Under the Covers of DynamoDB

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amazon web services

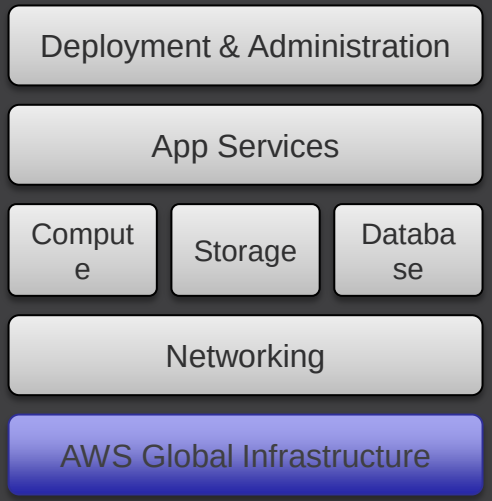
Overview

1. Getting started
2. Data modeling
3. Partitioning
4. Replication & Analytics

1

Getting started

Global infrastructure



Regions

An independent collection of AWS resources in a defined geography

A solid foundation for meeting location-dependent privacy and compliance requirements

Availability Zones

Designed as independent failure zones

Physically separated within a typical metropolitan region

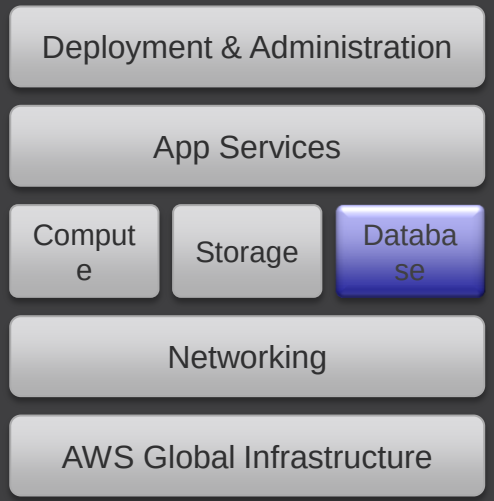
Edge Locations

To deliver content to end users with lower latency

A global network of edge locations

Supports global DNS infrastructure (Route53) and CloudFront CDN

Database



Relational Database Service (RDS)

Database-as-a-Service – MySQL, Oracle, MS SQL Server, PostgreSQL

No need to install or manage database instances

Scalable and fault tolerant configurations

DynamoDB

Provisioned throughput NoSQL database

Fast, predictable performance

Fully distributed, fault tolerant architecture

SimpleDB

Redshift

Data Warehouse Service up to Petabyte

Cost effective, fully managed

Easy connection to BI solutions

DynamoDB is a managed NoSQL database service.

Store and retrieve any amount of data.

Serve any level of request traffic.

Without the operational burden.

Consistent, predictable performance.

Single digit millisecond latency.

Backed on solid-state drives.

Flexible data model.

Key/attribute pairs. No schema required.

Easy to create. Easy to adjust.

Seamless scalability.

No table size limits. Unlimited storage.

No downtime.

Durable.

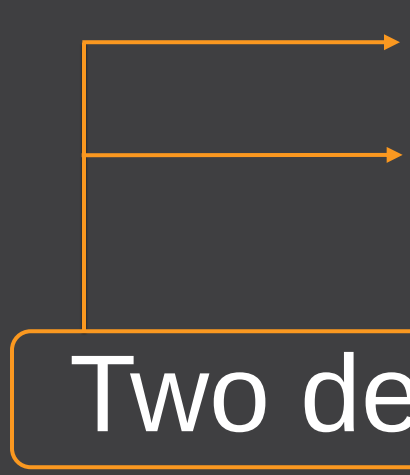
Consistent, disk only writes.

Replication across data centers and availability zones.

Without the operational burden.

Focus on your app.

Two decisions + three clicks
= ready for use

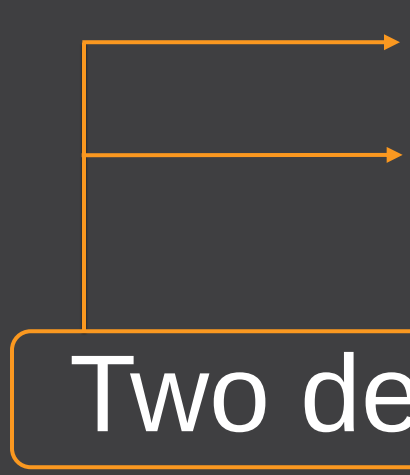


Level of throughput

Primary keys

Two decisions + three clicks

= ready for use



Level of throughput

Primary keys

Two decisions + three clicks

= ready for use

Provisioned throughput.

Reserve IOPS for reads and writes.

Scale up for down at any time.

Pay per capacity unit.

Priced per hour of provisioned throughput.
Calculated in capacity units (up to 4kB read or 1kB write)

Write throughput.

Size of item x writes per second

$0.0065 for 10 write units

Consistent writes.

Atomic increment and decrement.

Optimistic concurrency control: conditional writes.

Transactions.

Item level transactions only.

Puts, updates and deletes are ACID.

Multi-operation transactions in Java library.

Strong or eventual consistency

Read throughput.

Strong or eventual consistency

Read throughput.

Provisioned units = size of item x reads per second

$0.0065 per hour for 50 units

Strong or eventual consistency

Read throughput.

Provisioned units = $\frac{\text{size of item x reads per second}}{2}$

$0.0065 per hour for 100 units

Strong or eventual consistency

Read throughput.

Same latency expectations.

Mix and match at ‘read time’.

Provisioned throughput is managed by DynamoDB.

Data is partitioned and managed by DynamoDB.

Reserved capacity.

Up to 53% for 1 year reservation.

Up to 76% for 3 year reservation.

Indexed data storage.

$0.25 per GB per month.

Tiered bandwidth pricing:
aws.amazon.com/dynamodb/pricing

Authentication.

Session based to minimize latency.

Uses the Amazon Security Token Service.

Handled by AWS SDKs.

Integrates with IAM.

Field/row permissions possible

Monitoring.

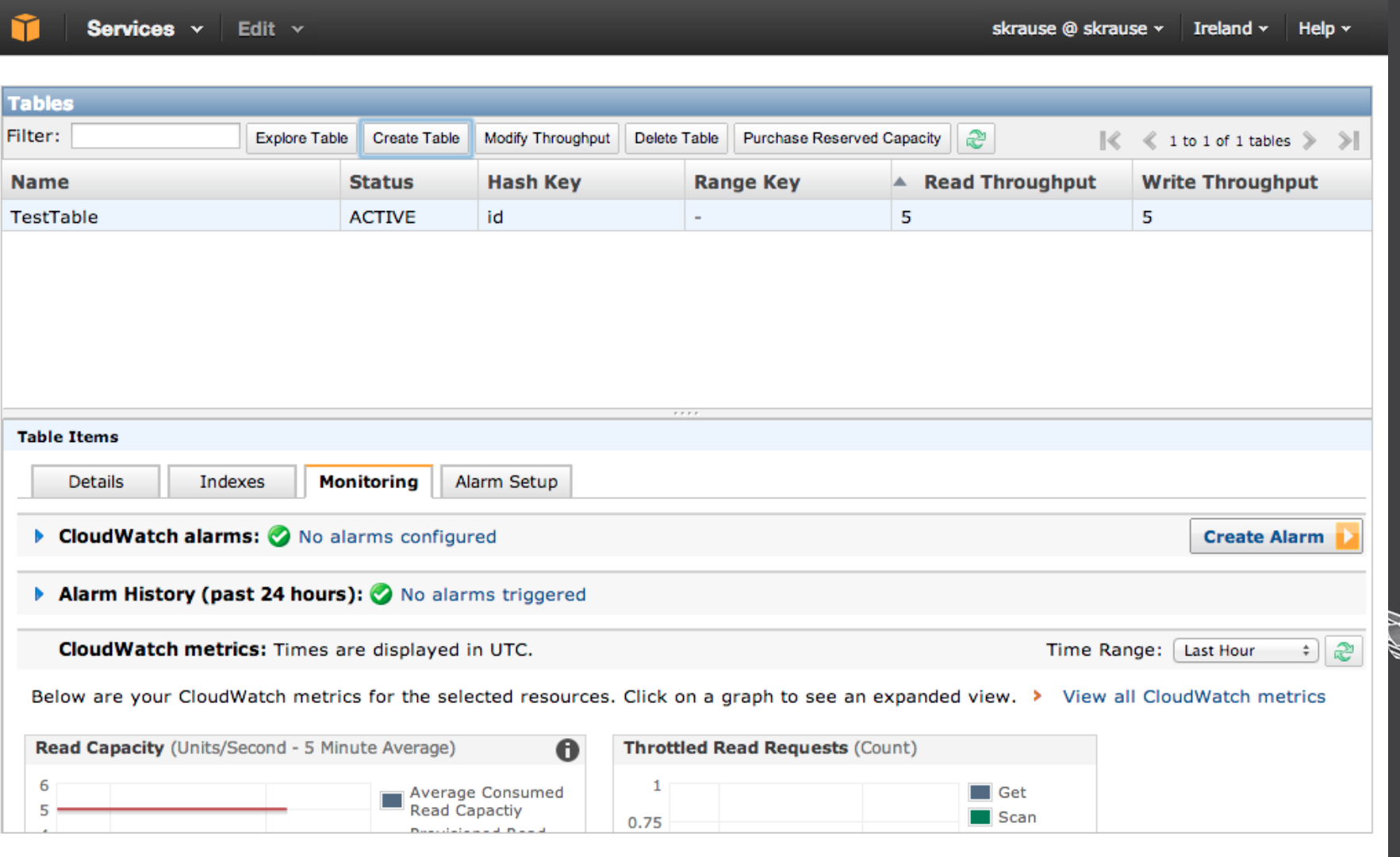
CloudWatch metrics:
latency, consumed read and write throughput,
errors and throttling.

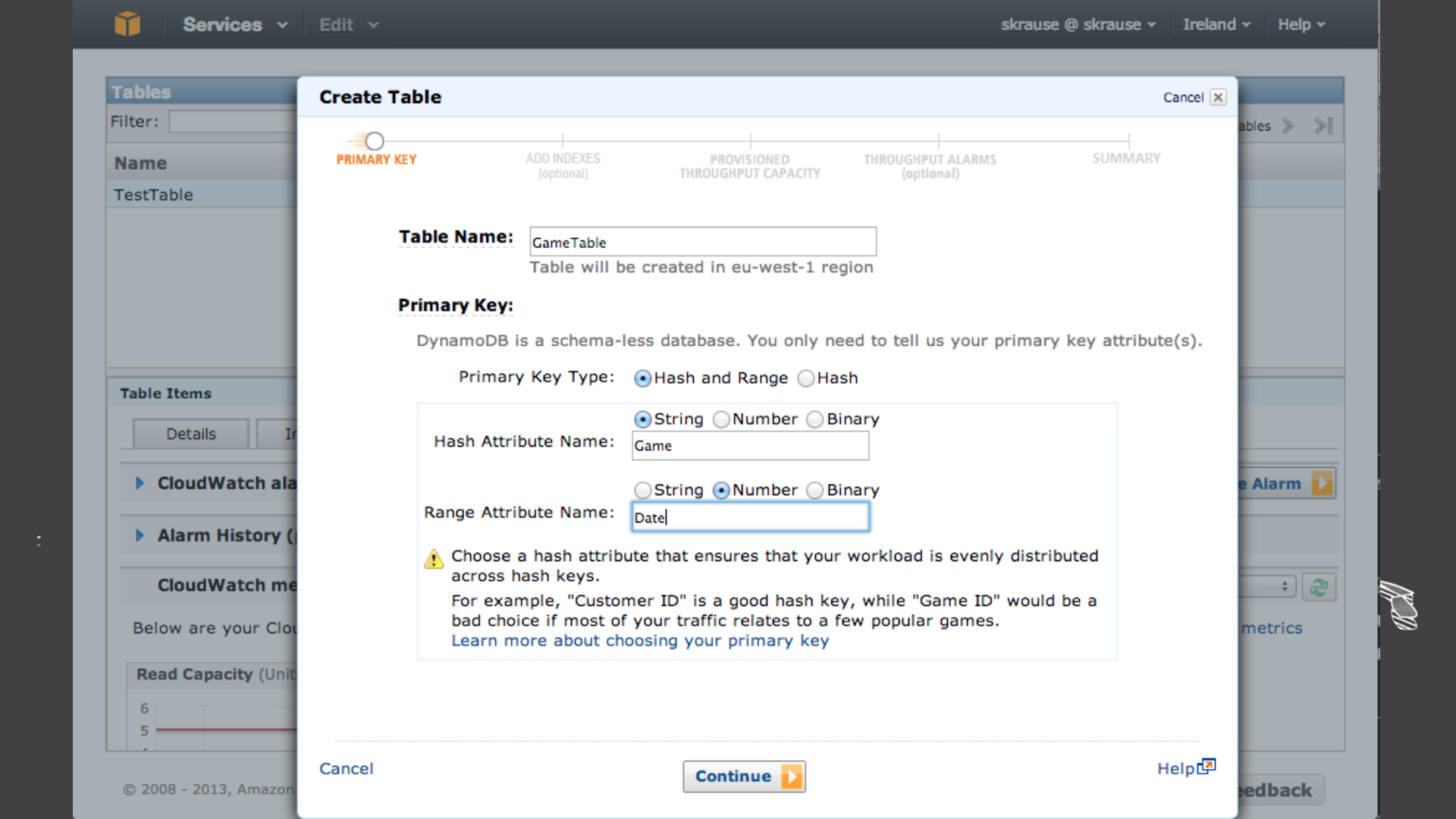
Libraries, wrappers and mocks.

ColdFusion, Django, Erlang, Java, .Net,
Node.js, Perl, PHP, Python, Ruby

http://j.mp/dynamodb-libs

DEMO


Services
Edit
skrause @ skrause
Ireland
Help
Tables
Filter:
Explore Table
Create Table
Modify Throughput
Delete Table
Purchase Reserved Capacity
1 to 1 of 1 tables
Name
Status
Hash Key
Range Key
Read Throughput
Write Throughput
TestTable
ACTIVE
id
-
5
5
Table Items
Details
Indexes
Monitoring
Alarm Setup
CloudWatch alarms: No alarms configured
Create Alarm
Alarm History (past 24 hours): No alarms triggered
CloudWatch metrics: Times are displayed in UTC.
Time Range:
Last Hour
Below are your CloudWatch metrics for the selected resources. Click on a graph to see an expanded view.
View all CloudWatch metrics
Read Capacity (Units/Second - 5 Minute Average)
6
5
Average Consumed Read Capactiy
Throttled Read Requests (Count)
1
0.75
Get
Scan


Services
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skrause @ skrause
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Help
Tables
Filter:
Name
TestTable
Table Items
Details
CloudWatch ala
Alarm History (
CloudWatch me
Below are your Clou
Read Capacity (Unit
6
5
© 2008 - 2013, Amazon
Create Table
Cancel
PRIMARY KEY
ADD INDEXES (optional)
PROVISIONED THROUGHPUT CAPACITY
THROUGHPUT ALARMS (optional)
SUMMARY
Table Name:
GameTable
Table will be created in eu-west-1 region
Primary Key:
DynamoDB is a schema-less database. You only need to tell us your primary key attribute(s).
Primary Key Type: Hash and Range Hash
String Number Binary
Hash Attribute Name:
Game
String Number Binary
Range Attribute Name:
Date
Choose a hash attribute that ensures that your workload is evenly distributed across hash keys.
For example, "Customer ID" is a good hash key, while "Game ID" would be a bad choice if most of your traffic relates to a few popular games.
Learn more about choosing your primary key
Cancel
Continue
Help
Alarm
metrics
edback

Create Table

Cancel

PRIMARY KEY ✓ — ADD INDEXES (optional) — PROVISIONED THROUGHPUT CAPACITY — THROUGHPUT ALARMS (optional) — SUMMARY

Add Indexes (optional)

☑ Add one or more Local Secondary Indexes

> ⚠ You can only define local secondary indexes at table creation time, and cannot remove or modify them later. Local secondary indexes are not appropriate for every application; see Secondary Indexes and Item Collections.

Index Hash Key: Game (String)

Attribute to Index:* Score

Attribute to Index Type:* ◉ String ○ Number ○ Binary

Index Name:* Score-index

Projected Attributes:* Specify Attributes

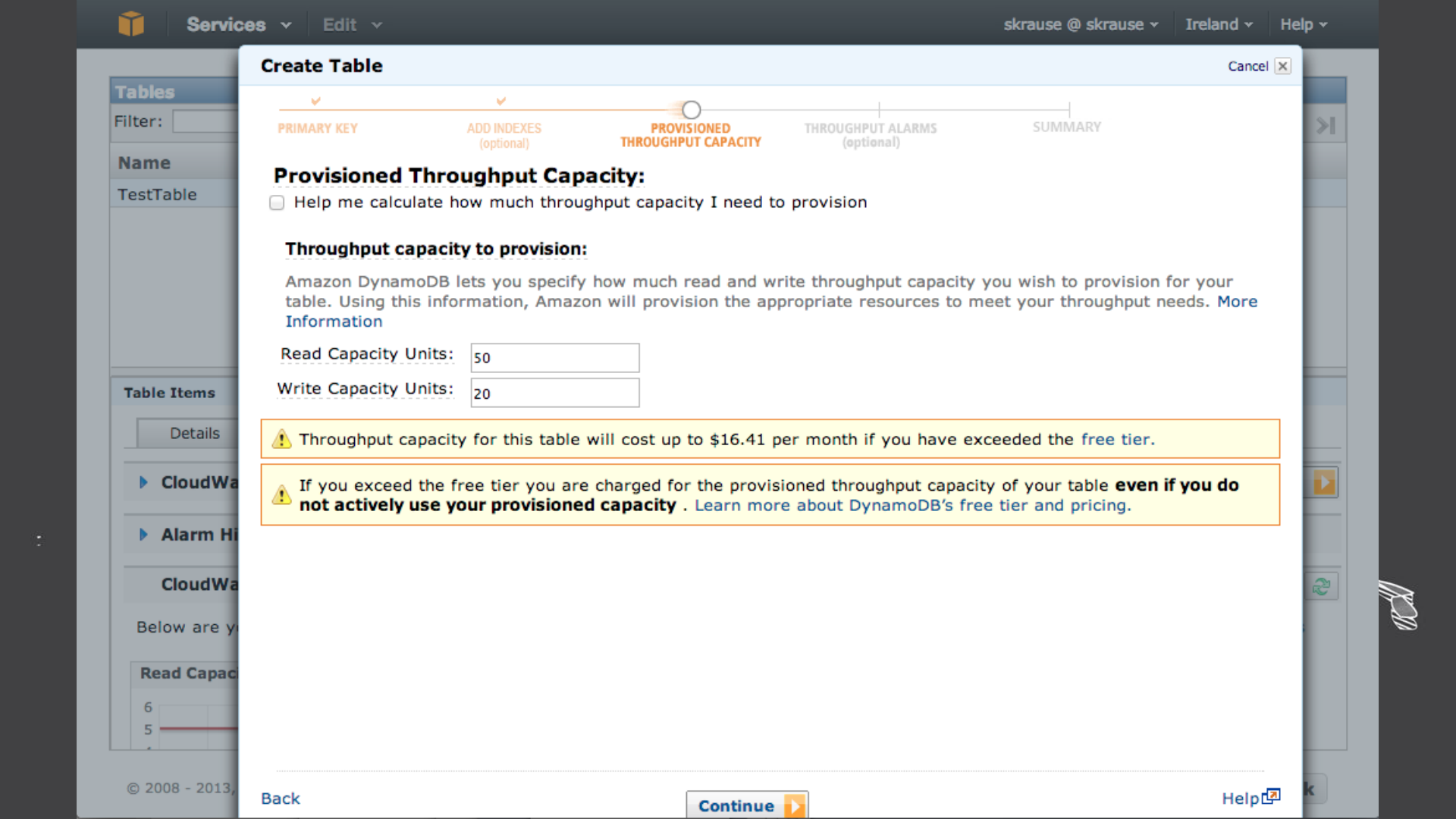
Date [Add]

Score ✕ Player ✕

Add Index

Index Name	Attribute To Index	Projected Attributes
No Local Secondary Indexes exist. Enter values and click Add Index to create one.		

Back — Continue — Help


Services
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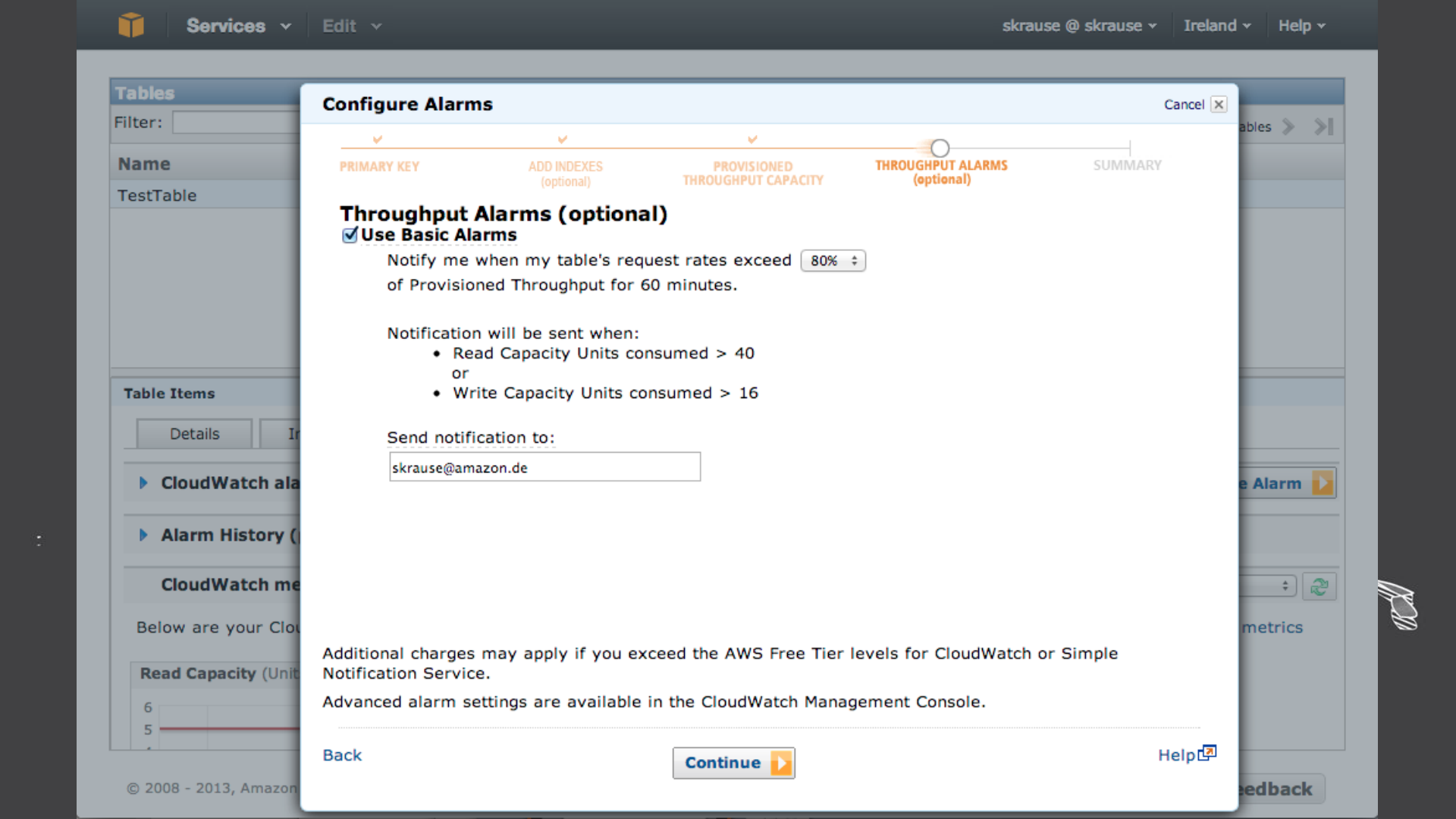
skrause @ skrause
Ireland
Help
Tables
Filter:
Name
TestTable
Table Items
Details
Create Table
Cancel
PRIMARY KEY
ADD INDEXES
(optional)
PROVISIONED
THROUGHPUT CAPACITY
THROUGHPUT ALARMS
(optional)
SUMMARY
Provisioned Throughput Capacity:
Help me calculate how much throughput capacity I need to provision
Throughput capacity to provision:
Amazon DynamoDB lets you specify how much read and write throughput capacity you wish to provision for your table. Using this information, Amazon will provision the appropriate resources to meet your throughput needs. More Information
Read Capacity Units:
50
Write Capacity Units:
20
Throughput capacity for this table will cost up to $16.41 per month if you have exceeded the free tier.
If you exceed the free tier you are charged for the provisioned throughput capacity of your table even if you do not actively use your provisioned capacity . Learn more about DynamoDB's free tier and pricing.
Back
Continue
Help
© 2008 - 2013,


Services
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Tables
Filter:
Name
TestTable
Table Items
Details
CloudWatch ala
Alarm History (
CloudWatch me
Below are your Clou
Read Capacity (Unit
6
5
© 2008 - 2013, Amazon
Configure Alarms
Cancel
PRIMARY KEY
ADD INDEXES (optional)
PROVISIONED THROUGHPUT CAPACITY
THROUGHPUT ALARMS (optional)
SUMMARY
Throughput Alarms (optional)
Use Basic Alarms
Notify me when my table's request rates exceed 80%
of Provisioned Throughput for 60 minutes.
Notification will be sent when:
Read Capacity Units consumed > 40
or
Write Capacity Units consumed > 16
Send notification to:
skrause@amazon.de
Additional charges may apply if you exceed the AWS Free Tier levels for CloudWatch or Simple Notification Service.
Advanced alarm settings are available in the CloudWatch Management Console.
Back
Continue
Help

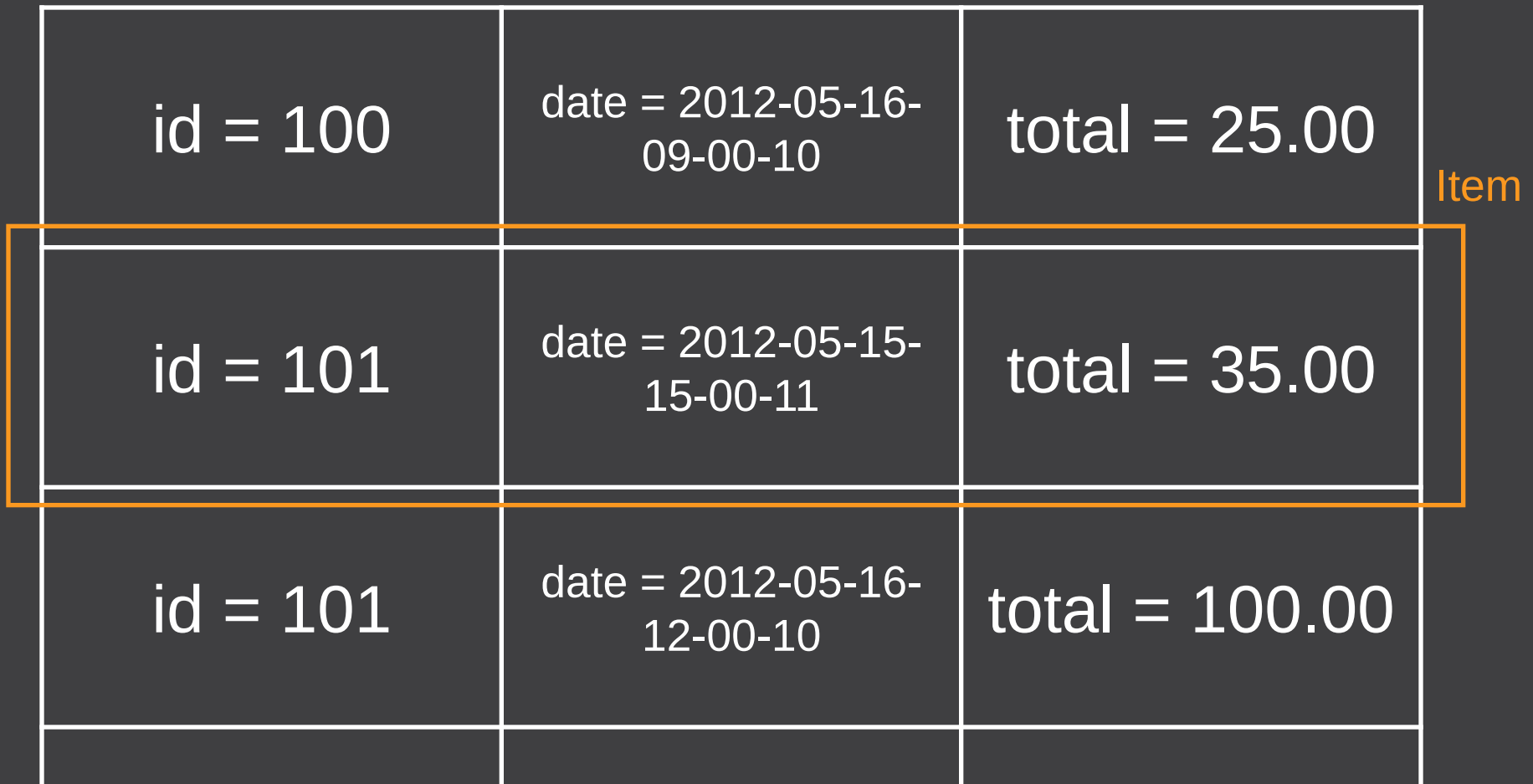
2

Data modeling

id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00

Table

id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00


id = 100
date = 2012-05-16-09-00-10
total = 25.00
Item
id = 101
date = 2012-05-15-15-00-11
total = 35.00
id = 101
date = 2012-05-16-12-00-10
total = 100.00

id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00

Attribute

Where is the schema?

Tables do not require a formal schema.

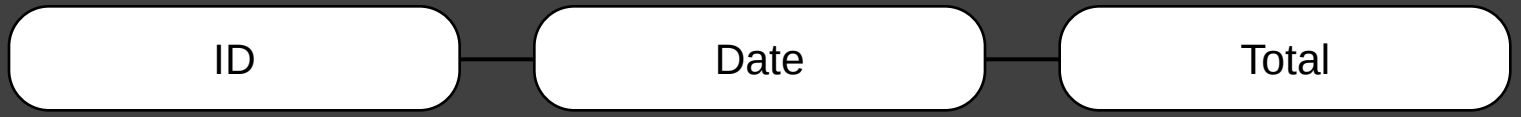
Items are an arbitrarily sized hash.

Indexing.

Items are indexed by primary and secondary keys.

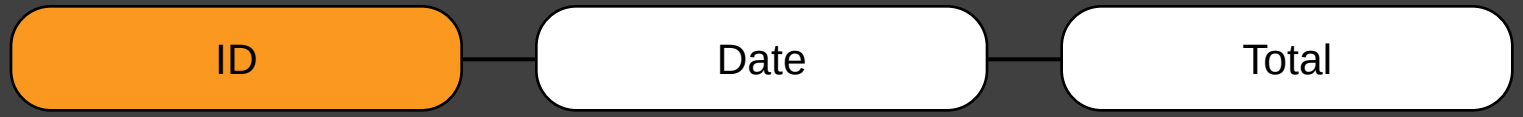
Primary keys can be composite.

Secondary keys are local to the table.

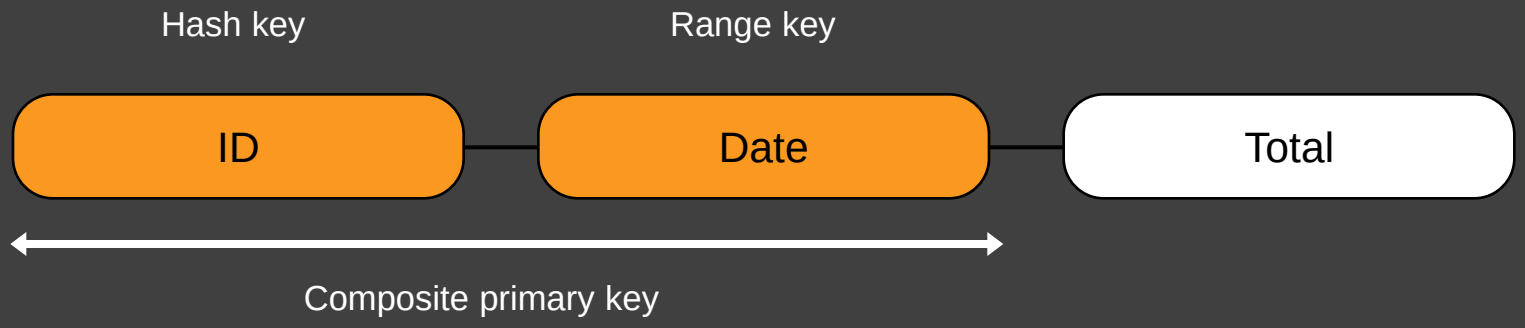


id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00
id = 102	date = 2012-03-20-18-23-10	total = 20.00
id = 102	date = 2012-03-20-18-23-10	total = 120.00

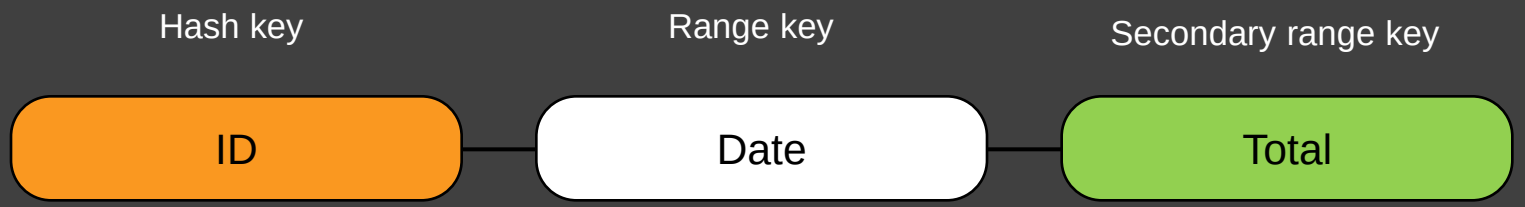
Hash key



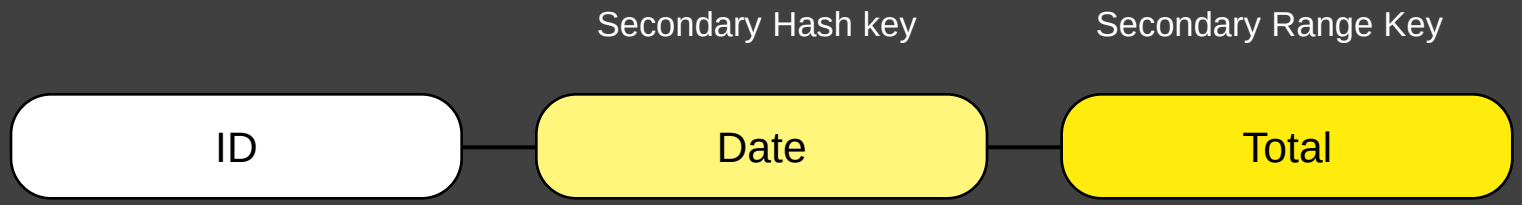
id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00
id = 102	date = 2012-03-20-18-23-10	total = 20.00
id = 102	date = 2012-03-20-18-23-10	total = 120.00



id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00
id = 102	date = 2012-03-20-18-23-10	total = 20.00
id = 102	date = 2012-03-20-18-23-10	total = 120.00



id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00
id = 102	date = 2012-03-20-18-23-10	total = 20.00
id = 102	date = 2012-03-20-18-23-10	total = 120.00



New

id = 100	date = 2012-05-16-09-00-10	total = 25.00
id = 101	date = 2012-05-15-15-00-11	total = 35.00
id = 101	date = 2012-05-16-12-00-10	total = 100.00
id = 102	date = 2012-03-20-18-23-10	total = 20.00
id = 102	date = 2012-03-20-18-23-10	total = 120.00

Programming DynamoDB.

Small but perfectly formed API.

CreateTable

UpdateTable

DeleteTable

DescribeTable

ListTables

Query

Scan

PutItem

GetItem

UpdateItem

DeleteItem

BatchGetItem

BatchWriteItem

CreateTable

UpdateTable

DeleteTable

DescribeTable

ListTables

Query

Scan

PutItem

GetItem

UpdateItem

DeleteItem

BatchGetItem

BatchWriteItem

CreateTable

UpdateTable

DeleteTable

DescribeTable

ListTables

Query

Scan

PutItem

GetItem

UpdateItem

DeleteItem

BatchGetItem

BatchWriteItem

```
dynamoDB = new AmazonDynamoDBClient(new ClasspathPropertiesFileCredentialsProvider());
dynamoDB.setEndpoint("https://dynamodb.eu-west-1.amazonaws.com");

CreateTableRequest createTableRequest = new CreateTableRequest().withTableName(tableName)
    .withKeySchema(new KeySchema(new KeySchemaElement().withAttributeName("name").withAttributeType("S")))
    .withProvisionedThroughput(new ProvisionedThroughput().withReadCapacityUnits(10L).withWriteCapacityUnits(10L));
TableDescription createdTableDescription = dynamoDB.createTable(createTableRequest).getTableDescription();
//Wait for table to become available
DescribeTableRequest describeTableRequest = new DescribeTableRequest().withTableName(tableName);
TableDescription tableDescription = dynamoDB.describeTable(describeTableRequest).getTable();

Map<String, AttributeValue> item = newItem("Bill & Ted's Excellent Adventure", 1989, "****", "James", "Sara");
PutItemRequest putItemRequest = new PutItemRequest(tableName, item);
PutItemResult putItemResult = dynamoDB.putItem(putItemRequest);

HashMap<String, Condition> scanFilter = new HashMap<String, Condition>();
Condition condition = new Condition()
    .withComparisonOperator(ComparisonOperator.GT.toString())
    .withAttributeValueList(new AttributeValue().withN("1985"));
scanFilter.put("year", condition);
ScanRequest scanRequest = new ScanRequest(tableName).withScanFilter(scanFilter);
ScanResult scanResult = dynamoDB.scan(scanRequest);
```

Conditional updates.

PutItem, UpdateItem, DeleteItem can take optional conditions for operation.

UpdateItem performs atomic increments.

One API call, multiple items

BatchGet returns multiple items by key.

BatchWrite performs up to 25 put or delete operations.

Throughput is measured by IO, not API calls.

CreateTable

UpdateTable

DeleteTable

DescribeTable

ListTables

Query

Scan

PutItem

GetItem

UpdateItem

DeleteItem

BatchGetItem

BatchWriteItem

Query vs Scan

Query for Composite Key queries.

Scan for full table scans, exports.

Both support pages and limits.

Maximum response is 1Mb in size.

Query patterns

Retrieve all items by **hash key**.

Range key conditions:
==, <, >, >=, <=, begins with, between.

Counts. Top and bottom n values.
Paged responses.

EXAMPLE 1:

Mapping relationships.

Players

user_id = mza	location = Cambridge	joined = 2011-07-04
user_id = jeffbarr	location = Seattle	joined = 2012-01-20
user_id = werner	location = Worldwide	joined = 2011-05-15

Players

user_id = mza	location = Cambridge	joined = 2011-07-04
user_id = jeffbarr	location = Seattle	joined = 2012-01-20
user_id = werner	location = Worldwide	joined = 2011-05-15

Scores

user_id = mza	game = angry-birds	score = 11,000
user_id = mza	game = tetris	score = 1,223,000
user_id = werner	location = bejewelled	score = 55,000

Players

user_id = mza	location = Cambridge	joined = 2011-07-04
user_id = jeffbarr	location = Seattle	joined = 2012-01-20
user_id = werner	location = Worldwide	joined = 2011-05-15

Scores

user_id = mza	game = angry-birds	score = 11,000
user_id = mza	game = tetris	score = 1,223,000
user_id = werner	location = bejewelled	score = 55,000

Leader boards

game = angry-birds	score = 11,000	user_id = mza
game = tetris	score = 1,223,000	user_id = mza
game = tetris	score = 9,000,000	user_id = jeffbarr

Players

user_id = mza	location = Cambridge	joined = 2011-07-04
user_id = jeffbarr	location = Seattle	joined = 2012-01-20
user_id = werner	location = Worldwide	joined = 2011-05-15

Query for scores by user

Scores

user_id = mza	game = angry-birds	score = 11,000
user_id = mza	game = tetris	score = 1,223,000
user_id = werner	location = bejewelled	score = 55,000

Leader boards

game = angry-birds	score = 11,000	user_id = mza
game = tetris	score = 1,223,000	user_id = mza
game = tetris	score = 9,000,000	user_id = jeffbarr

Players

user_id = mza	location = Cambridge	joined = 2011-07-04
user_id = jeffbarr	location = Seattle	joined = 2012-01-20
user_id = werner	location = Worldwide	joined = 2011-05-15

High scores by game

Scores

user_id = mza	game = angry-birds	score = 11,000
user_id = mza	game = tetris	score = 1,223,000
user_id = werner	location = bejewelled	score = 55,000

Leader boards

game = angry-birds	score = 11,000	user_id = mza
game = tetris	score = 1,223,000	user_id = mza
game = tetris	score = 9,000,000	user_id = jeffbarr

EXAMPLE 2:

Storing large items.

Unlimited storage.

Unlimited attributes per item.

Unlimited items per table.

Maximum of 64k per item.

Split across items.

message_id = 1	part = 1	message = <first 64k>
message_id = 1	part = 2	message = <second 64k>
message_id = 1	part = 3	joined = <third 64k>

Store a pointer to S3.

message_id = 1	message = http://s3.amazonaws.com...
message_id = 2	message = http://s3.amazonaws.com...
message_id = 3	message = http://s3.amazonaws.com...

EXAMPLE 3:

Time series data

Hot and cold tables.

April

event_id = 1000	timestamp = 2013-04-16-09-59-01	key = value
event_id = 1001	timestamp = 2013-04-16-09-59-02	key = value
event_id = 1002	timestamp = 2013-04-16-09-59-02	key = value

March

event_id = 1000	timestamp = 2013-03-01-09-59-01	key = value
event_id = 1001	timestamp = 2013-03-01-09-59-02	key = value
event_id =	timestamp =	key =

December January February March April

Archive data.

Move old data to S3: lower cost.
Still available for analytics.

Run queries across hot and cold data
with Elastic MapReduce.

3

Partitioning

Uniform workload.

Data stored across multiple partitions.

Data is primarily distributed by primary key.

Provisioned throughput is divided evenly across partitions.

To achieve and maintain full provisioned throughput, spread workload evenly across hash keys.

Non-Uniform workload.

Might be throttled, even at high levels of throughput.

BEST PRACTICE 1:

Distinct values for hash keys.

Hash key elements should have a high number of distinct values.

Lots of users with unique user_id.

Workload well distributed across hash key.

user_id = mza	first_name = Matt	last_name = Wood
user_id = jeffbarr	first_name = Jeff	last_name = Barr
user_id = werner	first_name = Werner	last_name = Vogels
user_id = simone	first_name = Simone	last_name = Brunozzi
…	…	…

BEST PRACTICE 2:

Avoid limited hash key values.

Hash key elements should have a high number of distinct values.

Small number of status codes.

Unevenly, non-uniform workload.

status = 200	date = 2012-04-01-00-00-01
status = 404	date = 2012-04-01-00-00-01
status 404	date = 2012-04-01-00-00-01
status = 404	date = 2012-04-01-00-00-01

BEST PRACTICE 3:

Model for even distribution.

Access by hash key value should be evenly distributed across the dataset.

Large number of devices.

Small number which are much more popular than others.

Workload unevenly distributed.

mobile_id = 100	access_date = 2012-04-01-00-00-01
mobile_id = 100	access_date = 2012-04-01-00-00-02
mobile_id = 100	access_date = 2012-04-01-00-00-03
mobile_id = 100	access_date = 2012-04-01-00-00-04
...	...

Sample access pattern.

Workload randomized by hash key.

mobile_id = 100.1	access_date = 2012-04-01-00-00-01
mobile_id = 100.2	access_date = 2012-04-01-00-00-02
mobile_id = 100.3	access_date = 2012-04-01-00-00-03
mobile_id = 100.4	access_date = 2012-04-01-00-00-04
...	...

4

Reporting & Analytics

Seamless scale.

Scalable methods for data processing.

Scalable methods for backup/restore.

Amazon Elastic MapReduce.

Managed Hadoop service for
data-intensive workflows.

aws.amazon.com/emr

```
create external table items_db
  (id string, votes bigint, views bigint) stored by
  'org.apache.hadoop.hive.dynamodb.DynamoDBStorageHandler'
   tblproperties
  ("dynamodb.table.name" = "items",
   "dynamodb.column.mapping" =
   "id:id,votes:votes,views:views");
```

```
select id, likes, views
from items_db
order by views desc;
```

Summary

1. Getting started
2. Data modeling
3. Partitioning
4. Replication & Analytics

Free tier.

aws.amazon.com/dynamodb

Thank you!

skrause@amazon.de
@AWS_Aktuell

amazon web services

Ressourcen

Getting Started Guide:
http://docs.aws.amazon.com/amazondynamodb/latest/developerguide/GettingStartedDynamoDB.html

http://aws.amazon.com/de

Beginnen Sie mit dem Free Tier:
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