Lab Validation Report

ParAccel PADB and NetApp SAN Optimized Solution

High Performance Analytics with Advanced Data Management Capabilities

By Julie Lockner

May 2011
Contents

Introduction .................................................................................................................................................. 3
ParAccel PADB and NetApp SAN Optimized Solution ....................................................................................... 4

ESG Lab Validation ........................................................................................................................................ 6
The Physical Test Environment ........................................................................................................................... 6
General Performance Characteristics .................................................................................................................. 7
Data Protection and Recoverability .................................................................................................................... 8
Instant Data Marts ........................................................................................................................................... 9

ESG Lab Validation Highlights ..................................................................................................................... 12
Issues to Consider ....................................................................................................................................... 12
The Bigger Truth ......................................................................................................................................... 13
Appendix ..................................................................................................................................................... 14

ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab’s expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by NetApp and ParAccel.
Introduction

Business data volumes are growing exponentially with no sign of slowing. Organizations looking to harness value from these “big data” sets in real-time operational settings need the ability to perform analytics quickly and efficiently and advanced data management features such as data protection, recoverability, and cloning. Existing infrastructure and processes that traditionally focused on reporting rather than data mining or analytics are coming up short, reaching plateaus in their ability to scale or meet operational service level agreements. ESG Lab validated the functional capabilities of ParAccel Analytic Database (PADB) Blended Scan SAN integration in combination with NetApp Snap and FlexClone technology—an integrated solution designed to address these challenges.

ESG research indicates that, in 2011, the top two business initiatives that will have the greatest impact on IT spending are cost reduction and business process improvements (see Figure 1).¹ Close behind, in the top four is improving business intelligence and delivery of real-time analytics.

![Figure 1. Business Initiatives That Will Have the Greatest Impact on IT Spending](source)

Real-time analytics is considered both an operational must-have and a strategic competitive advantage. With such increasing priority, the much-coveted data scientist needs access to a platform that supports data mining and complex analytics to scale; is agile in supporting evolving data types; can ingest massive volumes of new data sets quickly or recover just as quickly should the data load fail; and can present a prototyping environment to test models without breaking the bank. This last requirement is so crucial because, while budgets are growing modestly, IT is still required to do more with less. Once these models have been tested, they must be operationalized so that the business can benefit on a day to day basis. Shifting to a more real-time operational business model means analytics platforms with more advanced data management features as they become systems of record.

ParAccel PADB and NetApp SAN Optimized Solution

ParAccel PADB is a high performance, highly scalable analytics platform. Based on a multi-parallel processing (MPP) architecture, it is columnar database software that runs on commodity hardware. Key features such as the compile on query execution, compression on write, and parallel query optimizer turbo-charge extremely complex analytics. By making it a top performer in terms of both speed and optimizing hardware resources, IT organizations benefit from its ability to achieve higher performance with less cost.

Data scientists are in high demand; their time is precious. The PADB “load & go” design targets improving productivity, redirecting time from traditional tuning processes to more strategic initiatives such as finding value in data that offers a competitive advantage, streamlining operational processes, or finding cures for cancer. Once the data scientists have developed and tested new analytics, PADB also allows the analytics to be operationalized with minimal overhead so that businesses can benefit from them. Whether the schema is normalized, de-normalized, or dimensional, data can be quickly loaded and analyzed using standard SQL interfaces.

The compression-on-write feature offers two benefits: the data footprint is reduced, optimizing storage resources and eventually cost. It also adds performance benefits by shrinking the amount of data sent across the network.

MPP platforms are commonly deployed in a shared-nothing configuration; processes are distributed across server nodes, CPU compute resources, and direct attached storage to minimize latency introduced by layered network protocols found in a traditional SAN architecture. Challenges are introduced when the business requires high data protection and recoverability SLAs or when these systems are regulated and classified as systems of record.

NetApp offers a number of advanced data management features to ensure data is protected. Snapshot enables organizations to create point-in-time copies of file systems which can be used to protect data from a single file to a complete disaster recovery solution. Snapshot copies are created with no performance impact and minimal storage requirements. NetApp SnapRestore recovers file systems or data volumes in seconds from a Snapshot point in time copy. NetApp FlexClone technology instantly replicates data volumes and data sets as transparent virtual read/write copies in minimal storage space or impact to performance.

The ParAccel PADB and NetApp SAN Optimized solution, illustrated in Figure 2, gives data scientists and line of business owners client access via standard local area network (LAN) connectivity to an MPP database running on commodity servers with SAN integration to NetApp storage.

![Figure 2. ParAccel PADB and NetApp SAN Optimized Solution](image)

The ParAccel PADB on NetApp unified storage is integrated using the PADB SAN Storage Optimization feature, Blended Scan. A persistent copy of the analytical database is stored on NetApp SAN storage with data intelligently distributed on the ParAccel database cluster. The Blended Scan option offers additional benefits as well:

- The PADB Blended Scan option optimizes compute and bandwidth resources.
- The PADB database is stored as a system of record on SAN-based RAID storage.
- IT can apply standard backup and recovery policies with NetApp Snapshot and SnapRestore.
• NetApp Snapshot creates virtual PADB snap copies non-disruptively that can be used to recover a PADB database near instantaneously.
• NetApp FlexClone creates virtual PADB read/write copies non-disruptively that can be used as Instant Data Marts or clones used for test and development purposes.
• NetApp Snapshot and FlexClone require only a fraction of the amount of storage used by the original source database, making efficient use of storage resources.

NetApp’s unified storage platforms offer a multiprotocol architecture supporting NFS, CIFS, iSCSI, and Fibre Channel over Ethernet (FCoE). A single deployment can be used for multiple applications, benefiting consolidation projects and improving productivity. A ParAccel PADB deployment offering both NFS mounts for the PADB binaries and iSCSI SAN connectivity for the PADB data files with advanced data management features enables organizations to do more with less. PADB’s highly optimized SAN integration capability, through its Blended Scan option on a NetApp SAN storage array with advanced data management features, delivers the best of both worlds for applications in a single solution stack.
ESG Lab Validation

The functional capabilities of the ParAccel PADB Blended Scan SAN integration option, in combination with NetApp Snapshot and FlexClone technology, were assessed by ESG Lab via hands-on testing at a NetApp facility located in RTP, NC. The reference architecture used commodity servers and ParAccel PADB software configured with the Blended Scan option integrated with NetApp SAN storage. A large data set simulating a real-world operational data store and a TPC-H data model were used. This project benefited from NetApp and ParAccel marketing, engineering, architecture, and administration staff being on site during testing.

The Physical Test Environment

The test environment used to validate performance, data protection, and recoverability capabilities consisted of a four-compute-node PADB cluster integrated with a NetApp FAS3270A storage system using the iSCSI protocol as illustrated in Figure 3. The Instant Data Mart test environment consisted of two identical single compute node PADB clusters illustrated later in Figure 4. For each cluster configuration, a Leader node serves as the master for the entire PADB cluster and a standby node offers high availability and recoverability. The test environment was designed to support functional validation test plans rather than performance benchmarking. High level details of the configuration are listed in the Appendix.

Figure 3. Reference Configuration for Initial Lab Validation Tests

The PADB administrator accessed and interacted with the PADB database using a terminal connection directly to the Leader node. The storage administrator managed and provisioned storage on NetApp using FilerView. The ParAccel PADB clusters were connected via the cluster Interconnect over a 10Gb Ethernet network. Each node containing four internal disk drives, or 16 total local disks, was also connected to the NetApp array via a 10 Gb Ethernet iSCSI SAN. The NetApp FAS3270A storage array was used to store the PADB data files using four iSCSI LUNS and the NetApp FAS6080 storage array was connected to the cluster via NFS mount points and stored the PADB binaries. It also served as a staging area for data to be loaded into the PADB.

The Data Model

The data model used was based on a manufacturing company’s operational data store. The tables and data loaded into PADB consisted of:

- 85 tables (initial)
- No indexing or tuning database objects
General Performance Characteristics

The general performance tests measured the time elapsed to ingest newly created data, execute a baseline query, and compare the results when running the same query during an additional data load. The query used in this step issued a COUNT (*) for each table in the database scanning 6.22 billion rows.

ESG Lab measured PADB ingest speeds by loading 2.6 TB of raw data distributed into several hundred files spread across storage controllers, LUNs, and mount points. Data files were parsed to take advantage of Parallel Data Load on PADB with the recommended one stream per CPU. With four compute nodes, each running four quad-core processors, 64 streams were used. Files were evenly distributed across SAN and NFS controllers to maximize ingest speeds and minimize possibility of disk contention. Performance was measured by clocking the elapsed time of each task. The results are summarized in Table 1.

<table>
<thead>
<tr>
<th>Task</th>
<th>Elapsed Time</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>34:22 minutes</td>
<td>2.6 TB compressed down to 556 GB during load</td>
</tr>
<tr>
<td>Query</td>
<td>0.219 seconds</td>
<td>Count (*) was issued across 6.22 billion rows</td>
</tr>
<tr>
<td>Query with Load</td>
<td>0.263 sec – 0.404 sec</td>
<td>Response time during a load was variable</td>
</tr>
</tbody>
</table>

What the Numbers Mean

- **2.6 TB of raw data** represented 6.22 billion rows across 85 tables. Ingesting this volume of data in less than 35 minutes using only four compute nodes with compression on write was noteworthy.
- Once the original database load completed, the database size—post-compression on write and prior to additional loads—was 556 GB, representing a **78.6% reduction in storage consumption**.
- The baseline query executed a row count on every table in the database. The query returned in 0.219 seconds scanning each of the 6.22 billion rows. By extrapolating the results, the PADB was able to scan at a rate of **28.4 billion rows per second**.
- Reloading 2.6 TB into the same tables while executing the same count query did impact performance with variation ranging from 1.2 – 1.8X longer than the baseline query time. The query was executed ten times to gather a significant sample set, resulting in an average of 0.365 seconds, or 1.6X the baseline time.

Why This Matters

The ability to ingest data into an analytical platform quickly is crucial to productivity. In analytical applications, time spent lifting and moving large data sets is time wasted as productivity essentially comes to a halt. Fast ingest speeds on big data sets allow analysts to spend more time analyzing and less time dealing with the logistics of data collection. For mission-critical business processes that require real-time reporting, data load rates are even more critical for access to the most recent data. Reducing latency in identifying potential fraudulent transactions, monitoring risk measures, and identifying customer order system issues directly translates to business process improvement and better bottom lines.

ESG confirmed ParAccel PADB’s ability to ingest large volumes of data in little time. More than 2.6 TB of raw data was loaded into the database and available for querying in less than 35 minutes using only four compute nodes. By adding nodes to the cluster in a parallel load configuration, the ParAccel PADB can be set up to meet demanding load rate requirements. The ability to immediately query loaded data, scan at a rate of 28 billion rows per second, and maintain query access during loads was also validated, demonstrating the solution’s ability to provide business value through both performance and improved productivity.
Data Protection and Recoverability

Data protection and recoverability testing validated the solution’s ability to quickly recover from a failure with minimal additional storage resources. ESG Lab captured database statistics before and after the Snapshot and SnapRestore steps and measured the elapsed time of a set of queries. The data used in this test was the set from the previous test. The queries used were more complex in nature and looked for the following information:

- Aggregate product usage in terms of characteristics or configurations
- Product details sorted by serial number
- Predictive time series model for product usage with varying combinations of characteristics or configurations
- Specific product detail reports based on varying dimensions

The steps taken during the test plan execution are illustrated in Figure 4 and explained below.

1. The test initiated the creation of a NetApp Snapshot copy of the PADB. Baseline PADB statistics were collected by totaling the number of rows in the database and capturing the time required to run a query set.
2. The test simulated a failed data load as a result of an end-user error by adding a table and data to the PADB database.
3. The NetApp SnapRestore operation completed. PADB statistics were collected twice after the restoration. The first collection was timed during a PADB data redistribution process and the second collection was taken after the data redistribution process was complete. All the results were compared and are listed in Table 2.

Table 2. Data Protection and Recoverability Test Results

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Total # Rows</th>
<th>Elapsed Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Snapshot</td>
<td>7,854,048,951</td>
<td>14.178 seconds</td>
</tr>
<tr>
<td>After failed data load</td>
<td>7,854,048,955</td>
<td>N/A</td>
</tr>
<tr>
<td>After SnapRestore during data redistribution</td>
<td>7,854,048,951</td>
<td>3 minutes, 40 seconds</td>
</tr>
<tr>
<td>After data redistribution is complete</td>
<td>7,854,048,951</td>
<td>14.179 seconds</td>
</tr>
</tbody>
</table>
What the Numbers Mean

- The total number of rows before the Snapshot process and after the SnapRestore process was the same, indicating successful restoration.
- Analytical queries were run to baseline the performance of the PADB prior to and after the Snapshot and SnapRestore processes, respectively. Once the database was brought back online as part of a restore, data residing across the SAN on NetApp storage was redistributed to the local compute node disk cache. During this time, the SAN-based storage and the local compute node storage experienced significant read/write IO across the iSCSI and local interconnect networks. Once the data settled, performance was restored to the original expectation with minimal variation.

Why This Matters

Failed data loads often require reverting back to a point in time prior to the failure. This process is time-consuming and leaves the system unavailable. By being able to non-disruptively create a point in time copy and quickly revert back, productivity is restored with the system.

During the restoration process, the database is available for queries while the data is replicating across the SAN to each local node—although with degraded performance during the redistribution process. As analytical databases become more strategic and mission-critical, the ability to leverage data center standards for data protection and recoverability streamlines operational support tasks. Because NetApp Snapshot virtual copies take up a fraction of the space as a full backup copy, data storage usage efficiencies are significantly improved.

ESG confirmed NetApp’s ability to successfully create a Snapshot copy of the ParAccel PADB and restore it with zero data loss. The PADB database was back up and running instantly and available to run queries immediately. The entire process to create a Snapshot copy and restore using SnapRestore occurred in less than five minutes.

Instant Data Marts

The purpose of this test was to measure the time required to create an exact virtual replica of a PADB instance using NetApp FlexClone and then verify that the virtual copy was available to PADB administrator as a fully functional readable/writable PADB database. The test required reconfiguring the environment with a pair of identical single compute node clusters. Figure 5 illustrates the reference configuration used in this test.
The Data Model

The Instant Data Mart test configuration leveraged a TPC-H database model and data set. The tables and data loaded into PADB consisted of:

- Eight tables
- No indexing or tuning database objects
- 866 million rows loaded
- Database size: 42 GB

The query used in this test was:

```sql
select count (distinct c_address), count(distinct c_custkey) from customer;
```

The customer table contained 15 million unique entries.

Once the database was loaded with the TPC-H data set, the query was timed and recorded as a baseline. The NetApp FlexClone copy was created and mounted to the second pair of PADB Leader/Compute nodes. The same baseline query was run again on the FlexClone copy after the database was brought online but before the PADB Blended Scan data redistribution process completed. The query was rerun after the data redistribution process completed.

The Instant Data Mart was available for use in only one minute and eight seconds. During the data redistribution process, performance deteriorated; however, the database was fully functional and available. Once the data redistribution process completed, ESG Lab was able to verify that the performance of the Instant Data Mart was comparable to the source PADB instance.

An additional query was timed to compare performance when run separately and simultaneously on the source and Instant Data Mart copy. The results are summarized in Table 3.

---

2 The query used for this comparison is listed in the Appendix.
Table 3. Source and Instant Data Mart FlexClone Query Performance Comparisons

<table>
<thead>
<tr>
<th>Task</th>
<th>Source Elapsed Time (seconds)</th>
<th>Instant Data Mart Elapsed Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Query on source only</td>
<td>28.654</td>
<td>35.355</td>
</tr>
<tr>
<td>Query on clone only</td>
<td></td>
<td>32.311</td>
</tr>
<tr>
<td>Query run simultaneously on both source and clone</td>
<td>28.703</td>
<td>32.311</td>
</tr>
</tbody>
</table>

**What the Numbers Mean**

- During the PADB data redistribution process, query performance was significantly slower as data moved from the NetApp FlexClone copy to the Instant Data Mart compute node local disk. However, once the redistribution process completed, performance was comparable.
- Running queries on each instance individually and then simultaneously exhibited negligible difference.

Additional tests were run to verify the source and Instant Data Mart PADBs were indeed separate and distinct. These tests included creating objects and data simultaneously in both environments and confirming the systems maintained uniqueness.

Comparing storage usage on the NetApp FAS3270 before and after the FlexClone copy was created indicated very little difference in consumption. In Figure 7, a difference of only 1% in capacity was indicated post-clone.

**Figure 7. Storage Consumed as a Result of Creating the Instant Data Mart**

---

**Why This Matters**

Data scientists with near-instantaneous access to copies of a source analytical database that is both read/write capable can significantly improve productivity. Analysts can test and develop on copies of production data sets immediately or provision copies of databases to colleagues in a self-service model. Once these analytics have been developed and tested, they can be operationalized for lines of business. Because the virtual copies require minimal additional storage, use of system and storage resources is greatly improved. Not only are projects executed in a quicker time scale, speeding time to market, but errors associated with using aged data sets are reduced. Once projects are finished or analytical testing processes are complete, the extra clones can be easily dismantled, releasing resources back to the pool for future project development.

ESG validated that the ParAccel PADB and NetApp SAN Optimized solution was able to create a fully operational, read/write copy of a PADB analytical database in a little over one minute. This capability allows organizations to create Instant Data Marts quickly and effectively with efficient use of storage resources.
ESG Lab Validation Highlights

- PADB’s “load & go” design enables quick setup, eliminating complex design and tuning processes.
- NetApp and ParAccel demonstrated scalable performance with integrated, advanced data management capabilities.
- NetApp’s near instantaneous Snapshot creation and SnapRestore eliminates productivity issues after user error.
- NetApp FlexClone copies provide instant data marts is less than two minutes with a very small percentage of the storage footprint.

Issues to Consider

- While the PADB is available for querying immediately following a SnapRestore operation or after a FlexClone presentation, the system operates with degraded performance during the data redistribution process (“ReRep”).
- Advanced analytics library is available via third-party library—PADB is the computational engine.
- As of this writing, PADB requires data reload during scale-out activities.
- Companies moving from a “stack” infrastructure to a self-configured cluster may incur a material upfront investment in exchange for lower future investments.
The Bigger Truth

Business intelligence and real-time analytics are becoming a strategic competitive advantage for organizations that have successfully harnessed the value of their corporate data assets. As data sets grow, existing reporting or data warehouse architectures plateau in their ability to scale; real-time operational requirements require more availability and recoverability than current SLAs offer. Continuing to find and maintain value becomes cost prohibitive while maintenance processes become enormous business process disruptions.

Solutions based on the convergence of MPP analytical databases and SAN storage provide an architecture that offers the best of both worlds. Columnar MPP analytical databases that run on commodity hardware deliver high performance systems at a low cost. SAN storage delivers the reliability, availability, and manageability required for the mission critical applications the business relies upon. Solutions like ParAccel PADB with NetApp advanced data management features illustrate an effective integrated solution that meets business and operational requirements for real-time analytics.

ESG Lab validated not only the NetApp and ParAccel integrated solution’s ability to perform in multiple workload scenarios, but its ability to streamline management operations. The combination of a “load & go” design, modular “pay as you grow” configuration, fast ingest, and analytics performance means data teams can spend more time analyzing problems and delivering insight and IT can manage resources and budgets accordingly. The NetApp ParAccel data warehouse solution enhances productivity from multiple angles, addressing many of the key IT priorities as identified in ESG’s latest spending intentions research. It is hard for organizations to ignore evaluating the types of solutions that deliver the promised benefits.
## Appendix

### Table 4. High-level Hardware Configuration Details

<table>
<thead>
<tr>
<th>PADBCluster Statistics</th>
<th>Components 1x4 Compute Nodes</th>
<th>Components – 2 x 1 Compute Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leader Node HP DL380G6 Servers</td>
<td>1 x 1</td>
<td>2 x 1</td>
</tr>
<tr>
<td>Compute Node HP DL380G6 Servers</td>
<td>1 x 4</td>
<td>2 x 1</td>
</tr>
<tr>
<td>CPU/node</td>
<td>2x Quad-core Intel X-5560 2.8 GHz</td>
<td></td>
</tr>
<tr>
<td>Memory/node</td>
<td>72 GB RAM</td>
<td></td>
</tr>
<tr>
<td>Local Disk/node</td>
<td>16 x HDDs 10K RPM SAS 300 GB 2.5” (SFF)</td>
<td></td>
</tr>
<tr>
<td>NIC/node</td>
<td>1x Emulex 10-Gigabit Ethernet Dual-port PCIe card</td>
<td>1x Intel 10-Gigabit Ethernet Dual-port PCIe card</td>
</tr>
<tr>
<td>Switch - Interconnect</td>
<td>10GbE</td>
<td></td>
</tr>
<tr>
<td>Switch - iSCSI SAN</td>
<td>10GbE</td>
<td></td>
</tr>
<tr>
<td><strong>NetApp Storage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Storage</td>
<td>2 x NetApp 3270 Controllers</td>
<td>2 x NetApp 6080 Controllers</td>
</tr>
<tr>
<td></td>
<td>36 x 15Krpm 450 GB SAS HDDs per controller</td>
<td>9.2 TB Usable NFS mounted storage</td>
</tr>
<tr>
<td>PADB Binaries</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Query used in the Instant Data Mart test plan**

```sql
select l_orderkey, sum(l_extendedprice * (1 - l_discount)) as revenue, o_orderdate,
       o_shippriority
from customer, orders, lineitem
where c_mktsegment = 'BUILDING' and c_custkey = o_custkey and
      l_orderkey = o_orderkey and o_orderdate < '1995-03-15' and l_shipdate > '1995-03-15'
group by l_orderkey, o_orderdate, o_shippriority
order by revenue desc, o_orderdate
limit 10;
```