Best Practices for Running Microsoft SQL Server on AWS

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Where can I run my SQL Server workloads on AWS?

Amazon Relational Database Service (Amazon RDS)

Managed service with up to 128 vCPU, 4TBRAM, and 16 TB storage

Amazon Elastic Compute Cloud (Amazon EC2)

Self-managed virtual machine with up to 448 vCPU, 24TB RAM, and 400-TB storage

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SQL Server EC2 vs. RDS: Which should I use?

	EC2	RDS
License included	✓	✓
BYOL	✓	
Full control over the instance	✓	
Automated backups		✓
AWS-managed Multi-AZ deployment		✓
AWS-managed Read scale-out		✓
AWS-automated ability to scale Compute & Storage		✓

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Amazon RDS

Choice of open source and commercial databases

Cloud Native Engine	Open Source Engines	Commercial Engines
Amazon Aurora	PostgreSQL, MySQL, MariaDB	Microsoft SQL Server, ORACLE

RDS Platform

Automatic fail-over	Isolation & security	Advanced monitoring
Backup & recovery	Industry compliance	Routine maintenance
X-region replication	Automated patching	Push-button scaling

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Options for Deploying SQL Server on AWS

Amazon RDS for SQL Server

- **Consider RDS first**
- Focus on business value tasks
- High-level tuning asks
- Schema optimization
- No in-house database expertise

Scaling
High Availability
Database Backups
DBMS Patching
DBMS Install/Maintenance
OS Patching
OS Install/Maintenance
Power, HVAC, net

SQL Server on Amazon EC2

- Need full control over DB instance
- Backups
- Replication
- Clustering
- Options that are not available in RDS

Scaling
High Availability
Database Backups
DBMS Patching
DBMS Install/Maintenance
OS Patching
OS Install/Maintenance
Power, HVAC, net

AWS managed   **Customer managed**

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SQL Server Features at a Glance

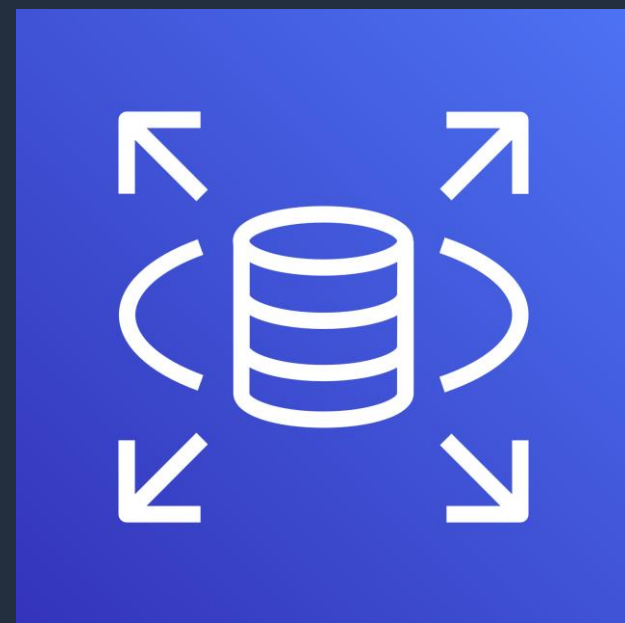|	Amazon RDS	Amazon EC2
Versions Supported:	2012 – 2019	All
Editions Supported:	Express, Web, Standard, Enterprise	All
High Availability:	AWS-managed	Self-managed
Encryption:	TDE, Column-level, Always Encrypted, TLS, EBS encryption	
Authentication:	Windows & SQL Authentication	
BI Stack:	SSIS, SSRS, SSAS (tabular)	All
Backups:	AWS- managed	Self-managed
Maintenance:	AWS- managed	Self-managed

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Amerikaanse RDS with SQL Server

Amazon RDS: Hassle-free flexibility

Instance type selection:

     t3 instances for lower cost

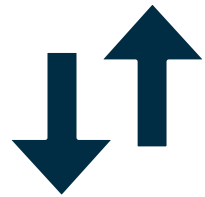   m5/m5d instances

     r5/z1d/x1e instances for more RAM

EBS volume type selection:

     GP2 volumes for lower cost

     IO1 volumes for I/O intensive, critical workloads

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Compute and Storage Scaling

**Scale Compute to
Handle Increased Load**
Up to 128 vCPUs
4TiB of RAM

**Scale Storage for
Larger Data Sets**
Scalable EBS storage up to 16TiB

**Scale Down to
Control Costs**
As little as 4 vCPU and
16 GiB of RAM

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Automated backups, Snapshots and Native Backups

- Backup and restore directly to and from S3 bucket
- Supports Compression
- Only full & diff backups (no t-log)
- Full, diff & t-log restores
- Multi-file backup/restore

Usage

```
exec msdb.dbo.rds_backup_database
        @source_db_name='database_name',
        @s3_arn_to_backup_to='arn:aws:s3:::bucket_name/file_name.extension',
        [@kms_master_key_arn='arn:aws:kms:region:account-id:key/key-id'],
        [@overwrite_s3_backup_file=0|1],
        [@type='DIFFERENTIAL|FULL'],
        [@number_of_files=n];
```
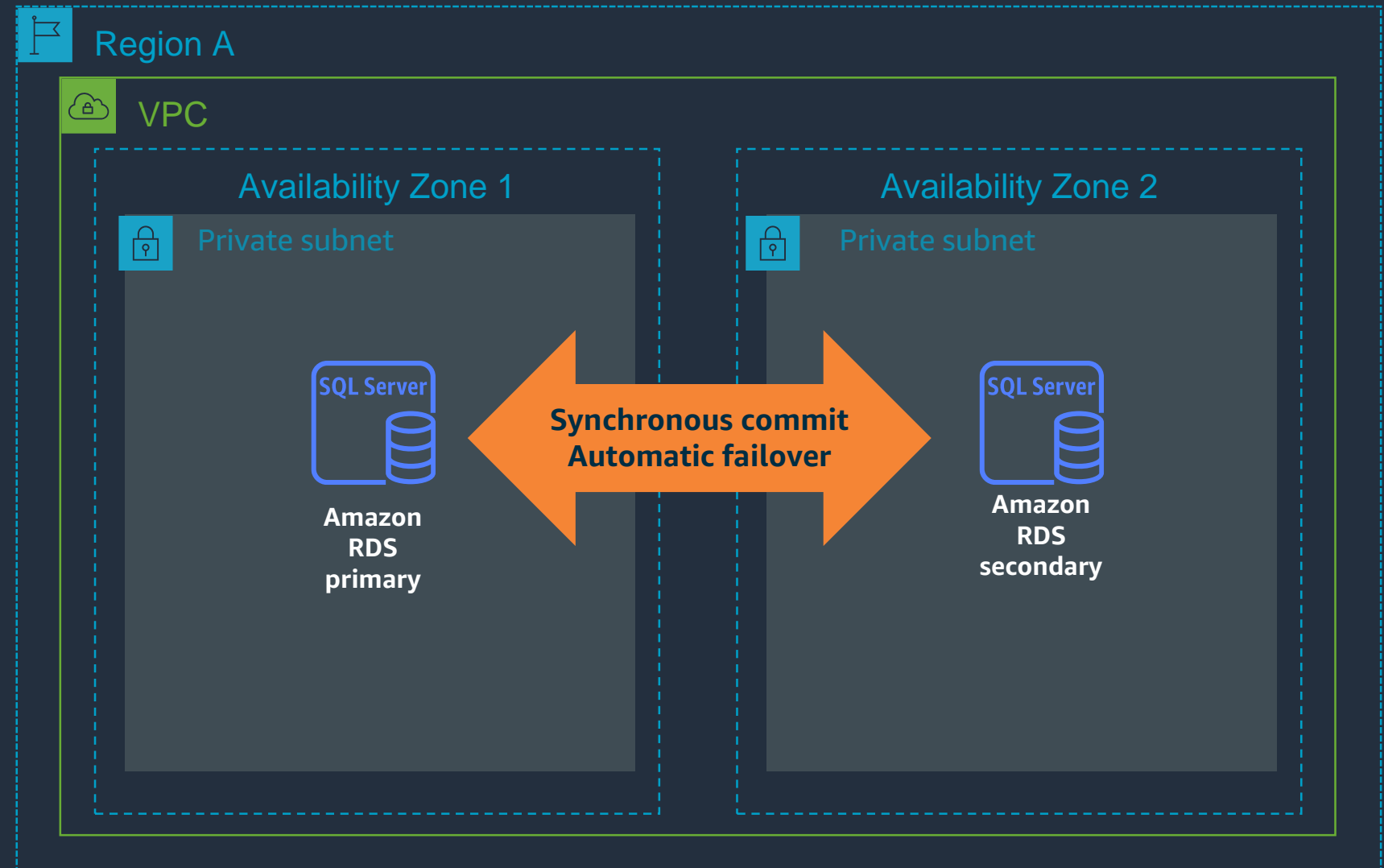
The following parameters are required:

- @source_db_name – The name of the database to back up.

- @s3_arn_to_backup_to – The ARN indicating the Amazon S3 bucket to use for the backup, plus the name of the backup file.

  The file can have any extension, but .bak is usually used.

**Amazon
RDS SQL Server**

*.bak

Amazon

SQL Server

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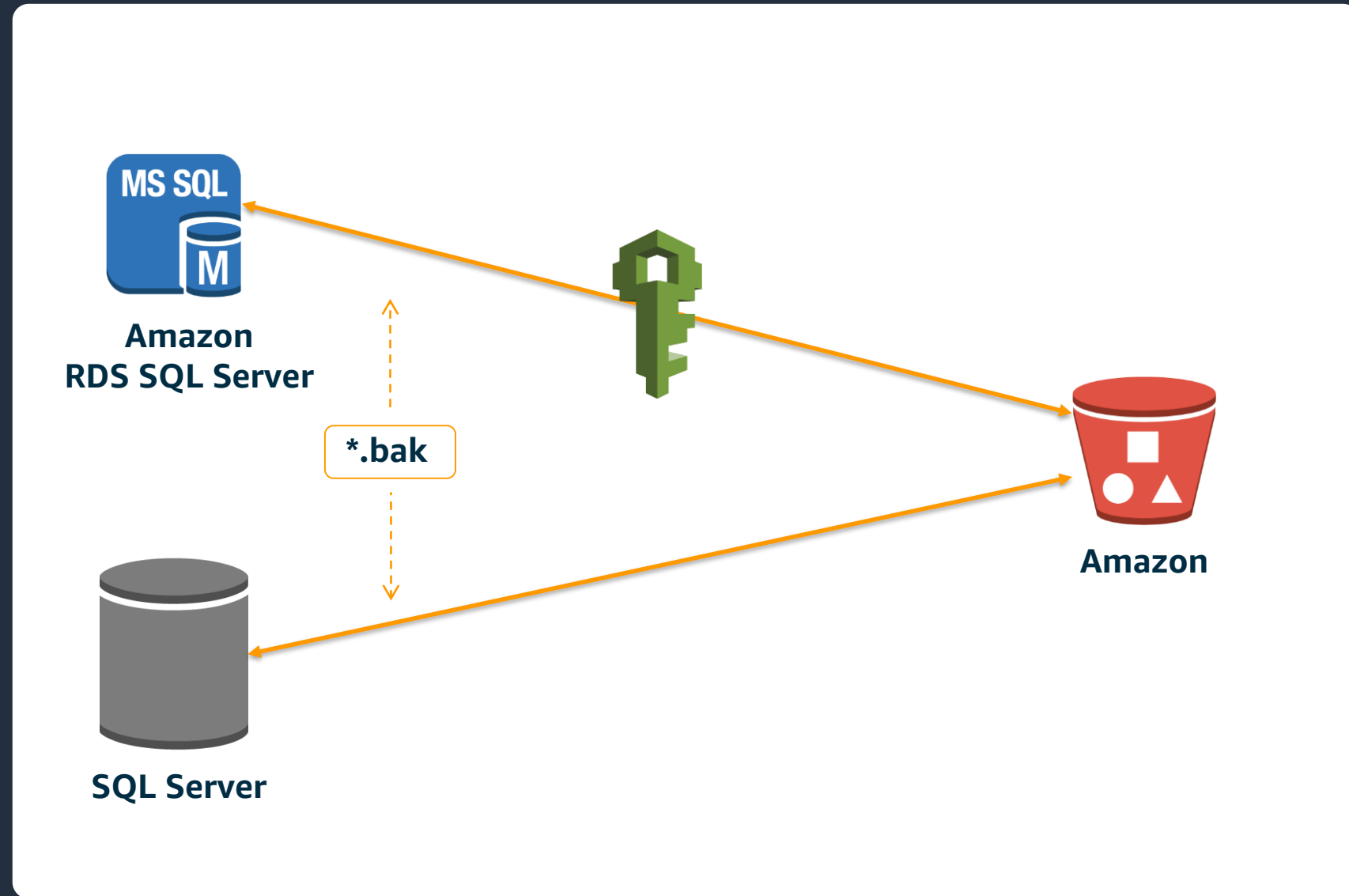
Amazon RDS
Multi-AZ SQL Server

- AlwaysOn AG (Basic AG for Standard) for 2016, 2017 & 2019

- DB Mirroring for 2012 and 2014

- Synchronous Secondary hot StandBy

- Automatic & Manual Failover

- No read traffic

Region A

VPC

Availability Zone 1

Private subnet

SQL Server

Amazon RDS primary

Synchronous commit
Automatic failover

Availability Zone 2

Private subnet

SQL Server

Amazon RDS secondary

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Read scale-out with Amazon RDS

- 2016+ Enterprise Edition feature
- Up to 5 asynchronous read replicas
- In-region
- Promotion
- Separate end-point

Cloud Watch metrics

Amazon CloudWatch metrics

- CPU Utilization
- DB Connections
- Free Storage Space
- Freeable memory
- Write / Read IOPS
- Queue Depth
- Write / Read Throughput
- Swap usage
- Write / Read Latency
- Network Receive Throughput
- Network Transmit Throughput
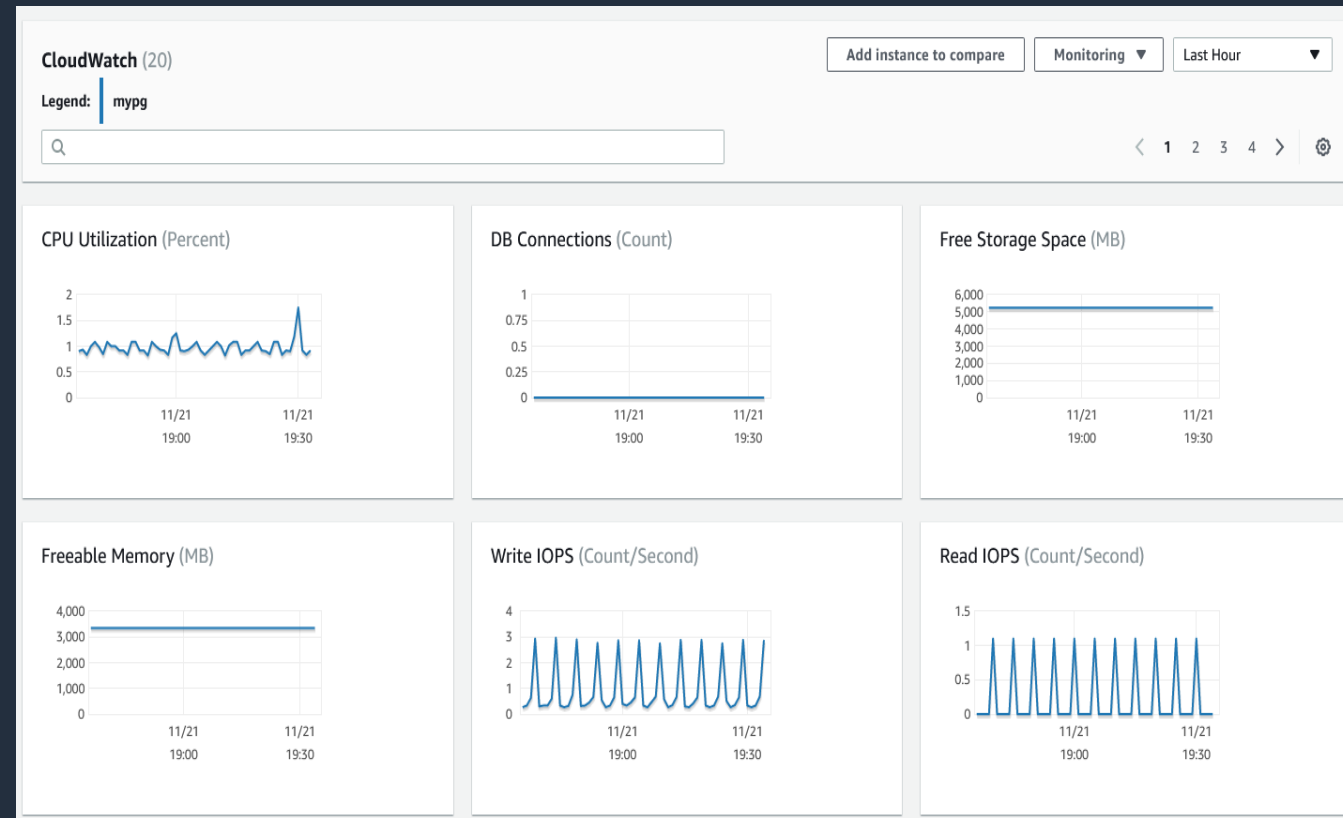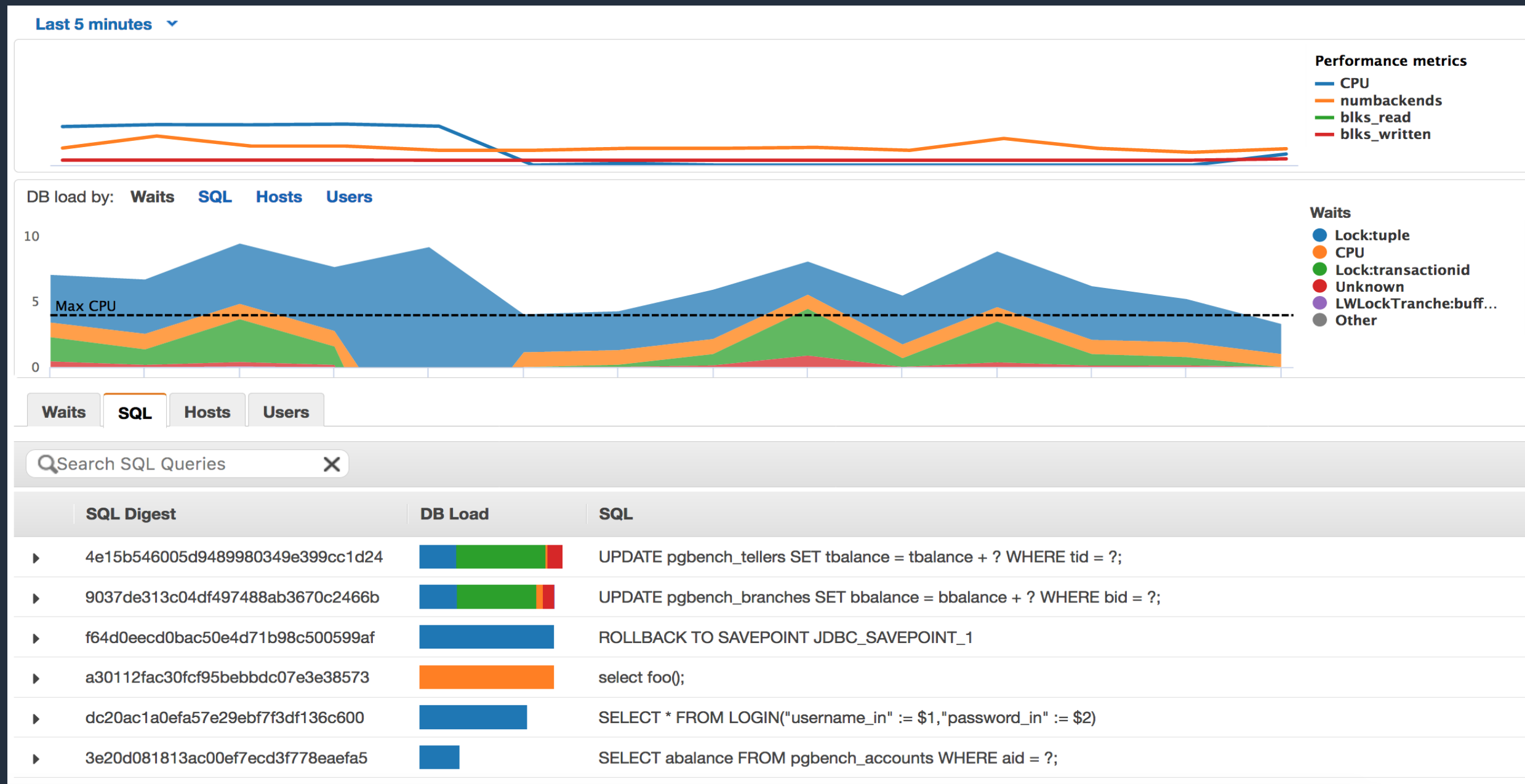
Amazon RDS Enhanced Monitoring

Overview:

- OS Level Monitoring Metrics – 26 system and per process metrics
- Metrics delivered to CloudWatch Logs
- Up to 1 second granularity

Compared to CloudWatch Metrics:

- Agent based metrics collections
- There can be differences with CloudWatch metrics due to collection source (hypervisor vs. agent) – eg. CPU

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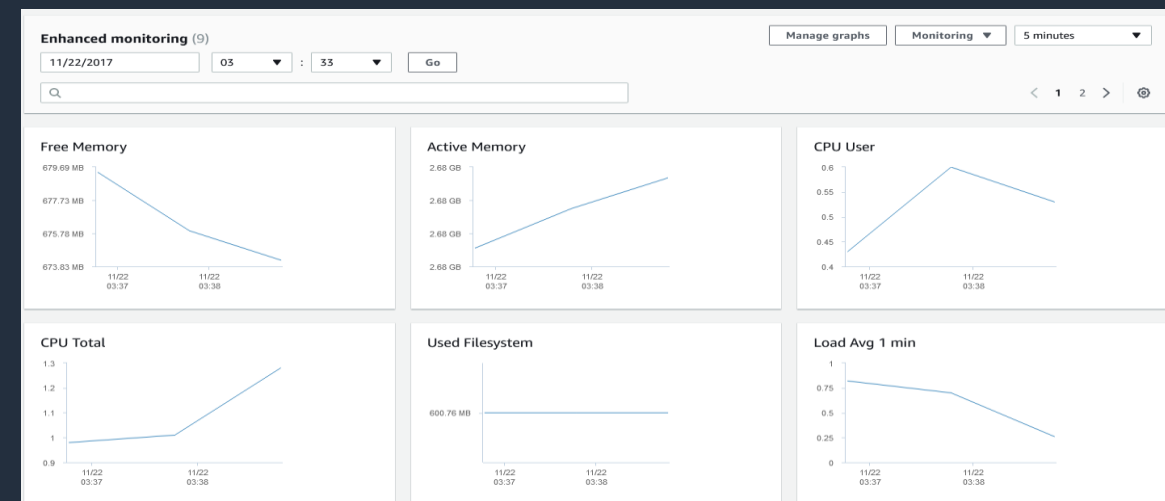
Performance Insights for RDS SQL Server

# Monitoring RDS SQL Server performance

1 **Amazon CloudWatch**

2 **Enhanced Monitoring**

3 **Performance Insights**

4 **SQL Server Native (DMVs/DMFs, Profiler, etc)**

5 **3rd Party (Ola Hallengren, SentryOne, etc)**

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Migrating Data to & from Amazon RDS

1 **.BAK File Save & Restore**
Leverages SQL Server's native backup functionality

2 **AWS Database Migration Service**
Minimize downtime during migrations, migrate between different DB platforms, Schema Conversion Tool

3 **SQL Server Replication**
Push subscriptions to transactional replication

4 **Microsoft SQL Server Database Publishing Wizard, Import/Export**
Export to T-SQL files, load using **sqlcmd**

5 **AWS Marketplace**
Third-party data import and export tools and solutions

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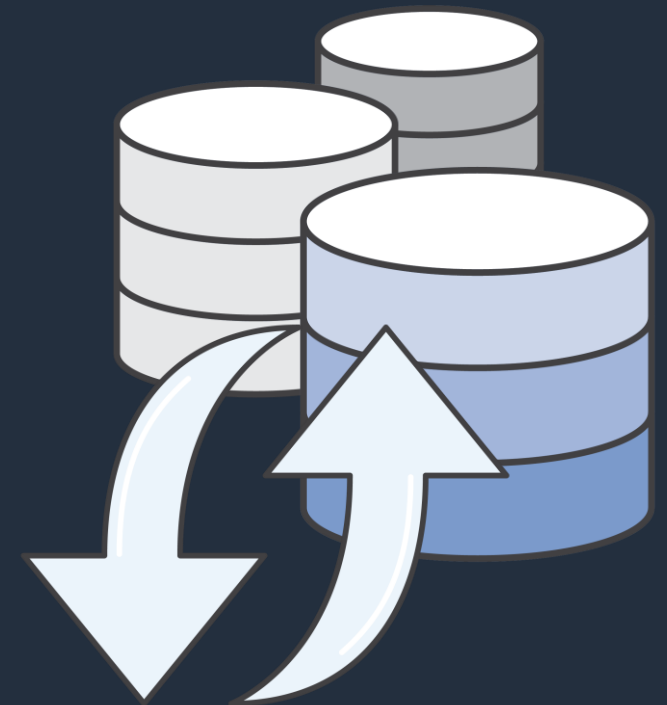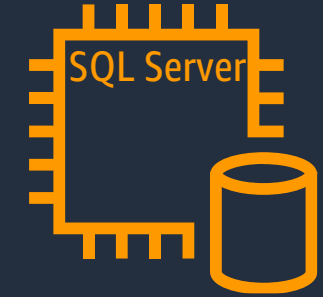
Amazon EC2 with SQL Server

SQL Server on Amazon EC2
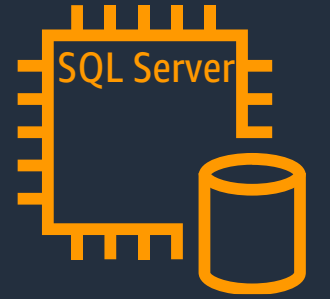
SQL Server

- How to start
  - Spin up an EC2 instance and install from customer media (BYOL)
  - Spin up an EC2 instance that includes SQL in the Amazon Machine Instance (AMI)

- Self-Managed SQL Server
  - Security, patching & updates
  - Backups
  - High Availability

- Full SQL Server sysadmin privileges

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Optimizing Performance for SQL Server on EC2

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Amazon EC2: Purpose-built computing

Current instance families and generation	Family/usage
M5, M5a, M5zn (4.5GHz)	**General purpose compute**
T2, T3	Burstable performance
C5, C5n, C5a,C4	Compute optimized
X1, X1E, R5, R5d, R5a, Z1d (4.0GHz)	**Memory optimized**
P2, G3, F1	Accelerated computing
I3, I3en	**Storage optimized (I/O)**
H1, D2	Storage optimized (Density)

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Get the maximum EBS performance on Amazon EC2

General Purpose SSD

Amazon EC2

GP3

99.8% - 99.9% durability

1 GiB - 16 TiB

Max IOPS per volume (16 KiB I/O)

16,000   16,000   →   32,000

Max throughput per volume

1,000 MiB/s

R5b
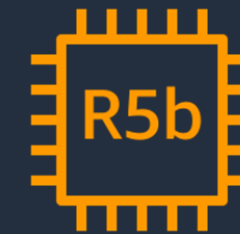
R5b.4xlarge

Max EBS Bandwidth 10,000Mbps

Maximum IOPS 43,333

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Get the maximum EBS performance on Amazon EC2

Provisioned IOPS SSD

Amazon EC2

IO2

99.999% durability

4 GiB - 16 TiB

Max IOPS per volume (16 KiB I/O)

64,000   64,000   →   128,000
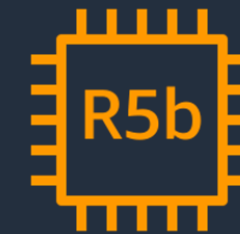
Max throughput per volume

1,000 MiB/s

R5b

R5b.12xlarge

Max EBS Bandwidth 30,000Mbps

Maximum IOPS 130,000

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Place tempdb in EC2 Instance Store
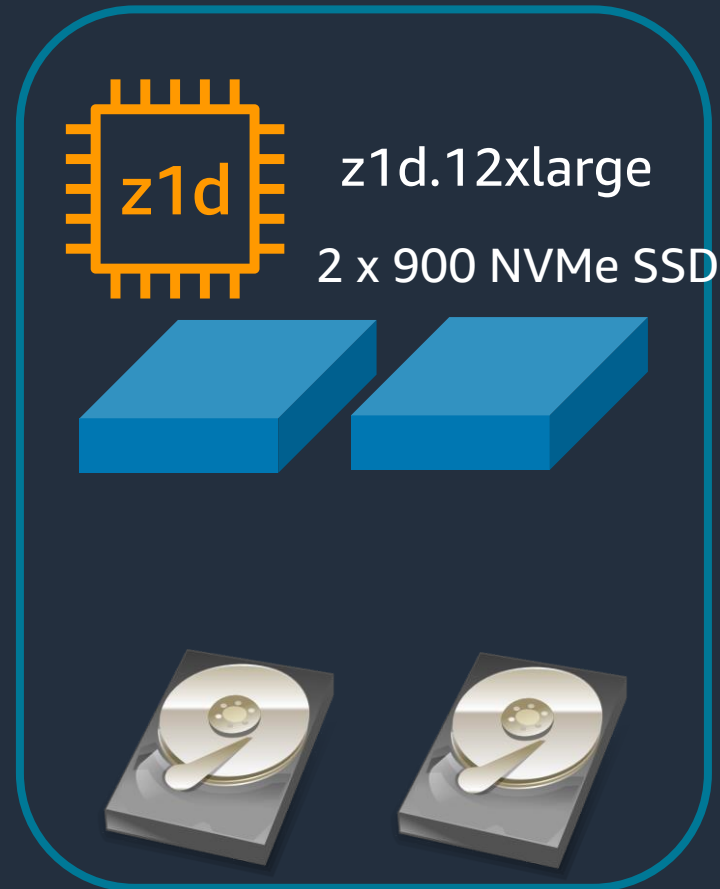
Amazon EC2

z1d

z1d.12xlarge

2 x 900 NVMe SSD

What is instance storage?

- Some instance types come with direct attached disk-based storage
    - SSD
    - NVMe SSD
- Included in the hourly cost
- Data on instance storage does not persist a user- initiated instance stop/start or hardware failure
- Fast disk I/O without going over the network
- Traffic does not count towards EBS IOPS

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Place tempdb in EC2 Instance Store

Amazon EC2

z1d

z1d.12xlarge

2 x 900 NVMe SSD

What is instance storage?
- Some instance types come with direct attached disk-based storage
  Disk Mirroring
  - SSD
  - NVMe SSD
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Amazon FSx for Windows File Server

Amazon FSx for Windows File Server

Region

Amazon FSx
for Windows File Server

\\fs-0123456789.example.com

mdf   mdf   ldf

CREATE DATABASE [DBonFSx] ON PRIMARY (name = N'DBonFSx_data',

filename = N'\\Fsx_UNC_Path\DB\DBonFSx_data.mdf',

size = 8192kb, maxsize = unlimited,filegrowth = 1024kb)

log ON (name = N'DBonFSx_log',

filename =N'\\ Fsx_UNC_Path \DB\DBonFSx_log.ldf',

size = 1024kb, maxsize = 2048gb, filegrowth = 10%)

GO

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Optimize your disk layout or file distribution

Data Files
Random Access

.mdf   .ndf   .ndf

Log Files
Sequential Access

.ldf   .ldf   .ldf

Tempdb Data Files
Random Access

.mdf   .ndf   .ndf

Tempdb Log Files
Sequential Access

.ldf   .ldf   .ldf

Backup Files
Sequential Access

.bak

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Optimize your disk layout or file distribution

Amazon EBS

File distribution

Amazon EC2 Instance

R5b

GP3/IO2 — Data File

File Group

GP3/IO2 — Data File

SQL Server

GP3/IO2 — Transaction Log File

ST1/SC1 — Backup Files

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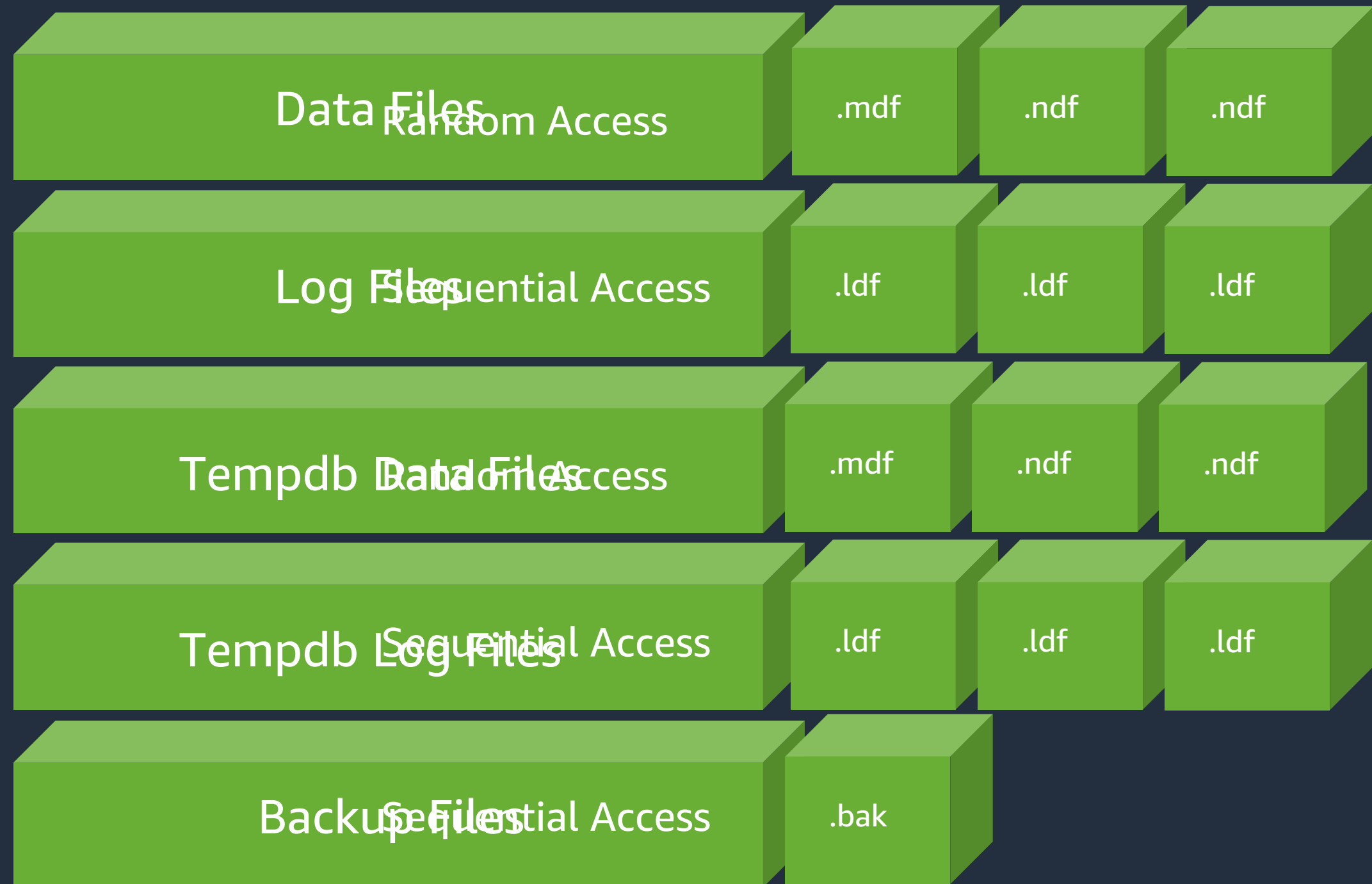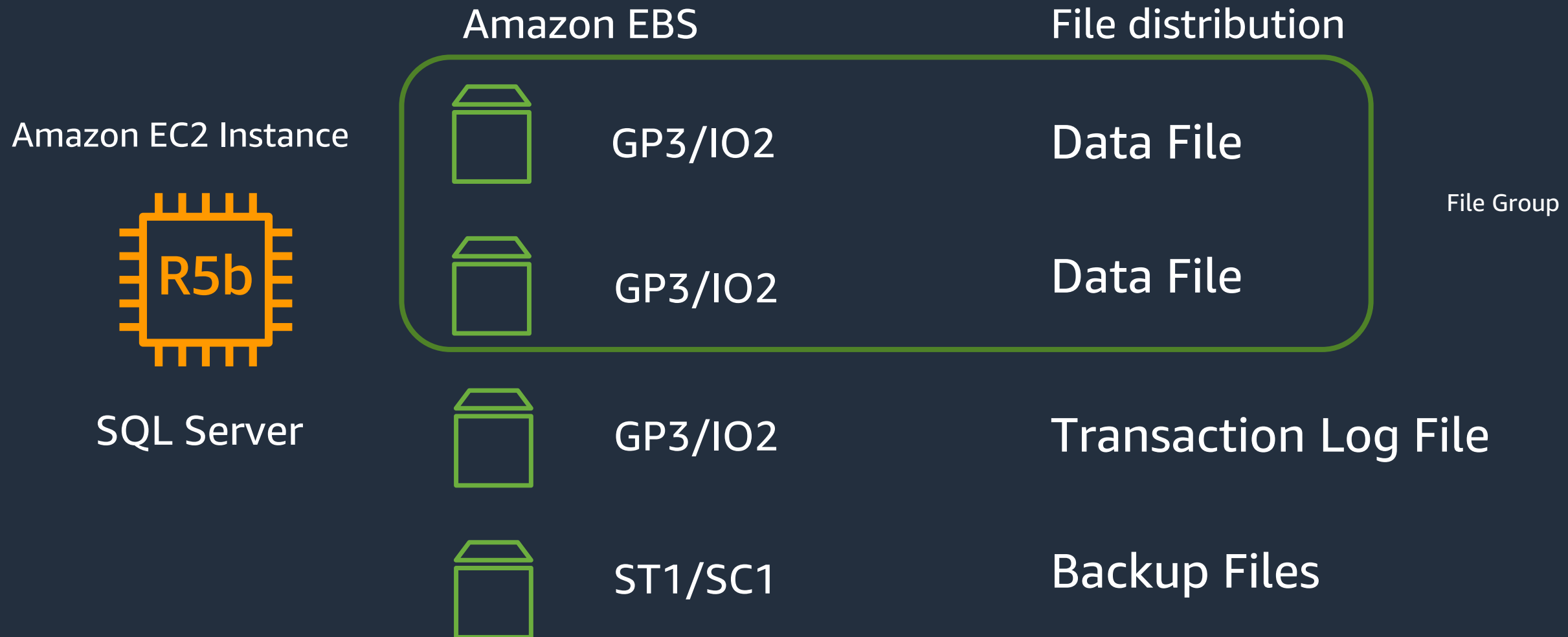
# High Availability Best Practices for SQL Server on EC2

SQL Server HA/DR on EC2

- Windows clusters can span Availability Zones or regions

- Mirroring

- AlwaysOn Availability Groups

- Transaction Log Shipping

- SQL Failover Cluster Instance

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Multi-AZ Always On Availability Group

- Infrastructure:
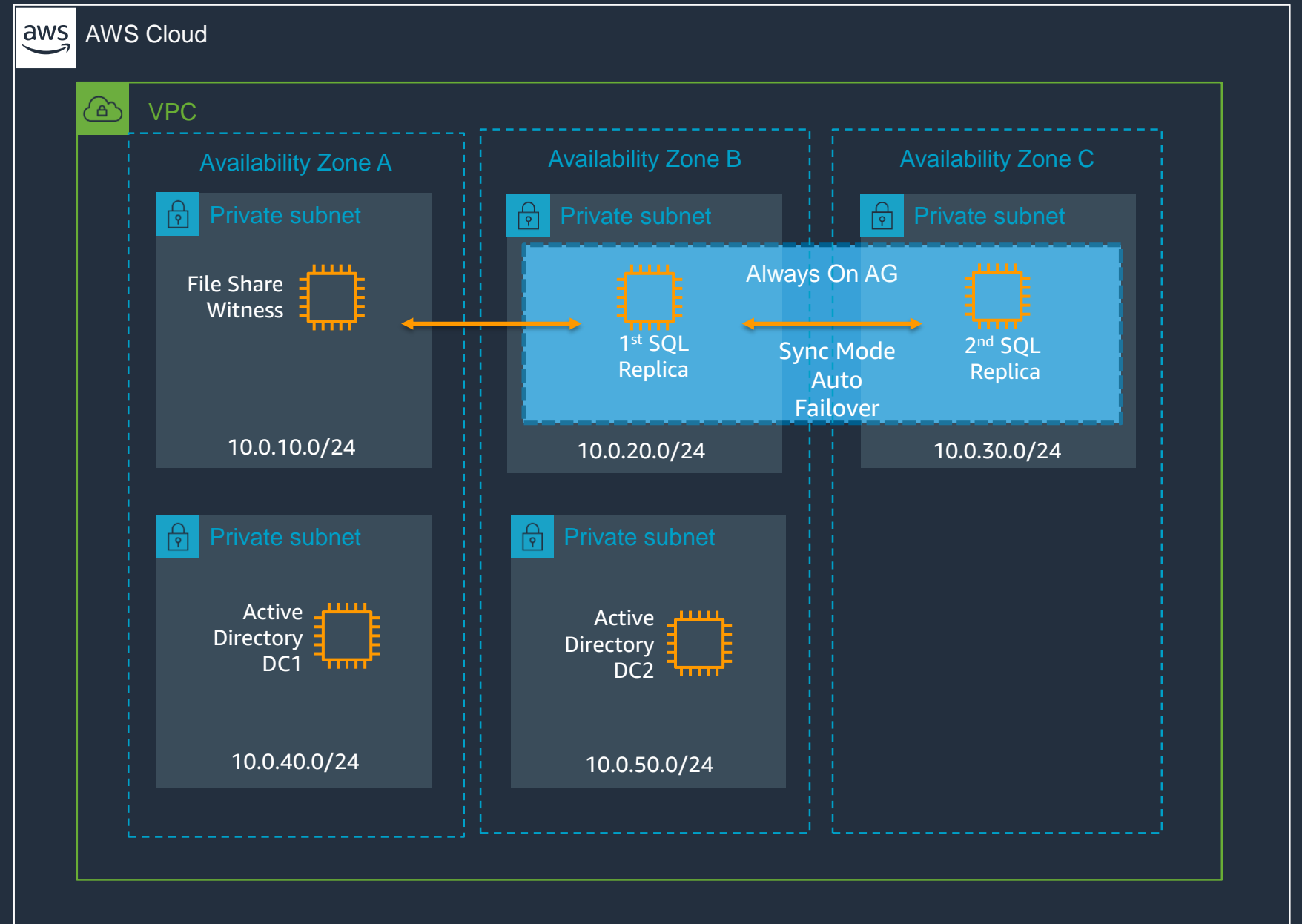 - Shared-nothing configuration
  - Storage configured and managed outside of WSFC
  - Flexibility and granularity of storage configuration and maintenance
  - Limited SQL resources managed by WSFC

- SQL Server:
  - Database-level HA solution
  - Manual adding logins, SQL Agent jobs, certificates and other SQL Server instance level objects to all secondary
  - Data/Transactions replicated through SQL Server
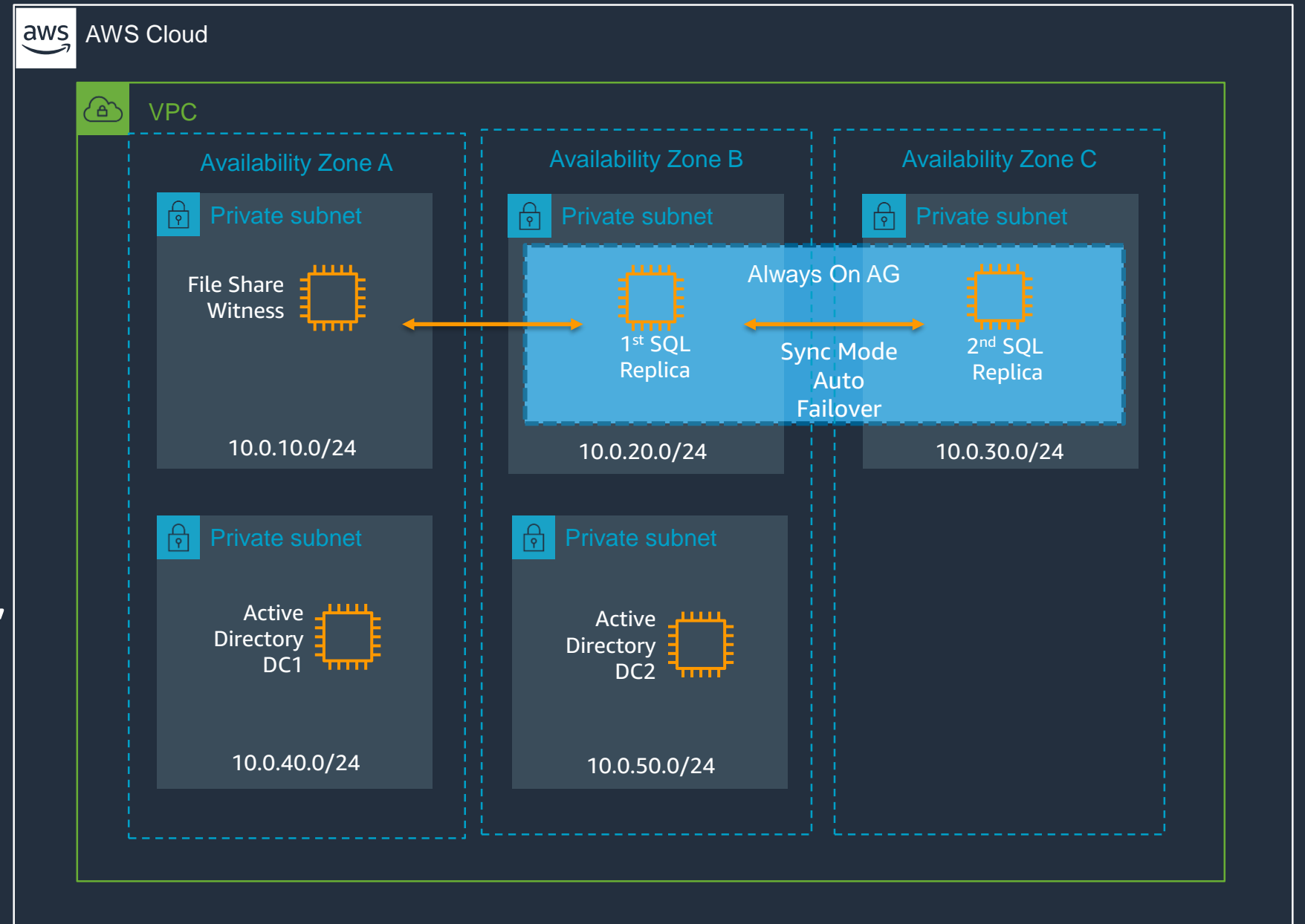
Multi-AZ Always On Availability Group

- Best Practices:
  - Multi AZ setup
  - Use File Share Witness
  - MultiSubnetFailover = Yes
  - Connect to Listener
  - RegisterAllProvidersIP = Yes
  - Change default HostRecordTTL
  - SQL Native Client Providers

aws AWS Cloud

VPC

Availability Zone A

Private subnet

File Share Witness

10.0.10.0/24

Private subnet

Active Directory DC1

10.0.40.0/24

Availability Zone B

Private subnet

Always On AG

1st SQL Replica

Sync Mode Auto Failover

10.0.20.0/24

Private subnet

Active Directory DC2

10.0.50.0/24

Availability Zone C

Private subnet

2nd SQL Replica

10.0.30.0/24

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Multi-Region Always On Availability Group

AWS Cloud

VPC

Availability Zone A

Private subnet
File Share Witness
10.0.10.0/24

Availability Zone B

Private subnet
1st SQL Replica
10.0.20.0/24

Availability Zone C

Private subnet
2nd SQL Replica
10.0.30.0/24

Always On AG

Sync Mode Auto Failover

Private subnet
Active Directory DC1
10.0.40.0/24

Private subnet
Active Directory DC2
10.0.50.0/24

Async Mode Manual Failover

AWS Transit Gateway

Peering connection

AWS Cloud

VPC

Availability Zone A

Private subnet
3rd SQL Replica
10.1.10.0/24

Private subnet
Active Directory DC3
10.1.20.0/24

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SQL Failover Cluster Instances and Amazon FSx

- Infrastructure:
  - Clustered disk resource via SMB and continuously available shares (CAFS)
  - AWS managed SMB file system
  - Storage and Network traffic using the same network pipe
  - Managed storage configuration and maintenance
  - Very limited control over file system configuration (e.g. 4k vs. 64k allocation unit)

- SQL Server:
  - Instance-level HA solution
  - Logins, SQL Agent jobs, certificates and other SQL Server instance level objects are in-tact after failover
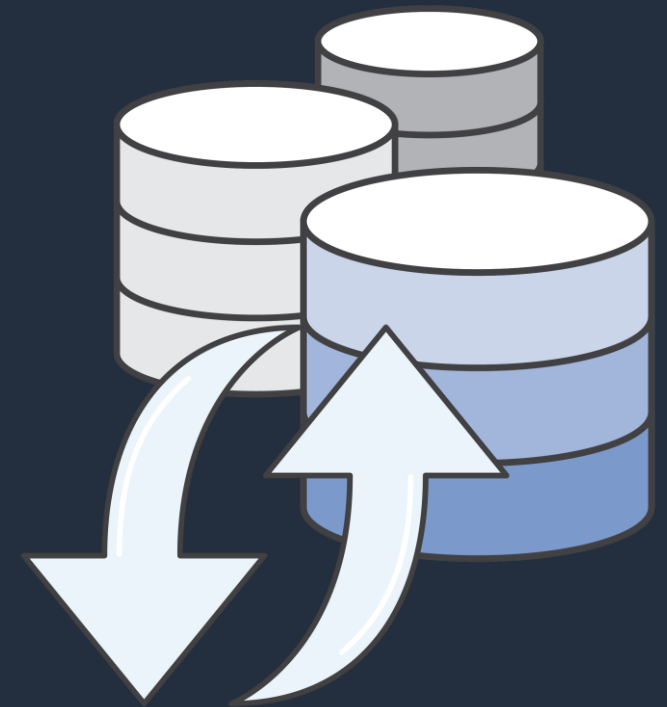
Migrating SQL Server to EC2

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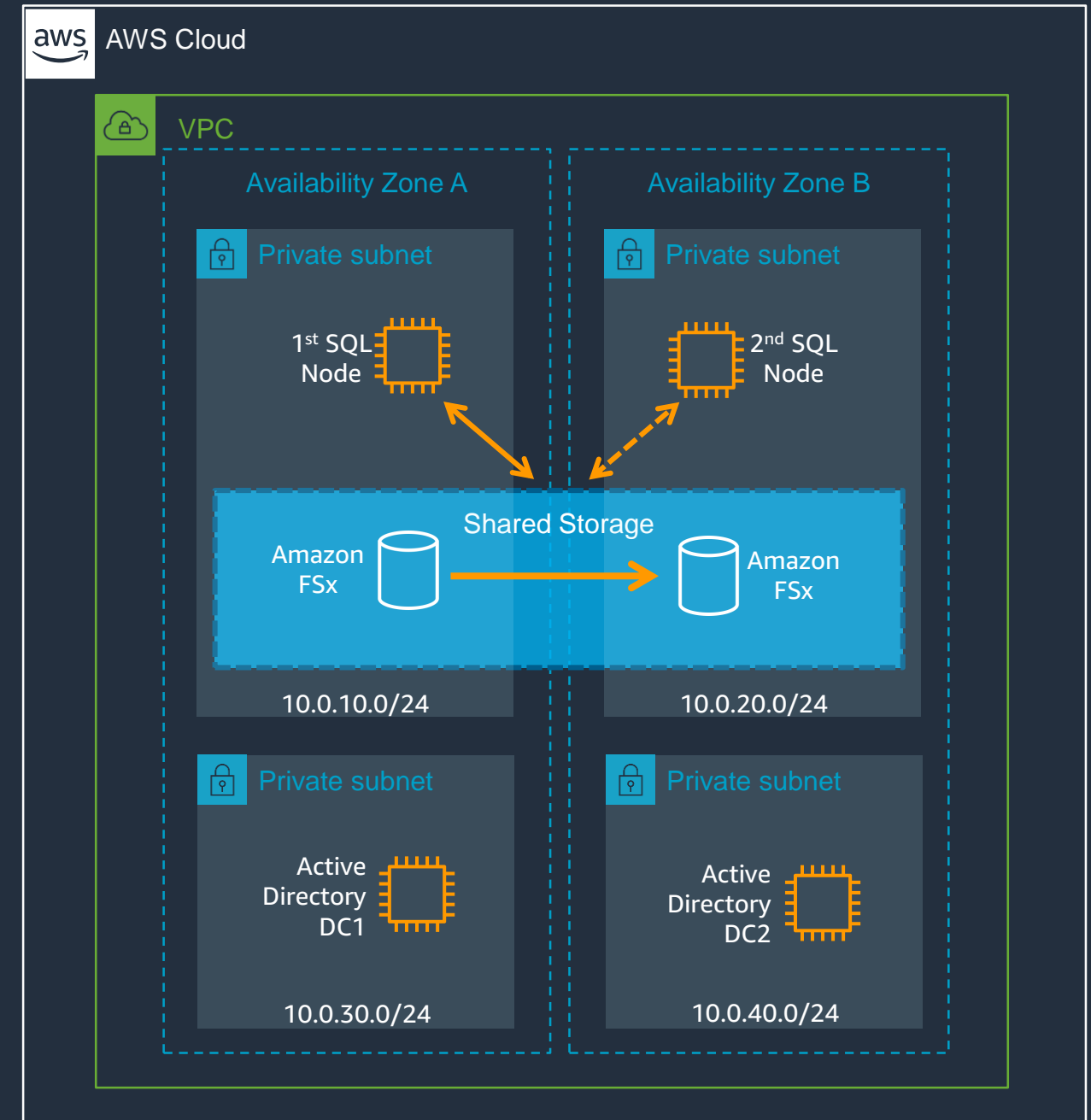
Migrating Data to & from Amazon EC2

1 **Backup & Restore**
SQL Server's native backup functionality

2 **SQL Always On Availability Group**
Asynchronous-commit mode, distributed AGs
(SQL Server 2016+)

3 **AWS Database Migration Service**
Minimize downtime during migrations, migrate
between different DB platforms

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Thank you

migrations@amazon.com

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