INNOVATE

DATA EDITION

19 August 2021

Extreme performance at cloud scale: Supercharge your real-time applications with Amazon ElastiCache

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Agenda

- In-memory Datastore Fundamentals
- Caching Concepts
- Lazy Loading Pattern
- Amazon ElastiCache for Redis
- Best Practices

In-memory Datastore Fundamentals

Datastore Trait Comparison

Feature	Disk	In-memory
Writes / Reads	Disk	Memory
Engine latency	Milliseconds (ms)	Microseconds (µs)
Performance bottleneck	Disk	Network
Throughput	Moderate	High
Data	Data models	Rich data structures

Why Performance Matters

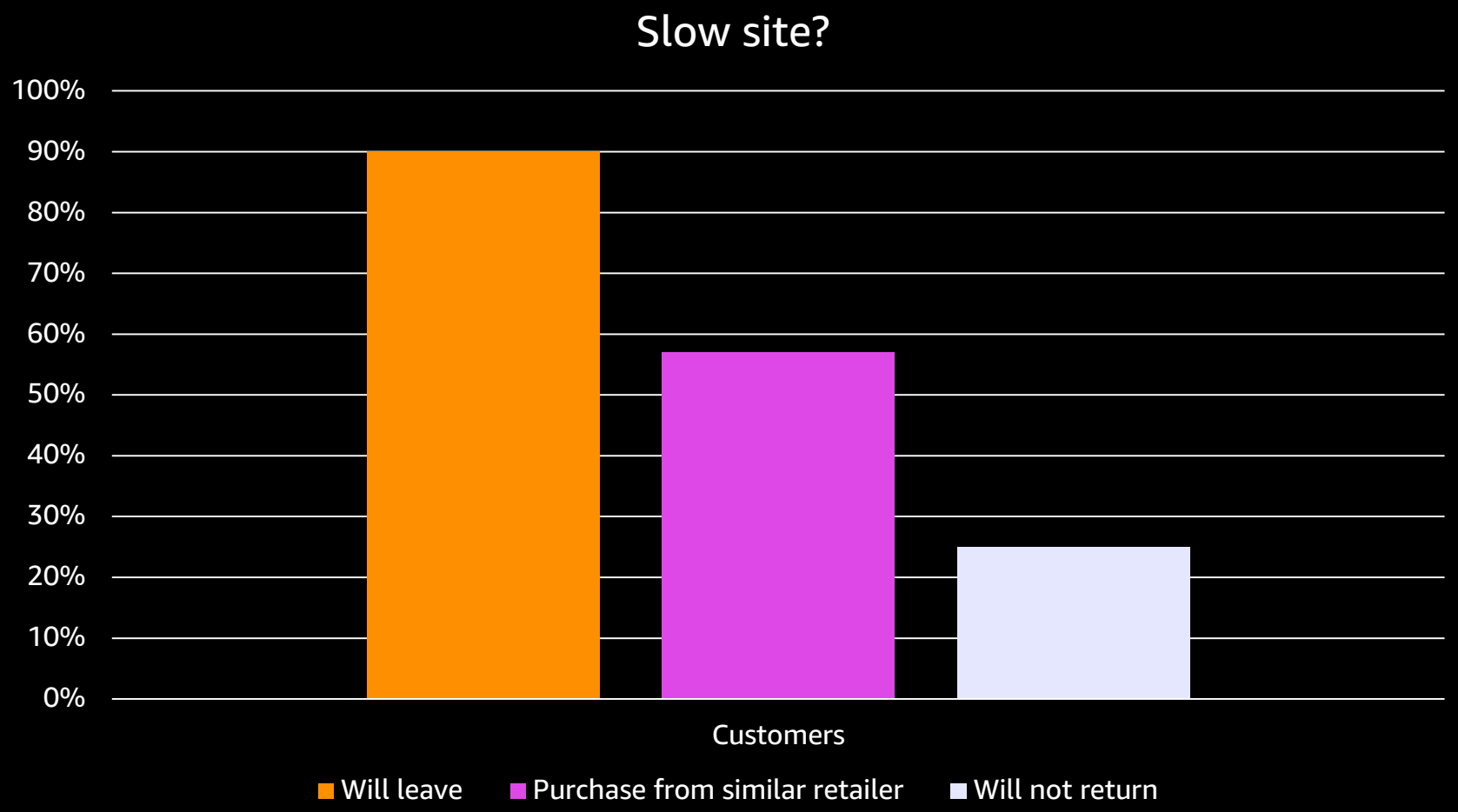
“A 100-millisecond delay in website load time can hurt conversion rates by 7 percent.”

"A two-second delay in web page load time increases bounce rate by 103 percent."

– 2017 Akamai Study

https://www.akamai.com/uk/en/about/news/press/2017-press/akamai-releases-spring-2017-state-of-online-retail-performance-report.jsp

Why Performance Matters



https://www.businessnewsdaily.com/15160-slow-retail-websites-lose-customers.html

The Need for Speed

FAST: Memory is at least 50x faster than SSDs

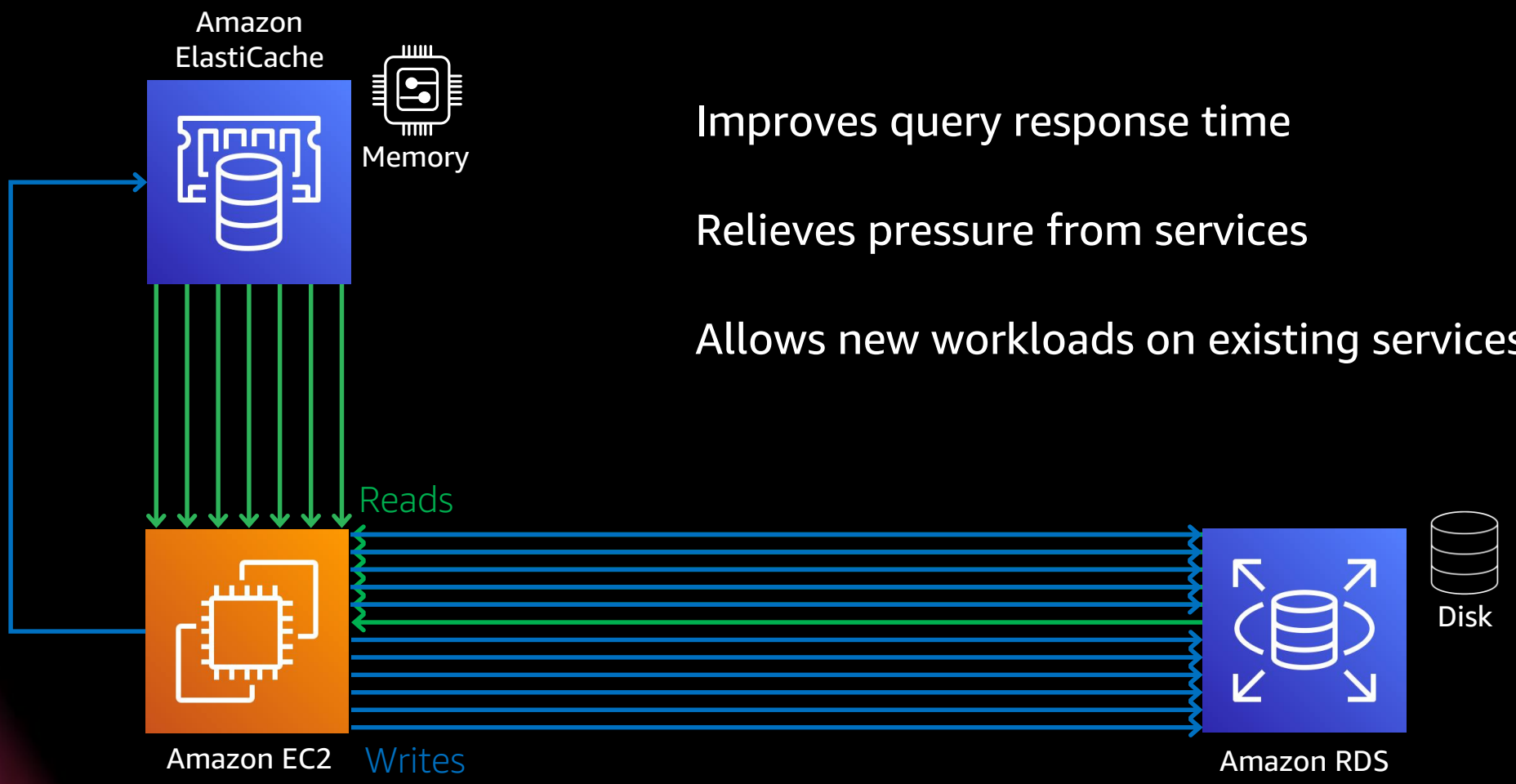
PREDICTABLE: Key-based index, no disk seek time

µs is the new ***ms***

Amazon
ElastiCache

Caching Concepts

Caching Concepts

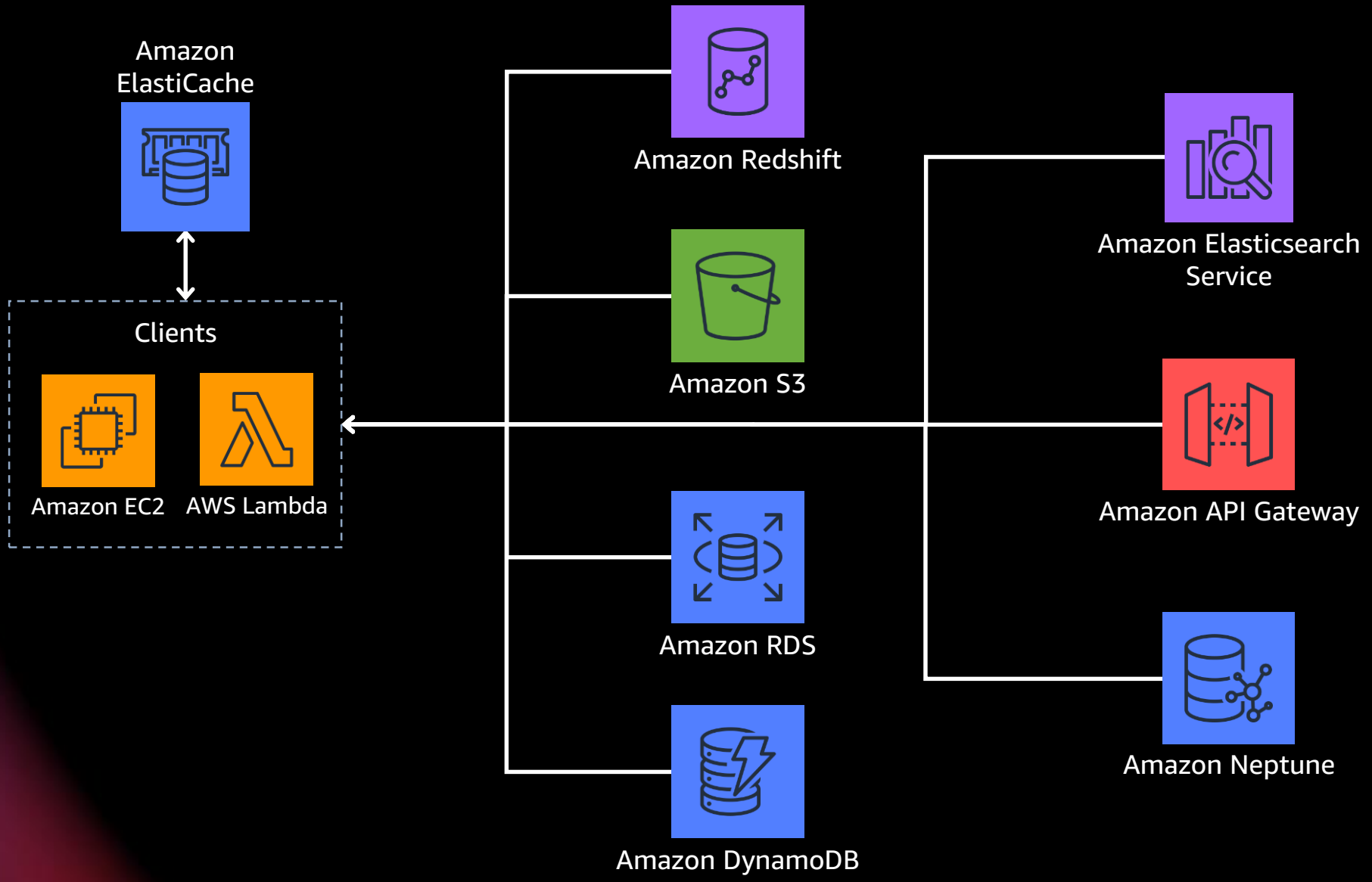


Improves query response time

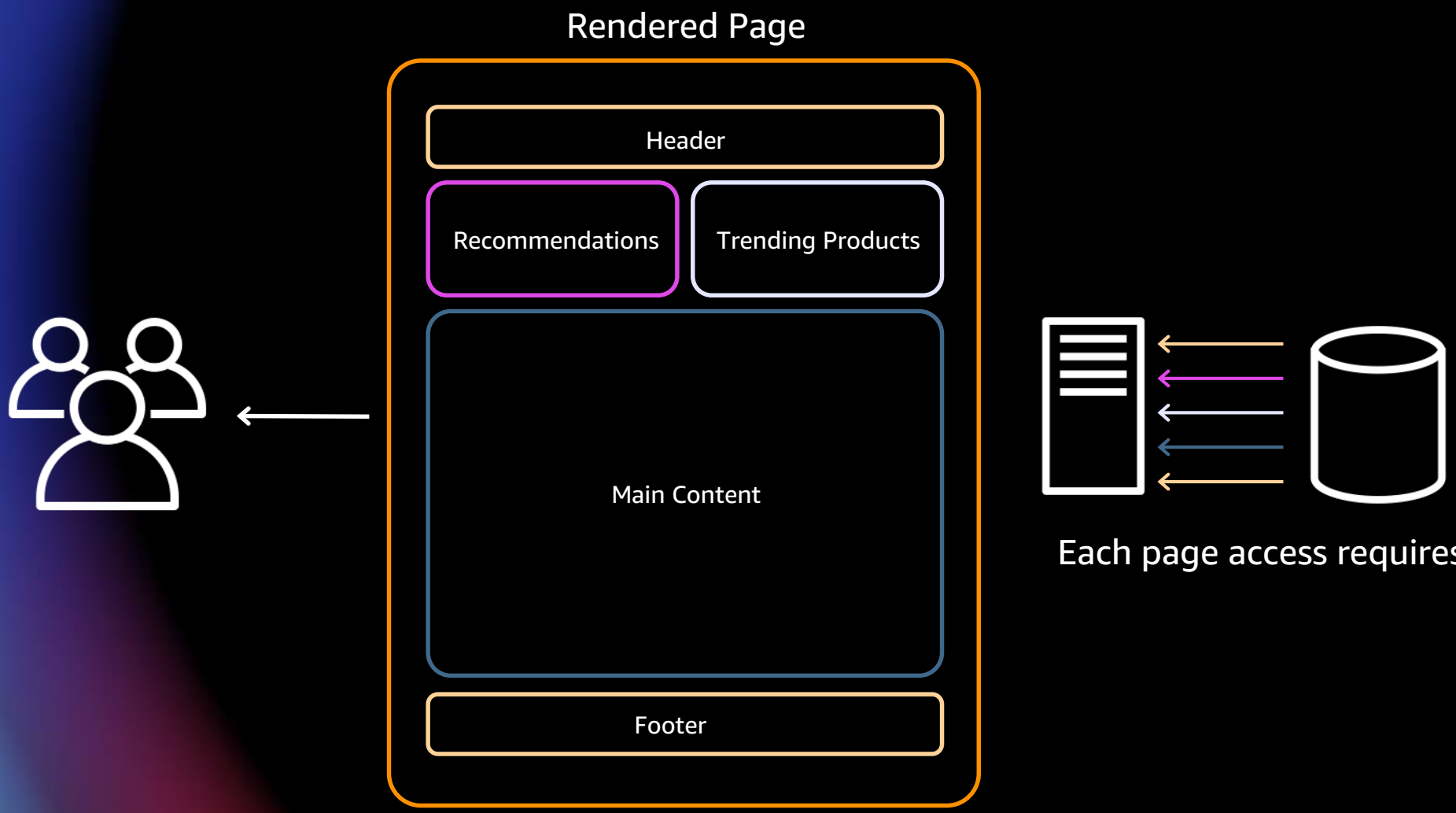
Relieves pressure from services

Allows new workloads on existing services

Caching Concepts

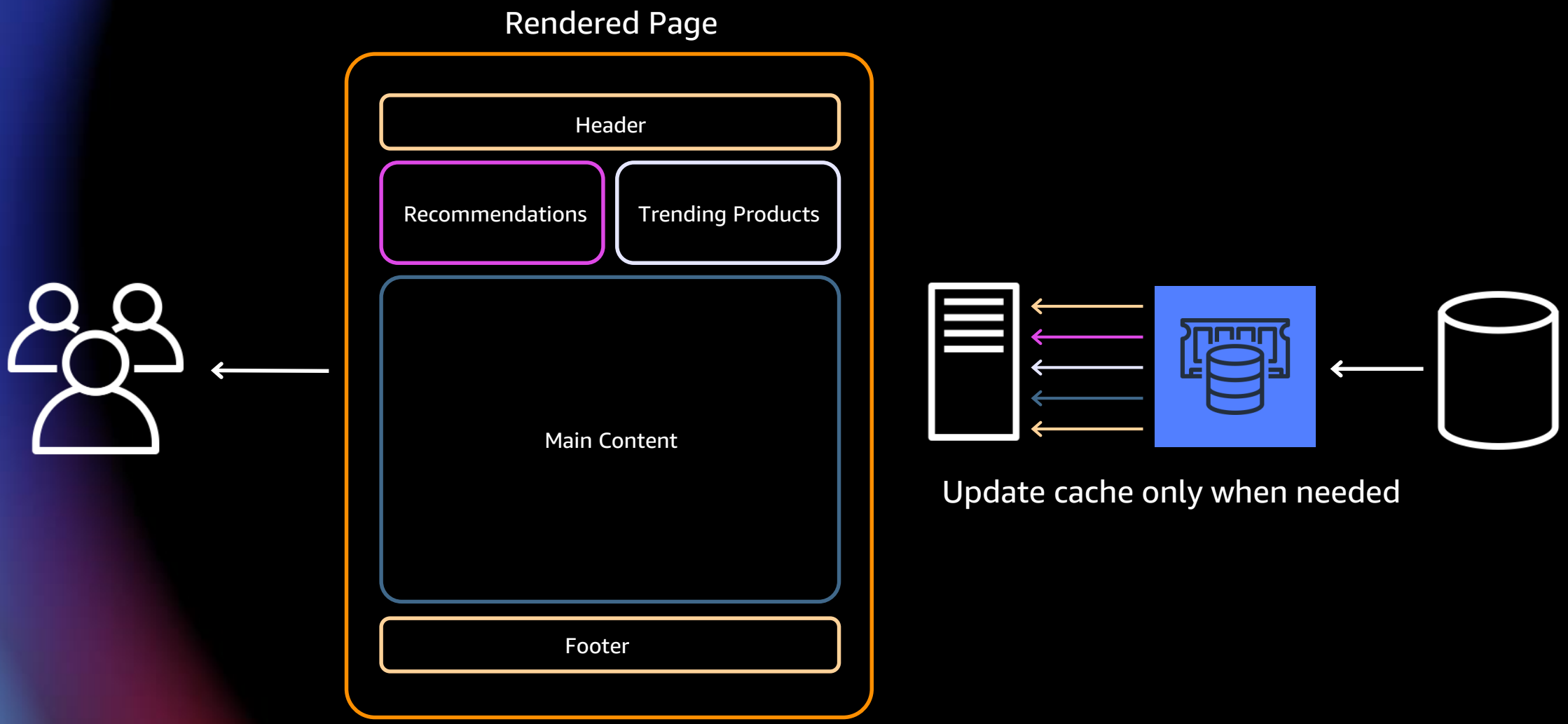


Caching Concepts

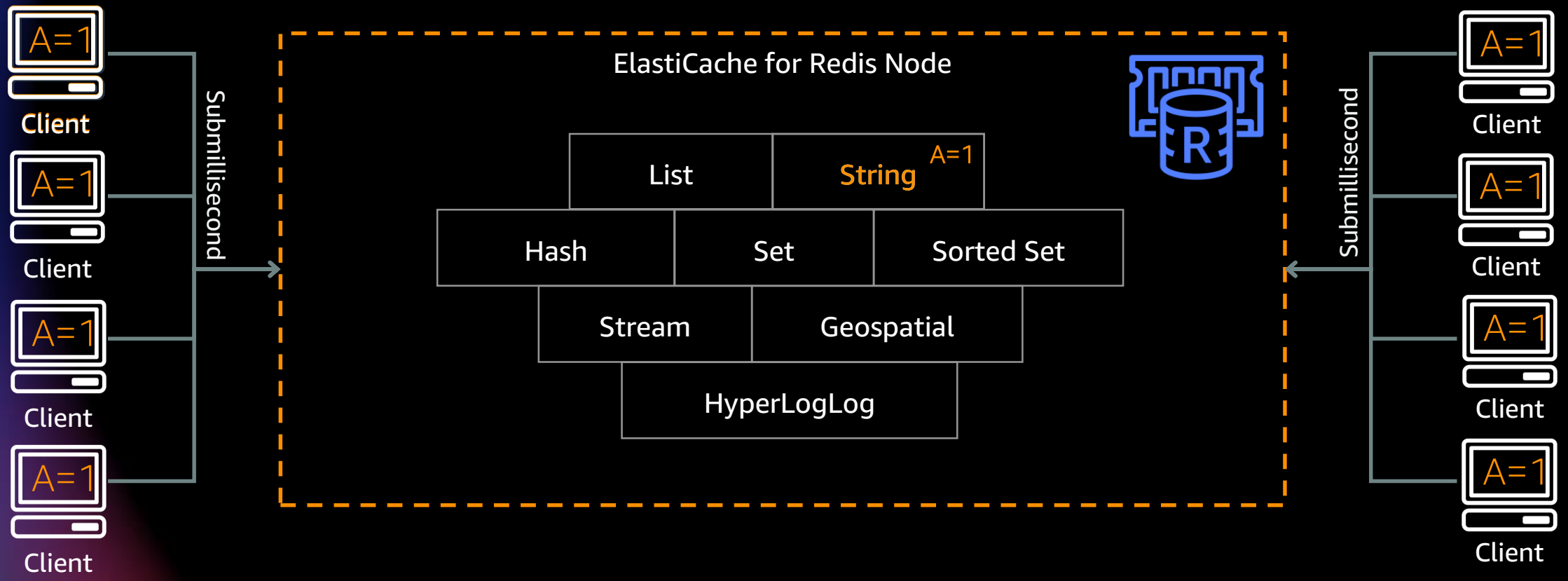


Each page access requires multiple database queries

Caching Concepts

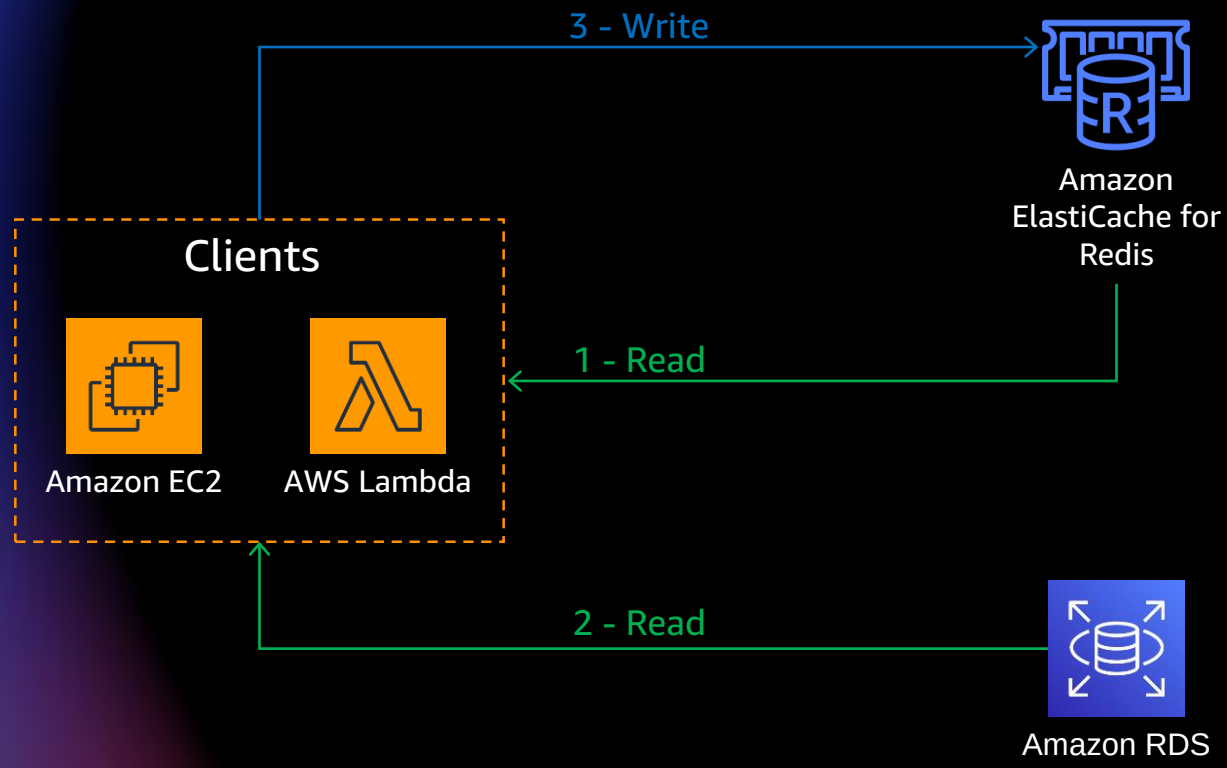


Caching Concepts - Data Structures



Lazy Loading Pattern

Lazy Loading



1. Read from cache
2. Read from source (if miss)
3. Write to cache

Advantages

- Avoids unnecessary data in cache
- Cache can be repopulated at anytime
- Immediate benefit

Disadvantages

- Cache miss may be expensive
- Data "freshness" factor

Lazy Loading

```
> SELECT
    customers.name, SUM(orders.num_items)
  FROM
    customers, orders
  WHERE
    customers.id = X AND
    orders.customer_id = customers.id
```

MD5 Hash

"ecf361704f15aa0e26e3b24e1ce6d1d6"

Key

ecf361704f15aa0e26e3b24e1ce6d1d6

~32 bytes

Value

"\x80\x03M\xd2\x06cdecimal\nDecimal\n…"

~140 bytes

Lazy Loading

```
def fetch(sql):

  key=get_md5_hash(sql)

  if r.get(key) is not None:
    return pickle.loads(value)

  else:
    cursor=m.cursor()
    cursor=execute(sql)
    value=cursor.fetchall()
    r.setex(key, TTL, pickle.dumps(value))
    return value
```

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Lazy Loading

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    return value
```

```
SELECT
  COUNT(*) FROM users
WHERE . . .
```

```
SELECT
  customers.customer_id,
  reviews.review_id
FROM customers, reviews
WHERE . . .
```

Amazon RDS Caching Example

Step 1: Query cache

Step 2: Read from source

Step 3: Write to cache

```python
import pymysql, redis, pickle, hashlib

m = pymysql.connect('rds_host', ...)
r = redis.Redis(host='elasticache_endpoint', ...)

### Pass in SQL string
sql = "SELECT ... FROM ..."

### Convert SQL string into a shorter, unique hash for use as Redis key
key = hashlib.sha224(sql.encode('utf-8')).hexdigest()

### Check for value in Redis
value = r.get(key)

if value is None:

    print ("Cache Miss")

    ### Fetch result set from RDS
    cursor=m.cursor()
    cursor.execute(sql)
    value = cursor.fetchall()

    ### Store full result set in Redis
    r.psetex(key, pickle.dumps(value))
    return value

else:

    ### Return cached result set from Redis
    print ("Cache Hit")
    return pickle.loads(value)
```

Amazon S3 Caching Example

Step 1: Query cache

Step 2: Read from source

Step 3: Write to cache

```
import boto3
import redis

r = redis.StrictRedis(host="elasticache_endpoint", port=6379)
s3 = boto3.resource('s3')

### Pass in s3_bucket_name and s3_object_key and
### check to see if value is in Redis
value = r.get(s3_bucket_name + ':' + s3_object_key)

if value is None:

    print("Cache Miss")

    ### Get data from S3
    obj = s3.Object(s3_bucket_name, s3_object_key)
    data = obj.get()['Body'].read().decode('utf-8')

    ### Store the data into Redis
    r.set(s3_bucket_name + ':' + s3_object_key, data)

else:

    print("Cache Hit")
    print("Data retrieved from redis = " + value)
```

Amazon ElastiCache for Redis

Amazon ElastiCache

Fully managed

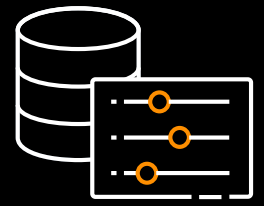
AWS manages all hardware and software setup, configuration, monitoring.

Extreme performance

In-memory data store and cache for sub-millisecond response times.

Scalable

Write and memory scaling with sharding.
Non-disruptive scaling.
Read scaling with replicas.



OSS compatible

Fully compatible with open source.

Redis Community

"Most popular key-value store"

Rank			DBMS	Database Model	Score		
Dec 2020	Nov 2020	Dec 2019			Dec 2020	Nov 2020	Dec 2019
1.	1.	1.	Redis	Key-value, Multi-model	153.63	-1.79	+7.39
2.	2.	2.	Amazon DynamoDB	Multi-model	69.12	+0.23	+7.49
3.	3.	3.	Microsoft Azure Cosmos DB	Multi-model	33.54	+1.04	+2.11
4.	4.	4.	Memcached	Key-value	25.89	+0.15	+1.43

– DB-Engines.com

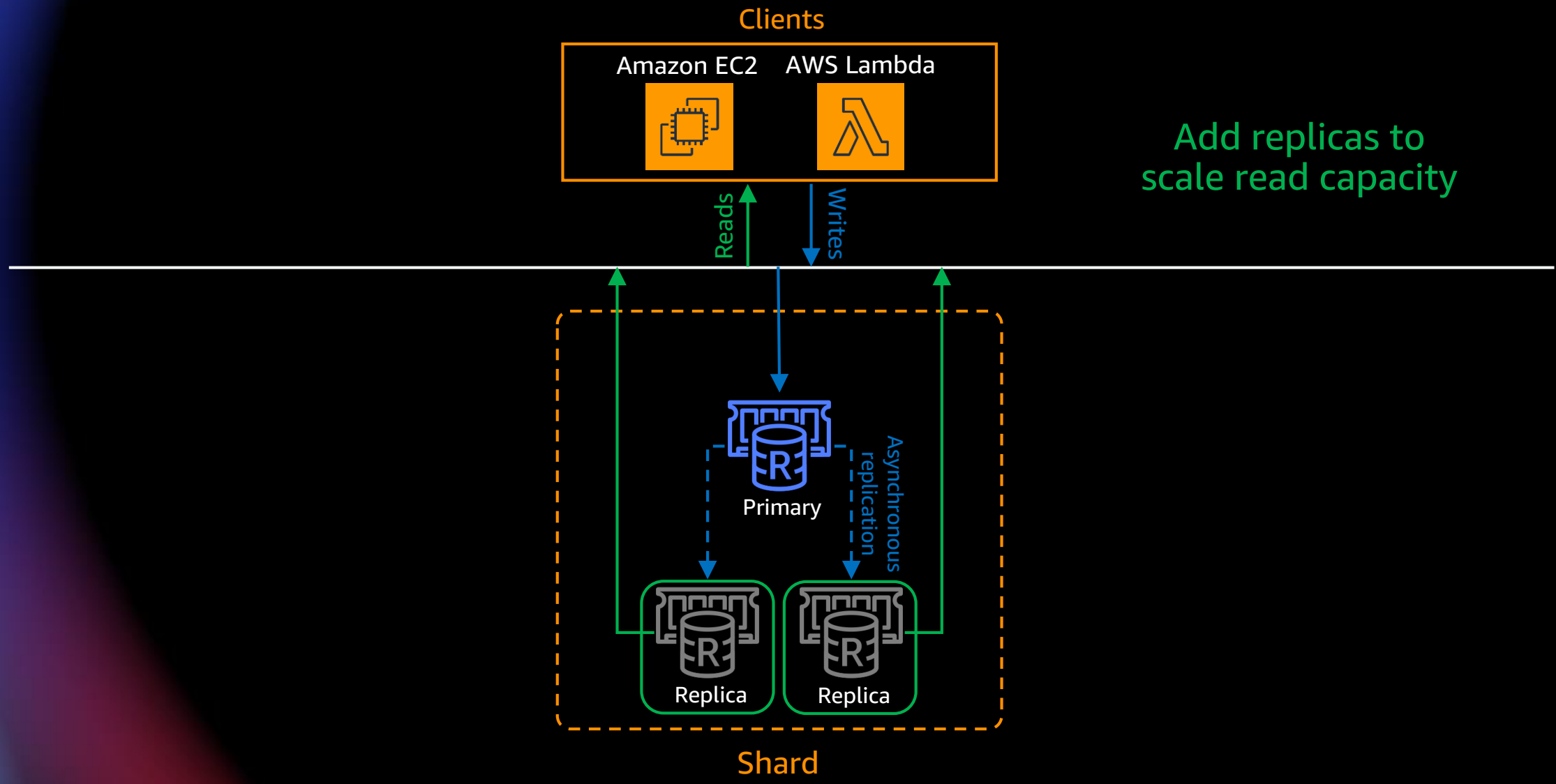
https://db-engines.com/en/ranking/key-value+store

"Most loved database"

- Stack Overflow

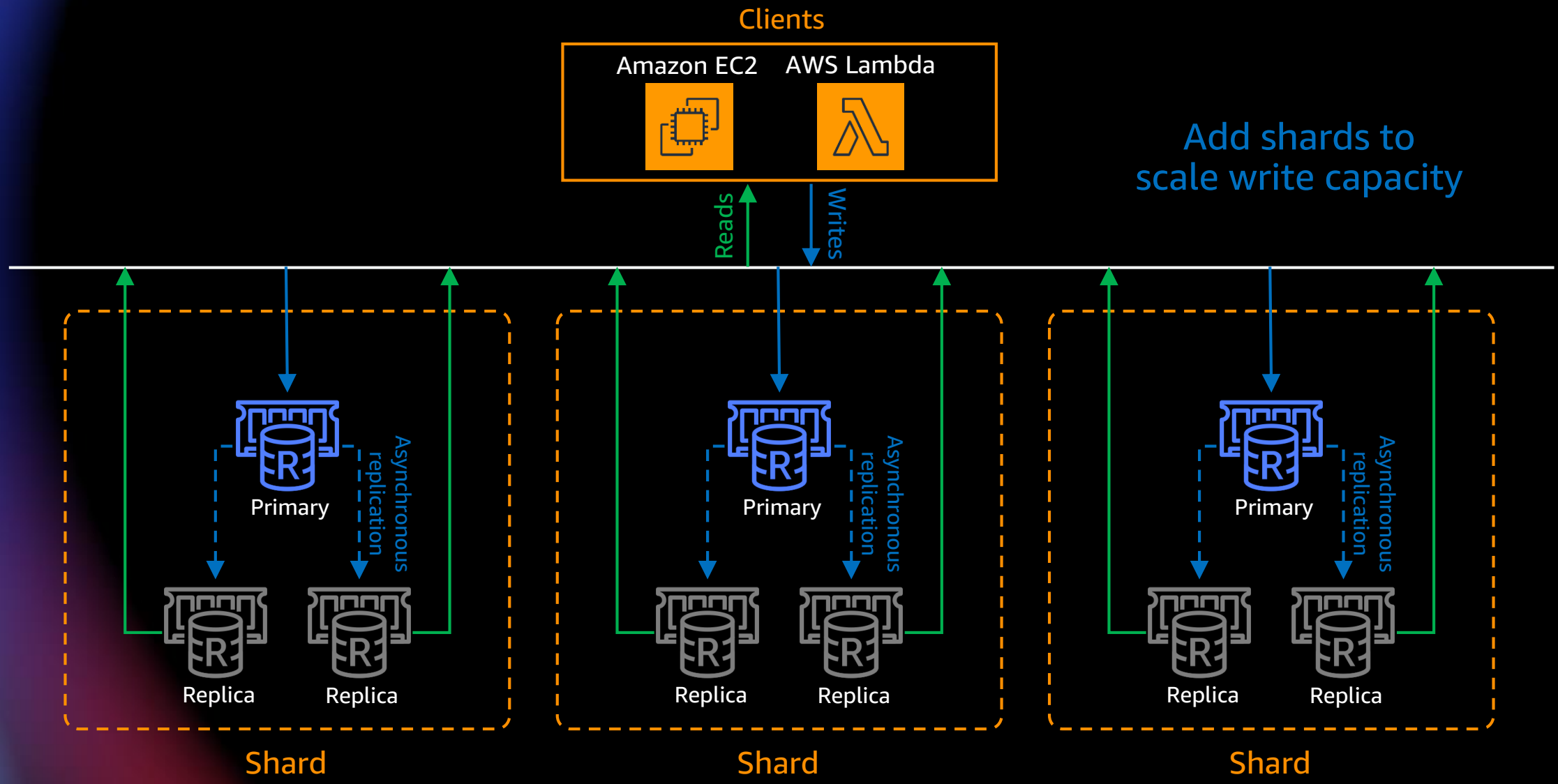
https://insights.stackoverflow.com/survey/2020#technology-most-loved-dreaded-and-wanted-databases-loved4

Scaling Reads

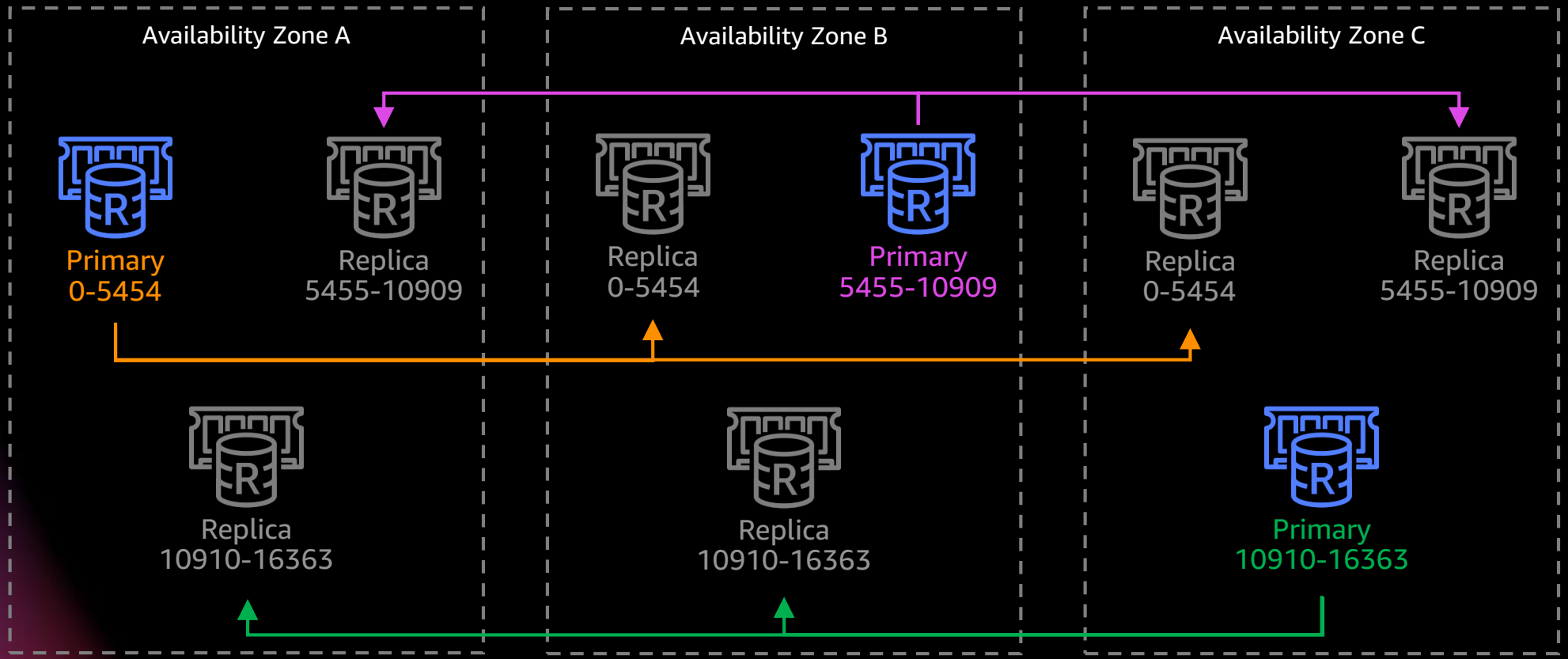


Add replicas to scale read capacity

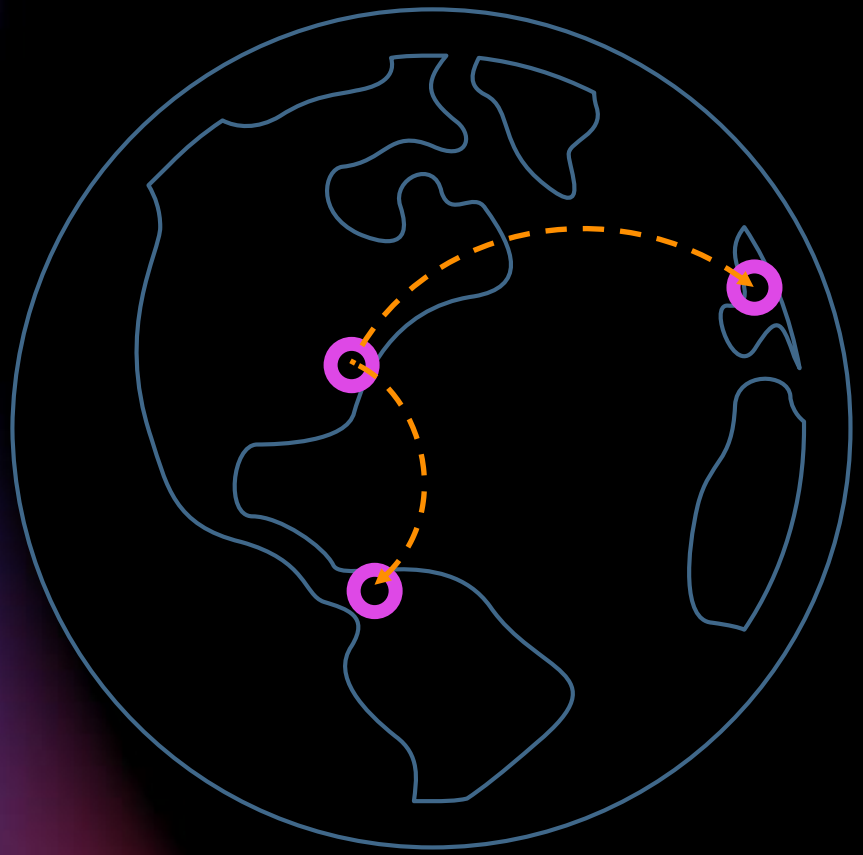
Scaling Writes



High Availability



Global Datastore



Fully managed, fast, reliable, secure cross-region replication

- Disaster Recovery
- Low latency reads
- Replication typically < 1s

Best Practices

Best Practices - Evictions

Keys can be automatically removed when memory is full

Policy Name	Description
allkeys-lru	Evicts the least recently used (LRU) regardless of TTL set
volatile-lru*	Evicts the least recently used (LRU) from those that have a TTL set
allkeys-lfu	Evict any key using approximated least frequently used (LFU)
volatile-lfu*	Evict using approximated LFU among the keys with a TTL set
volatile-ttl*	Evicts the keys with shortest TTL set
volatile-random*	Randomly evicts keys with a TTL set
allkeys-random	Randomly evicts keys regardless of TTL set
no-eviction	Doesn't evict keys at all. This blocks future writes until memory frees up.

** Volatile policies only evicts keys with TTLs*

Best Practices - Time To Live (TTL)

Assign freshness factor / expiry

Explicitly assign to individual keys (they are not global)

Assign during creation / modification of key

Some keys should not have TTLs

Set TTL as relative (`EXPIRE`/`PEXPIRE`) or fixed time (`EXPIREAT`)

Add a random jitter (+/-)

Best Practices - Clients

Connections

- Connection pooling reduces client and server CPU overhead
- Use exponential back-off for reconnects

Reads or Writes

- Connect to read replicas ('`readonly`' parameter) for reads
- Use the reader endpoint for replicas (cluster-mode-disabled only)

Performance

- Pipelines greatly increase throughput for bulk inserts
- Use '`CLIENT REPLY {OFF|ON|SKIP}`' to control server responses
- Ensure client library supports Redis cluster mode

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