

STG301 - Amazon Web Services Storage Tiers

Enterprise Workloads - Best Practices



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- AWS Storage Options
- Enterprise Storage challenges
- AWS Storage solutions – Best Practices, Performance
- A storage configuration for Oracle Database
- Case study - RISO



AWS Storage options



Storage Services on AWS

- AWS provides multiple storage options for enterprise workloads

Traditional Workloads	Storage Migration Techniques	Application Specific Storage Options
<ul style="list-style-type: none">Ephemeral StorageElastic Block StorageAmazon Simple Storage Service (S3)Amazon Glacier	<ul style="list-style-type: none">Amazon Direct ConnectAmazon Export/ImportAmazon Storage Gateway3rd Party Storage GatewaysTsunami, BitTorrent, 3rd party solutions	<ul style="list-style-type: none">Amazon ElastiCacheAmazon DynamoDBAmazon RDSAmazon RedShiftAmazon CloudFront



Performance is critical

- What storage option has a typical transfer rate of 1 to 2 MB/sec ?
- This storage device has single threaded performance that is limited to ~17 MB/sec ?
- What storage option has up to 32 MB/sec bursting to 40 MB/sec ?
- 4 PIOPS volumes at 1000 IOPS will saturate this type of instance network bandwidth ?
- What storage option produces ~100-145 MB/s read and write IOPS ? (source)
- Transfer ~3 TB a day using this storage option ?



Enterprise Storage Requirements



Enterprise Storage requirements

Performance

- Requires consistent performance, each application has unique requirements
- Addressed by storage layers like SSD, SAN, NAS etc..

Durability and Availability

- Addressed by using RAID, Disk Backups, Tape Backups

Cost

- Requires high CAPEX

Elasticity and Scalability

- Often addressed by over provisioning



Enterprise storage on AWS

Performance

- Provisioned IOPS, SSD, EBS Optimized Instances

Durability and Availability

- Built in replication across AZ; snapshots can be replicated across regions

Cost

- Pay for what you use, Buy vs Build

Elasticity and Scalability

- Use as little or as much as you want or need



Enterprise Use Cases – Storage Requirements

	Databases	Application Software	File Server	Archival Storage (Long term backups)
Latency (Performance)	Low	Moderate	Moderate	Moderate
Durability and Availability	High	High	High – Moderate	High Durability – Low
Cost (\$/GB)	High	Moderate	Low	Very Low
Elasticity and Scalability	High – Predictable	Low – Stable	High – Spiky	Medium - Predictable



AWS Storage Solutions



Ephemeral Store – Best Practices

- **Use with caution**
- Not all instance types have instance store storage
 - Second generation High Memory instances, Micro instances
- Use rsync to copy data from instance store volumes to EBS volumes as applicable to ensure protection
- Initialize the volume before using for High performance applications
 - dd if=/dev/zero of=/dev/sdb bs=1M
- Add to AMI's explicitly if required, when creating images



Ephemeral Store – Anti-patterns

- Persistent storage – use EBS / S3 instead
- Database storage – use EBS / PIOPS – EBS volumes
 - Ephemeral Store may be used for temporary tables spaces (with proper bootstrapping)
 - cr2.8xlarge/ hi1.4xlarge provide SSD backed instance-store volumes, which may be used for temporary database storage using specific database features
- Shared storage – use EBS / S3 instead
- Snapshots— use EBS instead
 - Optionally rsync the contents of instance store volumes to EBS volumes depending on the use case



EBS – Best Practices

- Use striping for multiple volumes, to increase IOPS
 - RAID 0 and RAID 1+0

	RAID 0 (Stripe)	RAID 1+0 (Stripe and Mirror)
Usage Drivers	I/O performance is more important than fault tolerance	Fault tolerance is more important than I/O performance
Advantages	I/O is distributed across the volumes in a stripe resulting in better performance	Data is replicated and striped across volumes for better durability
Disadvantages	Overall performance of the stripe is limited to the worst performing volume in the set	Doubles the amount of I/O required from the instance to EBS
Recoverability	EBS Snapshots are complex to manage, Must depend on third party backup methods	Fault tolerant due to replication, however EBS Snapshots may be complex to manage and perform complete disk group recovery
Cost	Very little to No overhead, Utilization ratio can be high	Doubles storage cost. May also have impact on network performance at instance level during high volume data transfers

- Use EBS optimized Instance types
 - uses an optimized configuration stack that provides additional, dedicated capacity for EBS I/O
 - Provides the best performance for EBS volumes by minimizing contention between EBS I/O and other traffic
 - Delivers dedicated throughput to EBS, with options between 500 Mbps and 1,000 Mbps
 - Costs an additional low, hourly fee for the dedicated capacity
 - Cannot be enabled for a running instance, requires start and stop of instance
 - Not available for all instance-types
 - Not required for cluster instance types



EBS – Best Practices

- EBS optimized Instance types availability

Network Performance	EBS Optimization	Instance - types	Comments
Very Low / Low	Not Available	M1.small, t1.micro	Not recommended for I/O intensive workloads, application scale out is recommended
Moderate	No	M1.medium, c1.medium, m2.xlarge,	Not recommended for I/O intensive workloads
	Yes	M1.large, m3.xlarge, m2.2xlarge	Can provide up to 500 Mbps of dedicated EBS throughput. Can be used for Moderate to High I/O workloads
High	Yes	M1.xlarge, m3.2xlarge, c1.xlarge, m2.4xlarge	Can provide up to 1000 Mbps of dedicated EBS throughput. Can be used for High I/O workloads
10 Gigabit	Not Available	cc2.8xlarge, cr1.8xlarge , hi1.4xlarge, hs1.8xlarge , cg1.4xlarge	EBS optimization is not required as these instances provide better network throughput and can deliver better I/O performance



Provisioned IOPS – Best Practices

- Provisioned IOPS volumes are designed to deliver within 10% of the provisioned IOPS performance 99.9% of the time
 - when attached to EBS-Optimized instances
 - enough I/O requests to maintain its optimal average queue length
 - The read and write operations have a block size of 16 KB or less
- Prepare new PIOPS volumes by touching all blocks to ensure consistent performance
- Avoid taking EBS snapshots (for both PIOPS and Standard EBS volumes) during peak load
- Avoid throttling overall network pipe / EBS – optimization by attaching too many PIOPS volumes

- Queue Length
 - Maintaining the optimal average queue length is crucial for delivering provisioned throughput
 - If the workload maintains an average queue length that is higher than your optimal value, then your per-request I/O latency will increase and in this case you should provision more IOPS for your volume
 - Maintain Average Queue length of 1 for every 200 Provisioned IOPS and tune that value based on your application requirements
 - VolumeQueueLength cloudwatch metric may be used for each volume to identify potential performance issues

- Cloud Watch metrics to monitor for EBS volumes
 - VolumeQueueLength
 - VolumIdleTime
 - VolumeReadOps
 - VolumeWriteOps
 - VolumeThroughputPercentage (for PIOPS volumes)
 - VolumeConsumedReadWriteOps (for PIOPS volumes)
- VolumeWriteOps/VolumeReadOps needs to be monitored for standard EBS volumes to find potential need to convert them to PIOPS

- EBS storage is not recommended for below use cases
 - Temporary Storage
 - Not recommended for SWAP disks
 - Highly Durable Storage
 - EBS is designed to provide 99.5% - 99.9% annual durability. For better durability use S3
 - Static data or web content
 - Use S3 or Cloud Front instead
 - Key-Value pair information
 - Use one of Database technology by AWS
 - Data that required very low access latency (like session data)
 - Use in-memory options like ElastiCache or DynamoDB

- S3 Performance considerations
 - S3 can support *100 requests per second* without much tuning effort.
 - If higher performance is required, optimization is required
 - For a GET intensive workloads – Use Cloud Front
 - For a mix of request types – optimize the key names for better performance
- For Enterprise Workloads
 - To optimize backup processes
 - utilize multiple backup threads
 - If S3 backup is performed from with-in VPC, make sure that S3 can be accessed directly from private subnet
 - Usage of NAT instance may become a bottleneck

- Use cases where S3 is not recommended
 - File System
 - Even though it can emulate File system formats using key's it is not recommended to use as an alternate to File System. Using of tools which can mount S3 bucket as a file system may have severe performance/cost impact
 - Structured data with Query
 - Use RDS instead
 - Rapidly Changing data
 - Use EBS volumes instead
 - Data that is rarely accessed
 - Use Glacier instead



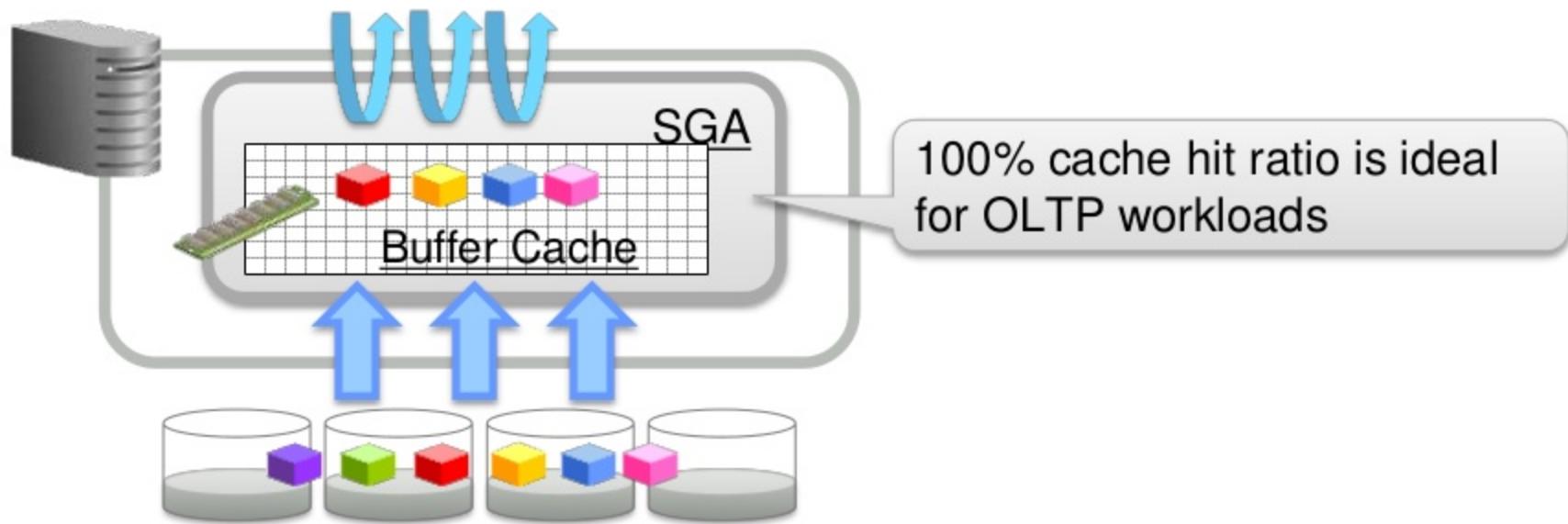
AWS Storage Options Summary

Storage option	General	Database	Applications	Speed	Durability
Instance Store	Swap	temporary files	Reports cache, webserver cache	Very low latency	Very Low; Volatile
EBS – PIOPS		Data files, redo logs		Low latency	Moderate; Needs to be backed up regularly
EBS	Boot volume	Binaries, archive logs	Binaries	Moderate latency	Moderate; Needs to be backed up regularly
S3	Backups	Backups	Backups	Longer latency	Very High durability
Glacier	Long term backups	Long term backups	Long term backups	Restore times of 3-5hrs	Very High durability



Database I/O Patterns

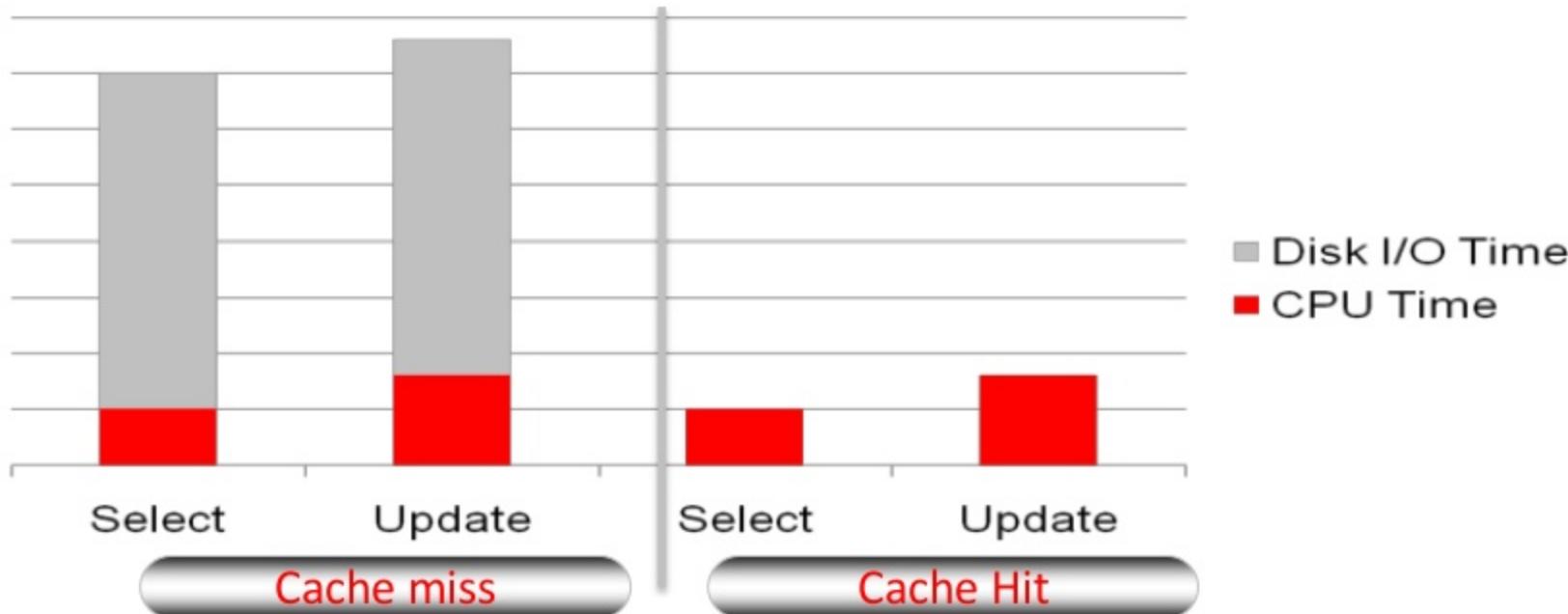
- Cache data in memory from disk to achieve fast query response
- For OLTP/ DSS workloads, memory should be big enough to hold as much as possible





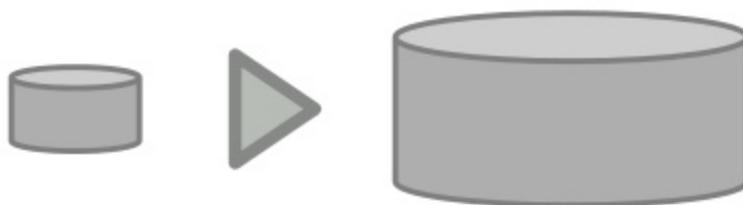
Database I/O Patterns

- CPU time is mainly consumed by I/O wait

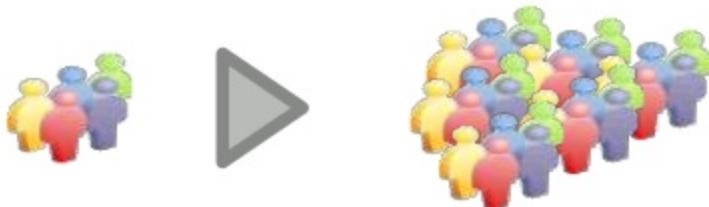


Database cache has limits

1. Data Size is increasing...

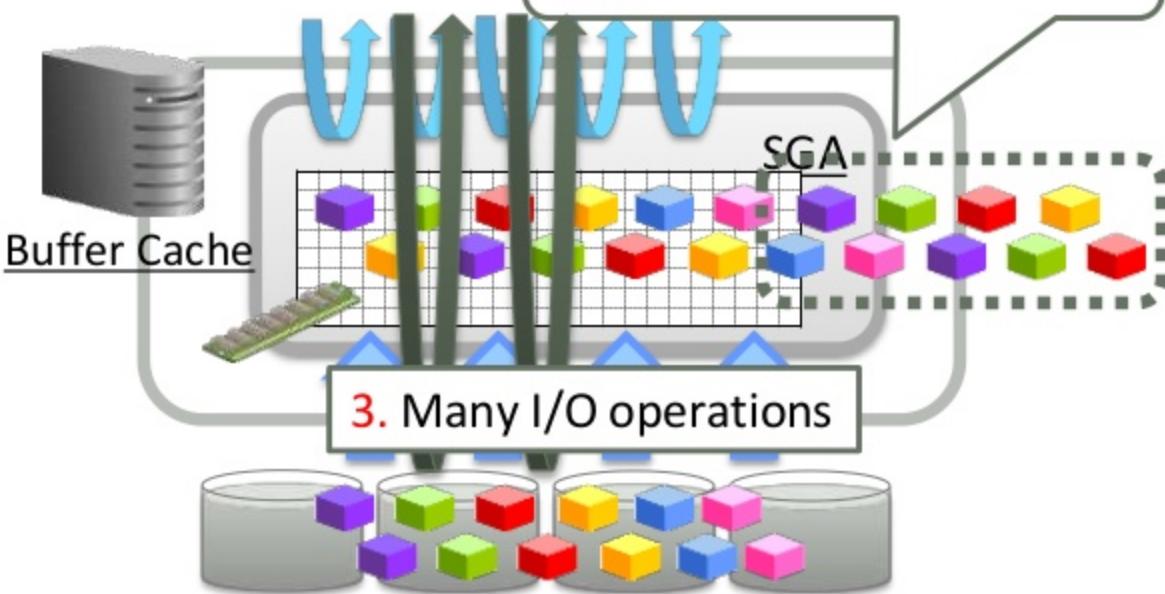


2. User Volume is increasing...

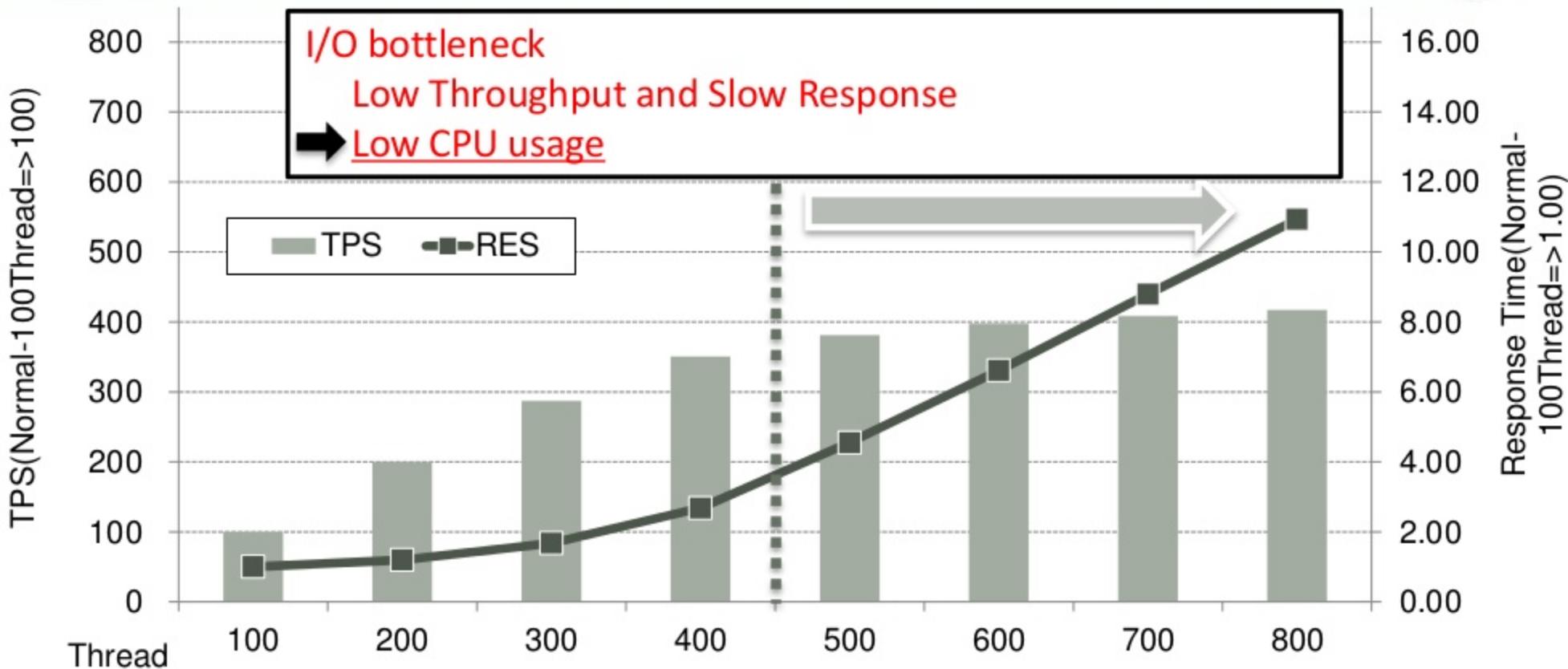


1. Huge amounts of data

2. Not possible to cache all data



Impact of I/O on CPU Response times



Source: oracle corporation



Storage Best Practices for Oracle

- Oracle Automatic Storage Management feature is recommended option to optimize storage performance on AWS
- SAME (Stripe And Mirror Everything) feature of Oracle ASM will help distributing entire data across multiple ebs volumes
- ASM along with PIOPS EBS volumes can provide robust storage performance on AWS
- Oracle Secure Backup for Cloud Module will enable backups directly from Oracle Database/ASM to S3 using RMAN
- RMAN channels can be optimized for optimal system throughput and Storage performance



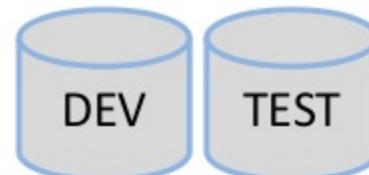
Typical Storage Configuration for Oracle

	Storage Type	Comments
Binaries	EBS Volume	Standard Volume; EBS Snapshots Enabled
Data Files	PIOPS - EBS Volumes	Striped across multiple volumes using ASM or any other technology PIOPS of 1000 or above
Redo Log files	PIOPS – EBS Volumes	Use Separate EBS Volumes for each group Preferable to use ASM disk groups
Archive log files	EBS Volumes	Standard volumes for normal database workloads. PIOPS for highly transactional environments
Backup Files	EBS Volumes / S3	Standard EBS Volumes for local backups Use OSB / other technology to push to S3



Storage Options for Oracle

- Sample Disk Layout for Oracle Database using ASM



+PROD_DATA



4 EBS Volumes
4000 PIOPS

+PROD_FRA



4 EBS Volumes
1000 PIOPS

+DEV_DATA

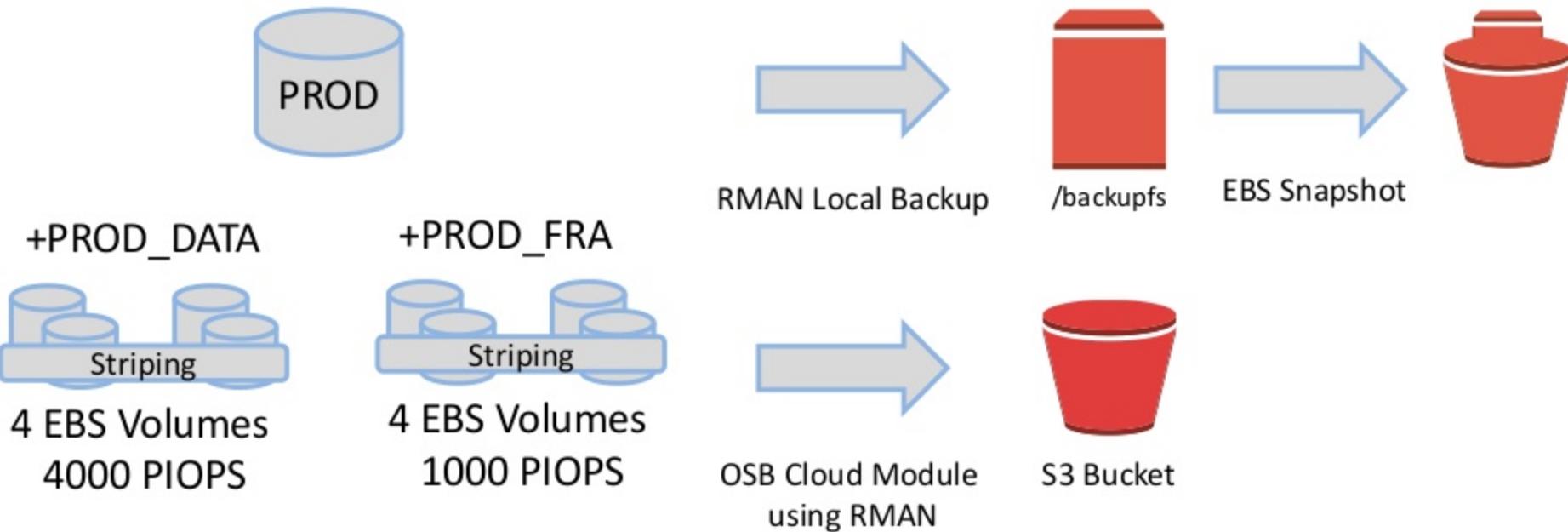


4 EBS Volumes
500 PIOPS

ASM Instance with 16,000+ IOPS



Database Backup Best practices





SSD Storage with Oracle

- AWS provides 2 instances types with SSD storage
 - cr1.8xlarge – 240GB of SSD
 - hi1.4xlarge – 2048GB of SSD
- This SSD storage is ‘ephemeral’ use with caution for data files
- However, SSD can be leveraged by using “Oracle Flash Cache” without risk
 - Available at no additional cost, Database Smart Flash Cache on Oracle Solaris and Oracle Enterprise Linux
- Oracle Flash Cache simply extends the buffer cache to leverage SSD
- Recommended use case for environments with huge working data sets
 - ETL processes for data warehouses
 - Reporting work load



Case Study - RISO

Chris Gattoni, IT Director



About RISO, Inc.

Who RISO Is

Mission

RISO means “ideal.” RISO strives to create fundamentally unique new technologies in paper-based communication. Every product we manufacture offers the ideal solution to our customers. At the same time, RISO carries on a tradition of caring for the world at large through our environmental and community support programs. Just as we are committed to delivering the ideal products and service, we strive to be an ideal corporate citizen in every country in which we conduct business.

Company Overview

RISO, Inc. is a world leader in digital printing solutions, with award winning printing technologies that are at the forefront of the printing equipment industry. RISO printers help improve **productivity**, **increase versatility**, and **reduce costs**.

About RISO, Inc.

What RISO Does

RISO sells **high speed** inkjet printers and digital duplicators. They're **low-cost**, **durable**, & **reliable** production printers.

RISO strives to create fundamentally unique new technologies in paper-based communication through an approach that emphasizes **productivity**, **cost containment**, and **versatility**. Every product we manufacture delivers these benefits in a balance that offers the ideal solution to our customers.



Speed up your color communications!

- Key Challenges
 - End-of-Life Hardware
 - CAPEX vs OPEX
 - Upcoming Datacenter Migration
 - IT not spending enough time on core functions
- AWS Solution
 - Migrate from existing hardware to AWS EC2 platform
 - Lower TCO
 - No datacenter to maintain , resulting in more flexibility for infrastructure team
 - Scalable and Elastic platform



On-Premise Environment

- Infrastructure spread across multiple locations
 - Connectivity required from multiple locations
 - Multiple servers, SAN Storage, Network equipment
 - Printers, Tape Libraries, File Servers
- Applications include
 - Oracle ERP
 - Oracle Business Intelligence
 - LACROSSE applications on MS SQL Server
 - Domain controllers, PING Identity, Monitoring Servers
 - Ticketing Systems



Target AWS Environment

- Virtual Private Cloud with multiple VPN Tunnels for redundancy
 - Separate VPN Tunnels to each remote location
 - Access restricted only via VPN Tunnel for better security
- EC2 servers with EBS storage
 - EBS – PIOPS for Database storage
- Tape Library replaced with AWS S3
- DR setup for core infrastructure components like Domain Controller etc..
- DR build for Enterprise Applications in separate region



Storage Options on AWS

- Leveraged all Storage options to ensure optimal performance in AWS
 - Ephemeral – Swap space / Temp storage
 - EBS Volumes – OS Boot volumes / Software binaries / Application storage
 - EBS - PIOPS Volumes – Oracle Data files, Redo logs on striped volumes
 - S3(RRS) – for storing Non Prod backups using third party backup appliance
 - S3 – for storing Production backups
 - Glacier – Long term archival of backups
 - Export/Import – to transfer 2TB+ data to Glacier using USB disks



Key Challenges

- 32-bit vs 64-bit instance types
 - AWS provides limited options to run 32-bit applications
 - Legacy applications were not certified to run on 64-bit instances
 - Upgrade to latest versions was not feasible
 - 32-bit instance types were unable to provide enough throughput
 - Network performance / EBS performance was not sufficient to meet user load
- Solution: EBS PIOPS with Scale Out
 - Implemented multiple EBS PIOPS volumes with EBS Optimization for better I/O
 - Scaled out Application middle tier to use multiple servers for better throughput
 - Used Custom built AMI's to run legacy applications to avoid AWS dependency



Key Takeaways

- AWS provides multiple Storage options for enterprise workloads
- No single option fits all workloads
- Proper planning and validation of I/O performance is the key for success
- Phased approach for AWS migration
 - Start with a POC
 - Migrate Test / Dev environments
 - Build DR in Cloud
 - Migrate Production workloads
- Continuous monitoring of key performance metrics is crucial for success

- AWS Architecture Center
<http://aws.amazon.com/architecture/>
- Storage Options in the AWS Cloud
http://media.amazonwebservices.com/AWS_Storage_Options.pdf
- AWS: Overview of Security Process
http://media.amazonwebservices.com/pdf/AWS_Security_Whitepaper.pdf
- Roadmap to Moving Your Applications to the Cloud
<http://www.appsassociates.com/white-papers/moving-applications-to-cloud>
- AWS Test Drive Labs – Try your application on cloud
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