Database: DynamoDB

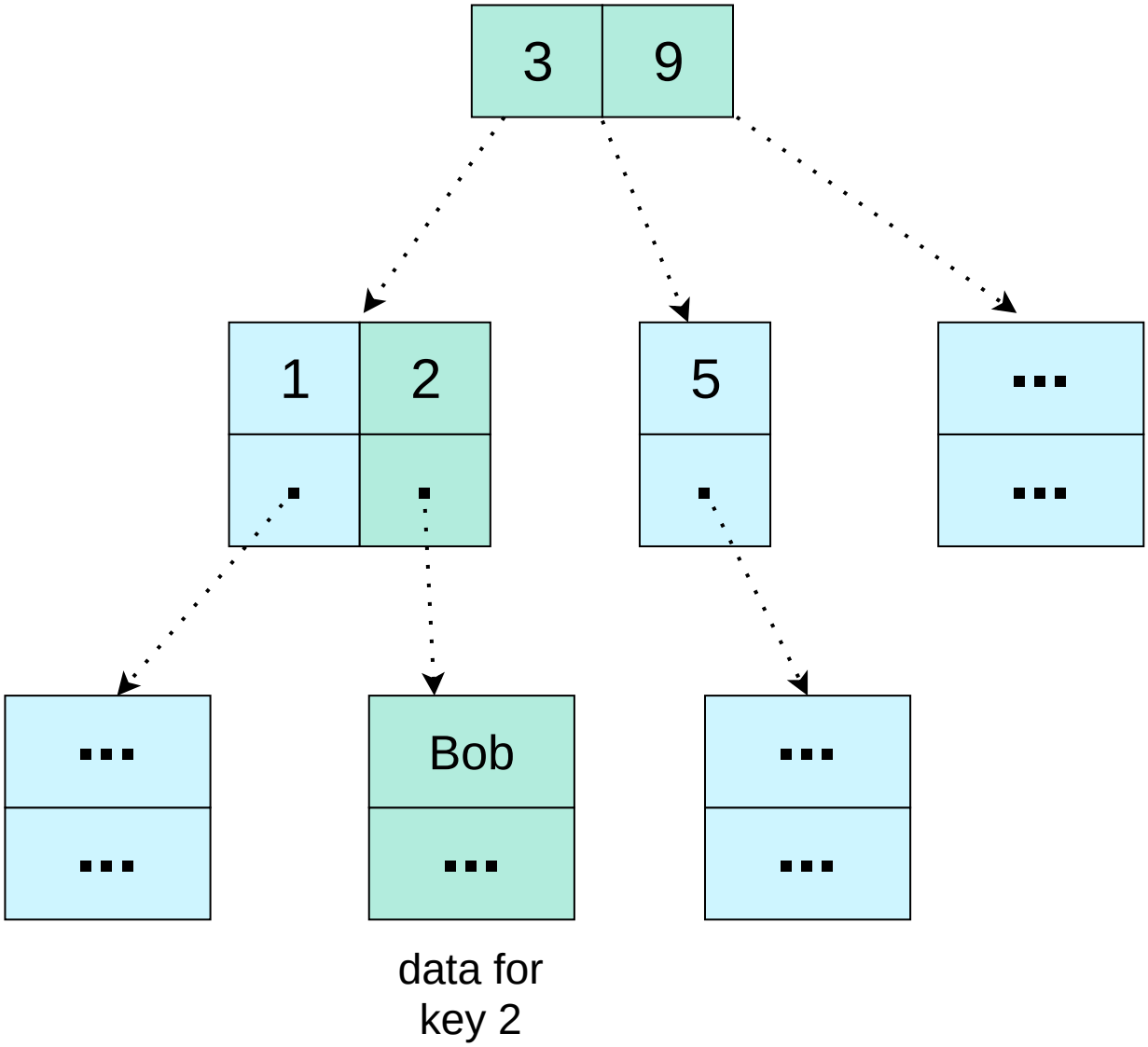
DynamoDB features, the pros and cons of DynamoDB indexes and when it is a great default choice for a database will be discussed in this lesson. To conclude, we will list down our recommendations on the use of DynamoDB indexes.

We'll cover the following

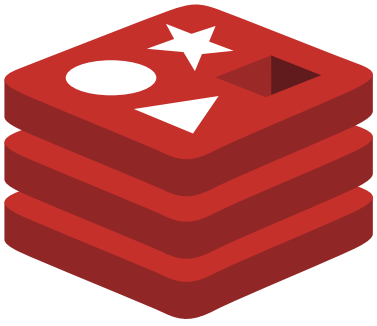
- DynamoDB vs relational database
- Query processing
- Storage cost
- Request pricing
  - On-demand
  - Provisioned capacity
- DynamoDB indexes
  - Local indexes
  - Global indexes

Data structure in the cloud

Amazon describes DynamoDB as a database, but it’s best seen as a highly-durable data structure in the cloud. A partitioned B-tree data structure, to be precise.



B tree of customer data and their keys



DynamoDB is much more similar to a **Redis** than it is to a **MySQL**. But, unlike **Redis**, it is immediately consistent and highly-durable, centered around that single data structure. If you put something into DynamoDB, you'll be able to read it back immediately and, for all practical purposes, you can assume that what you have put will never get lost.

It is true that DynamoDB can replace a relational database, but only if you think you can get away with storing all your data in a primitive B-tree. If so, then DynamoDB makes a great default choice for a database.

DynamoDB vs relational database#

The following table shows some high-level differences between DynamoDB and relational database:

DynamoDB	Relational Database
Suitable for web-scale applications, including social networks, gaming, media sharing, and Internet of Things (IoT).	Suitable for ad hoc queries; data warehousing; OLAP (online analytical processing).
DynamoDB is schemaless. DynamoDB can manage structured or semistructured data, including JSON documents.	The relational model requires a well-defined schema, where data is normalized into tables, rows, and columns.
DynamoDB requires you to do most of the data querying yourself within your application. You can either read a single value out of DynamoDB, or you can get a contiguous range of data.	Most of the data quering and processing is done close to the data side.
In DynamoDB, if you want to aggregate filter or sort, you have to do that yourself, after you receive the requested data range.	Data aggregation and sorting is done at the data side and the final summary is sent to application.

Query processing#

Having to do most query processing on the application side isn't just inconvenient. It also comes with performance implications. Relational databases run their queries close to the data, so if you're trying to calculate the sum total value of orders per customer, then that rollup gets done while reading the data, and only the final summary (one row per customer) gets sent over the network. However, if you were to do this with DynamoDB, you'd have to get all the customer orders (one row per order), which involves a lot more data over the network, and then you have to do the rollup in your application, which is far away from the data. This characteristic will be one of the most important aspects of determining whether DynamoDB is a viable choice for your needs.

Storage cost#

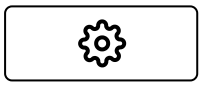
Another factor to consider is cost. As you can see in the table below, storing 1 TB in DynamoDB costs more as compared to storing 1 TB in S3.

1 TB in DynamoDB	1 TB in S3
$256/month	$23.55/month

Data can also be compressed much more efficiently in S3, which could make this difference even bigger.

However, *storage cost is rarely a large factor when deciding whether DynamoDB is a viable option. Instead, it's generally* ***request pricing*** *that matters most.*

Q



One of the major differences between DynamoDB and relational database is that in DynamoDB, data aggregration is done close to the data as opposed to relational database.

A) True

B) False

Submit Answer

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Request pricing#

On-demand#

By default, you should start with DynamoDB's on-demand pricing and only consider the provisioned capacity as cost optimization. On-demand costs $1.25 per million writes, and $0.25 per million reads. Now, since DynamoDB is such a simple data structure, it's often not that hard to estimate how many requests you will need. You will likely be able to inspect your application and map every logical operation to a number of DynamoDB requests. For example, you might find that serving a web page will require four DynamoDB **read** requests. Therefore, if you expect to serve a million pages per day, your DynamoDB requests for that action

would cost $1/day.

Let's do a fun exercise: Use the below widget to calculate the on-demand cost when $0.25 is the cost per million reads. You just have to put the *number* of **read** requests (in millions) required for serving a web page, in the first cell. It will automatically generate the cost in the next cell.

No. of read request (millions per second)	On-demand read cost ($)
4	*f* 1

Here's another activity: Use the below widget to calculate the on-demand cost when $1.25 is the cost per million writes. You just have to put the *number* of **write** requests required for serving a web page, in the first cell. It will automatically generate the cost in the next cell.

	A	B
1	No. of write request (millions per second)	On-demand write cost ($)
2	100	*f* 125

Provisioned capacity#

If the performance characteristics of DynamoDB are compatible with your application and the on-demand request pricing is in the ballpark of

acceptability, you can consider switching to provisioned capacity. On

paper, that same workload that cost $1/day to serve 1 million pages would only cost $0.14/day with provisioned capacity, which seems like a very spectacular cost reduction. However, this calculation assumes that:

- Requests are evenly distributed over the course of the day
- There is absolutely zero capacity headroom. (You would get throttled if there were a million and one requests in a day.)

Obviously, both of these assumptions are impractical. In reality, you're going to have to provide abundant headroom in order to deal with the peak request rate, as well as to handle any general uncertainty in demand. With provisioned capacity, you will have the burden to monitor your utilization and proactively provision the necessary capacity.

Let's do a fun exercise: Use the below widget to calculate the provisioned cost when $0.00013 is the cost per read capacity unit (RCU) per hour. You just have to put the *number* of **read** requests per hour required for serving a web page, in the first cell. It will automatically generate the cost in the next cell.

No. of read requests per hour	Provisioned read cost per hour ($)
50000	*f* 6.499999999999999

Here's another activity: Use the below widget to calculate the provisioned cost when $0.00065 is the cost per write capacity unit (WCU) per hour. You just have to put the *number* of **write** requests per hour required for serving a web page, in the first cell. It will automatically generate the cost in the next cell.

No. of write requests per hour	Provisioned write cost per hour ($)
50000	*f* 32.5

In general:

- You will almost always want to start with on-demand pricing (no capacity management burden).
- Then, if your usage grows significantly, you will almost always want to consider moving to provisioned capacity (significant cost savings).

However, if you believe that on-demand pricing is too expensive, then DynamoDB will very likely be too expensive, even with provisioned capacity. In that case, you may want to consider a relational database, which will have very different cost characteristics than DynamoDB.

It is important to note that:

- With on-demand pricing, the capacity you get is not perfectly on-demand. Behind the scenes, DynamoDB adjusts a limit on the number of reads and writes per second, and these limits change based on your usage. However, this is an opaque process and, if you want to ensure that you reserve capacity for big fluctuations in usage, you may want to consider using provisioned capacity for peace of mind.

> **NOTE:** It is very important to note that the prices mentioned above are only for the purpose of understanding cost comparisons. These prices are subject to change anytime by AWS. Therefore, most current prices should be referenced for final business decisions.

Q With on-demand request pricing, you will have the burden to monitor your utilization and proactively provision the necessary capacity.

A) True

B) False

Submit Answer

Reset Quiz

DynamoDB indexes#

A final word about DynamoDB indexes. They come in two flavors:

- Local indexes
- Global indexes

Local indexes came first in early 2013, and global indexes were added just a few months later.

Local indexes#

The only advantage of local indexes is that they're immediately consistent, but they do come with a very insidious downside. Once you create a local index on a table, the property that allows a table to keep

growing indefinitely goes away. Local indexes come with the constraint

that all the records that share the same partition key need to fit in 10 GB, and once that allocation gets exhausted, all write operations with that partition key will start failing.

Global indexes#

On the other hand, global indexes don't constrain your table size in any way, but reading from them is eventually consistent (although the delay is almost always unnoticeable). Global indexes also have one insidious downside, but for most scenarios, it is much less worrisome than that of local indexes.

DynamoDB has an internal queue-like system between the main table and the global index, and this queue has a fixed (but opaque) size. Therefore, if the provisioned throughput of a global index happens to be insufficient to keep up with updates on the main table, then that queue can get full. When that happens, disaster strikes:

- All write operations on the main table start failing.

The most problematic part of this behavior is that there's no way to monitor the state of this internal queue. So, the only way to prevent it is:

- To monitor the throttled request count on all your global indexes, and then to react quickly to any throttling by provisioning additional capacity on the affected indexes.

Nevertheless, this situation tends to only happen with highly active tables, and short bursts of throttling rarely cause this problem. Global indexes are still very useful, but keep in mind the fact that they're eventually consistent and that they can indirectly affect the main table in a very consequential manner if they happen to be underprovisioned.

In the next lesson, we will take a look at when should we use S3.

← Back

Next →

The Default Heuristic

Storage: S3

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