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AWS Solutions Architect

Route 53

Н. Ганжигүүр
Fibo Cloud

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DNS System

What is DNS

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Phonebook-тэй ижилхэн

- IP хаяг болон бусад төвөгтэй замуудыг хүн уншихад ойлгомжтой байдлаар илэрхийлэх
- Хувьсах сервисүүдийг статик домэйн болгож хадгалах

https://ip-ranges.amazonaws.com/ip-ranges.json

How DNS Works

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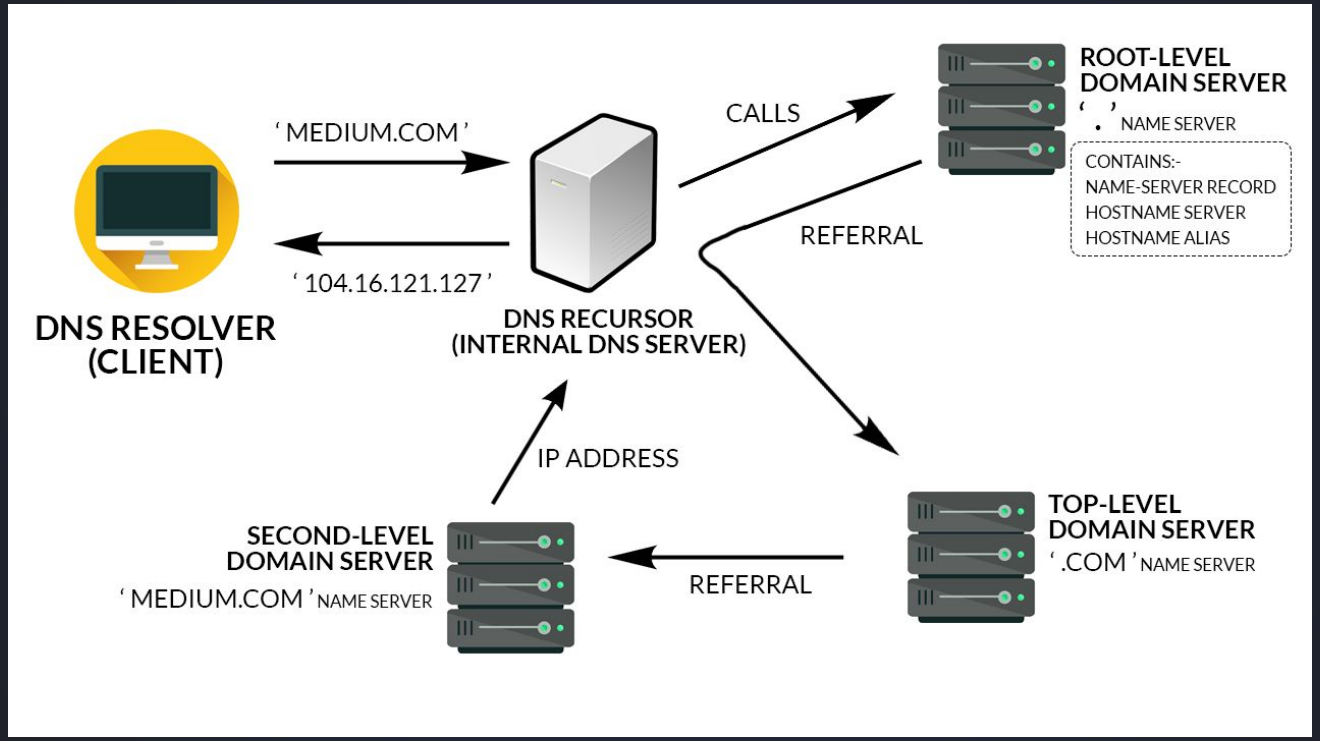

Top level domains

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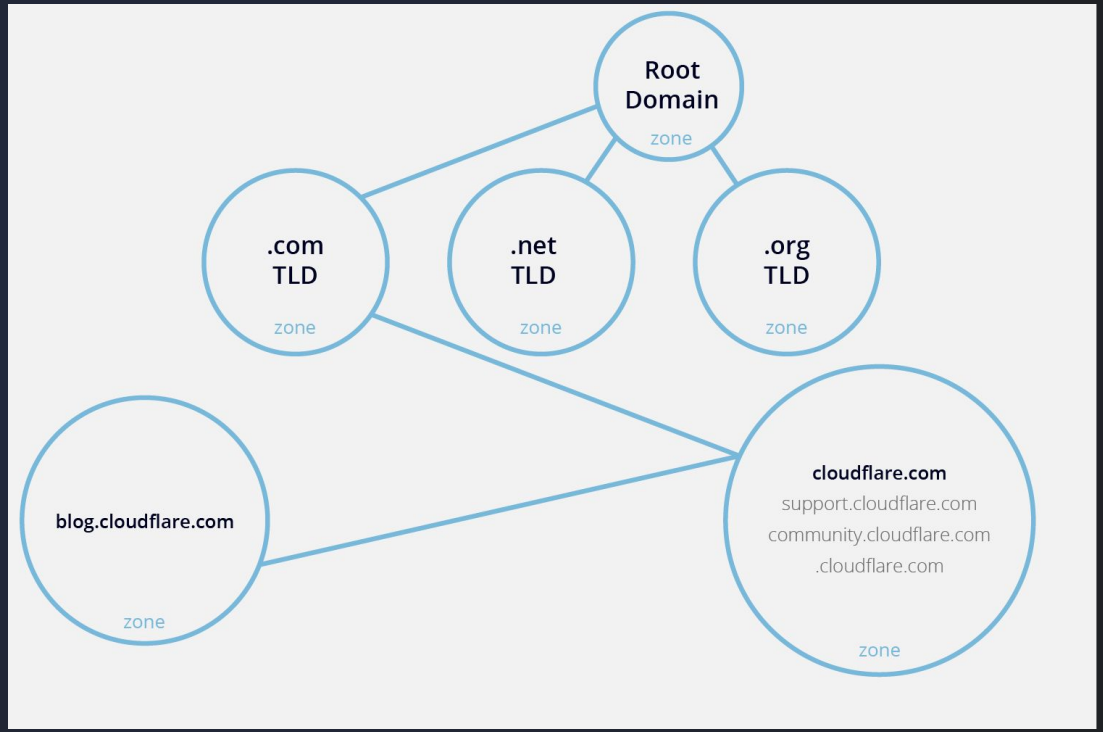
DNS Root Servers:
Top level domains controlled by the root zone (root servers)

TLD:
The top tier in the DNS hierarchy. Generally structured into geographic codes - such as .com, .org, .mn and .edu. Large orgs or country orgs are delegated control of these by the root servers to be authoritative.



Registrar and WhoIS database

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Root zone database:
IANA-р удирдагддаг.

https://www.iana.org/domains/root/db

Registrar:
Top level домэйнийг хэрэглээнд нийлүүлдэг байгууллага.

WhoIS database дээр бүх домэйнийг дундаа хадгалдаг.

Жишээ нь: AWS, Godaddy.

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AWS Route 53

AWS Route 53

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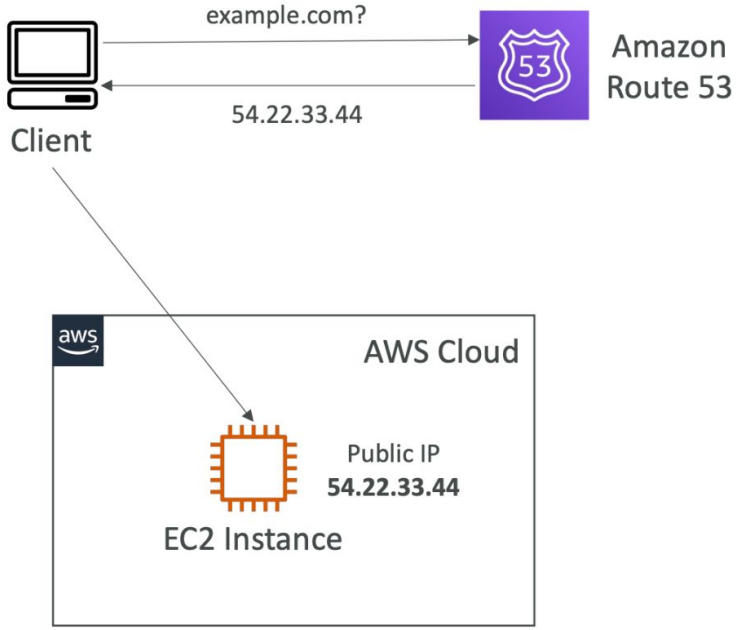
- A highly available, scalable, fully managed and *Authoritative* DNS
  - Authoritative = the customer (you) can update the DNS records
- Route 53 is also a Domain Registrar
- Ability to check the health of your resources
- The only AWS service which provides 100% availability SLA
- Why Route 53? 53 is a reference to the traditional DNS port



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Route 53 – Records

- How you want to route traffic for a domain
- Each record contains:
  - **Domain/subdomain Name** – e.g., example.com
  - **Record Type** – e.g., A or AAAA
  - **Value** – e.g., 12.34.56.78
  - **Routing Policy** – how Route 53 responds to queries
  - TTL – amount of time the record cached at DNS Resolvers
- Route 53 supports the following DNS record types:
  - (must know) A / AAAA / CNAME / NS
  - (advanced) CAA / DS / MX / NAPTR / PTR / SOA / TXT / SPF / SRV

Route 53 – Record Types

- A – maps a hostname to IPv4
- AAAA – maps a hostname to IPv6
- CNAME – maps a hostname to another hostname
  - The target is a domain name which must have an A or AAAA record
  - Can't create a CNAME record for the top node of a DNS namespace (Zone Apex)
  - Example: you can't create for example.com, but you can create for www.example.com
- NS – Name Servers for the Hosted Zone
  - Control how traffic is routed for a domain

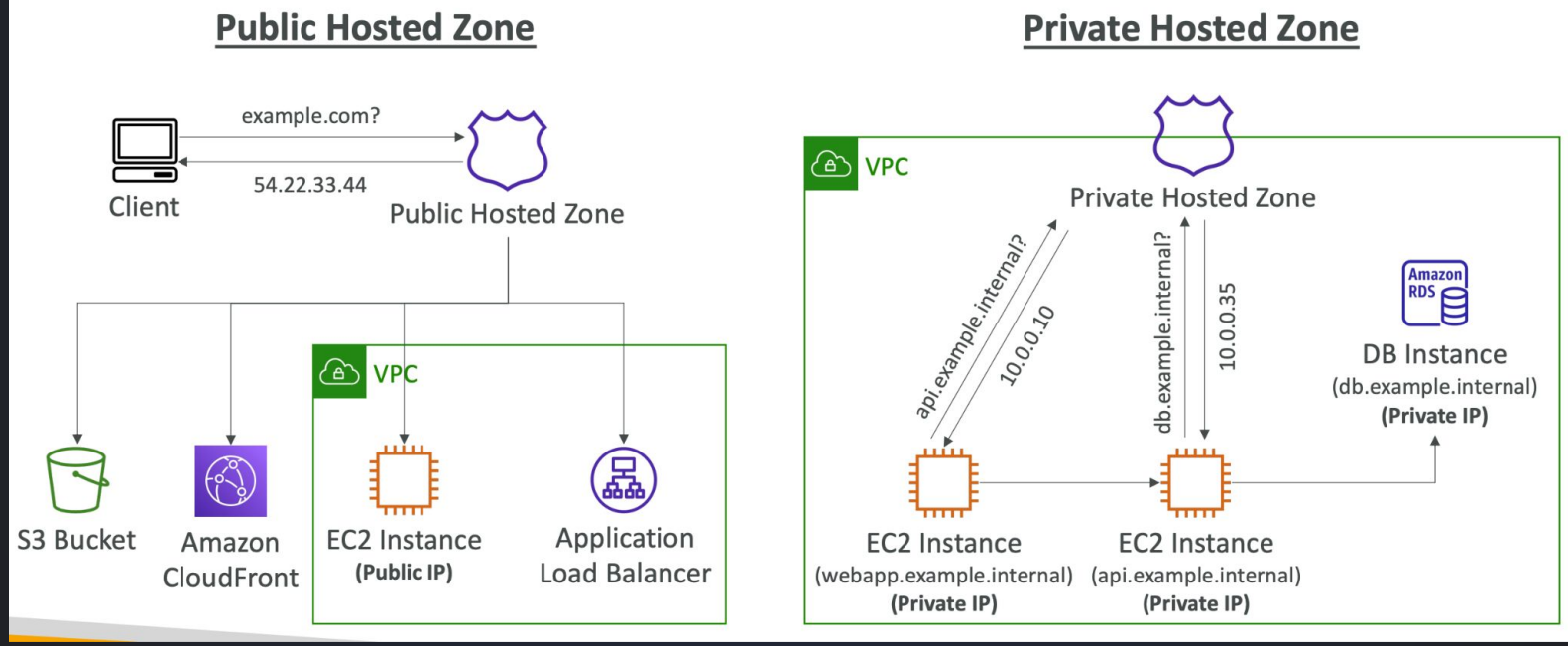
Route 53 – Hosted Zones

- A container for records that define how to route traffic to a domain and its subdomains

- **Public Hosted Zones** – contains records that specify how to route traffic on the Internet (public domain names)
  application1.mypublicdomain.com
- **Private Hosted Zones** – contain records that specify how you route traffic within one or more VPCs (private domain names)
  application1.company.internal

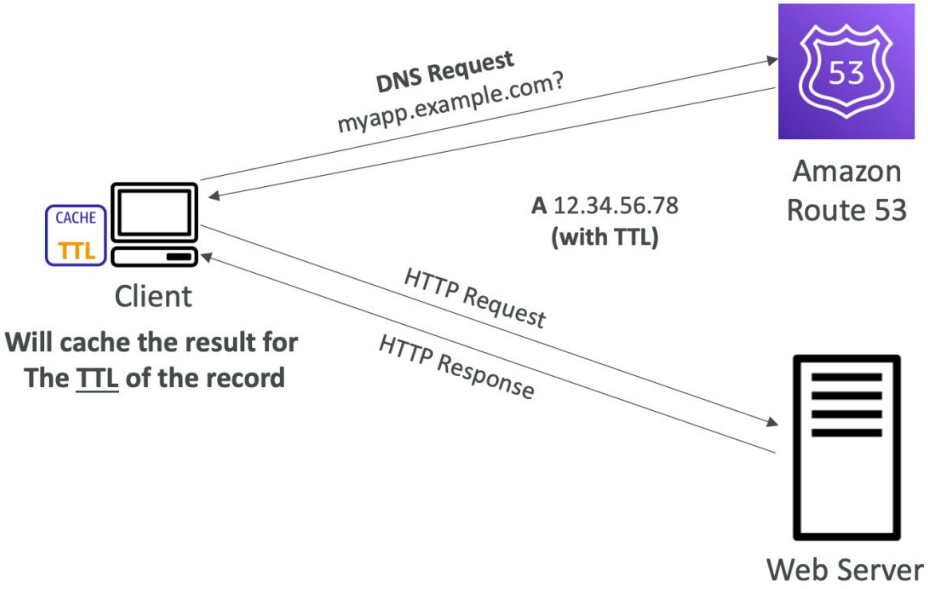
- You pay $0.50 per month per hosted zone

Route 53 – Public vs. Private Hosted Zones



Route 53 – Records TTL (Time To Live)

- High TTL – e.g., 24 hr
  - Less traffic on Route 53
  - Possibly outdated records
- Low TTL – e.g., 60 sec.
  - More traffic on Route 53 ($$)
  - Records are outdated for less time
  - Easy to change records
- Except for Alias records, TTL is mandatory for each DNS record



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Route 53 features

Features

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- Routing policy
  - Simple routing
  - Weighted routing
  - Latency based routing
  - Failover routing
  - Geolocation routing
  - Geoproximity routing
  - Multi-answer routing
- Health check
- Domain load balancing

Simple Routing

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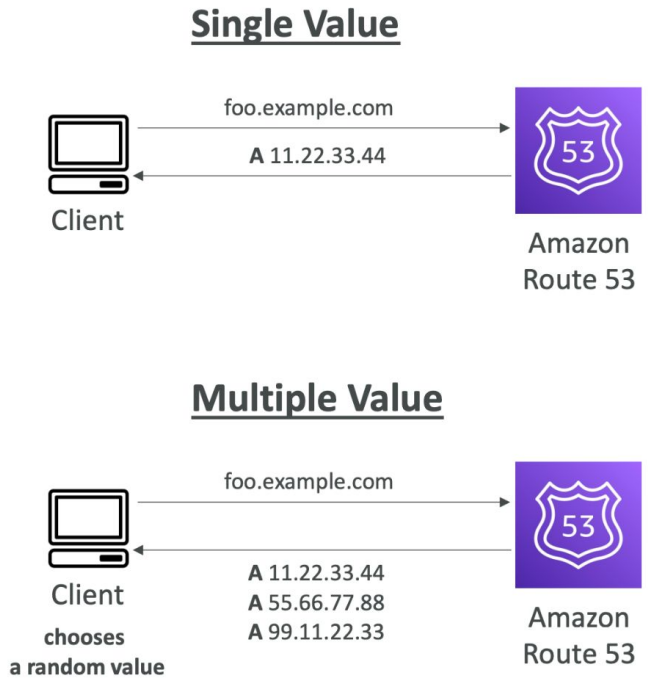
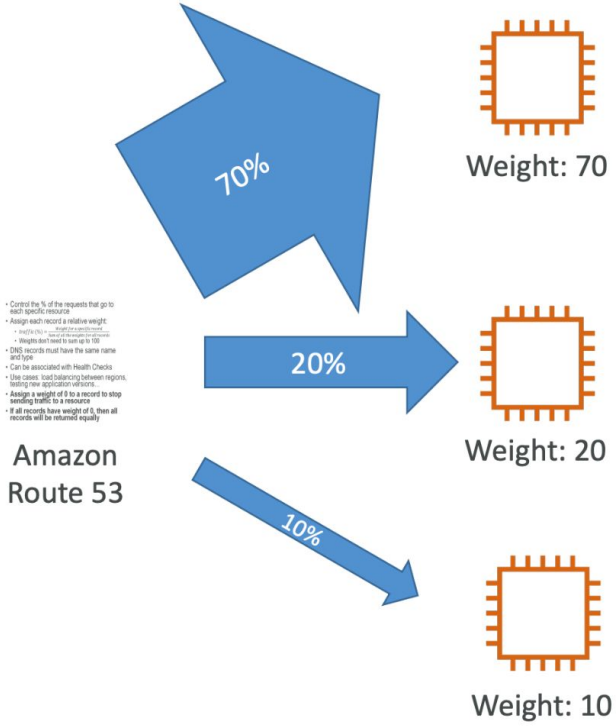
Routing Policies – Simple

- Typically, route traffic to a single resource
- Can specify multiple values in the same record
- If multiple values are returned, a random one is chosen by the client
- When Alias enabled, specify only one AWS resource
- Can't be associated with Health Checks



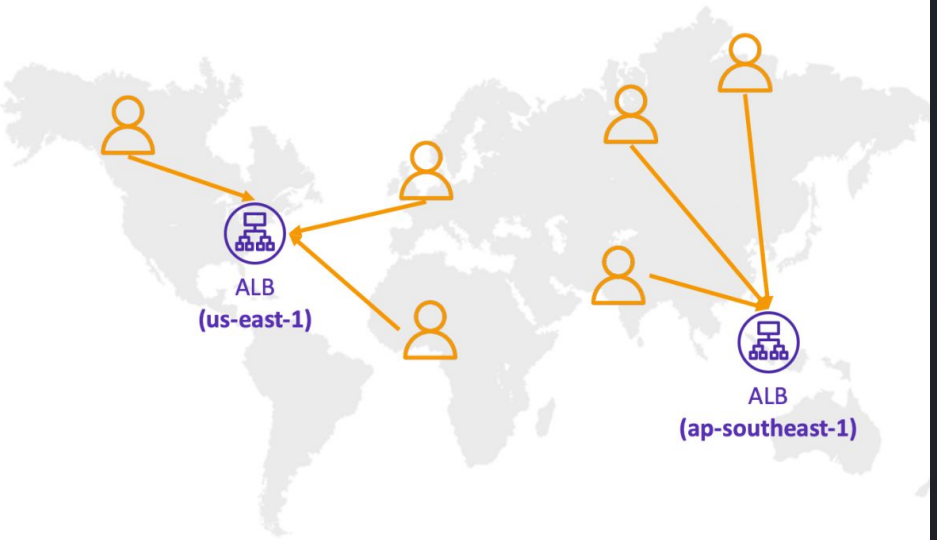
Routing Policies – Weighted

- Control the % of the requests that go to each specific resource
- Assign each record a relative weight:
  - $traffic\ (\%) = \frac{Weight\ for\ a\ specific\ record}{Sum\ of\ all\ the\ weights\ for\ all\ records}$
  - Weights don't need to sum up to 100
- DNS records must have the same name and type
- Can be associated with Health Checks
- Use cases: load balancing between regions, testing new application versions…
- Assign a weight of 0 to a record to stop sending traffic to a resource
- If all records have weight of 0, then all records will be returned equally

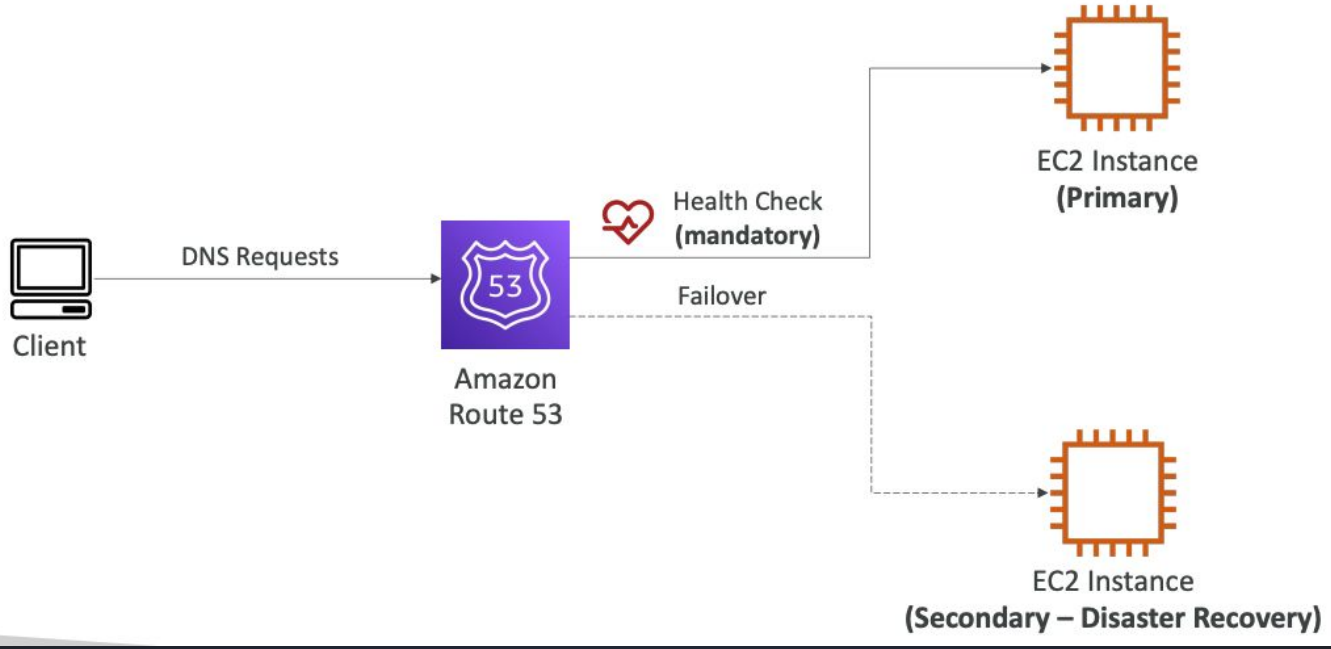


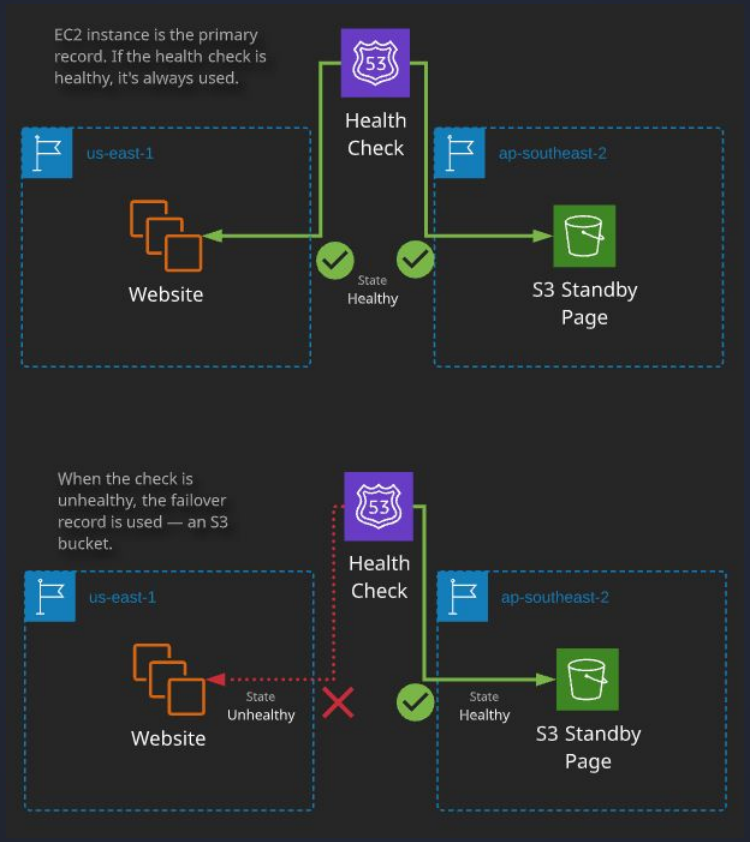
Routing Policies – Latency-based

- Redirect to the resource that has the least latency close to us
- Super helpful when latency for users is a priority
- Latency is based on traffic between users and AWS Regions
- Germany users may be directed to the US (if that's the lowest latency)
- Can be associated with Health Checks (has a failover capability)



Routing Policies – Failover (Active-Passive)




EC2 instance is the primary record. If the health check is healthy, it's always used.
53
Health Check
us-east-1
ap-southeast-2
Website
State Healthy
S3 Standby Page
When the check is unhealthy, the failover record is used — an S3 bucket.
53
Health Check
us-east-1
ap-southeast-2
State Unhealthy
Website
State Healthy
S3 Standby Page

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Routing Policies – Geolocation

- Different from Latency-based!
- This routing is based on user location
- Specify location by Continent, Country or by US State (if there's overlapping, most precise location selected)
- Should create a "Default" record (in case there's no match on location)
- Use cases: website localization, restrict content distribution, load balancing, …
- Can be associated with Health Checks

Geoproximity routing

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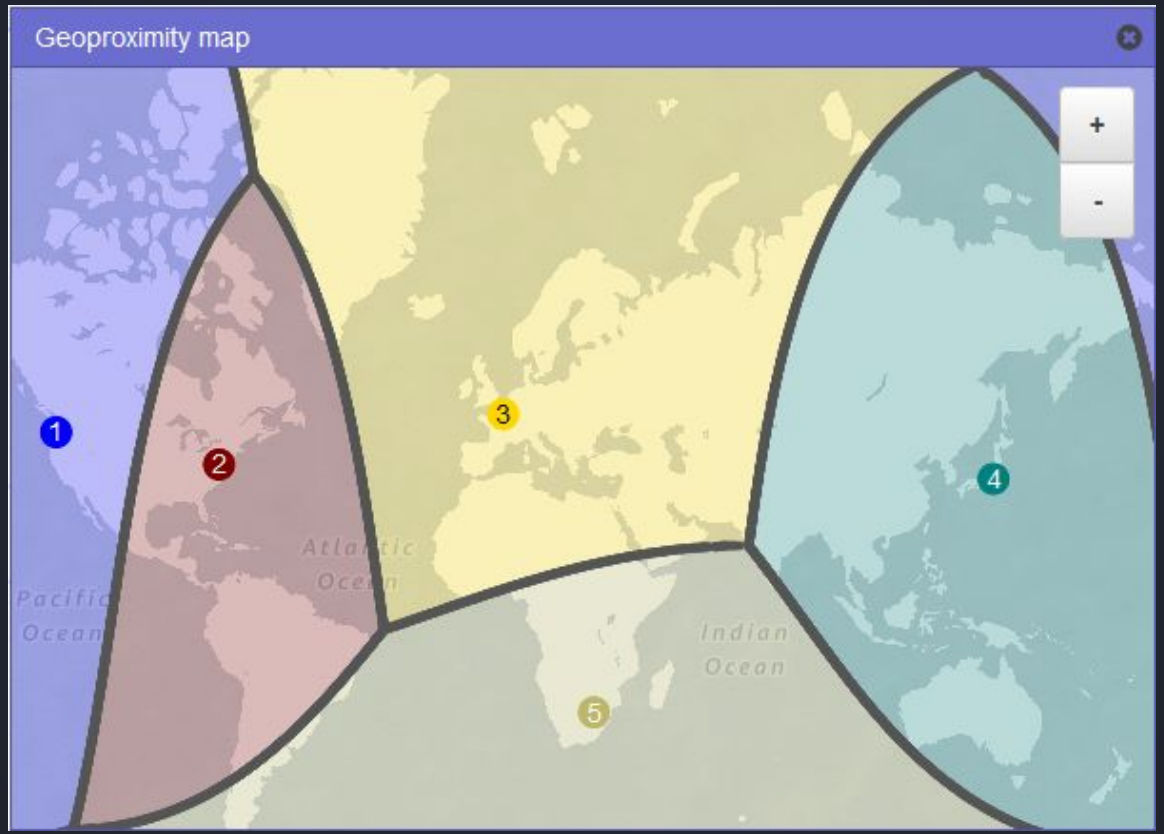

Routing Policies – IP-based Routing

- Routing is based on clients' IP addresses
- You provide a list of CIDRs for your clients and the corresponding endpoints/locations (user-IP-to-endpoint mappings)
- Use cases: Optimize performance, reduce network costs…
- Example: route end users from a particular ISP to a specific endpoint

Routing Policies – Multi-Value

- Use when routing traffic to multiple resources
- Route 53 return multiple values/resources
- Can be associated with Health Checks (return only values for healthy resources)
- Up to 8 healthy records are returned for each Multi-Value query
- Multi-Value is not a substitute for having an ELB

Name	Type	Value	TTL	Set ID	Health Check
www.example.com	A Record	192.0.2.2	60	Web1	A
www.example.com	A Record	198.51.100.2	60	Web2	B
www.example.com	A Record	203.0.113.2	60	Web3	C

AWS Certificate Manager

Easily provision, manage, and deploy public and private SSL/TLS certificates for use with AWS services and your internal connected resources

Get Started with AWS Certificate Manager

AWS Certificate Manager is a service that lets you easily provision, manage, and deploy public and private Secure Sockets Layer/Transport Layer Security (SSL/TLS) certificates for use with AWS services and your internal connected resources. SSL/TLS certificates are used to secure network communications and establish the identity of websites over the Internet as well as resources on private networks. AWS Certificate Manager removes the time-consuming manual process of purchasing, uploading, and renewing SSL/TLS certificates.

With AWS Certificate Manager, you can quickly request a certificate, deploy it on ACM-integrated AWS resources, such as Elastic Load Balancers, Amazon CloudFront distributions, and APIs on API Gateway, and let AWS Certificate Manager handle certificate renewals. It also enables you to create private certificates for your internal resources and manage the certificate lifecycle centrally. Public and private certificates provisioned through AWS Certificate Manager for use with ACM-integrated services are free. You pay only for the AWS resources you create to run your application. With AWS Certificate Manager Private Certificate Authority, you pay monthly for the operation of the private CA and for the private certificates you issue.

AWS Certificate Manager Private Certificate Authority

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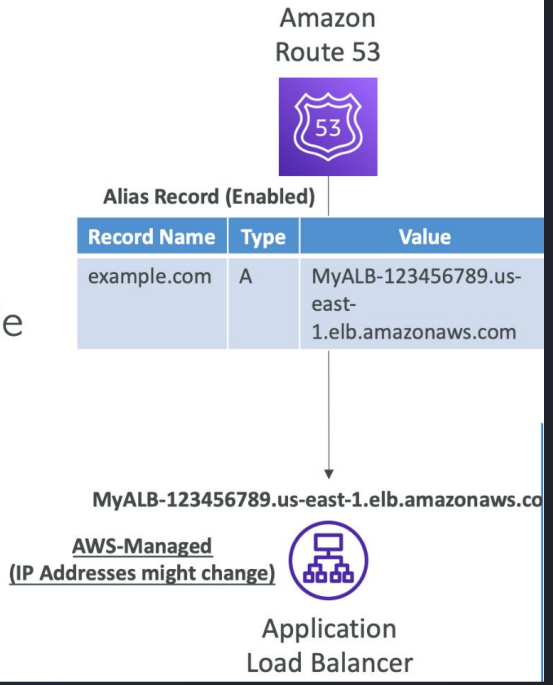
CNAME vs Alias

- AWS Resources (Load Balancer, CloudFront...) expose an AWS hostname:
  - lb1-1234.us-east-2.elb.amazonaws.com and you want myapp.mydomain.com

- CNAME:
  - Points a hostname to any other hostname. (app.mydomain.com => blabla.anything.com)
  - ONLY FOR NON ROOT DOMAIN (aka. something.mydomain.com)
- Alias:
  - Points a hostname to an AWS Resource (app.mydomain.com => blabla.amazonaws.com)
  - Works for ROOT DOMAIN and NON ROOT DOMAIN (aka mydomain.com)
  - Free of charge
  - Native health check

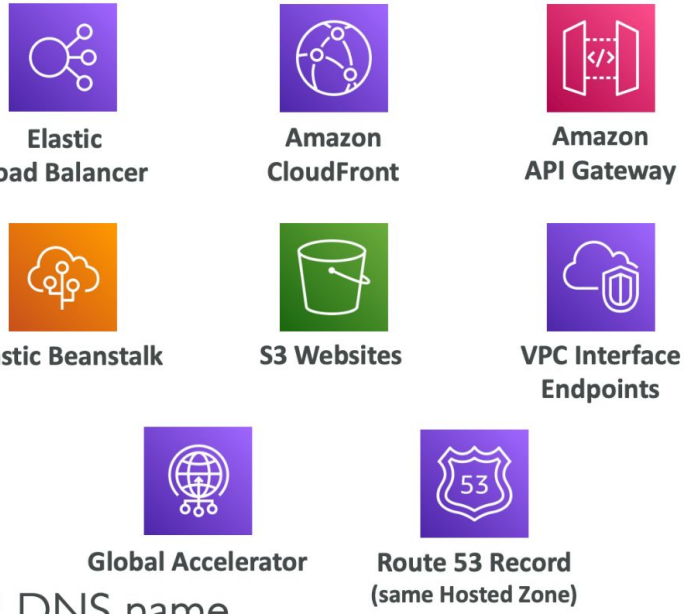
Route 53 – Alias Records

- Maps a hostname to an AWS resource
- An extension to DNS functionality
- Automatically recognizes changes in the resource's IP addresses
- Unlike CNAME, it can be used for the top node of a DNS namespace (Zone Apex), e.g.: example.com
- Alias Record is always of type A/AAAA for AWS resources (IPv4 / IPv6)
- You can't set the TTL



Route 53 – Alias Records Targets

- Elastic Load Balancers
- CloudFront Distributions
- API Gateway
- Elastic Beanstalk environments
- S3 Websites
- VPC Interface Endpoints
- Global Accelerator accelerator
- Route 53 record in the same hosted zone



- You cannot set an ALIAS record for an EC2 DNS name

Pricing

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Paying for What You Use

With Amazon Route 53, you don't have to pay any upfront fees or commit to the number of queries the service answers for your domain. Like with other AWS services, you pay as you go and only for what you use:

- Managing hosted zones: You pay a monthly charge for each hosted zone managed with Route 53.
- Serving DNS queries: You incur charges for every DNS query answered by the Amazon Route 53 service, except for queries to Alias A records that are mapped to Elastic Load Balancing instances, CloudFront distributions, AWS Elastic Beanstalk environments, API Gateways, VPC endpoints, or Amazon S3 website buckets, which are provided at no additional charge.
- Managing domain names: You pay an annual charge for each domain name registered via or transferred into Route 53.

Your monthly bill from AWS will list your total usage and dollar amount for the Amazon Route 53 service separately from other AWS services.

https://aws.amazon.com/route53/pricing/

Homework 1

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1. Домэйн холбож
2. 2 сервер асаах
3. Failover туршиж үзэх
4. SSL + Load balancer holboh

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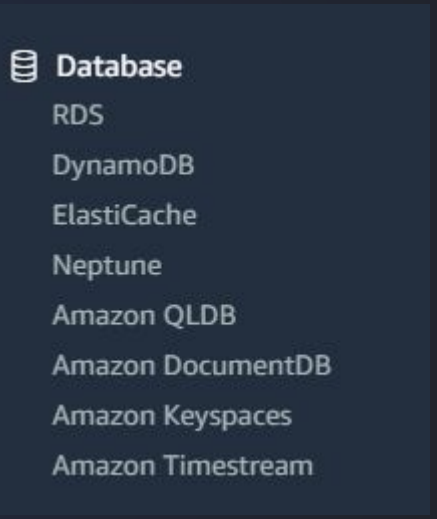
AWS Database Services



Database Types

- **RDBMS (= SQL / OLTP):** RDS, Aurora – great for joins
- **NoSQL database – no joins, no SQL :** DynamoDB (~JSON), ElastiCache (key / value pairs), Neptune (graphs), DocumentDB (for MongoDB), Keyspaces (for Apache Cassandra)
- **Object Store:** S3 (for big objects) / Glacier (for backups / archives)
- **Data Warehouse** (= SQL Analytics / BI): Redshift (OLAP), Athena, EMR
- **Search:** OpenSearch (JSON) – free text, unstructured searches
- **Graphs:** Amazon Neptune – displays relationships between data
- **Ledger:** Amazon Quantum Ledger Database
- **Time series:** Amazon Timestream

RDS

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Amazon's Relational Database service

ACID system
SQL language

Database
Table
Column
Record

Fixed number of columns

	A	B	C	D	E	F	G
1							
2							
3	**Exam Board ID**	**Student ID**	**First Name**	**Last Name**	**DOB**	**Missed Class**	
4	50006727441825	108	Jack	Smith	11/12/1999	No	
5	27177409767792	105	Jill	Williams	05/04/1998	No	
6	06910726304927	107	Chris	Jones	23/07/1999	No	
7	19347742282887	108	Ellen	Brown	14/08/1999	No	
8	30256691834572	109	Ophelia	Johnson	12/11/1998	No	
9	38025938704110	110	Alice	Wilson	15/01/1999	No	
10	27837846563334	111	Dave	Davis	30/10/1998	Yes	
11	10988362417000	112	Michael	Davies	03/03/1999	No	
12	99743725972001	113	Robert	Taylor	08/05/1999	No	
13							
14							

Class A | **Class B** | Class C | Exam Results | Attendance | Completed Work

Engine types

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Amazon RDS Overview

- RDS stands for Relational Database Service
- It's a managed DB service for DB use SQL as a query language.
- It allows you to create databases in the cloud that are managed by AWS
  - Postgres
  - MySQL
  - MariaDB
  - Oracle
  - Microsoft SQL Server
  - IBM DB2
  - Aurora (AWS Proprietary database)

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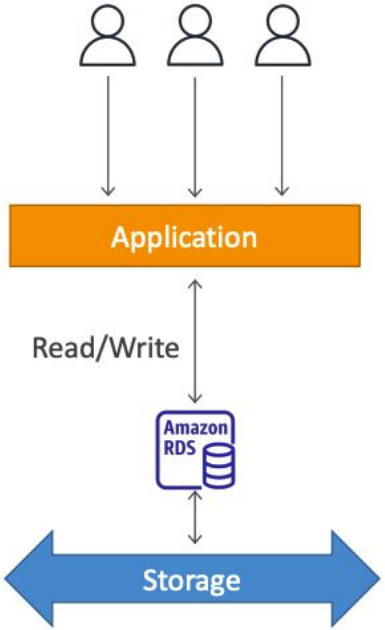
Advantage over using RDS versus deploying DB on EC2

- RDS is a managed service:
  - Automated provisioning, OS patching
  - Continuous backups and restore to specific timestamp (Point in Time Restore)!
  - Monitoring dashboards
  - Read replicas for improved read performance
  - Multi AZ setup for DR (Disaster Recovery)
  - Maintenance windows for upgrades
  - Scaling capability (vertical and horizontal)
  - Storage backed by EBS (gp2 or io1)
- BUT you can't SSH into your instances

RDS – Storage Auto Scaling

- Helps you increase storage on your RDS DB instance dynamically
- When RDS detects you are running out of free database storage, it scales automatically
- Avoid manually scaling your database storage
- You have to set **Maximum Storage Threshold** (maximum limit for DB storage)
- Automatically modify storage if:
  - Free storage is less than 10% of allocated storage
  - Low-storage lasts at least 5 minutes
  - 6 hours have passed since last modification
- Useful for applications with **unpredictable workloads**
- Supports all RDS database engines



2 main features

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Multi-AZ	Disaster recovery	Database cluster
Read replica	Performance	1 Master , read copies

Database scaling

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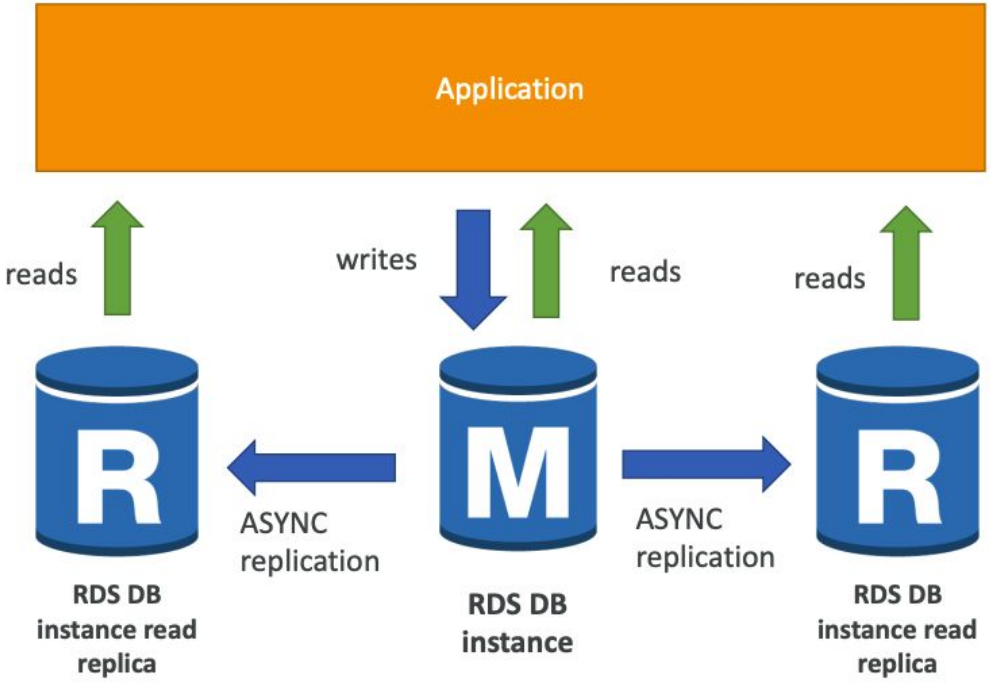
Vertical	Increase instance size
Horizontal	Create read replica

Multi-AZ бол performance нэмэхгүй !!! Зөвхөн DR

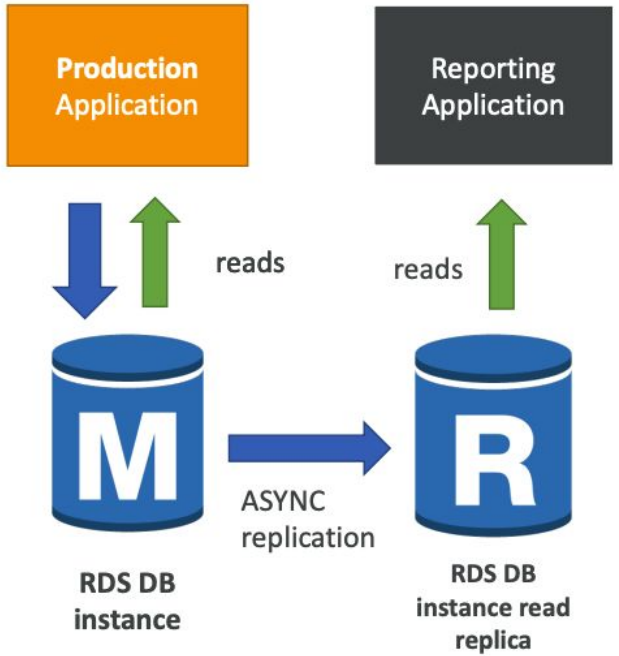
RDS Read Replicas for read scalability

- Up to 15 Read Replicas
- Within AZ, Cross AZ or Cross Region
- Replication is ASYNC, so reads are eventually consistent
- Replicas can be promoted to their own DB
- Applications must update the connection string to leverage read replicas



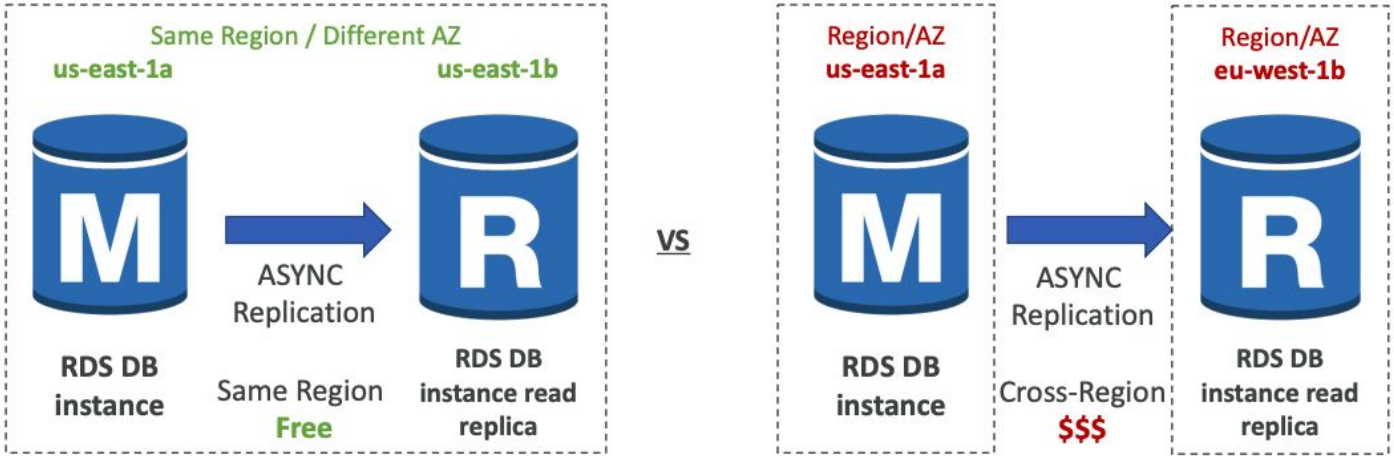
RDS Read Replicas – Use Cases

- You have a production database that is taking on normal load
- You want to run a reporting application to run some analytics
- You create a Read Replica to run the new workload there
- The production application is unaffected
- Read replicas are used for SELECT (=read) only kind of statements (not INSERT, UPDATE, DELETE)



RDS Read Replicas – Network Cost

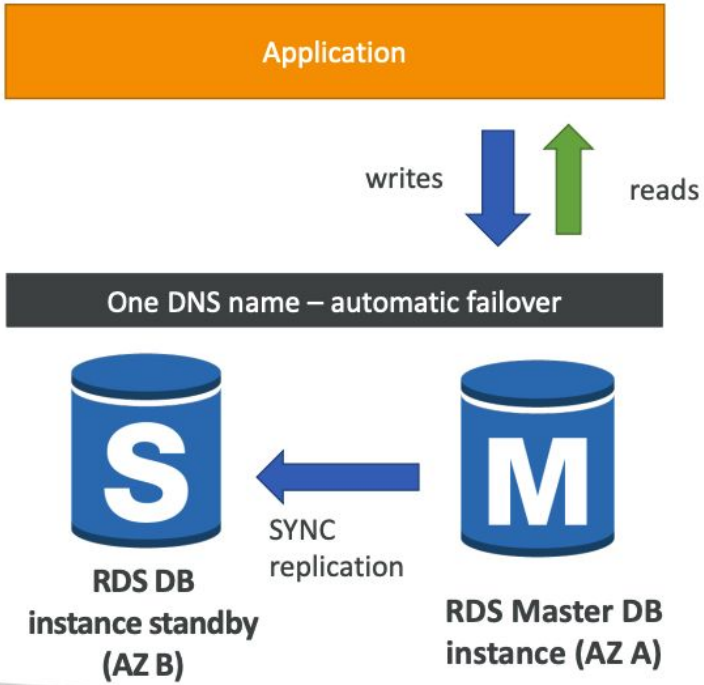
- In AWS there's a network cost when data goes from one AZ to another
- For RDS Read Replicas within the same region, you don't pay that fee



RDS Multi AZ (Disaster Recovery)

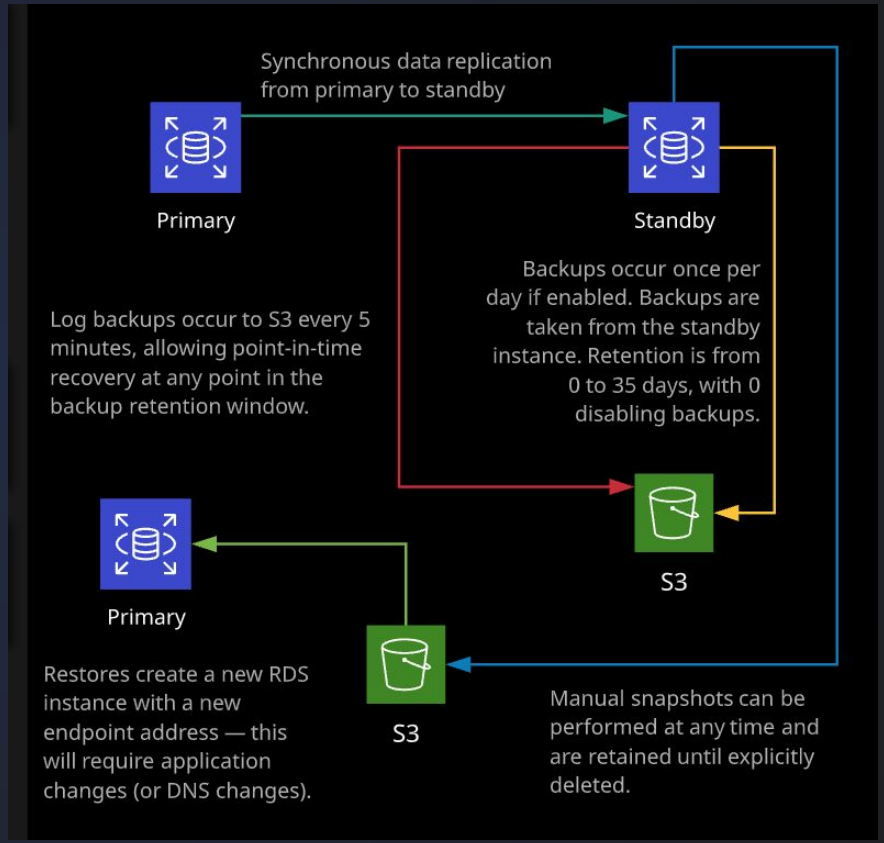
- SYNC replication
- One DNS name – automatic app failover to standby
- Increase availability
- Failover in case of loss of AZ, loss of network, instance or storage failure
- No manual intervention in apps
- Not used for scaling

- Note: The Read Replicas be setup as Multi AZ for Disaster Recovery (DR)



Key features

- Can be resized on the fly
- Auto snapshot/restore
- Has SSD storage
- Point in time recovery
- Monitoring
- Performance insight



Performance Insights

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Amazon RDS – Summary

- Managed PostgreSQL / MySQL / Oracle / SQL Server / DB2 / MariaDB / Custom
- Provisioned RDS Instance Size and EBS Volume Type & Size
- Auto-scaling capability for Storage
- Support for Read Replicas and Multi AZ
- Security through IAM, Security Groups, KMS , SSL in transit
- Automated Backup with Point in time restore feature (up to 35 days)
- Manual DB Snapshot for longer-term recovery
- Managed and Scheduled maintenance (with downtime)
- Support for IAM Authentication, integration with Secrets Manager
- RDS Custom for access to and customize the underlying instance (Oracle & SQL Server)

- **Use case:** Store relational datasets (RDBMS / OLTP), perform SQL queries, transactions

Homework 2

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1. MySQL or MariaDB instance public network дээр үүсгэнэ.
2. Өөрийн PC-ээс хандаж эхлэл Database болон Table row үүсгэнэ.
3. Түүнийгээ Snapshot авч хадгалаад түүнээсээ дамжуулж Private Zone-д шинэ DB instance үүсгэнэ.
4. Холбогдох port-уудыг зөвхөн 1 instance-н байгаа security group-г зөвшөөрнө.
5. Web server дээрээ Database-с мөр уншиж дэлгэцлэх веб асаана.
6. Database instance дээр automatic snapshot болон бусад анги дээр туршсан тохиргоонуудыг туршиж үзэх.

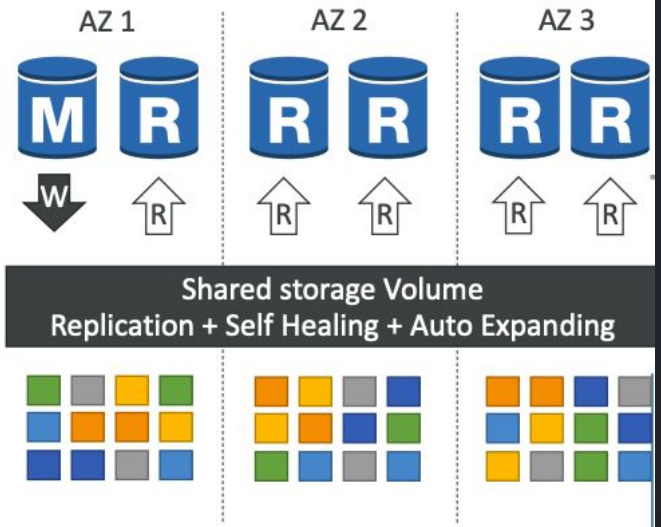
Source code: https://gist.github.com/Ganjiguur/f9a2819fcb950b68df7d8f99e0768b4a

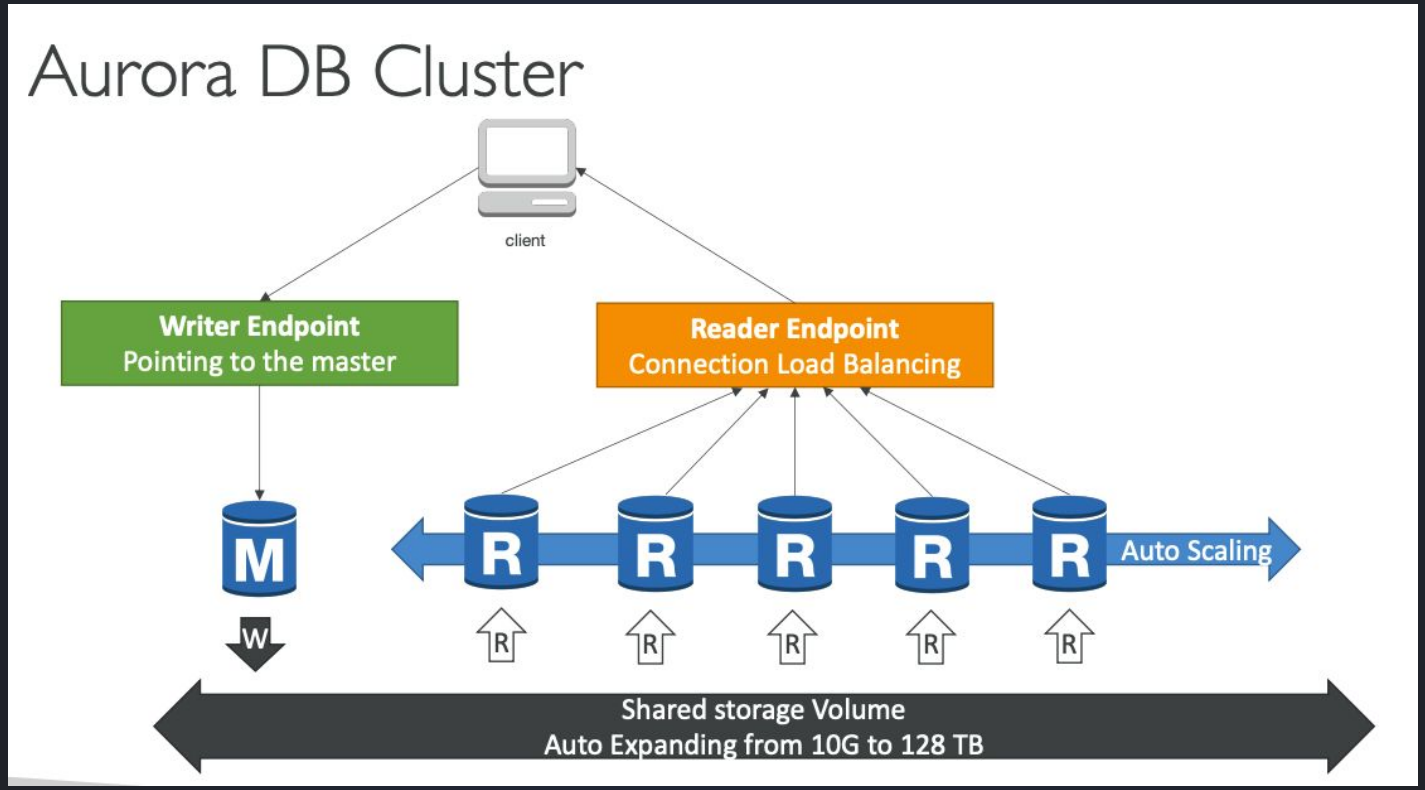
Amazon Aurora

- Aurora is a proprietary technology from AWS (not open sourced)
- Postgres and MySQL are both supported as Aurora DB (that means your drivers will work as if Aurora was a Postgres or MySQL database)
- Aurora is "AWS cloud optimized" and claims 5x performance improvement over MySQL on RDS, over 3x the performance of Postgres on RDS
- Aurora storage automatically grows in increments of 10GB, up to 128 TB.
- Aurora can have up to 15 replicas and the replication process is faster than MySQL (sub 10 ms replica lag)
- Failover in Aurora is instantaneous. It's HA (High Availability) native.
- Aurora costs more than RDS (20% more) – but is more efficient

Aurora High Availability and Read Scaling

- 6 copies of your data across 3 AZ:
  - 4 copies out of 6 needed for writes
  - 3 copies out of 6 need for reads
  - Self healing with peer-to-peer replication
  - Storage is striped across 100s of volumes
- One Aurora Instance takes writes (master)
- Automated failover for master in less than 30 seconds
- Master + up to 15 Aurora Read Replicas serve reads
- Support for Cross Region Replication



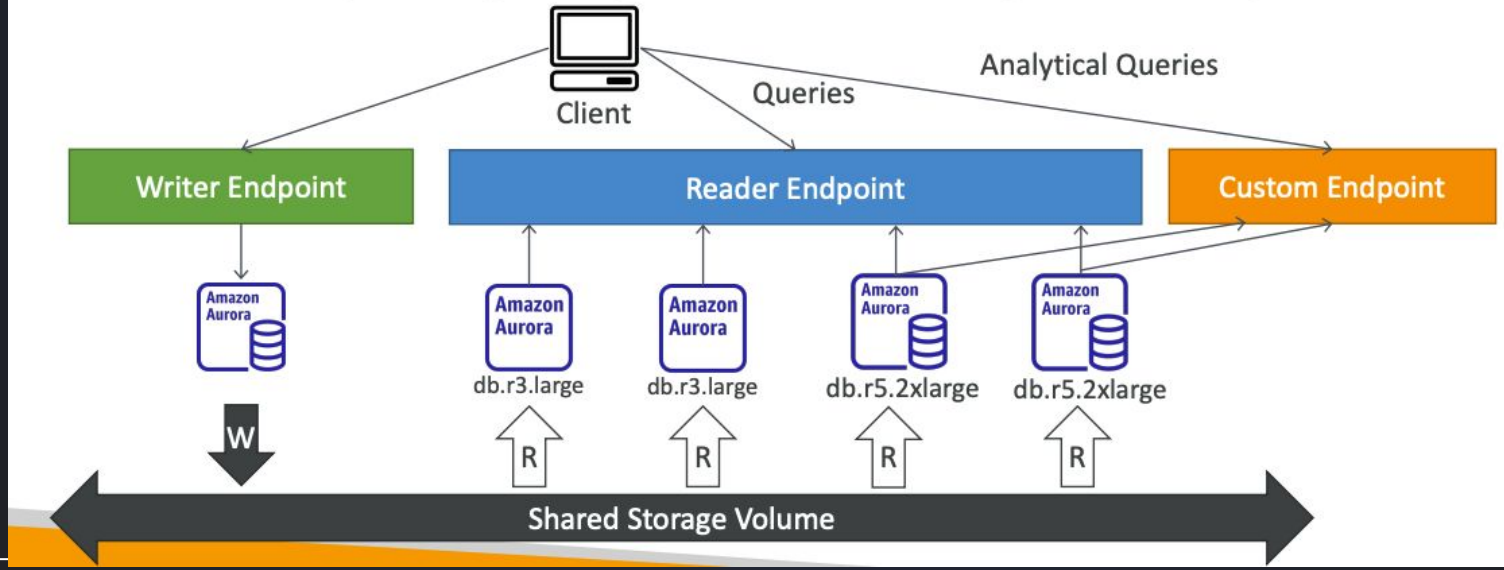

Aurora DB Cluster
client
Writer Endpoint
Pointing to the master
Reader Endpoint
Connection Load Balancing
M
W
R
R
R
R
R
Auto Scaling
R
R
R
R
R
Shared storage Volume
Auto Expanding from 10G to 128 TB

Features of Aurora

- Automatic fail-over
- Backup and Recovery
- Isolation and security
- Industry compliance
- Push-button scaling
- Automated Patching with Zero Downtime
- Advanced Monitoring
- Routine Maintenance
- Backtrack: restore data at any point of time without using backups

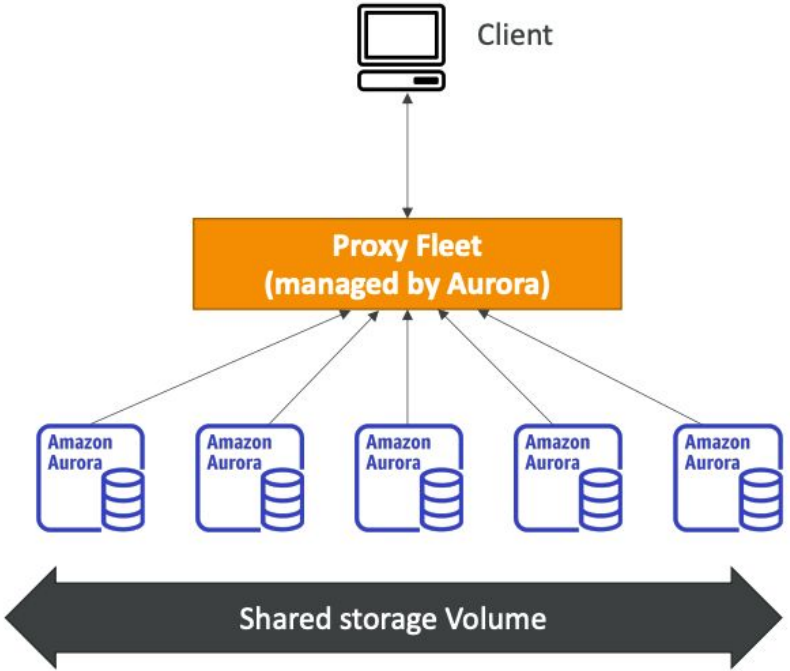
Aurora – Custom Endpoints

- Define a subset of Aurora Instances as a Custom Endpoint
- Example: Run analytical queries on specific replicas
- The Reader Endpoint is generally not used after defining Custom Endpoints



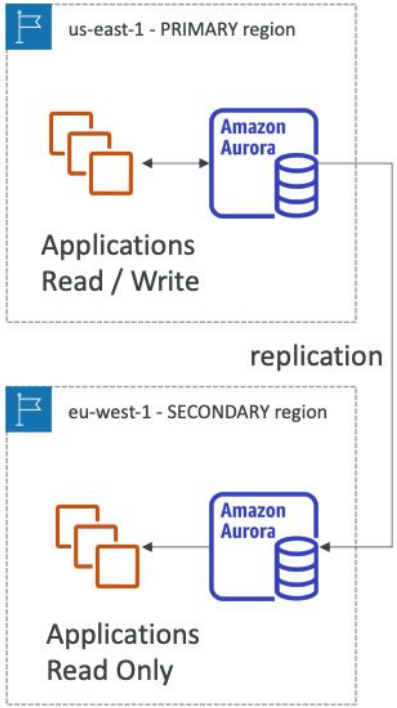
Aurora Serverless

- Automated database instantiation and auto-scaling based on actual usage
- Good for infrequent, intermittent or unpredictable workloads
- No capacity planning needed
- Pay per second, can be more cost-effective



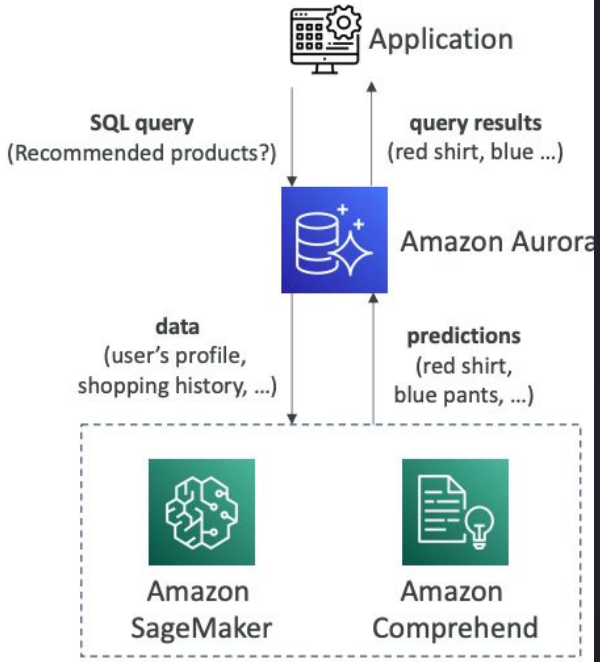
Global Aurora

- Aurora Cross Region Read Replicas:
  - Useful for disaster recovery
  - Simple to put in place
- Aurora Global Database (recommended):
  - 1 Primary Region (read / write)
  - Up to 5 secondary (read-only) regions, replication lag is less than 1 second
  - Up to 16 Read Replicas per secondary region
  - Helps for decreasing latency
  - Promoting another region (for disaster recovery) has an RTO of < 1 minute
  - Typical cross-region replication takes less than 1 second

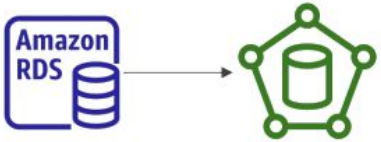


Aurora Machine Learning

- Enables you to add ML-based predictions to your applications via SQL
- Simple, optimized, and secure integration between Aurora and AWS ML services
- Supported services
  - Amazon SageMaker (use with any ML model)
  - Amazon Comprehend (for sentiment analysis)
- You don't need to have ML experience
- Use cases: fraud detection, ads targeting, sentiment analysis, product recommendations



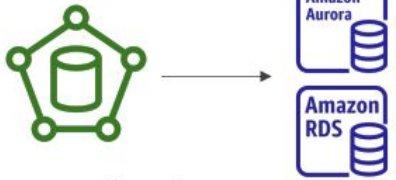
RDS Backups



- Automated backups:
  - Daily full backup of the database (during the backup window)
  - Transaction logs are backed-up by RDS every 5 minutes
  - => ability to restore to any point in time (from oldest backup to 5 minutes ago)
  - 1 to 35 days of retention, set 0 to disable automated backups
- Manual DB Snapshots
  - Manually triggered by the user
  - Retention of backup for as long as you want

- Trick: in a stopped RDS database, you will still pay for storage. If you plan on stopping it for a long time, you should snapshot & restore instead

RDS & Aurora Restore options



- Restoring a RDS / Aurora backup or a snapshot creates a new database

- Restoring MySQL RDS database from S3
  - Create a backup of your on-premises database
  - Store it on Amazon S3 (object storage)
  - Restore the backup file onto a new RDS instance running MySQL

- Restoring MySQL Aurora cluster from S3
  - Create a backup of your on-premises database using Percona XtraBackup
  - Store the backup file on Amazon S3
  - Restore the backup file onto a new Aurora cluster running MySQL

Aurora Database Cloning

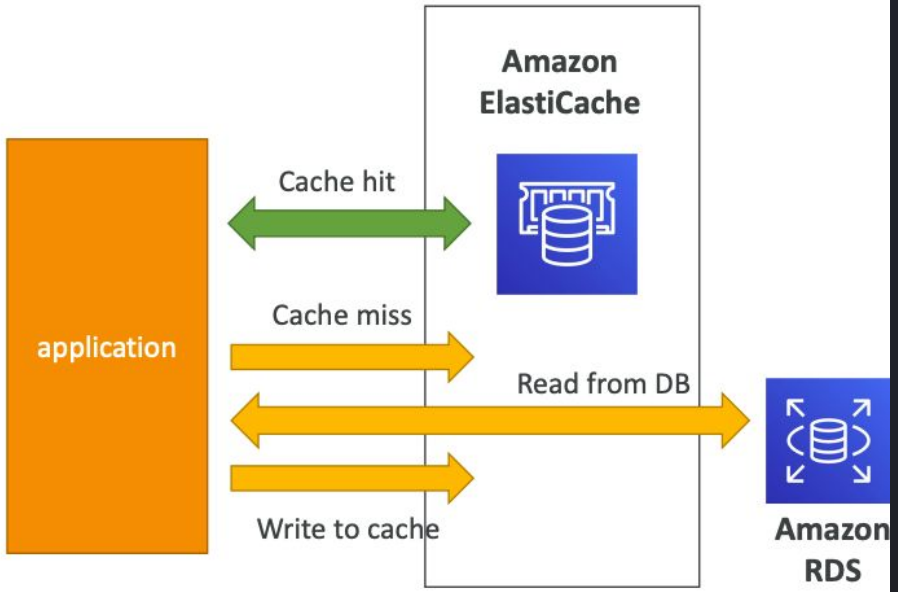
- Create a new Aurora DB Cluster from an existing one
- Faster than snapshot & restore
- Uses *copy-on-write* protocol
  - Initially, the new DB cluster uses the same data volume as the original DB cluster (fast and efficient – no copying is needed)
  - When updates are made to the new DB cluster data, then additional storage is allocated and data is copied to be separated
- Very fast & cost-effective
- Useful to create a "staging" database from a "production" database without impacting the production database

Amazon ElastiCache Overview

- The same way RDS is to get managed Relational Databases…
- ElastiCache is to get managed Redis or Memcached
- Caches are in-memory databases with really high performance, low latency
- Helps reduce load off of databases for read intensive workloads
- Helps make your application stateless
- AWS takes care of OS maintenance / patching, optimizations, setup, configuration, monitoring, failure recovery and backups
- Using ElastiCache involves heavy application code changes

ElastiCache
Solution Architecture - DB Cache

- Applications queries ElastiCache, if not available, get from RDS and store in ElastiCache.
- Helps relieve load in RDS
- Cache must have an invalidation strategy to make sure only the most current data is used in there.



ElastiCache – Redis vs Memcached

REDIS

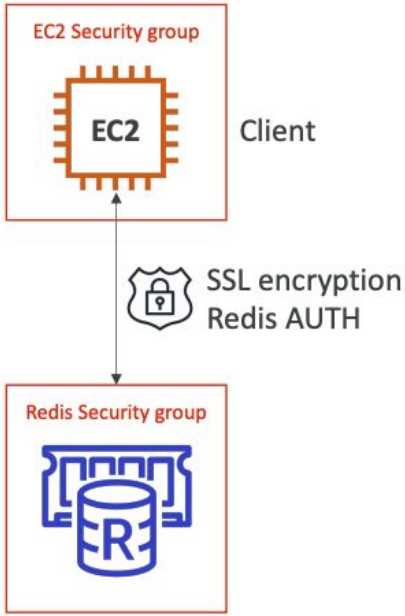
- **Multi AZ** with Auto-Failover
- **Read Replicas** to scale reads and have **high availability**
- Data Durability using AOF persistence
- **Backup and restore features**
- Supports Sets and Sorted Sets

MEMCACHED

- Multi-node for partitioning of data (sharding)
- No high availability (replication)
- Non persistent
- No backup and restore
- Multi-threaded architecture

ElastiCache – Cache Security

- ElastiCache supports IAM Authentication for Redis
- IAM policies on ElastiCache are only used for AWS API-level security
- Redis AUTH
  - You can set a "password/token" when you create a Redis cluster
  - This is an extra level of security for your cache (on top of security groups)
  - Support SSL in flight encryption
- Memcached
  - Supports SASL-based authentication (advanced)



DynamoDB

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Amazon's NoSQL database (Serverless)

Collection = Table
Document = Row

Key value pairs
JSON

MongoDB JSON format

```
{
  "_id" : ObjectId("59ef28591d47614201465112"),
  "Year" : 2017,
  "Month" : 10,
  "DayofMonth" : 14,
  "DayOfWeek" : 3,
  "DepTime" : 741,
  "CRSDepTime" : 730,
  "ArrTime" : 912,
  "CRSArrTime" : 849,
  "UniqueCarrier" : "PS",
  "FlightNum" : 1451,
  "ArrDelay" : 23,
  "DepDelay" : 11,
  "Origin" : "SAN",
  "Dest" : "SFO",
  "Distance" : 447
}
```

Amazon DynamoDB JSON format

```
{
  "depCitybyYear": "SAN-2017",
  "depTimeByFlightNum": "14-10:730|PS-1451",
  "oid__id": "59ef28591d47614201465112",
  "Year": 1987,
  "Month": 10,
  "DayofMonth": 14,
  "DayofWeek" : 3,
  "DepTime": 741,
  "CRSDepTime": 730,
  "ArrTime": 912,
  "CRSArrTime": 849,
  "UniqueCarrier": "PS",
  "FlightNum": 1451,
  "TailNum": "NA",
  "ArrDelay": 23,
  "Origin": "SAN",
  "Dest": "SFO",
  "Distance": 447
}
```

Other NoSQL on AWS

FIBO CLOUD EDUCATION

Atlas DB
DocumentDB
EC2

Amazon Neptune

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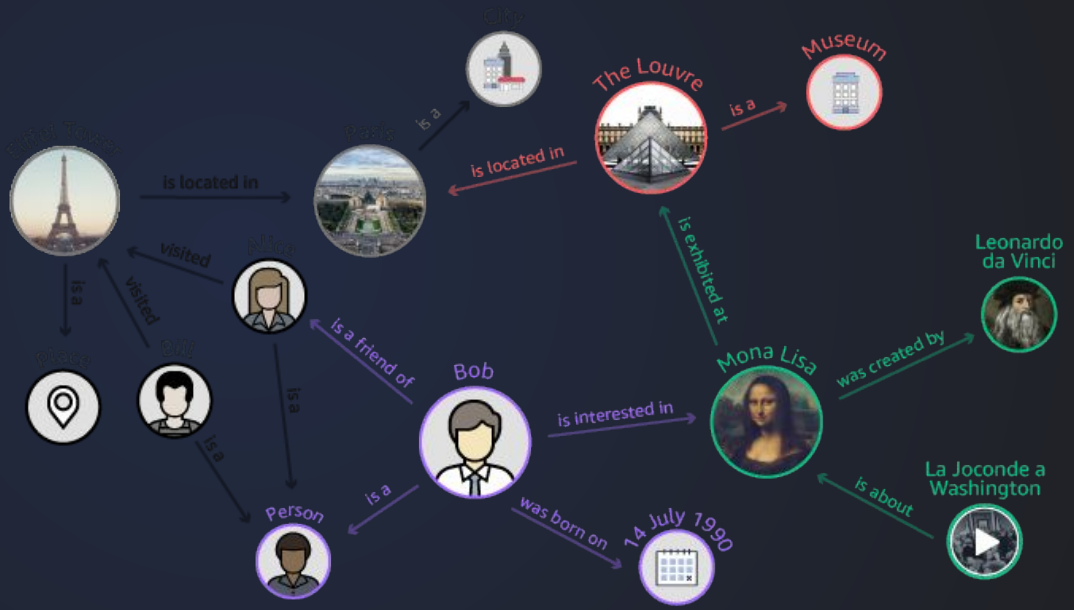
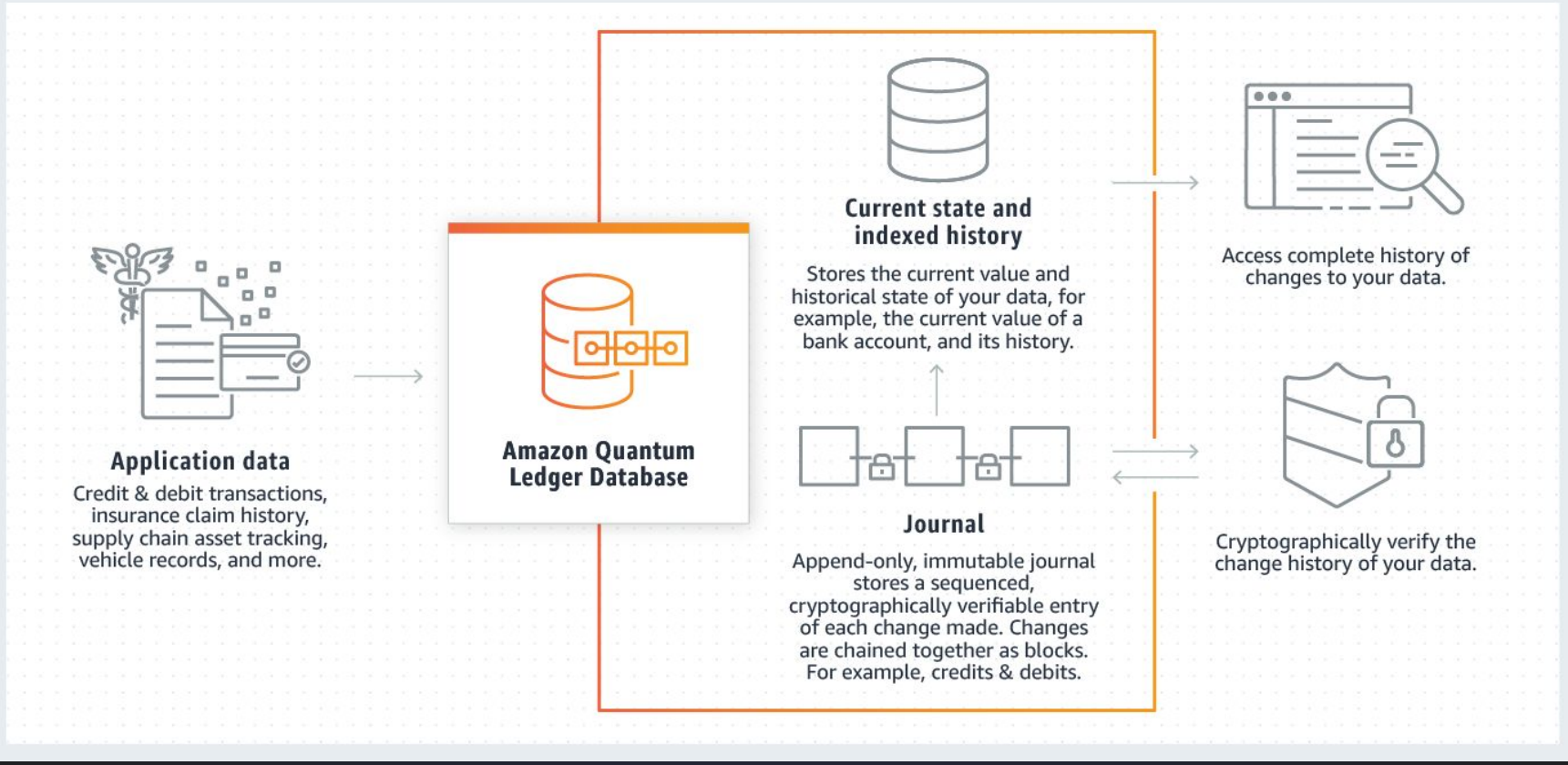


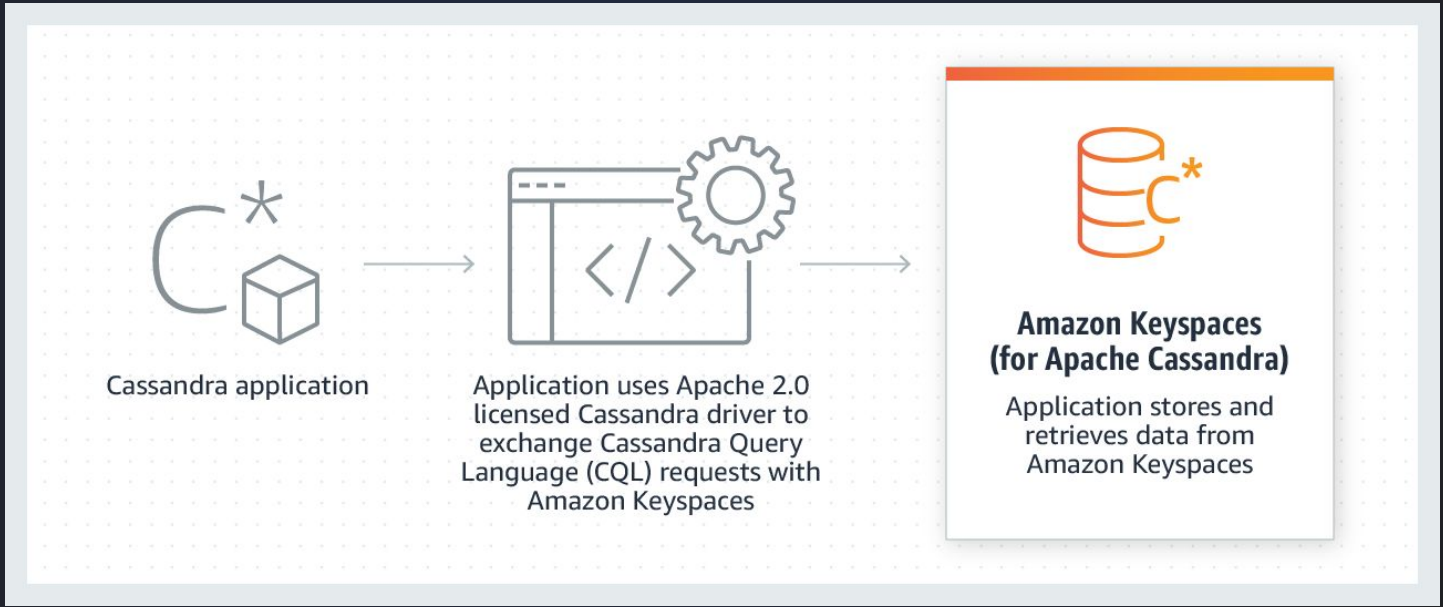
Amazon QLDB


Application data
Credit & debit transactions, insurance claim history, supply chain asset tracking, vehicle records, and more.
Amazon Quantum Ledger Database
Current state and indexed history
Stores the current value and historical state of your data, for example, the current value of a bank account, and its history.
Journal
Append-only, immutable journal stores a sequenced, cryptographically verifiable entry of each change made. Changes are chained together as blocks. For example, credits & debits.
Access complete history of changes to your data.
Cryptographically verify the change history of your data.

AWS Keyspaces

FIBO CLOUD EDUCATION

Serverless NoSQL



Amazon Timestream

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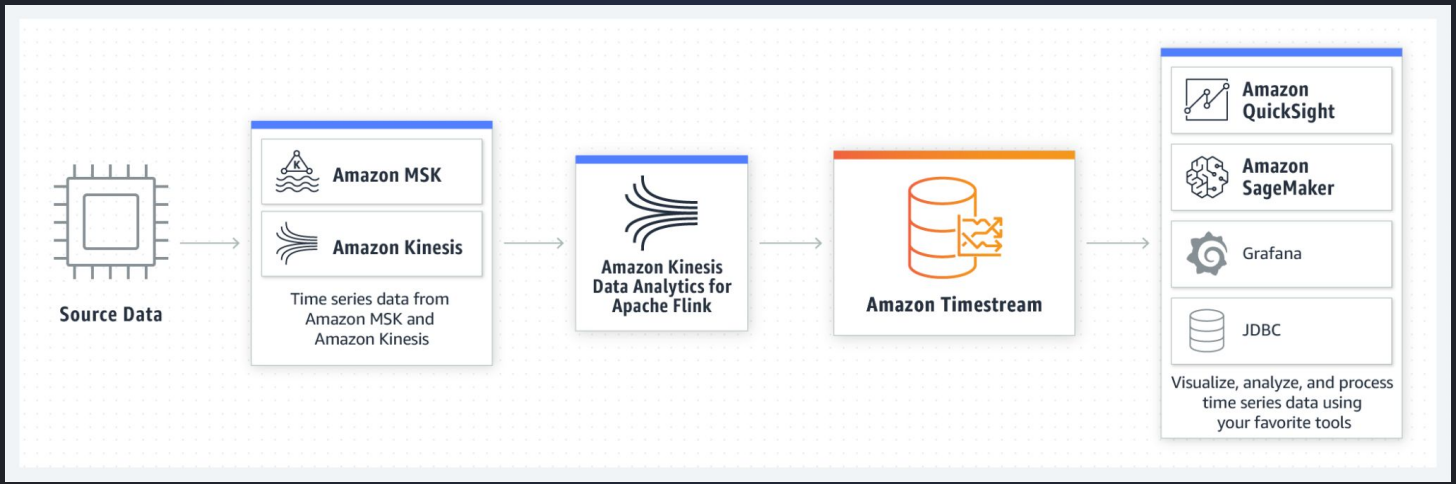

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https://www.altexsoft.com/blog/business/comparing-database-management-systems-mysql-postgresql-mssql-server-mongodb-elasticsearch-and-others/

https://insights.stackoverflow.com/survey/2020#technology-databases-all-respondents4

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