud-like flexibility, ease of management, improved user productivity and economic effectiveness as well as better service experience.

[3] Data Infrastructures include server, storage, I/O networks, hardware, software, services, data protection, best practices.

Enabling DBaaS Performance and User Productivity

Fast applications and workloads need fast underlying data platforms (database, DBaaS, SQL, NoSQL, Key-value based) along with robust data infrastructures that meet their Performance Availability Capacity Economic (PACE)[4] needs.

For DBaaS environments where many database instances are consolidated (aggregated) to share resources, use caution to prevent aggregation causing aggravation (performance bottlenecks). Database instances need performance including higher throughput bandwidth, activity rates (transactions, IOPs), along with lower response time latency.

There is more to database and DBaaS performance than speeding up transactional and query operations. Improving database user productivity also means accelerating table creation, load, extract and data transformation among other activities. Accelerating database instance performance also means boosting table scan performance of large queries while reducing response time.

Database performance includes reducing the time needed for database copy, clone, reorganization, or additional optimization and data protection (checkpoints, snapshots, backups) tasks.

To boost performance and meet service requirements, fast NVM also known as SSD are common data infrastructure resources.

In addition to speedier NVM and SSD data storage mediums, another DBaaS technology enabler is the new low-latency, CPU friendly I/O access protocol called NVM Express (NVMe).

NVMe

NVM Express (NVMe) is a high-speed, low latency server storage I/O protocol for accessing fast SSD, Storage Class Memory (SCM), Persistent Memory (PM) and other NVM based devices.

NVMe is an alternative to Fibre Channel (FC), iSCSI, SRP, SAS, SATA and other storage access protocols. NVMe supports direct server, rack-scale, as well as fabric attached storage deployments.

Fast NVM and SSD need fast access with NVMe, they are better together.

What is needed to address various DBaaS storage performance and management challenges are new solutions such as Excelero NVMesh. New solutions such as NVMesh provide, "local-like" performance of shared pooled NVM and SSD storage accessed via low-latency NVMe.

[4] PACE = Performance, Availability, Capacity, Economics – Software Defined Data Infrastructure Essentials (CRC Press 2017)

Excelero NVMesh –DBaaS Productivity Enabler

NVMesh is a new generation of flexible, elastic software-defined storage solution providing "local-like" performance of shared storage at scale. NVMesh supports pooling of storage for shared access. Unlike traditional SAN or other shared storage, NVMesh eliminates shared storage I/O bottlenecks found in those solutions.

NVMesh is architected from the ground up to grow from small to large with cloud-like elasticity as your DBaaS environment evolves. In addition to scaling, NVMesh supports current and emerging NVM SSD and SCM devices (future-proof).

NVMesh Enabling DBaaS

NVMesh DBaaS benefits include:

- Adapts to needs of different workloads
- Deterministic database performance
- Faster database operations
- "Local-like" performance of shared storage
- Increase productivity of database users
- Less time optimizing database instances
- Reduces storage scaling complexity
- Unlock full potential of modern hardware

NVMesh eliminates the complexities of early generation server SAN solutions by pooling resources instead of dedicated server-based storage. The benefit is improved server storage I/O resource usage, along with enhanced performance as well as simplified management.

Fast NVM, SSD, and SCM class storage devices need quick low-latency data access. NVMesh leverages NVMe combined with Excelero patented-technology to enable fast "local-like" performance and productivity of shared storage. NVMesh enables fast server I/O of shared pooled storage using patented peer-to-peer technologies.

Excelero patented technologies boost I/O performance while reducing server CPU cycles and response time. This reduction in CPU means NVMesh has a lower server hardware overhead footprint needed to support DBaaS environments. NVMesh enables your server to have more CPU cycles for your applications workloads.

Besides performance and user productivity, NVMesh DBaaS benefits include less hardware required, along with the more effective use of your database and other software licenses (more productive work per software license unit cost).

Removing Database Overhead

Database instances often need extra resource (server CPU and memory, storage, I/O) overhead capacity to meet performance requirements. The extra overhead capacity is used to support additional indices, tables, materialized or other views, along with other database instance operations to boost performance needs.

NVMesh I/O performance acceleration capabilities enable less hardware overhead to be required for database optimization.

The result is not only hardware cost savings, also a reduction in time spent on database instance optimization, software license savings (better ROI) and user productivity.

As an example of the relative improvement for DBaaS environments, the following figure compares traditional database storage solution approaches with new ones such as NVMesh. In figure 1, a relative comparison between conventional (left) hybrid (mix of HDD and flash SSD), all-flash arrays (AFA) based SAN systems along with early generation server-based software-defined solutions are shown. On the right of figure 1 is a next generation software-defined solution such as Excelero NVMesh with shared NVMe pooled NVM (SSD, Flash, SCM) devices.

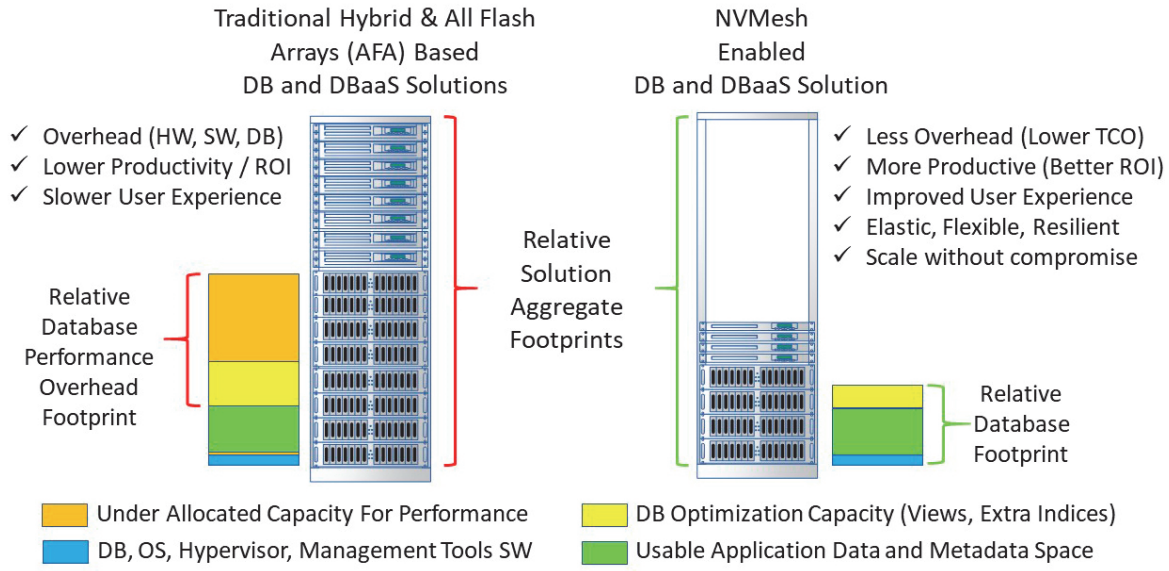


Figure 1 – Relative footprint of traditional solutions compared to NVMesh

By having a faster NVMe accessed shared pool of storage closer to database instances with NVMeash, less hardware overhead is needed for optimizing database instance performance.

Excelero NVMesh Database and DBaaS Customer Proof Point Example

An Excelero database and DBaaS customer experienced the speed of very large tablespace creation with NVMesh. A very large tablespace (20TB) was created on a four (4) node Oracle RAC 12c cluster. Using NVMesh the 20TB tablespace was deployed in one hour 3 minutes and 41 seconds. The NVMesh solution is about three times faster than any previously tested alternative storage solution. Note that the Oracle RAC 12c table deployment on NVMesh performed at a rate of about 1/3 terabyte per minute (e.g. about 5.23GBytes/second).

The benefit besides faster tablespace creation is that the DBaaS environment requires less overhead for optimization than previous tested approaches. This productivity improvement means ability to support more database instances in a DBaaS as well as traditional database environment, enabling better user productivity, as well as reduce cost per instance.

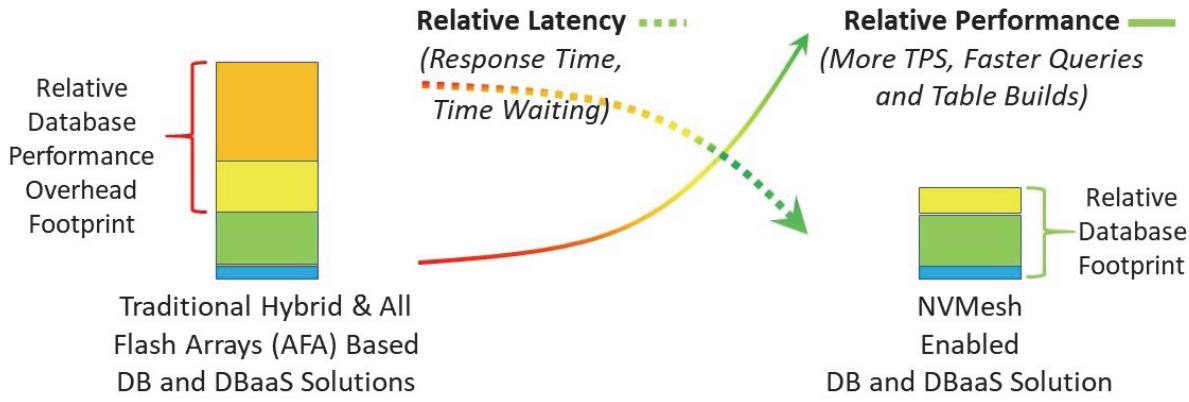
NVMesh Architecture for DBaaS Productivity

By keeping data closer to where it is needed, less time is spent waiting for I/Os from shared storage. NVMesh eliminates I/O wait-time and associated server CPU overhead by reducing the number of expensive network hops to shared fast pooled storage. Figure 2 shows how application database instances benefit from NVMesh with improved relative performance and lower latency.

On the left-hand side of figure 2, hybrid and AFA SAN-based solutions are shown. AFA and hybrid storage solutions provide improved performance over traditional all HDD based systems. However, fast shared AFA solutions can move or introduce new I/O bottlenecks forcing costly optimizations, management and hardware overhead.

NVMesh Performance Enablers

- CPU friendly storage software drivers
- Storage services are local to client
- Efficient caching of storage metadata
- High parallelism and scalability
- Low-latency peer to peer server I/O
- Fewer network hops to access storage
- Shared NVMe accessed pooled storage
- Eliminates traditional SAN bottlenecks
- Dynamic storage volume expansion
- Performance across several dimensions



Footprint = HW (Server, Storage, Network) + Software (DB, OS, Tools) + Facility (Power, HVAC, Floor) Costs (Capex+OpEx)

Figure 2 – Relative performance improvement by removing performance bottlenecks

On the right-hand side of figure 2, NVMesh is shown enabling improved relative performance regarding lower response times. Also shown in figure 2 (right) are more I/O activity (transactions per second [TPS] or IOPs) along with an increase in bandwidth for faster data throughput.

With NVMesh, extracts, clones, and large full table scans run quicker, database tables, indices, and other entities create as well as load faster. Instead of spending time creating and managing specific indices, materialized or different views, administrators can apply those resources and time to more productive business functions. The benefit is that less server and storage hardware is required (right-hand side of figure 2) while boosting relative DBaaS performance.

The NVMesh architecture is shown in figure 3 along with how it works to boost DBaaS performance. NVMesh separates management control path from data paths between clients accessing storage (targets).

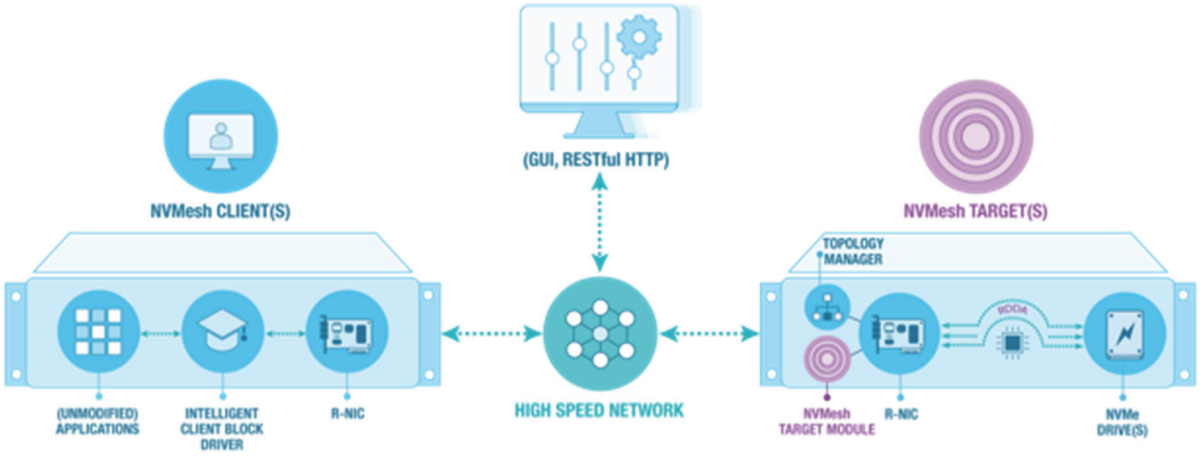


Figure 3 – NVMesh architecture Source: Excelero.com

NVMesh management is centralized with GUI and HTTP RESTful based interfaces. Applications and database servers access storage via an intelligent client block driver with Excelero patented technology that enables pooled shared storage with "local-like" performance.

The NVMesh client block driver communicates with NVMesh target module using low-latency, CPU off-loads for fast access to shared pooled storage. Depending on the deployment topology, the NVMesh target module can be on application or database servers (converged) or on storage nodes (disaggregated).

Unlike traditional converged and server software-defined storage, NVMesh off-loads server CPU leveraging R-NIC and high-speed, low latency networks between nodes. The benefit is more server CPU for database instances and applications workloads, along with deterministic performance that results in scaling with stability.

NVMesh Adapts to Your Needs

Being software-defined storage, besides supporting different tiers and categories of pooled fast NVM storage, NVMesh can be deployed in various configuration topologies to meet your workload needs. NVMesh is transparent to upper-level applications, workloads, and their data repositories or data platforms. This means NVMesh adapters to supporting different data platforms including database (SQL and NoSQL), DBaaS, key-value (KV) repositories, among many other application workloads.

With policy-based volume allocation and tiering capabilities, NVMesh can be configured with high-performance SSD including NVMe devices, and high-capacity SAS or SATA devices. You can define storage classes and volumes based on database instance needs.

NVMesh Adapting to Your Needs

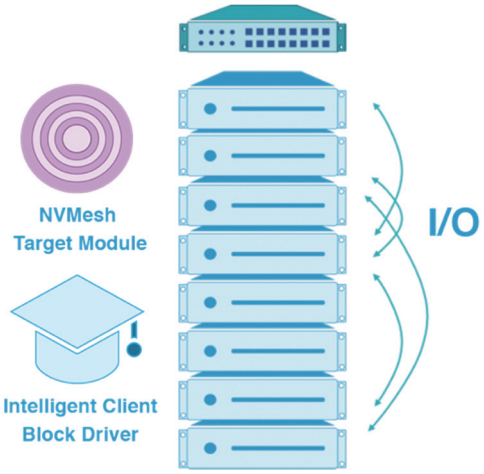
The flexibility of NVMesh includes:

- ✓ Policy based volume allocation
- ✓ Dynamic volume expansion
- ✓ Independent scaling of server and storage
- ✓ Supports DBaaS environments
- ✓ Converged and central deployments
- ✓ Multi-dimension performance scaling I/O activity, bandwidth and response time

As an example, low-latency write intensive NVMe based SSDs can be used for update intense or rapid table creation and loads. Another example is using lower cost, higher-capacity read optimized SAS or SATA SSDs for staging, imports, and other operations. For resiliency, NVMesh spreads data across different failure zones to meet availability, along with durability data protection needs.

NVMesh can be deployed in converged (aggregated), and centralized (disaggregated) configuration topologies. The adaptability of NVMesh enables you to choose the best deployment configuration to meet your DB, DBaaS and data infrastructure requirements.

Aggregated (Converged)
Local storage in clustered (scale-out) application or database servers



- Storage is unified into a shared pool
- NVMesh target module and intelligent client block driver run on all cluster nodes
- NVMesh bypasses server CPU (I/O offload)
- Scales performance linearly without complexity of server dedicated storage

Disaggregated (Centralized)
Separate storage and compute servers

- Storage is unified into a shared pool
- NVMesh target module on storage nodes
- Intelligent client block driver runs on application or database on servers
- Databases and applications get performance of local storage
- Eliminate bottlenecks of SAN storage

The Server StorageIO view: What this all means

Database instances and DBaaS need fast data infrastructures to support fast applications workloads with diverse needs. Enabling fast DBaaS means applying new solutions to remove common challenges, reduce complexity and eliminate barriers to productivity.

Excelero NVMesh Key Points

Key take away points include among others:

- ✓ Future-proof, flexible, elastic
- ✓ Independent scaling of server & storage
- ✓ Removes server storage I/O bottlenecks
- ✓ Streamline DBaaS storage management
- ✓ Boosts database user productivity
- ✓ Cloud-like database user experience

Excelero NVMesh is a solution with the flexibility to adapt to your environment, applications, and workloads. Designed, architected and defined from the ground up. With new algorithms that unlock the full potential of shared pooled, NVMesh unlocks the performance benefit of modern fast NVM and SSD based storage with "local-like" performance accessed via NVMe.

NVMesh addresses common database and DBaaS storage performance challenges by being a flexible, scalable, resilient software-based solution. As a storage solution, NVMesh adapts to your environment and application PACE workload needs while boosting user productivity. Keep in mind that while this report has focused on Database as a Service (DBaaS), Excelero NVMesh can adapt to the needs of various application workloads spanning enterprise to cloud along with hyper-scale environments as well as traditional database (SQL or NoSQL) scenarios.

Learn more about NVMesh and how it enables DBaaS environments at www.excelero.com

ABOUT THE AUTHOR

Greg Schulz is Founder and Sr. Consulting Analyst of independent IT advisory consultancy firm Server StorageIO (e.g., StorageIO®). He has worked in IT for an electrical utility, financial services, and transportation companies in roles ranging from business applications development to systems management, architecture, strategy, performance, and capacity planning. Mr. Schulz is the author of the books "Software Defined Data Infrastructures Essentials" (CRC Press 2017), as well as Intel, Recommended Reading List books "Cloud and Virtual Data Storage Networking" and "The Green and Virtual Data Center" via CRC Press, along with "Resilient Storage Networks" (Elsevier). Greg is a Microsoft MVP (Cloud Data Center Management) and VMware vExpert (vSAN and vCloud). Learn more at www.storageio.com and www.storageioblog.com on Twitter @StorageIO.