White Paper

Everpure

Oracle RMAN Backup and Recovery with FlashArray

Validated performance
on FlashArray//E
and FlashArray//C

Everpure

Contents

Executive summary

Oracle backup infrastructure must satisfy three competing demands simultaneously, and most solutions force a trade-off between them: capacity to store retained backups economically, backup throughput to meet shrinking backup windows, and restore throughput to meet recovery SLAs.

While deduplication helps with storage efficiency, it often compromises recovery performance. Many backup appliances store data in deduplicated form, which must be reassembled on read, introducing latency during recovery. Backup completes on schedule, while restore takes longer than planned.

Everpure™ FlashArray//E™ and FlashArray//C™ provide a cost-effective alternative for environments where backup scale fits within array capacity. Data reduction lowers effective cost per terabyte while maintaining fast restore performance. Unlike backup appliances that reassemble data on read, FlashArray™ delivers reads at full speed. In validated testing, FlashArray//C90 achieved over 30TB/hour backup throughput and 60TB/hour restore throughput, with restore consistently matching or exceeding backup rates.

FlashArray//E and FlashArray//C serve as consolidated backup repositories for multiple production environments over Network File System (NFS). Existing Everpure customers benefit from familiar operations.

This paper provides storage and platform teams with validated architectures, proven performance benchmarks, and example deployment patterns for implementing Oracle RMAN backup and recovery on FlashArray.

Solution overview

FlashArray//E and FlashArray//C serve as backup targets for Oracle Recovery Manager (RMAN), with Oracle Direct NFS (dNFS) providing the data path between database hosts and storage.

RMAN backup and restore operations write directly to FlashArray File Services over NFS. dNFS enables parallel data streams from the Oracle kernel, driving throughput without backup agents, intermediate appliances, or proprietary data formats. For environments using enterprise backup software, FlashArray integrates with Commvault and Veeam as a high-performance target.

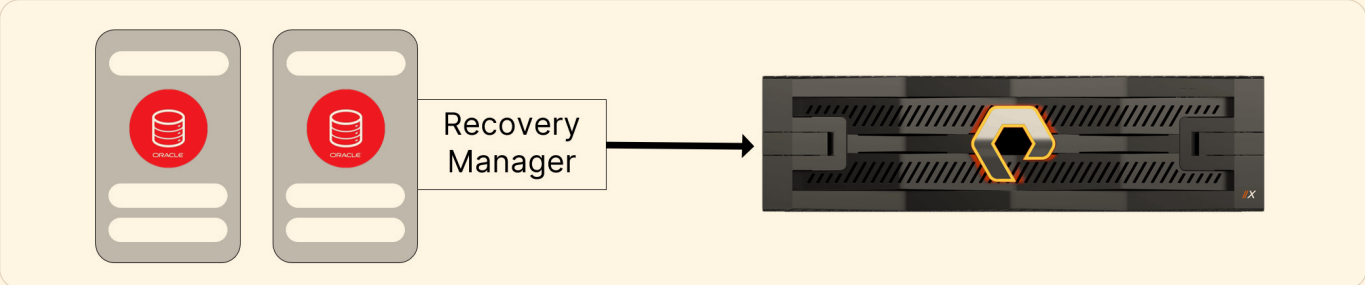

FIGURE 1 Oracle RMAN backup and recovery from NFS on FlashArray using dNFS

Solution benefits

FlashArray delivers several key benefits that address the backup and recovery challenges faced by enterprise Oracle environments:

- **Reclaim backup windows:** Backup completes faster, reducing pressure on maintenance schedules and database administrator time.
- **Meet recovery SLAs when it matters:** Fast restore means shorter outages during actual incidents, not just in planning documents.
- **Test recovery more often:** Practical restore speeds make regular disaster recovery testing feasible instead of theoretical.
- **Reduce infrastructure footprint:** Consolidate backup for multiple Oracle environments onto a single NFS target.
- **Protect against ransomware:** SafeMode™ Snapshots cannot be modified or deleted without multi-party authorization.
- **Simplify operations:** RMAN writes directly to NFS, eliminating the need for backup agents, proprietary formats, or additional software licensing.

Technology overview

Oracle Recovery Manager (RMAN)

Oracle Recovery Manager (RMAN) is the native backup and recovery solution for Oracle Database, integrated into the database kernel. RMAN performs block-level backups, reading data directly from datafiles and writing to backup destinations without requiring the database to be taken offline.

RMAN supports parallel operations through channels. Each channel represents a separate server process that reads from the database and writes to the backup destination simultaneously. Configuring multiple channels allows RMAN to scale backup and restore performance with available I/O bandwidth.

Key capabilities relevant to this solution:

- **Incremental backups** capture only changed blocks since the last backup, reducing backup volume and duration for large databases.
- **Incremental merge** maintains a continuously updated, full backup image by applying incremental changes, eliminating periodic full backup requirements.
- **Block-level recovery** restores individual corrupt blocks without requiring full datafile recovery.

RMAN writes backups as backup sets (proprietary format) or image copies (direct datafile copies). For FlashArray, image copies provide the fastest restore path since they require no conversion during recovery.

Oracle Direct NFS (dNFS)

Oracle Direct NFS (dNFS) is an optimized NFS client built into the Oracle database kernel, available since Oracle 11g. It bypasses the operating system's native NFS client, allowing Oracle to manage NFS connections directly from database processes. The Oracle RMAN configuration guide provides detailed steps for configuring dNFS and other properties if needed.

For backup and recovery workloads, dNFS provides:

- **Parallel I/O:** multiple concurrent connections to NFS storage, enabling RMAN channels to drive higher aggregate throughput than a single NFS mount
- **Connection management:** automatic load balancing across available network interfaces with recovery from transient failures
- **Reduced overhead:** eliminates the kernel NFS layer, reducing CPU overhead and memory copies in the I/O path

dNFS is configured through the oranfstab file, which specifies NFS server addresses, export paths, and network interfaces.

FlashArray//C and FlashArray//E

FlashArray//C and FlashArray//E are capacity-optimized, all-flash arrays designed for workloads where cost per terabyte matters (see Figure 2). FlashArray//C delivers balanced capacity and performance. FlashArray//E provides maximum capacity with hard-disk economics, making it suitable for long-term retention and archive.

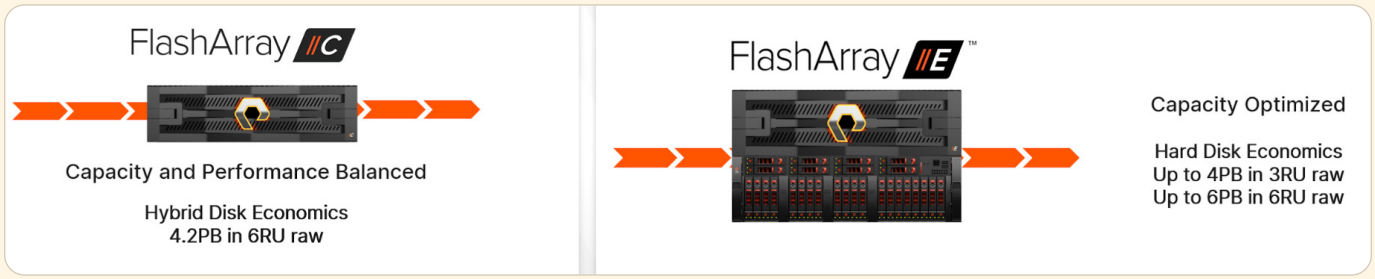

FIGURE 2 FlashArray//C and FlashArray//E positioning and capabilities

Characteristics relevant to Oracle backup and recovery include:

- **Fast restores:** reads return at full speed; data reduction does not introduce restore latency
- **Data reduction:** inline compression and deduplication lower effective cost per terabyte
- **NFS file services:** native NFS exports with no external gateway
- **SafeMode Snapshots:** immutable volume snapshot recovery points resistant to ransomware and accidental deletion

FlashArray File Services

FlashArray File Services provides native NFS protocol support directly from the array. For Oracle RMAN, NFS exports are provisioned as standard file systems with no agents or proprietary integrations.

Deployment is straightforward: create a file system, provision a directory for backup data, apply an NFS export policy, and connect Oracle dNFS. RMAN writes backup data directly without intermediate layers.

Performance validation

Performance results are based on Oracle RMAN backup and restore operations using Oracle 19c with dNFS enabled. Restore throughput is measured as database size divided by the duration of RESTORE DATABASE, representing the time to copy data files from backup storage to primary storage.

Environment

Table 1 shows the standalone instance and infrastructure configuration used.

Component	Detail
Compute	Servers: 8x Cisco UCS C220 M5 (2-socket) **CPU**: 2x Intel Xeon Platinum 8160 at 2.10GHz (48 cores/96 threads) **Memory**: 512GB RAM
Operating system	Oracle Linux Server 8.10 **Kernel**: UEK 5.4.17
Network	2x 25GbE NICs per host **Bonding:** IEEE 802.3ad LACP, layer 3+4 hash **Aggregate bandwidth**: 50Gbps
Primary storage	2x Everpure FlashArray//XL170 R5 (8x 32Gb Fibre Channel) (4 instances per array)
Backup storage	FlashArray//E, //C50, //C90 **Protocol**: NFSv3 with dNFS, with 1 NFS share and 1 VIF (2x 100GbE ports per controller)
Oracle Database	Oracle Database 19c Enterprise Edition **dNFS**: Enabled (ODM Library Version 6.0) **Database size**: 1TB per instance in a single bigfile tablespace

TABLE 1 Standalone instance configuration

Table 2 shows the two-node RAC configuration used.

Component	Detail
Compute	**Servers**: Cisco UCS C480 M5 (4-socket) **CPU**: 4x Intel Xeon Platinum 8176 at 2.10GHz (112 cores/224 threads) **Memory**: 1.5TiB RAM/NUMA: 8 nodes
Operating system	Oracle Linux Server 8.10 **Kernel**: UEK 5.4.17
Network	2x Mellanox ConnectX-6 Dx 100GbE NICs **Bonding**: IEEE 802.3ad LACP, layer 3+4 hash **Aggregate bandwidth**: 200Gbps
Primary storage	Everpure FlashArray//XL170 R5 (8x 32Gb Fibre Channel)
Backup storage	FlashArray//E, //C50, //C90 **Protocol**: NFSv3 with dNFS, with 1 NFS share and 1 VIF (2x 100GbE ports per controller)
Oracle Database	Oracle Database 19c Enterprise Edition **dNFS**: Enabled (ODM Library Version 6.0) **RAC**: 2-node cluster **Database size**: 10TB in a single bigfile tablespace

TABLE 2 RAC configuration

Testing used the RMAN parameters in Table 3.

Parameter	Value
Channels	64
Section size	4G
FilesPerSet	1

TABLE 3 RMAN parameters

Standalone performance

Testing measured backup and restore throughput with dNFS across multiple concurrent database instances on FlashArray//E, FlashArray//C50, and FlashArray//C90 (see Figure 3).

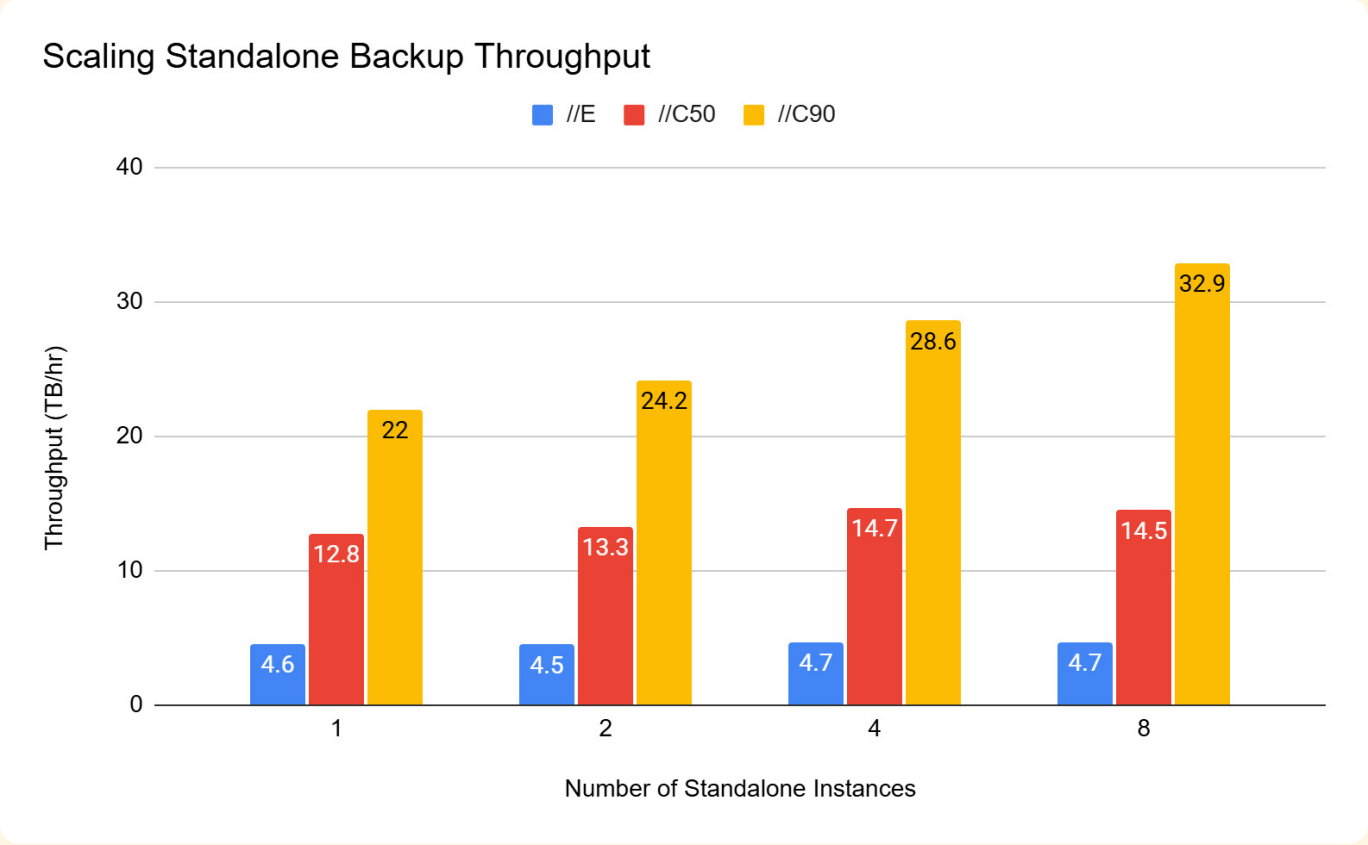

FIGURE 3 Standalone backup throughput by model and instance count

FlashArray//C50 and FlashArray//C90 scaled throughput with concurrent instances, reaching 14.5TB/hour and 32.9TB/hour, respectively, at eight instances (see Figure 4). FlashArray//E delivered consistent throughput around 4.7TB/hour regardless of instance count. This reflects product positioning: FlashArray//E optimizes for capacity density and cost per terabyte, making it suitable for long-term retention where throughput requirements are modest. FlashArray//C balances capacity and performance, scaling to meet demanding backup windows.

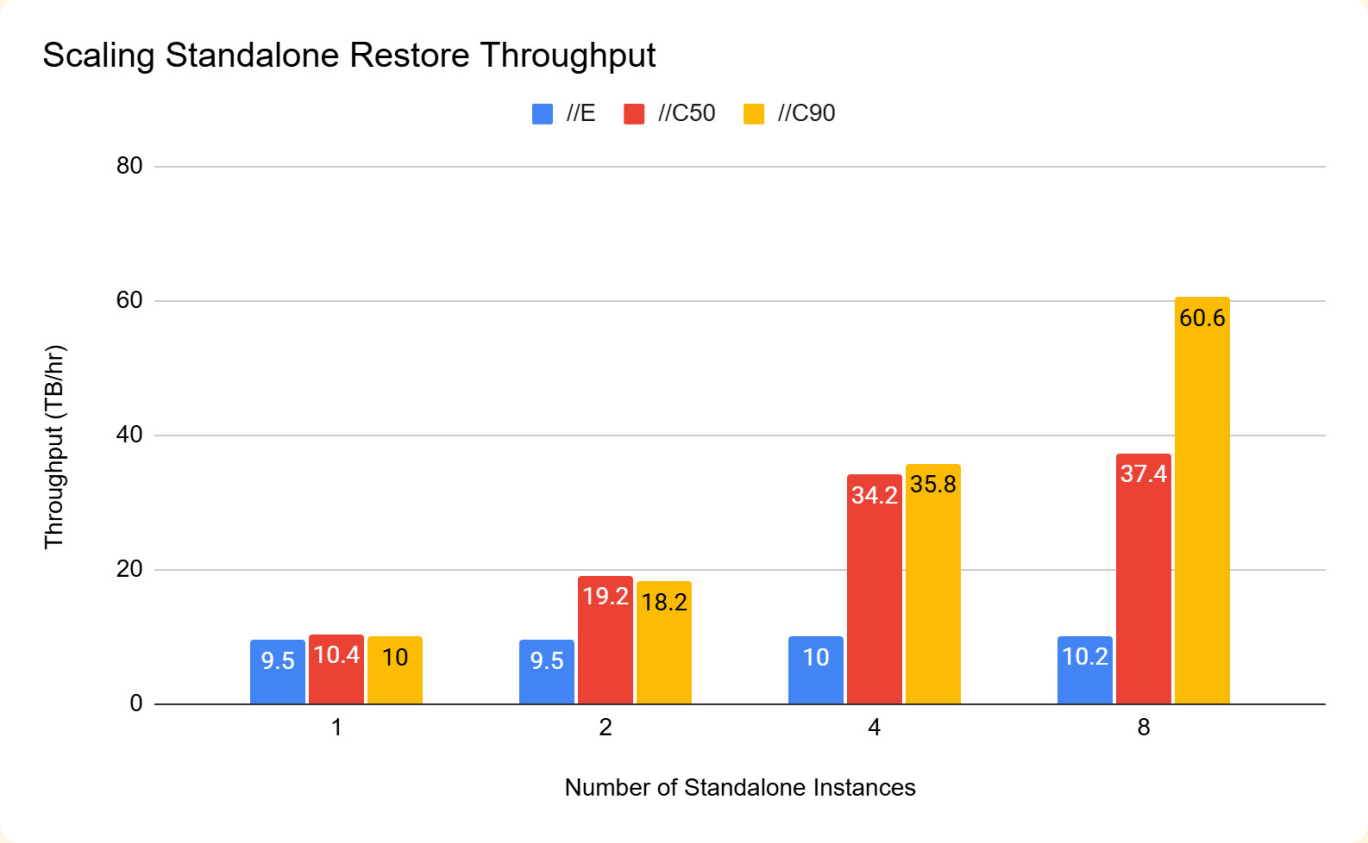

FIGURE 4 Standalone restore throughput by model and instance count

Restore throughput matched or exceeded backup rates at scale. FlashArray//C90 achieved 60.6TB/hour at eight concurrent instances. FlashArray//C50 reached 37.4TB/hour, and FlashArray//E delivered approximately 10TB/hour.

The key result: At scale, restore runs as fast as backup. There is no read penalty from data reduction. Recovery SLAs can be planned with the same confidence as backup windows.

RAC performance

Testing measured backup and restore throughput for a two-node RAC configuration with dNFS alongside FlashArray//C50 and FlashArray//C90 (see Figure 5).

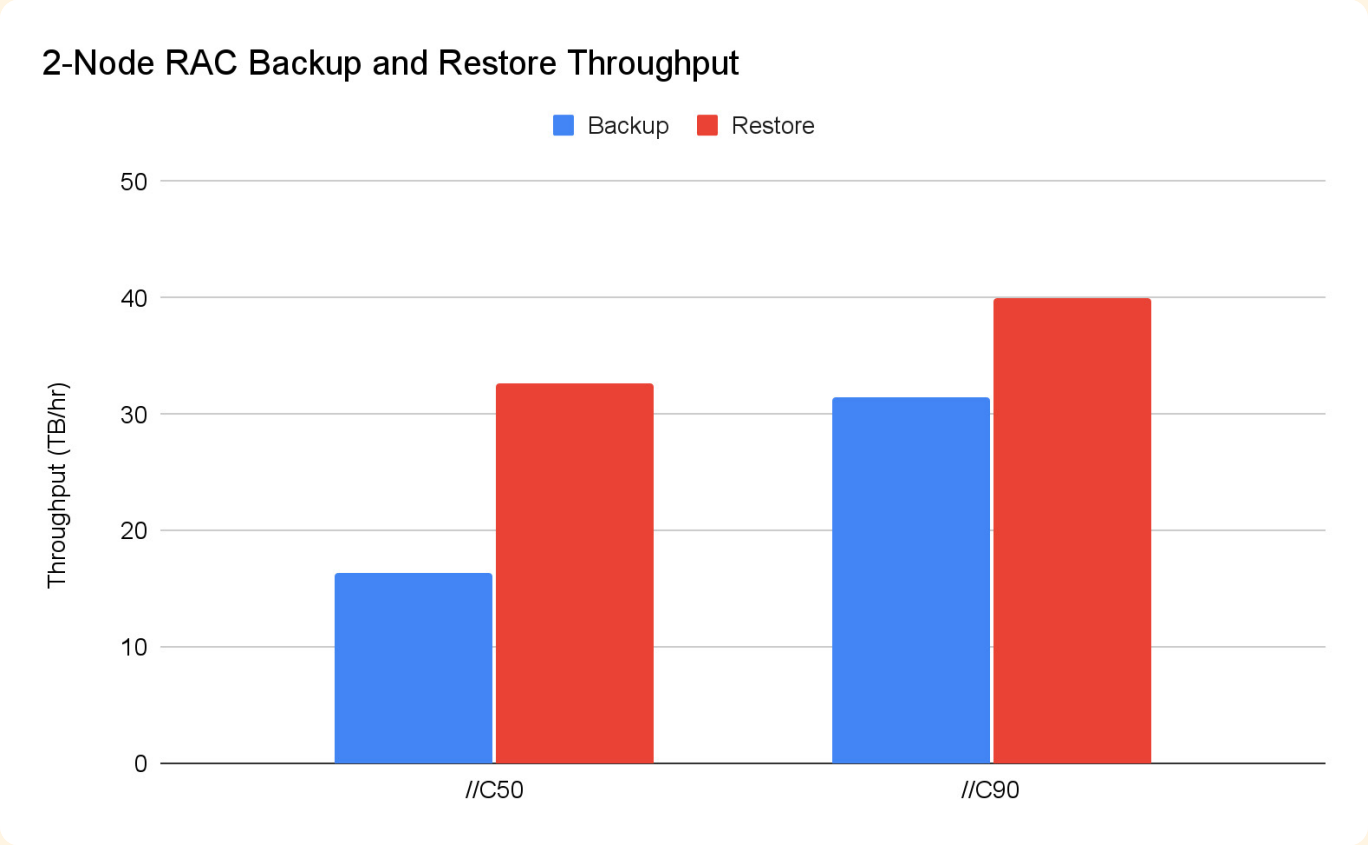

FIGURE 5 Two-node RAC backup and restore throughput with FlashArray//C50 and FlashArray//C90

FlashArray//C90 achieved 31.4TB/hour backup and 40TB/hour restore in RAC configurations. FlashArray//C50 delivered 16.4TB/hour backup and 32.7TB/hour restore. RAC environments benefit from the same restore performance characteristics as standalone instances.

Although FlashArray//E was not tested with RAC, standalone results showed consistent throughput regardless of concurrent load, so RAC testing would yield similar numbers. However, RAC environments typically support mission-critical workloads where FlashArray//C is the appropriate choice.

Recovery time examples

Based on validated restore throughput, the recovery times in Table 4 can be expected for SLA planning.

Database size	FlashArray//E	FlashArray//C50	FlashArray//C90
5TB	~30 minutes	~8 minutes	~5 minutes
10TB	~60 minutes	~16 minutes	~10 minutes
25TB	~2.5 hours	~40 minutes	~25 minutes
50TB	~5 hours	~80 minutes	~50 minutes

TABLE 4 Expected recovery times

Conclusion

Enterprise Oracle environments need backup infrastructure that balances capacity, backup throughput, and restore throughput. Traditional backup appliances optimize for capacity at the expense of recovery performance. FlashArray//C and FlashArray//E provide a cost-effective alternative without that trade-off.

The validated configurations in this paper are as follows:

- **FlashArray//C90**: over 30TB/hour backup and 60TB/hour restore
- **FlashArray//C50:** over 14TB/hour backup and 37TB/hour restore
- **FlashArray//E:** approximately 5TB/hour backup and 10TB/hour restore
- Restore throughput matching or exceeding backup rates at scale

FlashArray delivers reads at full speed, allowing you to plan recovery SLAs with the same confidence as backup windows.

For Oracle environments that need a consolidated backup repository with fast restore, FlashArray provides the throughput to meet both requirements.

Experience the FlashArray Firsthand with a Free Test Drive

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