RMOUG

TRAINING DAYS 2021

Reach for the Summit | February 8–11

Oracle Workloads in Azure

A Deep Dive

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rmoug.org

Deep Dive Instructor

Kellyn (Pot'Vin) Gorman
- SME for Oracle on Azure
  - Cloud Architecture and Engineering at Microsoft
- Current Microsoft Champion and Oak Table Network
- Former Oracle ACE Director
- Blogs at DBAkevlar.com, Microsoft Data Architecture Blog and Redgate Simple Talk
- Author of 7 books covering Oracle, SQL Server, DevOps and Diversity and Inclusion

Agenda

- Confirm Azure Portal Accounts and CLI Setup
- Oracle in a Microsoft World
- Part I- Azure Catalog, Images and Databases
- Part II- Knowing It's All About the Workload
- Part III- The IaaS/Data Conundrum
- Part IV- Migration, Tools and Challenges
- Part V- The Change and the Same

Confirmation of Prerequisites for Deep Dive Session

Setup an Azure Portal Account if you don't already have one to use for the session:

Create your Azure free account today | Microsoft Azure

Setup Azure Cloud Shell with cloud storage:

Azure Cloud Shell overview | Microsoft Docs

Persist files in Azure Cloud Shell | Microsoft Docs

Terms To Know

- **IaaS** = Infrastructure as a Service

- **AZ Commands** = Azure CLI command line functions

- **VM** = Virtual Machine

- **AWR** = Automatic Workload Repository, workload repository proprietary to Oracle. Retains 8 days by default 1-hour intervals on "snapshots", includes other tools/data.

Reference Links for Session

Azure Cloud Shell CLI with BASH:
Azure Cloud Shell Quickstart - Bash | Microsoft Docs
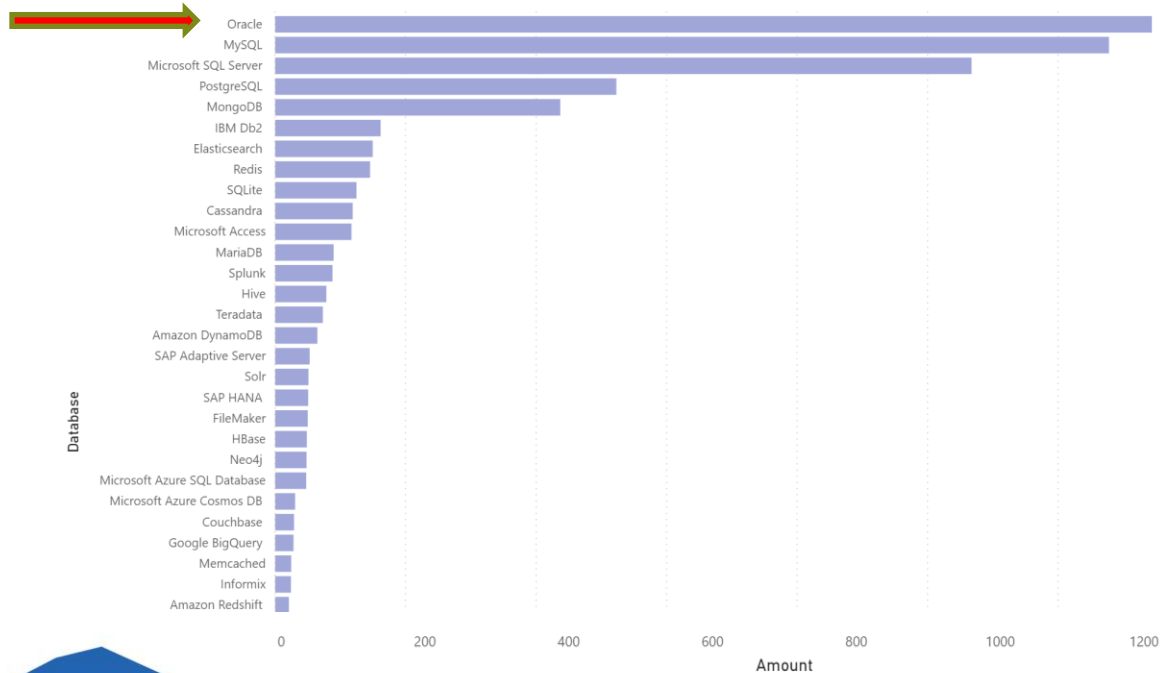Azure CLI Reference: Overview of the Azure CLI | Microsoft Docs
Oracle Software on Azure: Oracle Software on Azure | Microsoft Azure

Oracle in a Microsoft World

LARGE PERCENTAGE OF DATABASES IN THE WORLD ARE ORACLE

GARTNER MAGIC QUADRANT FOR OPERATIONS DATABASE MANAGEMENT SYSTEMS

Figure 1. Magic Quadrant for Operational Database Management Systems

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Viewing and Deploying an Oracle Database From Azure

Where Can I Find Oracle Images?

- The Database Images in the Azure Catalog for 12c are on Ubuntu- good "kick the tires" database.

- 18c and 19c is on Oracle Linux.

- If RHEL is desired, pull a RHEL image preferred and install the version of Oracle on it.

- **All licensing is BYOL!!**
  - **Let's talk about that….**

List out Oracle Linux Images in Azure

```
az vm image list --offer Oracle-Linux --all
--publisher Oracle --output table
```

List out Oracle Database Images in Azure

```
az vm image list
--offer Oracle-Database --all
--publisher Oracle --output table
```

Script to Deploy

./mv_oravm.sh

-resource group name

-Uni: Oracle:Oracle-Database-Se:18.3.0.0

-Server Name: Ora18db1

-Storage: Standard_LRS

•

- https://github.com/Dbakevlar/Misc-BASH/blob/master/mk_oravm.sh

You Now Have an Azure VM with Oracle Software Installed, (No Database)

Azure VMs with Oracle- Next Steps (dbakevlar.com)
* Start at the step, "Create the Database"

Oracle is Often the Anchor

- Big Data estates- often in the terabytes.
- Real Application Cluster, (RAC) that isn't supported in third-party clouds by Oracle.
- Many archaic systems with tons of legacy parameter settings and configurations.
- Either multi-tier systems dependent on Oracle or tons of PL/SQL functions and regular expressions.
  - Developers are dependent upon this code and can't take the time to retrain.
  - Refactoring to another platform could take years.
  - Application/vendor isn't supported on non-Oracle databases.

I Have Oracle, How Do I "Azure It"?

- Oracle in Azure is Infrastructure as a Service, (IaaS)

- Oracle to PostgreSQL, (PaaS), CosmosDB, Azure Synapse handles about 10-20% of cases

- Over 1700 customers are running Oracle on Azure IaaS today.

Lift and Shift is the reality, not the outlier.

Architecture

Understand Cloud HA and MAA

- Maximum Availability Architecture
  - Different names for different vendors.
  - Get a clear understanding of the SLA uptime for the business and environment.
  - Onprem datacenters are not the same as cloud architecture.
  - Pivot products and services to cover what you need.

- High Availability
  - Identify what HA means to stakeholders.
  - Often, it's specific features, not a product, then marry these to a cloud product which:
    - Matches the IaaS architecture
    - Overhead makes sense for the benefits
    - Has vendor support
    - Identify what cloud services may duplicate or simulate the same feature if unavailable.

RAC- Redundant Avoidable Cost

- Some Great Features

- Introduces redundancy in the Azure

- Multiple servers, high overhead, single database.

- Isn't *true* High Availability

  - All nodes in same datacenter

  - Focus on how to architect for the cloud, not on-prem.

Oracle Dataguard

- Similar to Always on AG

- Multiple Servers, standby databases.

- Only writes down, never up.

- 12c+ RAC-like features

  - Fast-start failover, switchover, session broker.

  - Can automate DB and Session failover

  - Rolling upgrades

It's All About the Workload

Do It Right, Don't Do It Twice

Move the Oracle workload, not the server to the cloud.

1.   The hardware is often quite old or was sized to last years.
2.   The database workload has grown and/or the workload has changed from the time the hardware was purchased.
3.   The hardware was incorrectly sized to begin with.

Using it to size the database in the cloud is ripe with failure.

1.   The Automatic Workload Repository, (AWR) report is the best data to collect to size a workload from Oracle
2.   AWR is always on in Oracle Enterprise Edition, (SE can use Statspack similarly.)

AWR Architecture

https://techcommunity.microsoft.com/t5/data-architecture-blog/estimate-tool-for-sizing-oracle-workloads-to-azure-iaas-vms/ba-p/1427183
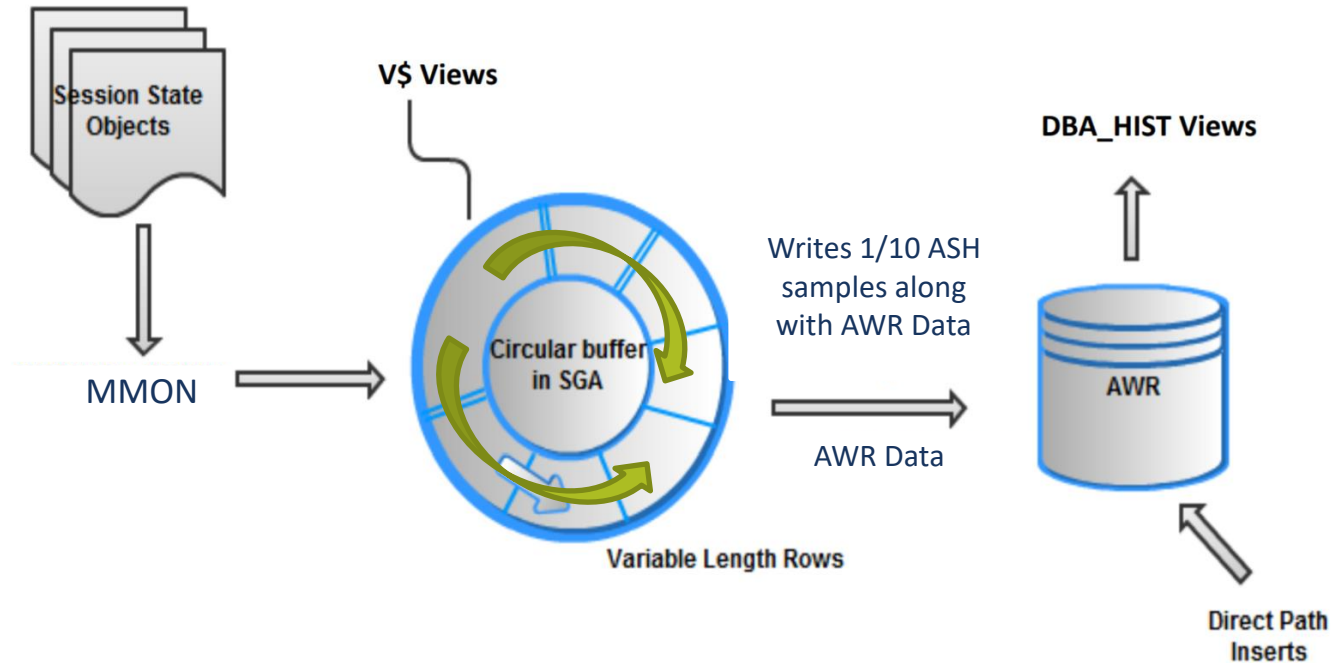
Sizing Requirements

- At least a one-week report. A report is taken with a beginning and ending snapshot- ANY snapshots that are in the repository can be used

- One report! Don't try to add reports data together- human intervention raises chance of human error.

- DBAs or developers may debate with what they think you need, but the report MUST contain the peak workload for the database. If it isn't included, the data could be inaccurate.

- Need assistance finding the peak in the repository? Check out this script!

- Size of the database, which is [surprisingly] not included in the AWR!

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Rarely Change "Fudge Factors"

- These are the numbers that are used to take missing workload data, address averages, additional immediate growth and calculation issues into consideration.

- Leave to the default values unless a specific type of workload, (Exadata, etc.)

Peak CPU factor	2.00
Est'd RAM factor	1.50
vCPU HT factor	4.00
%Busy CPU threshold	2.00
%Busy CPU multiplier	2.00
IO metrics (IOPS & MB/s) fudge factor	1.00

From a Few Data Points, Comes Great Value

Aggregated calculations by database

DB Name	%DB Time of Elapsed Time	Total vRAM (GiB) consumed only by Oracle	Est'd Azure vRAM for server	Total IOPS	Total Throughput (MB/s)	Est'd Azure IOPS for peak load	Est'd Azure Throughput (MB/s) for peak load	Est'd Azure vCPUs for avg load	Est'd Azure vCPUs for peak load
P████IL	23.233%	6	10	86.30	6.14	86.30	6.14	1	2
P████M	6.925%	5	8	55.11	6.24	55.11	6.24	1	2
P████SC	68.565%	11	16	229.23	114.26	229.23	114.26	3	6
P████Q	26.883%	7	10	44.23	5.02	44.23	5.02	2	4
PR████	73.735%	25	38	7,904.00	883.30	7,904.00	883.30	2	4
P████S	16.342%	5	7	94.35	33.36	94.35	33.36	1	4
P████3C	45.809%	9	13	463.73	73.78	463.73	73.78	2	4
P████7B	94.930%	43	65	286.58	39.20	286.58	39.20	4	8
P████12	8.323%	9	13	32.60	9.83	32.60	9.83	1	2
M████OEM	32.498%	9	14	548.05	86.76	548.05	86.76	2	4
D████DB	20.821%	8	12	29.67	3.20	29.67	3.20	1	2
P████P	819.528%	107	161	3,296.73	174.50	3,296.73	174.50	33	66
P████CP	266.874%	77	115	408.52	74.86	408.52	74.86	11	22
Total	1504.47%	322	484	13,479.10	1,510.44	13,479.10	1,510.44	64	130

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It's All About the Hardware

The IaaS-Data and AI Conundrum

- Infrastructure as a Service = Infrastructure

- Database = Data and AI

- Oracle Database = ???

Infrastructure knowledge is Essential for Oracle Workloads in Azure

- There **are limits** on VM Series for IOPs, MBPs and networking.
- Read up on the VM Series Documentation- know your VMs!
- Know the difference between storage limitations and per VM limits!

Understand IaaS VM Series

- A and B-series commonly won't work for database development
- D-series can work for some, but consider matching series to production, but lesser resources
- L and H-series are outliers for database workloads.

- Identify workload needs
- D-series is for general use
- **E-series and M-series are the most common VMs in the database industry**
  - E-series for average production databases
  - M-series for VLDB, (very large databases or heavy processing)

Choose the right VM for your workload and reduce costs

Migrate your business and mission critical workloads to Azure and realize operational efficiencies. Run SQL Server, SAP, Oracle® software and high-performance computing applications on Azure Virtual Machines. Choose your favorite Linux distribution or Windows Server.

Deploy virtual machines featuring up to 416 vCPUs and 12 TB of memory. Get up to 3.7 million local storage IOPS per VM. Take advantage of up to 30 Gbps Ethernet and cloud's first deployment of 200 Gbps InfiniBand.

VM Series

When one VM is too much- Constrained VMs

- Allows for isolation of vCPU to application licensing for database and app workloads
- Matched in existing series VMs in the Azure Pricing Calculator
- Share storage between databases or apps

- Before choosing, ensure your product licensing support constrained vCPU VMs
- Carefully match workloads on IO and memory, not just vCPU usage when combining.

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Specialized Constrained vCPU VMs

Name	vCPU	Specs
Standard_M8-2ms	2	Same as M8ms
Standard_M8-4ms	4	Same as M8ms
Standard_M16-4ms	4	Same as M16ms
Standard_M16-8ms	8	Same as M16ms
Standard_M32-8ms	8	Same as M32ms
Standard_M32-16ms	16	Same as M32ms
Standard_M64-32ms	32	Same as M64ms
Standard_M64-16ms	16	Same as M64ms
Standard_M128-64ms	64	Same as M128ms
Standard_M128-32ms	32	Same as M128ms
Standard_E4-2s_v3	2	Same as E4s_v3
Standard_E8-4s_v3	4	Same as E8s_v3
Standard_E8-2s_v3	2	Same as E8s_v3
Standard_E16-8s_v3	8	Same as E16s_v3

Storage is SEPARATE and Important

- Ensure you know the IO workload for your database going to the cloud
- Understand both the MB/s and the IO throughput for the database.
- Oracle has demonstrated, on average, much higher demands for IO than MSSQL, MySQL or PostgreSQL.

- *Storage is separate to ensure the right combination in IaaS can be reached.*

Storage Considerations

What is the storage to be used for?

Data- OLTP, DSS, OLAP, Big Data?

Logging

Backup

Ensure that backups and data refresh requirements are calculated into the IO demands for the database.

Storage Accounts

- Know the difference between storage Account Types:
  - ~~V1 vs. V~~
  - ~~Storage~~
  - Fil~~e~~
  - ~~Sto~~se Type v2 whenever possible.

Most database workloads are going to require:

- Premium SSD storage.
- Ultra Disk
- Azure NetApp Files

Redundancy

- **Locally Redundant Storage, (LRS)-** copies data synchronously 3 times within a single physical location in the same region. Not considered HA.

- **Zone-Redundant Storage, (ZRS)-** copy data synchronously across 3 Azure AZ in the primary region. HA would have first 2 in first region and 3rd in secondary region.

- **Geo-Redundant Storage, (GRS)-** Copies data synchronously in a single physical location of the primary region using LRS, then copies data async to a physical location in a secondary region.

- **Geo-Zone-Redundant Storage, (GZRS)-** Copies data synchronously across 3 Azure AZ in primary region using ZRS & then copies to a physical region in a secondary region.

Storage Account Details

Storage Account	Services	Supported Tiers	Access Support	Replication
GP V2	Blob, File, Queue, Table, Disk, Data Lake Gen2	Standard, Premium	Hot, Cool, Archive	LRS, GRS, RA-GRS, ZRS, GZRS, RA-GZRS,
GP V1	Blob, File, Queue, Table and Disk	Standard, Premium	N/A	LRS, GRS, RA-GRS
Block Blob Storage	Blob	Premium	N/A	LRS, ZRS
File Storage	File Only	Premium	N/A	LRS, ZRS
Blob Storage	Blob	Standard	Hot, Cool, Archive	LRS, GRS, RA-GRS

Name	Capacity (GiB)	IOPS per disk	Max burstable IOPS	Throughput per disk (MB/s)	Max burstable throughput per disk (MB/s)	Cache limit per disk (GiB)
P1	4	120	3,500	25	170	4
P2	8	120	3,500	25	170	8
P3	16	120	3,500	25	170	16
P4	32	120	3,500	25	170	32
P6	64	240	3,500	50	170	64
P10	128	500	3,500	100	170	128
P15	256	1,100	3,500	125	170	256
P20	512	2,300	3,500	150	170	512
P30	1,024	5,000		200		1,024
P40	2,048	7,500		250		2,048
P50	4,096	7,500		250		4,095
P60	8,192	16,000		500		4,095
P70	16,384	18,000		750		4,095
P80	32,727	20,000		900		4,095

Source: Managed disks pricing

Ultra Disk

Ultra Disk Offerings									
Disk Size (GiB)	4	8	16	32	64	128	256	512	1,024-65,536 (in increments of 1 TiB)
IOPS Range	1,200	2,400	4,800	9,600	19,200	38,400	76,800	160,000	160,000
Throughput Range (MB/s)	300	600	1,200	2,000	2,000	2,000	2,000	2,000	2,000

Ultradisks

- Often the first recommendation by Infra
- Be aware of the limitations before recommending for database workloads:
  - Oracle 12.2 later is supported
  - Only supports un-cached reads and un-cached writes
  - Doesn't support disk snapshots,
  - VM images, OS Disk, availability sets, Azure Dedicated Hosts, or Azure disk encryption
  - No integration with Azure Backup or Azure Site Recovery
- Offers up to 16 TiB per region per subscription unless upped via support.
- Isn't available in all regions.

	Capacity per disk (GiB)	IOPS per disk	Throughput per disk (MB/s)
Mininum	4	100	1
Maximum	65536	160000	2000

Azure NetApp Files

	Azure Files	Premium Files	Azure NetApp Files	Premium Disk
Performance	1K IOPs	100K IOPs	**320K IOPs**	20K IOPs
Capacity Pool	5TB	100TB	**500TB**	32TB
AD Integration	Azure AD	N/A	**Bring Your Own AD / Azure AD**	N/A
Protocol	SMB	SMB	**NFS & SMB**	Disk
Data Protection		LRS Only	**Snapshots Back Up Tools**	Snapshots

- Fully Managed, PaaS, Microsoft Azure Storage Service
- All Flash Baremetal Storage
- Only dependent on Nic, not VM.
- Available in Standard, Premium, (common) and Ultra, (optimal)

IO Throttling

- Why it happens?
  - No, you can't have all the resources for yourself.
- What all can be involved?
  - It's not just the database.
- How to identify it?
  - What do to when it is identified?

Size	vCPU	Memory: GiB	Temp storage (SSD) GiB	Max data disks	Max cached and temp storage throughput: IOPS/MBps (cache size in GiB)
Standard_M8ms	8	218.75	256	8	10000/100 (793)
Standard_M16ms	16	437.5	512	16	20000/200 (1587)
Standard_M32ts	32	192	1024	32	40000/400 (3174)

- [Azure IO Performance for the RDBMS DBA- Part I (dbakevlar.com)](#)

- [Why a One-Week Report for AWR Sizing in Azure (dbakevlar.com)](#)

- [Prepping an Oracle Database for a Cloud Migration (dbakevlar.com)](#)

- [Oracle Storage Snapshots with Azure Backup - Microsoft Tech Community](#)

- [Backup Scenarios for Oracle on Azure IaaS - Microsoft Tech Community](#)

- [Estimate Tool for Sizing Oracle Workloads to Azure IaaS VMs - Microsoft Tech Community](#)

Bring in Additional Solutions

- High IOPS-
  - MBPs: Azure NetApp Files
  - Higher IO throughput: Consider ANF or Ultradisk
  - Consider disk striping of smaller disks and parallel processing at the database level.
  - Shut off unnecessary maintenance jobs.

- Backups, batch loading and other challenges:
  - Offload backups with secondary backup solutions.
  - Refactor batch processing with other services, (Azure Data Factory, Azure Analysis Services, Databricks, etc.)

Types of cache Settings

- Available to Premium Storage
  - A Multi-tier caching technology, aka BlobCache
  - The default is set to Read/Write, which isn't viable for databases
  - Read Cache is, as it caches reads, while letting writes pass through to disk.
  - Limit of 4095Gib on per individual premium disk
    - **Results in any disk above a P40 for entirety will silently disable read caching.**
    - Larger disks are preferably used without caching, otherwise additional space is wasted.
    - Use smaller disks and choose to stripe and mirror or bursting.
  - M-series available and VM series dependent.

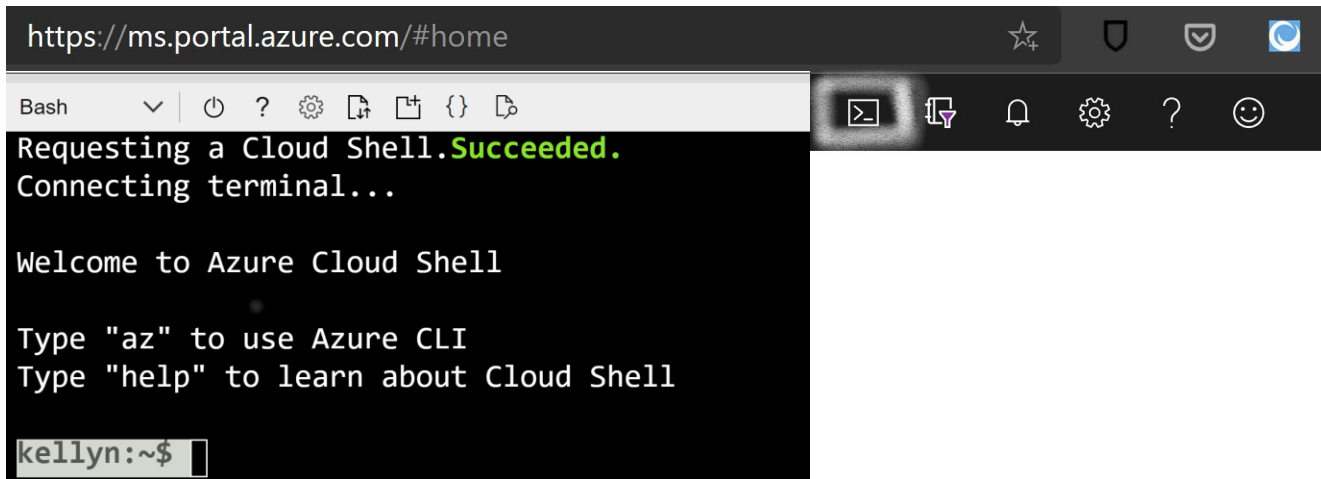# Keep the Tools, Lose the Old Hardware

Failure Due to Backups

- Modernize the way the database is backed up and restore.
- RMAN- It's an archaic backup tool and datapump data refresh strategies can impact a cloud environment heavily in IO and network latency
- Snapshot technology with database consistency should be your FIRST choice in backup solutions.
  - Oracle AWR can demonstrate the impact on the overall database workload of RMAN and datapump jobs.
  - Consider different vendors, such as Azure NetApp Files, Commvault, Veeam (and soon) Azure Backup.

Azure Cloud Shell

- Use the Azure Cloud Shell-

- Bash Interface

- Cloud Storage, port all existing scripts over, minor updates.


```
https://ms.portal.azure.com/#home

Bash          ✕    ⏻   ?   ⚙   ⬆   ⬆   {}   ⬇                    ▶_   ⫚   🔔   ⚙   ?   ☺

Requesting a Cloud Shell.Succeeded.
Connecting terminal...

Welcome to Azure Cloud Shell

Type "az" to use Azure CLI
Type "help" to learn about Cloud Shell

kellyn:~$
```

https://azure.microsoft.com/en-us/features/cloud-shell

Simplify the Shift to the Cloud

- Migrate your tools that you already use to monitor and manage the database on-prem into the cloud whenever possible.
    - For Oracle, we implement Oracle Enterprise Manager, (Cloud Control) to ensure the cloud environment looks just like their onprem one.
    - Use features to automate patching
- Incorporate DevOps automation to the cloud changes FIRST
- If you're new to Linux, then consider automating the OS patching with the Azure Linux automated patching service

Simulate PaaS in IaaS

- Create Templates and then push to your own Image Library, (create once, use repeatedly)

- Use Lifecycle Management Pack with Oracle Enterprise Manager to automate monitoring, management and database patching.

- Use OEM IP scanning to pick up new servers/databases and add them to monitoring and management.

- Set up automated backups with a jump VM box to support it.

- Use Linux Automated Patching, (preview) to automate OS patching of VMs.

Migration and Synchronization

It's Not Just Infrastructure

- No matter if during the migration or when there are issues:
  - Infrastructure support will be the first line of defense.
  - Database workload will be an afterthought.
  - Data support may be a request only option.

- First inclination is to "throw iron" at the problem.
  - Demand to look at the code, database design, etc.
  - If you fix the real cause, you fix it once vs. revisiting it over and over.
  - Do have support take advantage of advanced Azure tools to help identify where the problem is, (IO, memory, CPU)

Tools for Migration

- RMAN Backups/Clones
- Full Backup
- RMAN Duplicate
- Thick Clone technologies
- Oracle DataGuard

- Modern Tools
- VM Migration tools
- Azure NetApp Files
- Veeam
- Azure Migration Services

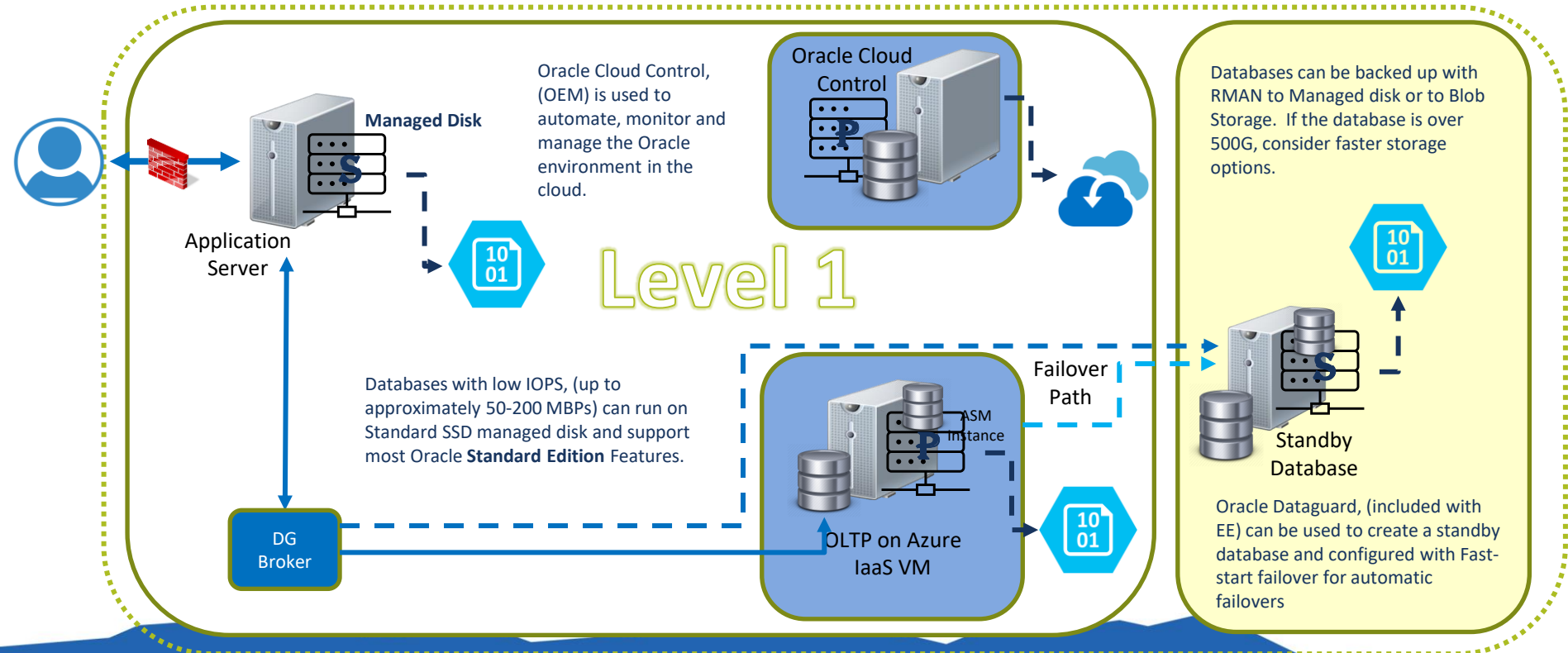| Third Party Tools		Oracle Tools	
	Azure Data Factory		Golden Gate
	SQL Data Examiner		Change Data Capture packages
	dbForge Data Compare		PL/SQL
	SQL Delta Duo		Datapump

Customer Migrations

Create A Base Image

- Customers use either Oracle Linux, (OL) or Red Hat, (RHEL)
- Build out their Oracle installation, (ASM, scripts, etc.)
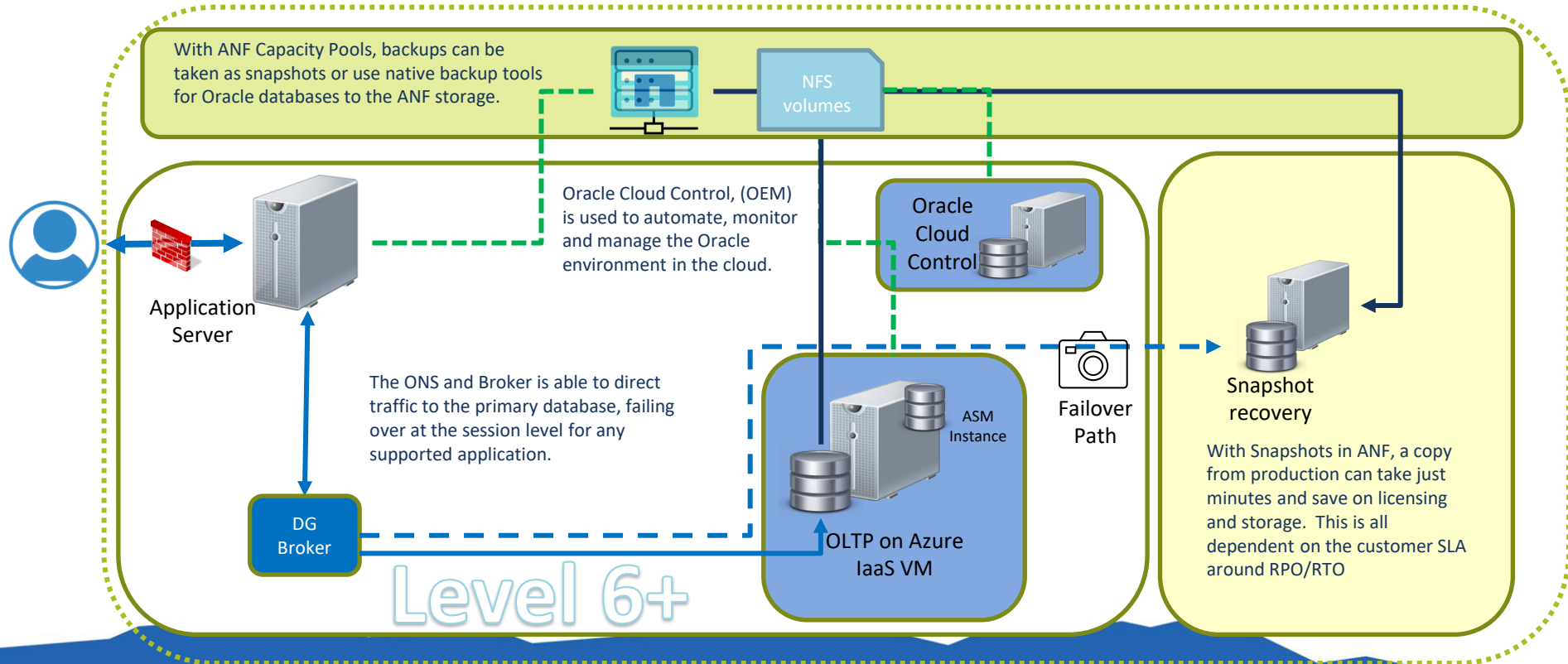- Create their images
- Deploy

https://dbakevlar.com/2020/03/locating-oracle-enterprise-linux-images-for-azure/
https://docs.microsoft.com/en-us/azure/virtual-machines/windows/capture-image-resource
Create a Simple Oracle VM on Azure IaaS (dbakevlar.com)

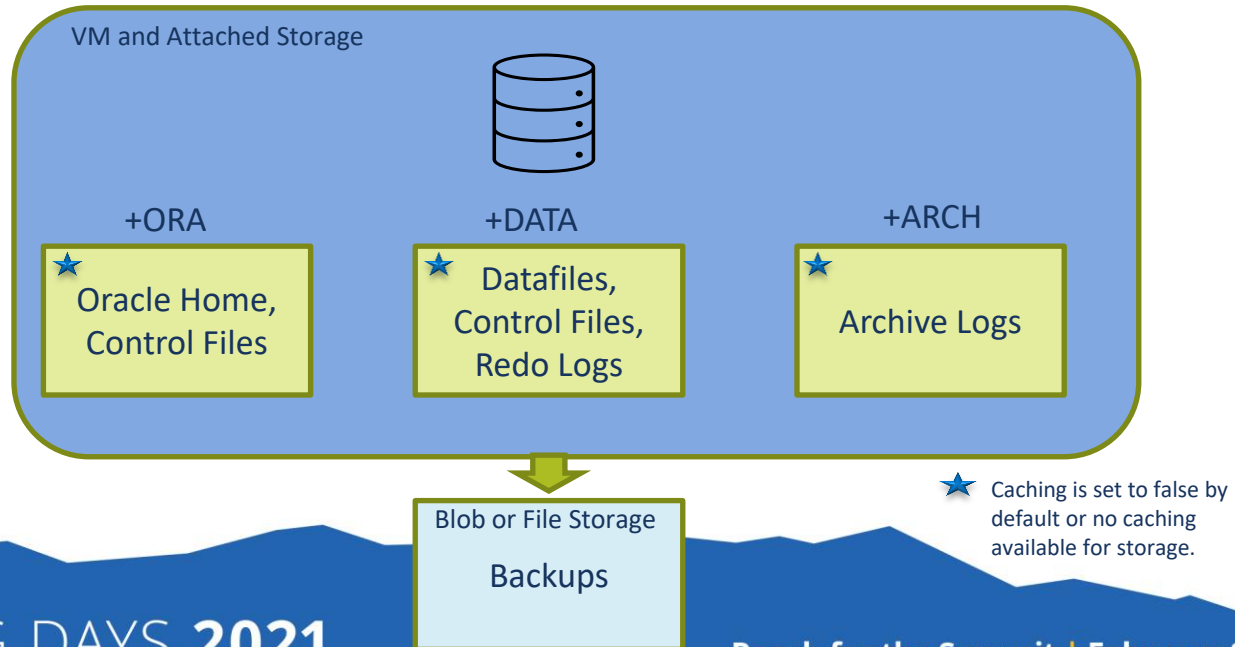# Small Oracle Workloads- Azure Standard Managed Disk for Low IO Database Workloads and Blob Storage for Backups

Oracle Cloud Control, (OEM) is used to automate, monitor and manage the Oracle environment in the cloud.

Managed Disk

Oracle Cloud Control

Databases can be backed up with RMAN to Managed disk or to Blob Storage. If the database is over 500G, consider faster storage options.

Level 1

Databases with low IOPS, (up to approximately 50-200 MBPs) can run on Standard SSD managed disk and support most Oracle **Standard Edition** Features.

Failover Path

ASM Instance

DG Broker

OLTP on Azure IaaS VM

Standby Database

Oracle Dataguard, (included with EE) can be used to create a standby database and configured with Fast-start failover for automatic failovers

Application Server

Availability Zone- Primary

Availability Zone- Secondary

Azure

Oracle Architecture in Azure with Azure NetApp Files as the Warm Standby for Large Oracle Database Workloads

With ANF Capacity Pools, backups can be taken as snapshots or use native backup tools for Oracle databases to the ANF storage.

NFS volumes

Oracle Cloud Control, (OEM) is used to automate, monitor and manage the Oracle environment in the cloud.

Oracle Cloud Control

Application Server

The ONS and Broker is able to direct traffic to the primary database, failing over at the session level for any supported application.

DG Broker

OLTP on Azure IaaS VM

ASM Instance

Failover Path

Snapshot recovery

With Snapshots in ANF, a copy from production can take just minutes and save on licensing and storage. This is all dependent on the customer SLA around RPO/RTO

Level 6+

Availability Zone- Primary

Availability Zone- Secondary

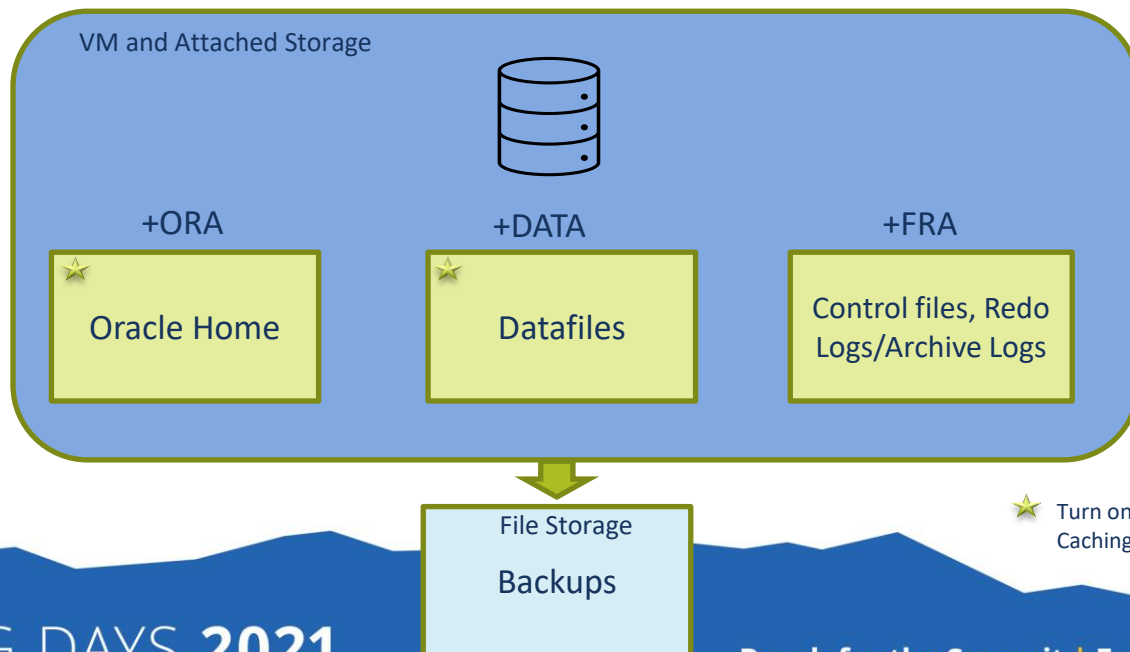Datafile Optimization through Storage

Distribution of Data Across Storage- Level 1

Managed Disk Premium with combination of Datafiles and Redo Datafiles. If ASM is used, the alias' are listed above the volume:
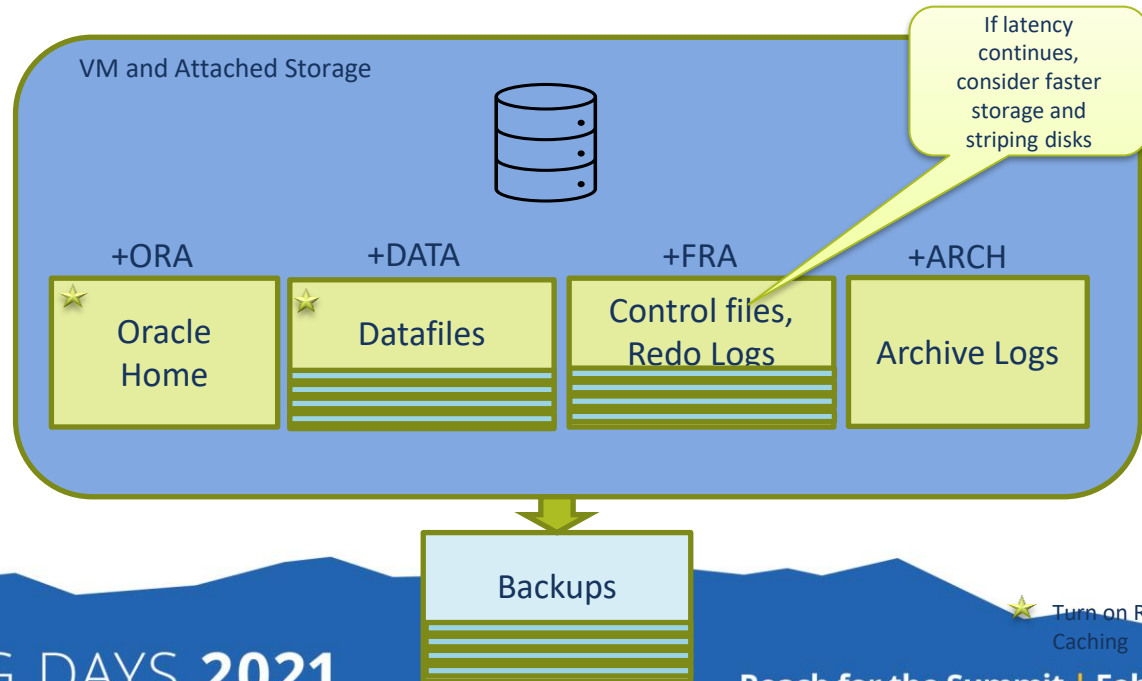
VM and Attached Storage

+ORA

★ Oracle Home, Control Files

+DATA

★ Datafiles, Control Files, Redo Logs

+ARCH

★ Archive Logs

Blob or File Storage

Backups

★ Caching is set to false by default or no caching available for storage.

Distribution of Data Across Storage- Level 2

Managed Disk Premium with separation of Datafiles and Redo Datafiles.

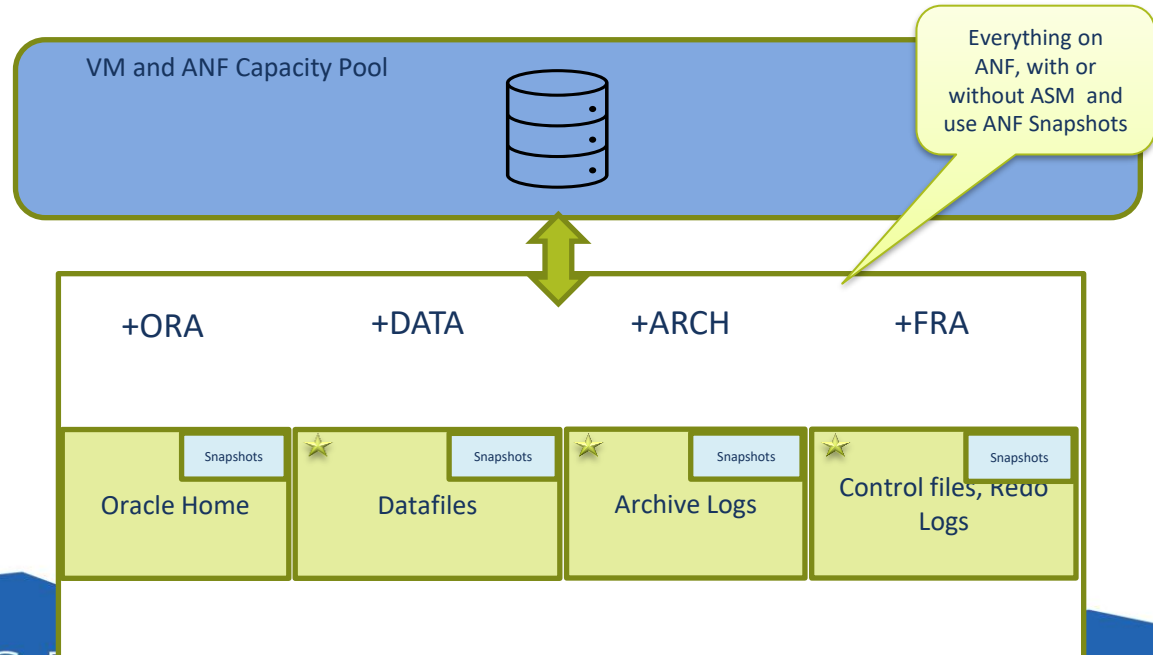VM and Attached Storage

+ORA
+DATA
+FRA

Oracle Home

Datafiles

Control files, Redo Logs/Archive Logs

File Storage

Backups

Turn on Read-Only Caching

Distribution of Data Across Storage- Level 4

Azure NetApp Files for All Storage and Move to ANF Snapshots

Clean up

- From the Portal:
  - Locate your resource group
  - Delete Resource group

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- dbakevlar@gmail.com
- kegorman@microsoft.com

Reference Links

Oracle Dataguard on Azure:

https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/oracle/configure-oracle-dataguard

Oracle Dataguard Far Sync:

https://docs.oracle.com/database/121/SBYDB/create_fs.htm#SBYDB5416

Oracle DataGuard standby from RAC to single instance:

https://docs.oracle.com/en/database/oracle/oracle-database/19/sbydb/configuring-data-guard-standby-databases-in-oracle-RAC.html#GUID-3140A293-DDD8-4559-8493-B6C21646E90F

Azure VM Sizing:

Generation 1: https://docs.microsoft.com/en-us/azure/virtual-machines/linux/sizes

Generation 2: https://docs.microsoft.com/en-us/azure/virtual-machines/linux/generation-2

Isolated Bare Metal:

https://docs.microsoft.com/en-us/azure/virtual-machines/linux/isolation

Express Route Documentation:

https://docs.microsoft.com/en-us/azure/expressroute/

Ultradisks for Azure Linux VMs:

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