



# AWS Foundation

Database Services



# Agenda



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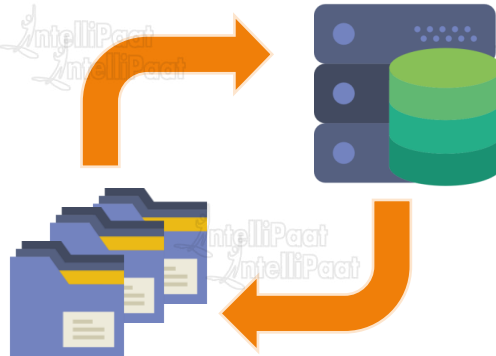


# What is a Database?



# What is a Database?

- ★ Database is a collection of information which is organized so that the data or the information can be easily accessed, maintained and updated. The data in a database can be added, updated, expanded and deleted.
- ★ A software system created to perform all these operations on a Database is called Database management system or DBMS



# Types of Database

# Types of Database

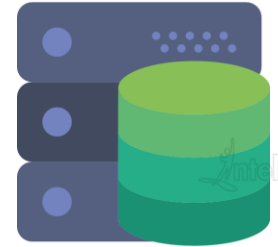
There are several types of Databases that are categorized on the basis of various factors. Following is the list of most used and popular types of Databases which are categorized mainly on the basis of different ways of storing data in each database.

★ RDBMS

★ NoSQL Database

★ Hierarchical Database

★ Flat file database



# Types of Database

**RDBMS**

**NoSQL Database**

**Hierarchical Database**

**Flat file database**

In RDBMS the data is stored in tabular form and SQL (Structured Query Language) is used in RDBMS to run queries for inserting, updating, deleting and searching the data or records.



# Types of Database



**RDBMS**

**NoSQL Database**

**Hierarchical Database**

**Flat file database**

NoSQL Databases don't follow the normal row/column or table approach of storing Data like RDBMS thus it's a non relational database system. NoSQL Database store data in JSON format.

The data structures included in NoSQL are key value, wide column, graph or documentations.





# Types of Database

**RDBMS**

**NoSQL Database**

**Hierarchical Database**

**Flat file database**

Data is stored in a parent-children relationship nodes.  
Hierarchical database also contain the information of respective groups of data according to the parent/child relationships along with the data



# Types of Database

**RDBMS**

**NoSQL Database**

**Hierarchical Database**

**Flat file database**

There are no particular structures for indexing and recognizing relationships between the data in Flat file database. All the records follow a uniform format and are saved in a file called flat file which can be a plain text file or even a binary file.





# Databases on AWS?

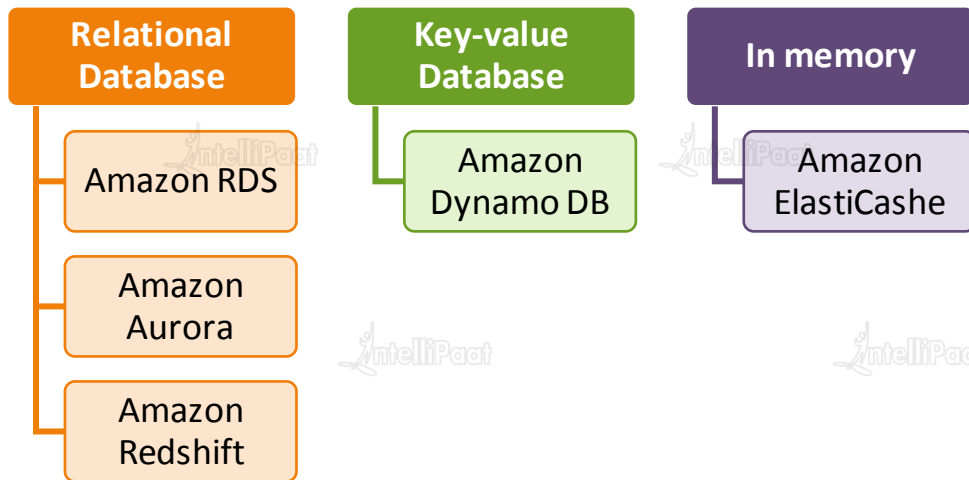


# Database on AWS



Amazon Web Services (AWS) provides fully managed and purpose-built Database services to support the relational as well as non relational database requirements of their clients.

Following listed are Database services provided by AWS



# Introduction to RDS

# Introduction to RDS

- ★ Amazon RDS (Relational Database Service) is used to set up, manage and scale a relational database instance in the cloud.
- ★ RDS is a fully managed RDBMS service.
- ★ Amazon RDS manages backups, software patching, failure detection and many more tasks.
- ★ With RDS, CPU, memory, storage and IOPS are all independent and hence can be scaled independently
- ★ RDS offers mainly six database engines, namely, Amazon Aurora, PostgreSQL, MySQL, MariaDB, Oracle Database, and SQL Server.





# Multi AZ Deployments

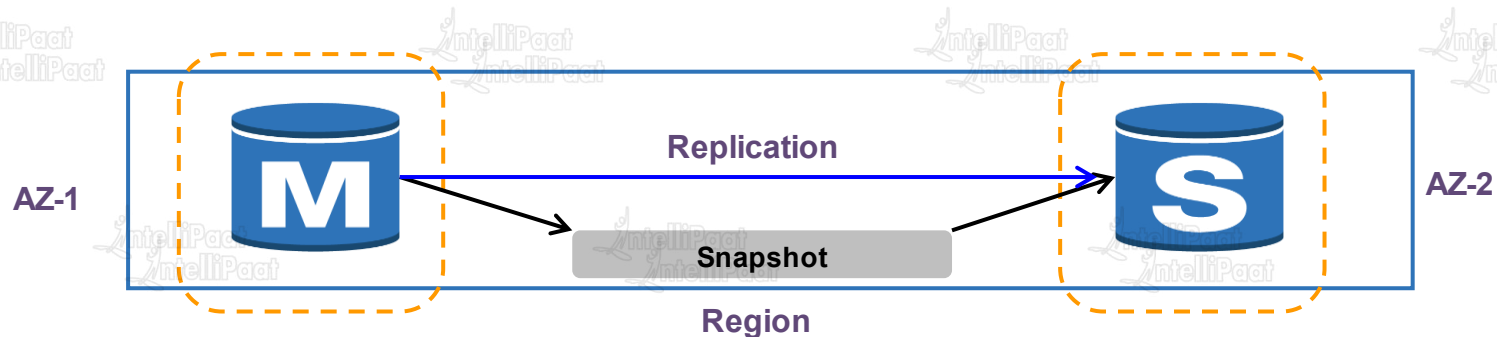


# Multi-AZ

- ★ Amazon RDS provisions as well as maintains synchronous a replica of DB Instances. This replica is termed as standby replica and the DB instance which gets synchronously replicated is termed as primary DB instance.
- ★ The primary DB instance is replicated to a standby replica in different availability zones.

Hence multi availability zones deployment provides:

- ★ Data redundancy
- ★ Elimination of I/O freezes
- ★ Less Latency spikes during system backups





# Features in Amazon RDS

# Features in Amazon RDS



**Performance and Scalability**

**High Availability**

**Security**

**Backup and Restore**

**Maintenance and Upgrades**

- ★ Various storage types in Amazon RDS such as general purpose storage and provisioned IOPS storage are designed to deliver consistent, fast and predictable I/O performance.
- ★ The compute and memory resources can be scaled up or down as per the deployment requirements. Scaling up can be done up to a maximum of 32 vCPUs and 244 GiB of RAM.



# Types of Database



**Performance and Scalability**

**High Availability**

**Security**

**Backup and Restore**

**Maintenance and Upgrades**

Amazon RDS provides enhanced availability as well as failover support for database instances as a result of using Multi- AZ deployments.



# Types of Database



**Performance and Scalability**

**High Availability**

**Security**

**Backup and Restore**

**Maintenance and Upgrades**

Amazon RDS allows to encrypt the database using the key that are managed by the users only. The automated backups, snapshots or read replicas of the encrypted data will also be encrypted.



# Types of Database

**Performance and Scalability**

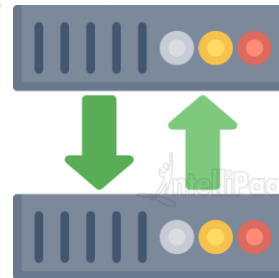
**High Availability**

**Security**

**Backup and Restore**

**Maintenance and Upgrades**

- ★ The feature of automated backup in Amazon RDS offers point in time recovery for the data of the database instance.
- ★ User initiated backups are also an option for backup in Amazon RDS. These are called Database snapshots



# Types of Database

**Performance and Scalability**

**High Availability**

**Security**

**Backup and Restore**

**Maintenance and Upgrades**

- ★ RDS management console can be used to view key operational metrics such as computer, memory, storage capacity utilization, I/O activity and more.
- ★ Major engine version upgrades (changes might not be compatible with existing applications) and minor version upgrades ( backward-compatible with existing applications) can be performed.





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# Read Replica



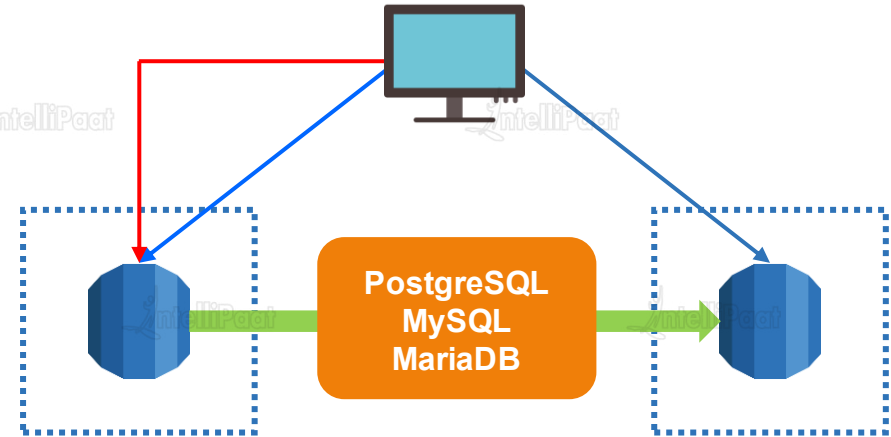
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# Read Replica



- ★ Read replica is an exact replica of the primary DB instance.
- ★ RDS uses DB engine's inbuilt replication functionality to create these read replicas.
- ★ Replication happens asynchronously.
- ★ Read replicas can be created in same or different region. Automatic Backup has to be enabled.



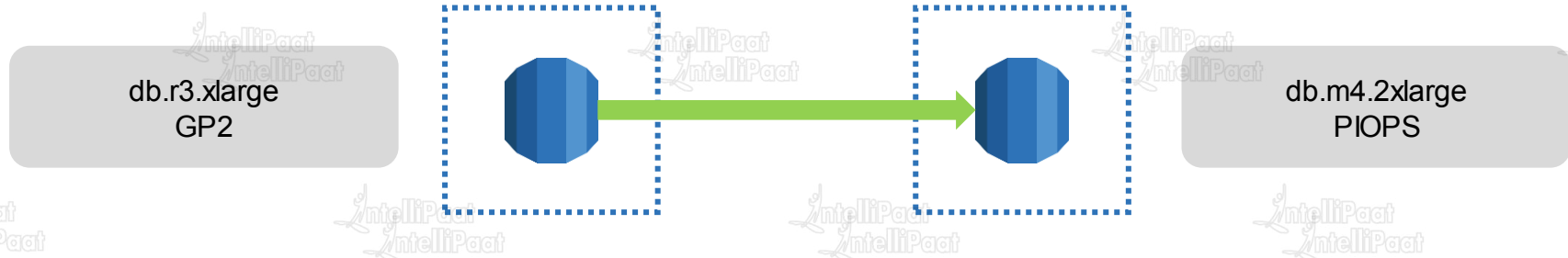


Amazon RDS does not support circular replication of DB instances. Creating Read Replica is different for all Amazon RDS DB engines, for example, read replica can be created from another read replica for MySQL and PostgreSQL whereas the same is not possible for Oracle DB engines.

## Some other significant differences in read replicas of various RDS DB engines:

PostgreSQL	MySQL & MariaDB	Oracle
Physical Replication	Logical Replication	Physical Replication
Read Replicas cannot be made writeable	Read Replicas can become writeable	Read Replicas cannot be made writeable
Automated backups cannot be performed on PostgreSQL read replicas but manual snapshot can be created	Automated backups can be performed	Manual snapshots cannot be created in Oracle read replica, even the automatic backup cannot be enabled

# Read Replica



Source Storage Type	Replication Storage Type	Storage Size
PIOPS	PIOPS or GP2 or Standard	100GB – 3TB
GP2	PIOPS or GP2 or Standard	100GB – 3TB
GP2	GP2 or Standard	Less than 100GB
Standard	PIOPS or GP2 or Standard	100GB – 3TB
Standard	GP2 or Standard	Less than 100GB



# Reserved DB Instances



# Reserved DB Instances



Amazon RDS offers the option to reserve a DB Instance for one or three year term for which the user gets a significant discount as compared to the On-demand Instant pricing for DB instance.

## Features of Reserved DB Instances

- ★ There are three types of payment options available for Reserved Instances, namely, All Upfront, Partial Upfront, and No Upfront.
- ★ Reserved Instances can save up to an average of 69% over On- Demand Instances.
- ★ Reserved Instances are available in all of the AWS regions and for all supported DB engines.



# Pricing and Designs



# Pricing and Designs



- **On-Demand Instances**

- Single-AZ Deployments
- Multi-AZ Deployments

- **Reserved Instances**

- db.m4.large

STANDARD 3-YEAR TERM					
Payment Option	Upfront	Monthly*	Effective Hourly**	Savings over On-Demand	On-Demand Hourly
Partial Upfront	\$657.00	\$32.85	\$0.07	60%	\$0.175
All Upfront	\$1,717.00	\$0.00	\$0.06533	63%	

- **Storage**

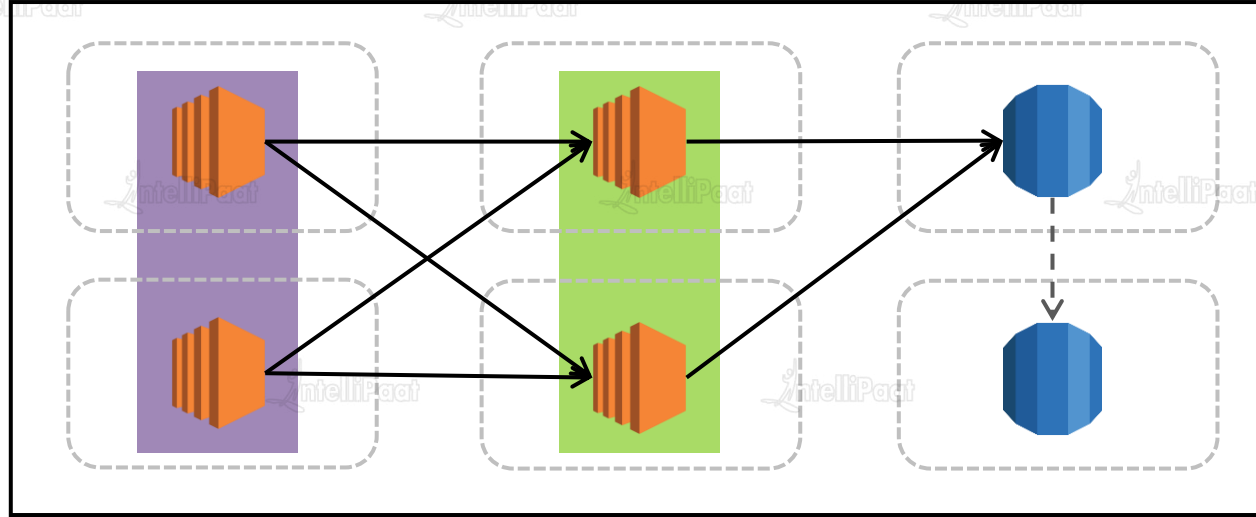
- SSD (SAZ): \$0.115 per GB/month
- SSD (MAZ): \$0.23 per GB/month
- PIOPS (SAZ): Storage - \$0.125 per GB/month, PIOPS Rate - \$0.10 per IOPS/month
- Magnetic (SAZ): Storage - \$0.10 per GB/month, I/O Rate - \$0.10 per 1M requests

- **Backup** – FREE up to the size of active databases in a region. Additional storage is \$0.095 per GB/month.

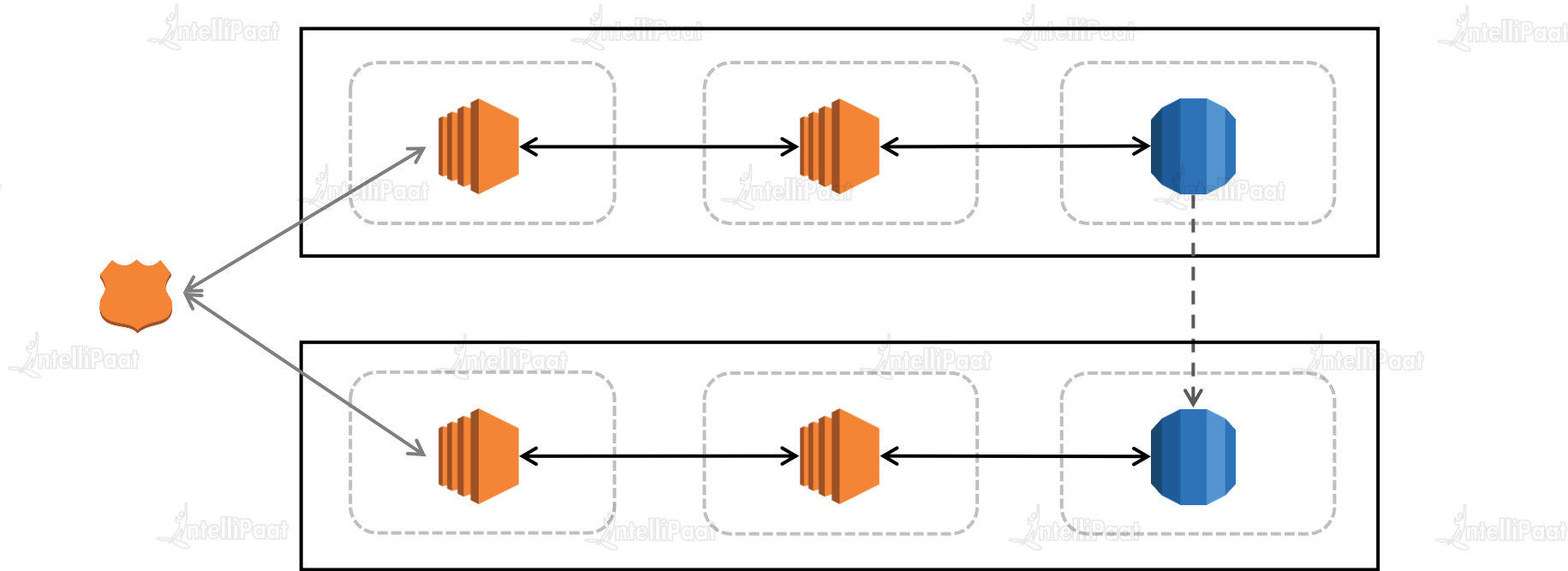
- If there's an active MySQL DB instance with 500 GB-month of provisioned database storage and an active PostgreSQL DB instance with 200 GB-month of provisioned database storage, up to 700 GB-month of backup storage will not have any charge.

- **Data Transfer charges** (IN is free, OUT depends on where data is moving out)

# Pricing and Designs



# RDS Design Patterns





# Demo 1: DB Instance



- Create subnet group for RDS VPC – aws-foundation-subnet-grp.
- Create 2 security groups – one for Web Servers and another for DB instance which should allow access only from web servers.
- Launch a MySQL DB instance: mysql-rds-db-instance.
- Ignore backup setup as of now.
- Modify a DB instance.
- Connect to the DB instance from your machine.
- Change database instance to use multi-AZ deployment.
- Create another DB instance with Multi-AZ deployment.



# Introduction to Amazon Aurora



# Introduction to Amazon Aurora



- ★ Amazon Aurora is a relational database engine built for cloud and is completely compatible with MySQL and PostgreSQL.
- ★ Amazon Aurora is fully managed by Amazon RDS, which in turn automates administrative tasks such as database setup, patching, backups and more.





# Benefits of Amazon Aurora



# Benefits of Amazon Aurora



## High Performance and scalability



Provides 5X the throughput of standard MySQL and 3X the throughput of standard PostgreSQL

## Highly Secure



Provides multiple levels of security including encryption using user generated keys and network isolation using Amazon VPC.

## High Availability and Durability



Offers greater than 99.99% availability and an option to backtrack to a previous point in time.

## Fully managed



Amazon Aurora is fully managed by RDS and automates time consuming tasks such as hardware provisioning, software patching, setup, or backups.



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# Pricing



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# Pricing



★ DB Instance – pay as you go, price varies from one instance class to another.

★ Pricing for various Database Engines in N. Virginia region (DB Instance class – db.r3.xlarge, Multi-AZ deployment)

★ Reserved DB Instance.

★ For details visit <https://aws.amazon.com/rds/pricing/>

Database Engine	Price Per Hour	Storage Cost	I/O Cost
Amazon Aurora	\$0.580	\$0.100/GB per month	\$0.200 per 1 million requests
MySQL	\$0.480	\$0.230/GB per month	\$0.20 per IOPS-Month
MariaDB	\$0.950	\$0.230/GB per month	\$0.20 per IOPS-Month
Oracle (SE2)	\$1.957	\$0.230/GB per month	\$0.20 per IOPS-Month
PostgreSQL	\$1.000	\$0.230/GB per month	\$0.20 per IOPS-Month

# Demo 1: Aurora DB Cluster



- Create an Aurora DB instance and specify all the details.
- Note the endpoint.
- Create 1 Aurora replica.
- How to create cross-region read replica.



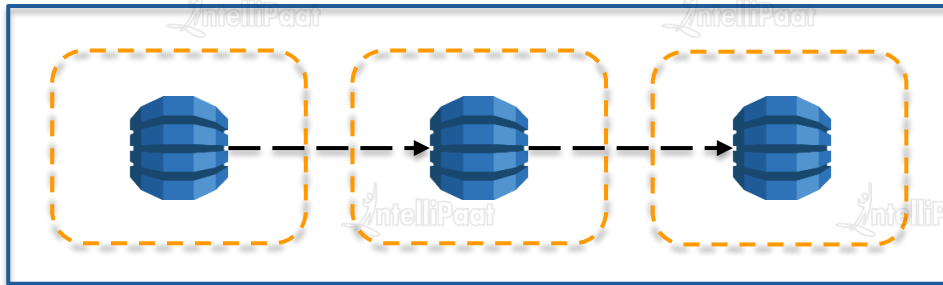


# Introduction to DynamoDB



# Introduction to DynamoDB

- ★ DynamoDB is a fully managed NoSQL database. In DynamoDB no Database administration is required.
- ★ DynamoDB automatically spreads the data and traffic for tables over a sufficient number of servers to handle throughput and storage requirements.
- ★ JSON formatted documents can be stored as items in DynamoDB.



# Core Components of DynamoDB

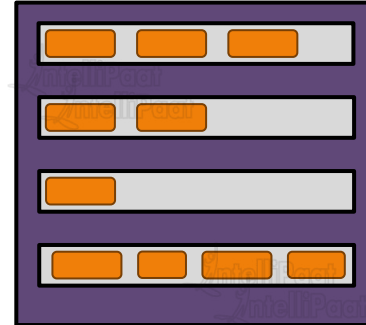
# Core Components of DynamoDB

**Tables**

**Items**

**Attributes**

In DynamoDB, the collection of items is known as a table. A table in DynamoDB is not a structured table with fixed number of cells or columns.



**Table**

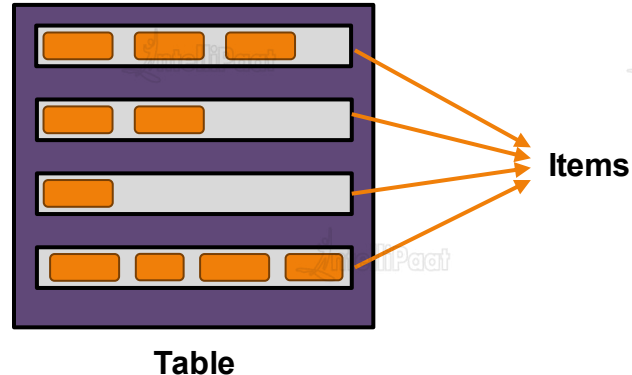
# Core Components of DynamoDB

**Tables**

**Items**

**Attributes**

Each table in DynamoDB contains one or more than one items.  
Items are made up of group of attributes that are uniquely identifiable.



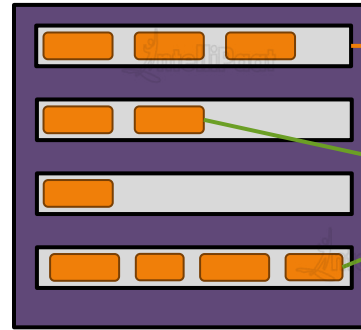
# Core Components of DynamoDB

**Tables**

**Items**

**Attributes**

Attributes in DynamoDB are fundamental data elements or values that reside in item. Equivalent to data values that reside in a particular cell of a table in relational database.



**Items**

**Attributes**

**Table**

- DynamoDB operations has to be done by provided APIs
  - CreateTable – Create a new table. Can be used to create indexes as well.
  - DescribeTable – Returns information about tables.
  - ListTables – Returns all tables.
  - UpdateTable - Modifies the settings of a table or its indexes, creates or remove new indexes on a table, or modifies DynamoDB Streams settings for a table.
  - DeleteTable – Removes table and its dependent objects.
  - PutItem – Writes a single item, primary key must be specified.
  - BatchWriteItem - Writes up to 25 items to a table.
  - GetItem – Retrieves a single item with Primary Key.
  - BatchGetItem – Retrieves up to 100 items from a table.
  - Query - Retrieves all of the items that have a specific partition key.
  - Scan - Retrieves all of the items in the specified table or index.
  - UpdateItem - Modifies one or more attributes in an item when Primary Key is provided.
  - DeleteItem – Deletes a single item with a specific Primary Key.



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# Pricing and Designs



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# DynamoDB Pricing (us-east-1)



- ★ Free Tier per month – 25 RCU, 25 WCU, 25 GB data storage, 2.5 Million Read Requests from DynamoDB streams. **Free Tier does not expire.**
- ★ RCU - \$0.09 per RCU/month.
- ★ WCU - \$0.47 per WCU/month.
- ★ Data Storage - \$0.25 per GB/month.

## Application Requirement:

- 10 million eventual consistent reads per day
- 10 million writes per day
- 200 GB of data
- Max Item size is 1 KB

Write per second =  $10M / (24 \times 60 \times 60) = 115.7$   
WCU needed = 116  
Write Cost =  $116 \times 0.47 = \$54.52$

Reads per second = 115.7  
RCU needed =  $116 / 2 = 58$   
RCU Cost =  $58 \times 0.09 = \$5.22$

Storage Cost =  $200 \times 0.25 = \$50$

Total Cost =  $54.52 + 5.22 + 50 = \$109.74$

If FREE TIER not consumed =  $42.77 + 2.97 + 43.75 = \$89.49$

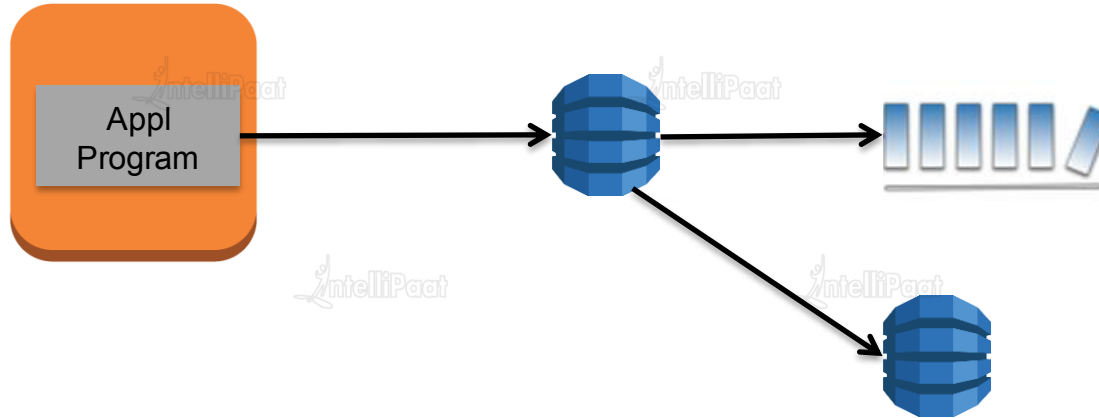
# DynamoDB Pricing – Reserved Capacity



- ★ Min 100 RCU and WCUs.
- ★ Upfront Fee has to be paid.
- ★ Max for 1 year.
- ★ Data Transfer IN – Free
- ★ Data Transfer OUT within the same region – Free
- ★ Data Transfer OUT across other regions – Chargeable

Monthly Commitment	Upfront	Hourly
100 Write Capacity Units	\$150.00	\$0.0128 per Hour
100 Read Capacity Units	\$30.00	\$0.0025 per Hour

# Design Patterns





# What is Amazon Redshift

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- ★ Amazon Redshift is a fully managed data warehouse service in the cloud. The data in Amazon Redshift data warehouse can be scaled up to petabyte or more.
- ★ To create a database, a set of nodes called as Amazon Redshift Cluster has to be launched.



# Advantages of Amazon Redshift

# Advantages of Amazon Redshift



**Faster Performance**

**Easy to setup, deploy and manage**

**Cost-effective**

**Secure**

- ★ Even on large datasets, Amazon Redshifts delivers fast query performance. It also uses ML to predict incoming query runtime and assigns them optimal queue for fast processing.
- ★ Easy to setup, deploy and manage
- ★ It also provides performance boost when it comes to executing repeat queries by using result caching.



# Advantages of Amazon Redshift

**Faster Performance**

**Easy to setup, deploy and manage**

**Cost-effective**

**Secure**

- ★ AWS provisions the infrastructure of the data warehouse automatically, making it simple and easy to create new data warehouse with just a few clicks in the AWS console.
- ★ It also automatically backs up the data in the data warehouse to the Amazon S3





# Advantages of Amazon Redshift

**Faster Performance**

**Easy to setup, deploy and manage**

**Cost-effective**

**Secure**

- ★ Amazon Redshift is the most cost effective data warehouse where the user only has to pay for the resources they provision.
- ★ Redshift is the only cloud data warehouse offering On-Demand pricing and no up-front costs



# Advantages of Amazon Redshift

**Faster Performance**

**Easy to setup, deploy and manage**

**Cost-effective**

**Secure**

- ★ Amazon redshift provides end to end encryption with just a couple of parameter settings. Amazon Redshift takes care of key management.
- ★ Amazon Redshift also enables users to configure firewall rules, providing full control over network access of the data warehouse cluster.





# What is ElastiCache?



# What is ElastiCache?



ElastiCache is a web service that provides high performance, cost-effective and scalable caching solution. It makes it easy to manage and scale a distributed in-memory data store or cache environment in the cloud itself.



# Why AWS ElastiCache?

# Why AWS ElastiCache?

## Response time

Using ElastiCache improves the load and response time by allowing to retrieve data from a fast in-memory system, eliminating the dependence on slower disk based databases.

## Scalability

AWS ElastiCache is designed to be able to automatically modify itself to scale out or scale in as per the fluctuating application requirements.

## Complete Management

AWS ElastiCache can also automate common administrative tasks such as hardware provisioning, failure recovery, backups, software patching and more.



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# Demo



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# Quiz





**1. Memcached clusters are comprised of up to how many nodes?**

A. 10

B. 20

C. 6

D. 5

**2. Single Redis shard configuration groups can have how many nodes in a single cluster?**

A. 10

B. 20

C. 6

D. 5

## 3. Can we rename cluster in Redshift?

A. Yes

B. No

**4. Redshift achieves extremely fast query execution by using Columnar data storage?**

A. Yes

B. No



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