AWS re:Invent

DAT305

Real-world use cases for Amazon DynamoDB

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Three things to consider

Hi!

URL

Office hours

Agenda

1. DynamoDB fundamentals
2. Three distilled steps for a successful design
3. Three real-world use cases for DynamoDB

Amazon DynamoDB

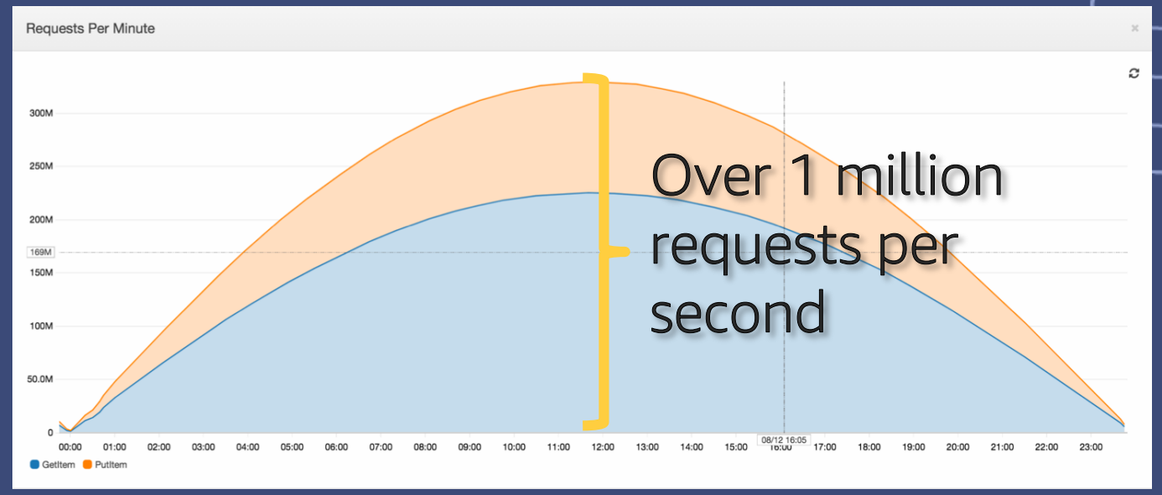
Key value

Durable

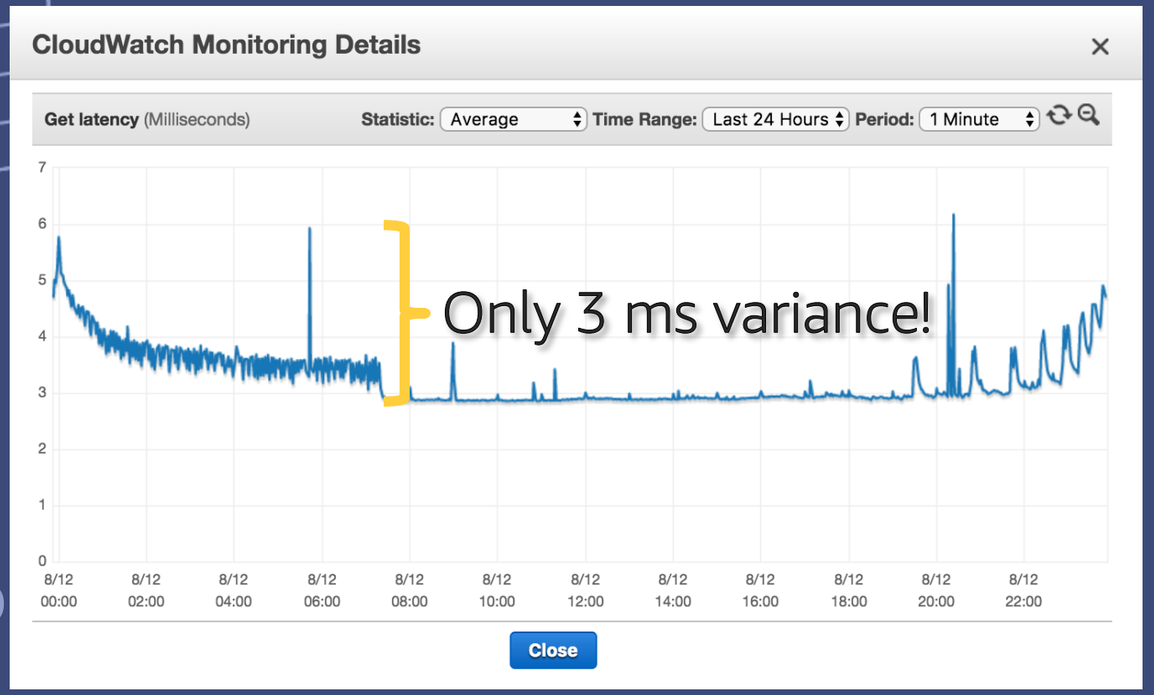
Low latency

Amazon DynamoDB

Request Volume



Latency

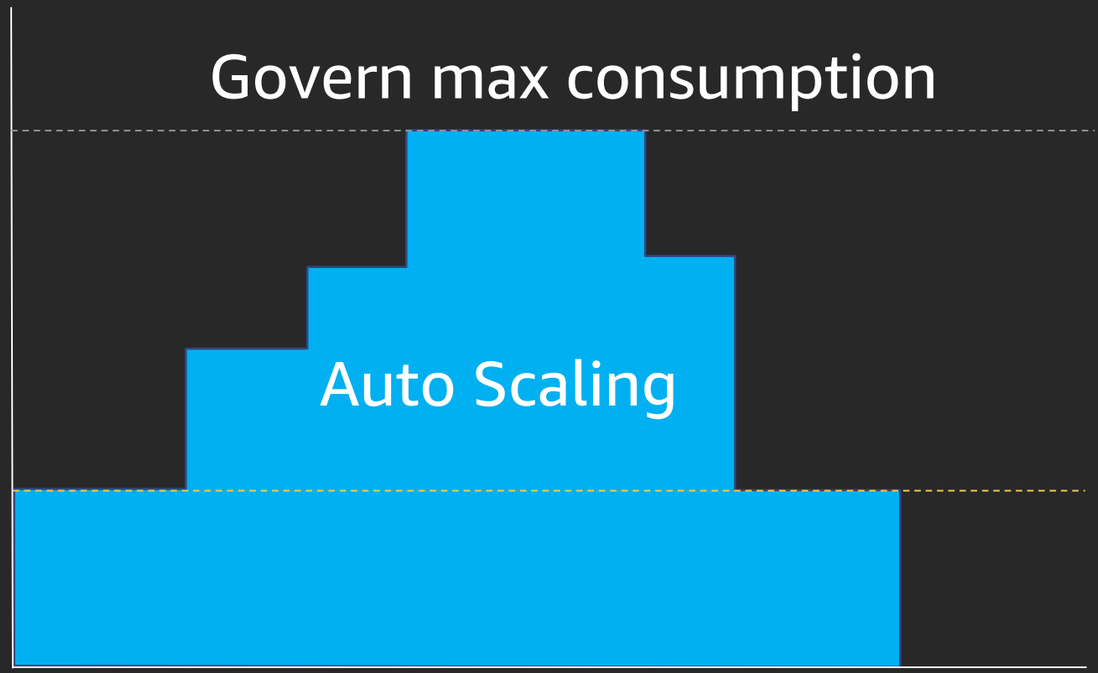


Key Value

Durab

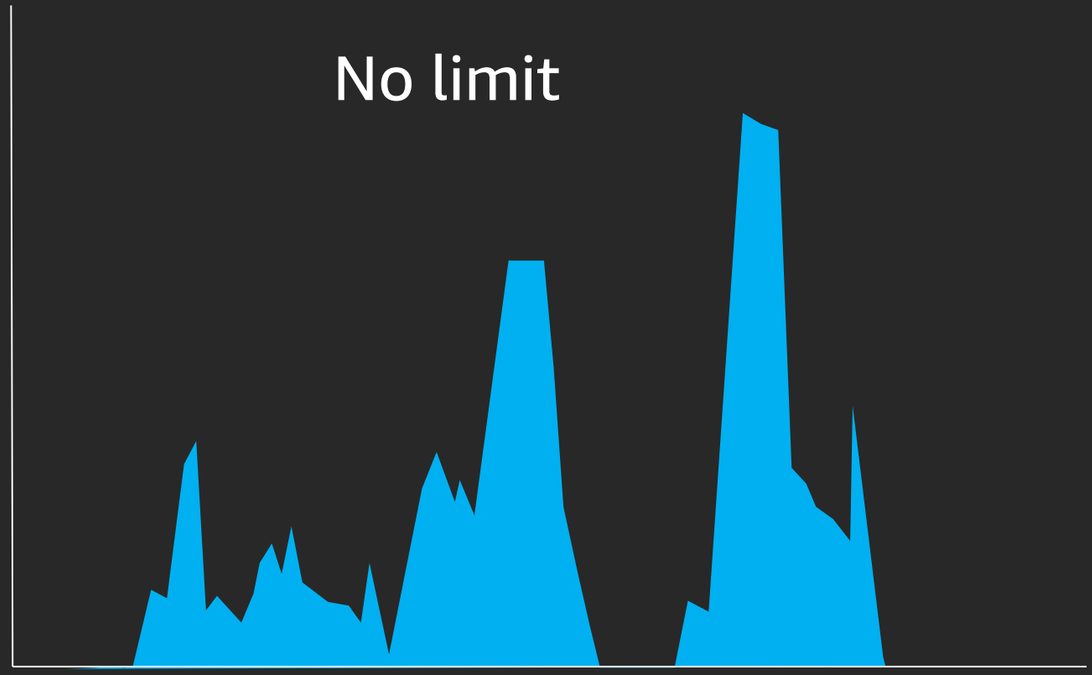
DynamoDB: Capacity managed for you

Provisioned



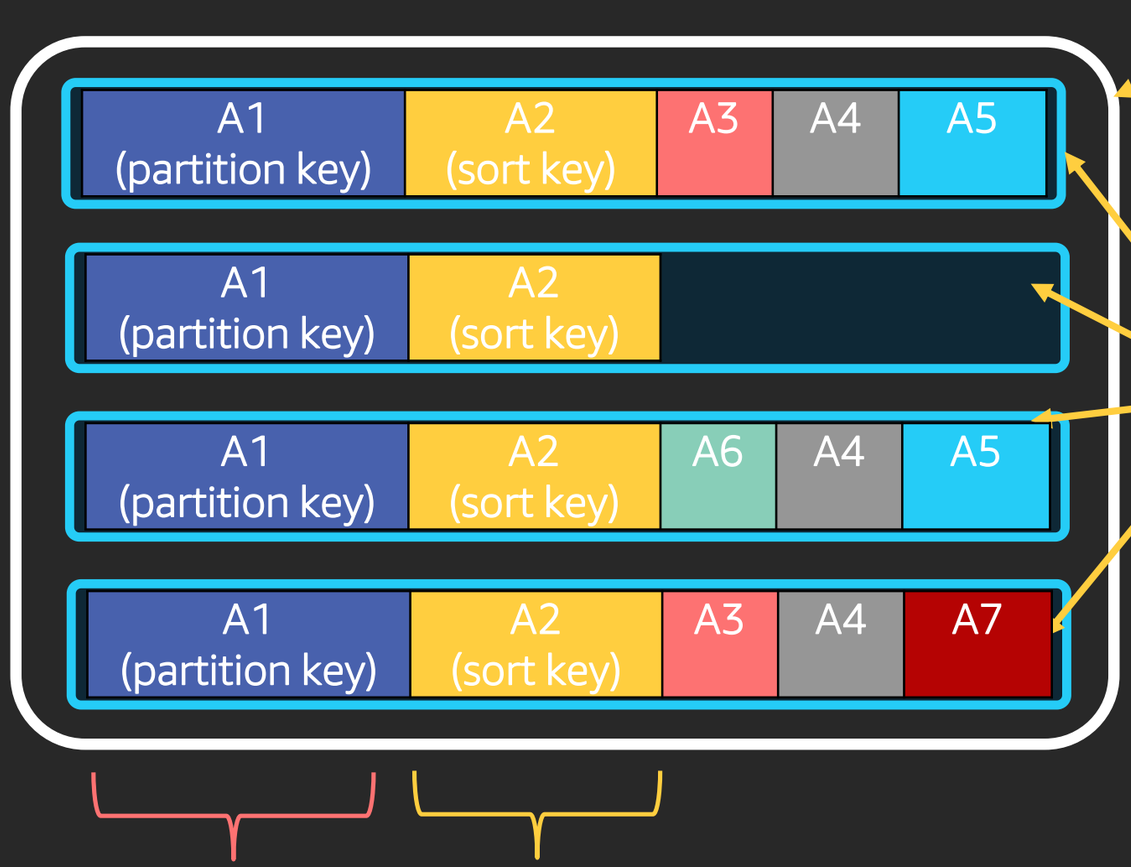
Set a minimum

On-Demand



Start at zero

DynamoDB table



All items for a partition key
==, <, >, >=, <=
“begins with”
“between”
sorted results
counts
top/bottom N values
paged responses

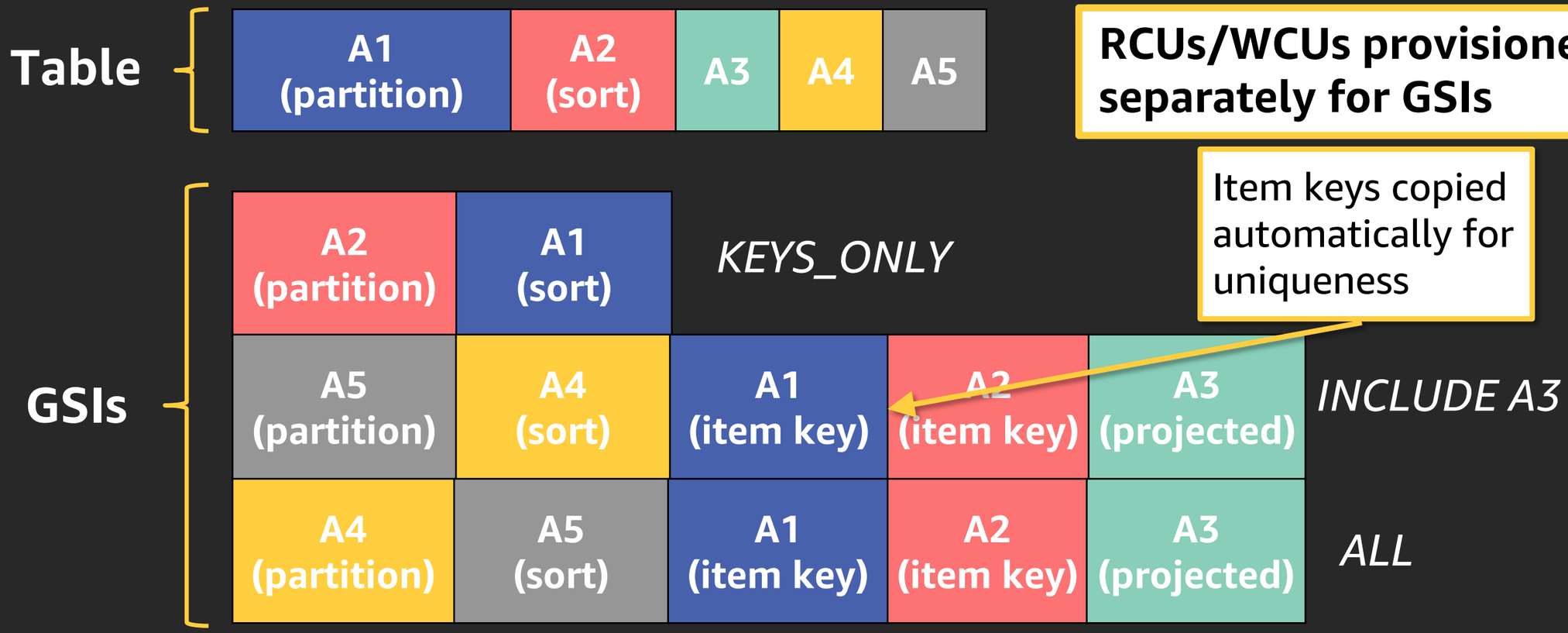
Mandatory
Key-value access pattern
Determines data distribution

Optional
Model 1:N relationships
Enables rich query capabilities

Global secondary index (GSI)

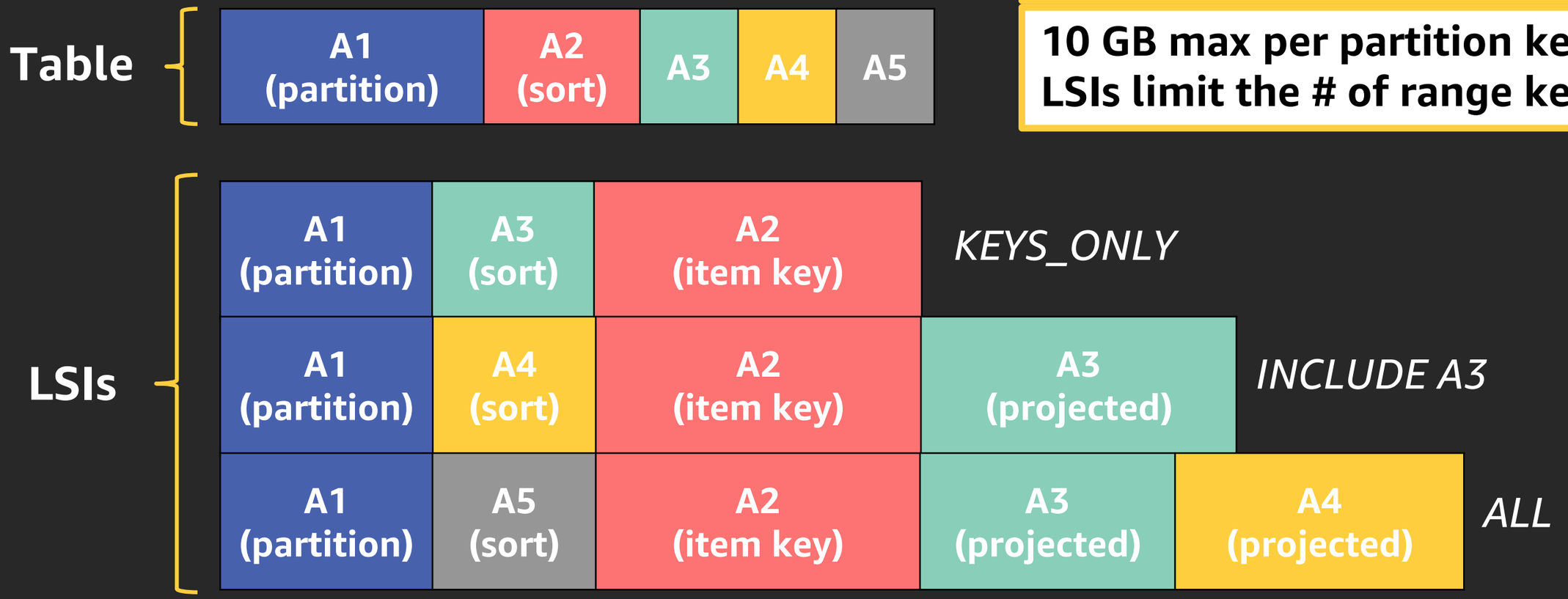
Up to 20 GSIs per table

Alternate partition and/or sort key
Index is across all partition keys
Use composite sort keys for compound indexes



Local secondary index (LSI)

Alternate sort key attribute
Index is local to a partition key



Collection limits
10 GB max per partition key. LSIs limit the # of range keys.

Distilled design concepts

Distilled design concepts

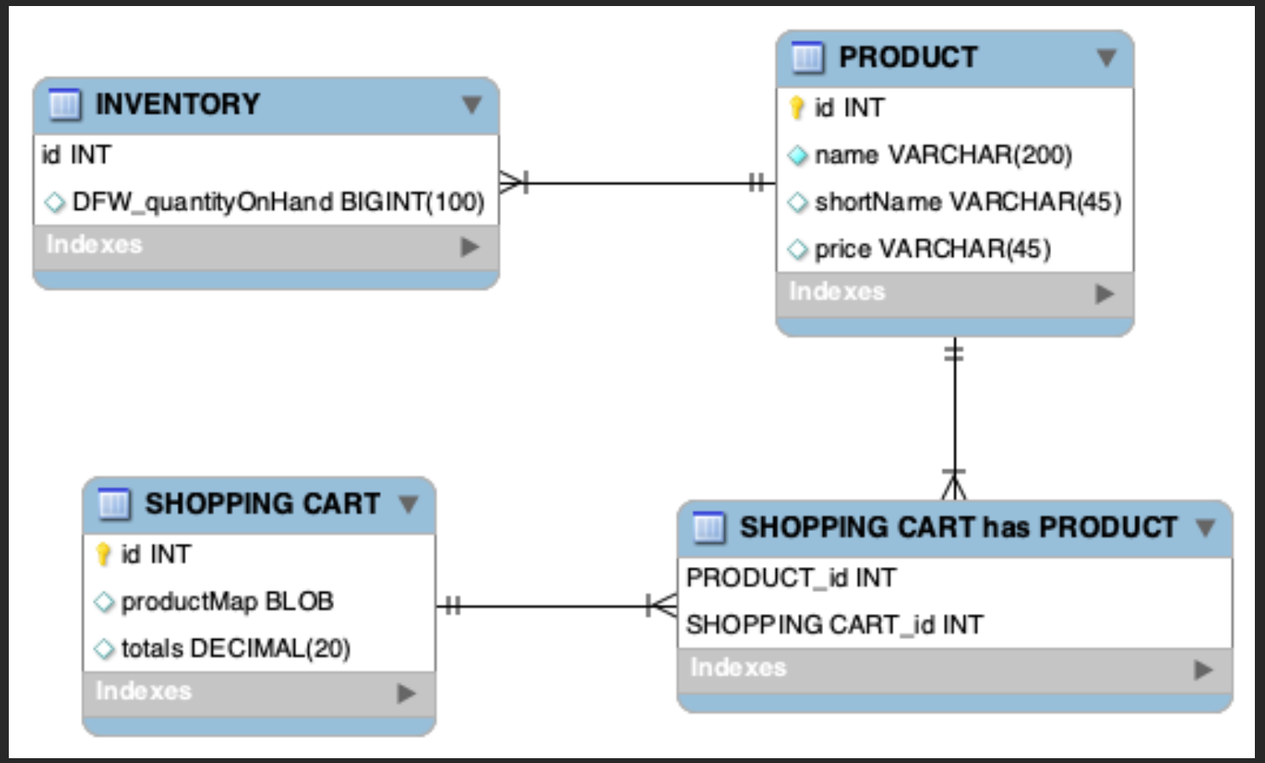
1. Understand the use case
2. Model the entity relationships
3. Write down the queries

1. Understand the use case

- ✓ Industry knowledge
- ✓ Is this a new or existing feature?
- ✓ Is DynamoDB the operational database?
- ✓ Who are the actors querying data from DynamoDB?

2. Model the relationships

- ✓ Entity-relationship diagrams are here to stay



3. Establish the queries

- ✓ **Get all `PRODUCTS` from `SHOPPING CART`**
- ✓ **Get all `SHOPPING CARTs` holding a `PRODUCT`**
- ✓ **Reserve the `PRODUCT` in `INVENTORY` during checkout**

Tip: think in SQL, and then convert to words

3. Establish the queries

- ✓ **Get all `PRODUCTS` from `SHOPPING CART`**

```
SELECT products FROM cart where cart_id = 'YYY';
```

- ✓ **Get all `SHOPPING CARTs` holding a `PRODUCT`**

```
SELECT cart_id FROM products_cart WHERE product_id = 'XXX';
```

- ✓ **Reserve the `PRODUCT` in `INVENTORY` during checkout**

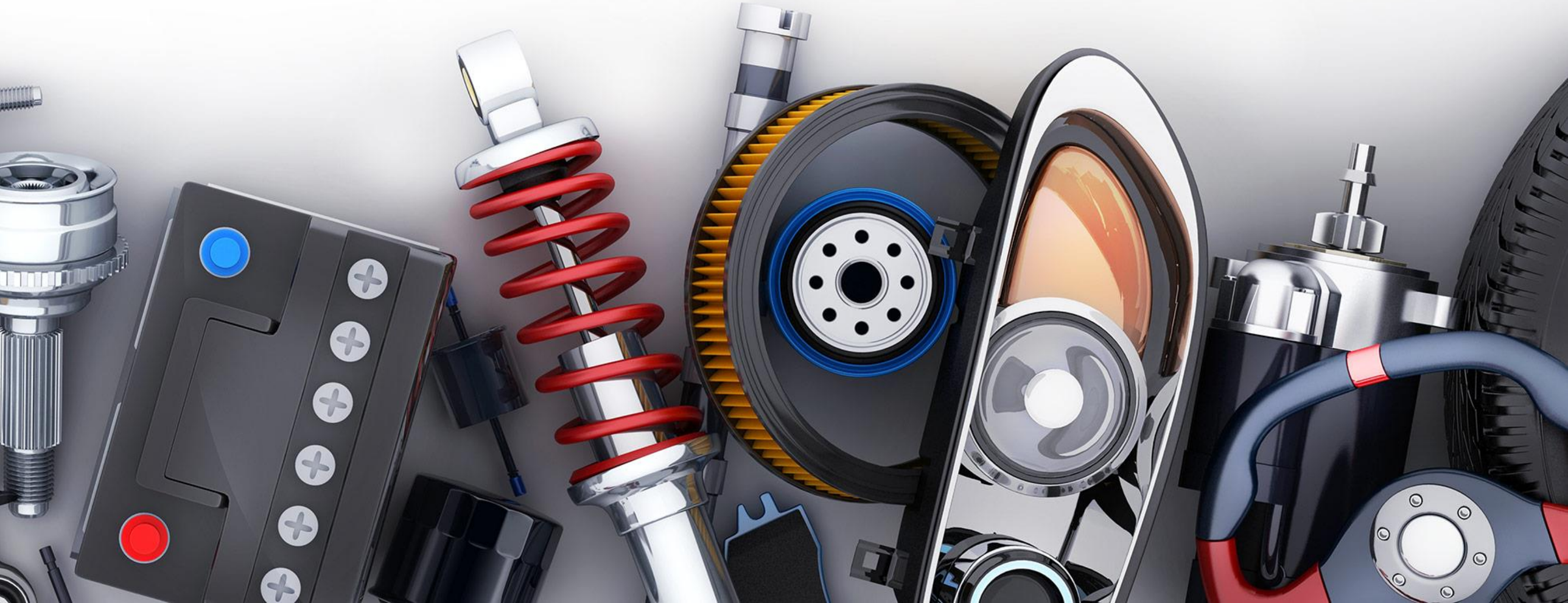
```
UPDATE inventory SET qoh = qoh - 1 WHERE product_id = 'XXX'
      AND qoh > 0;
```

Remember, DynamoDB is API driven and does not use SQL.

Real world use cases

Customer #1: Midwest industrial manufacturer

Use case: n:m relationships, data lake processing



Why Dynamo?

- Low latency
- Need durability
- Operational data

Schedule

8A - Start
10-noon - Lab
Noon-1p - EAT
1p-3p - Design

Possible partition keys:

- Process order id

Possible sort keys:

- ???

Queries:

1. Get all steps for process order

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Possible partition keys:

- ✓ Process order id

Possible sort keys:

- ???

Queries:

1. Get all steps for process order

Real-world additive manufacturing

Process an order for a set of parts, and track it all!

Step 1: Gather "Materials"

e.g. Aluminum

Step 2: Mix "Materials"

Mix, and measure

mass and volume

Step 3: Print "Parts"

2 or more parts

e.g. drill bit

Step 4: Bake "Parts"

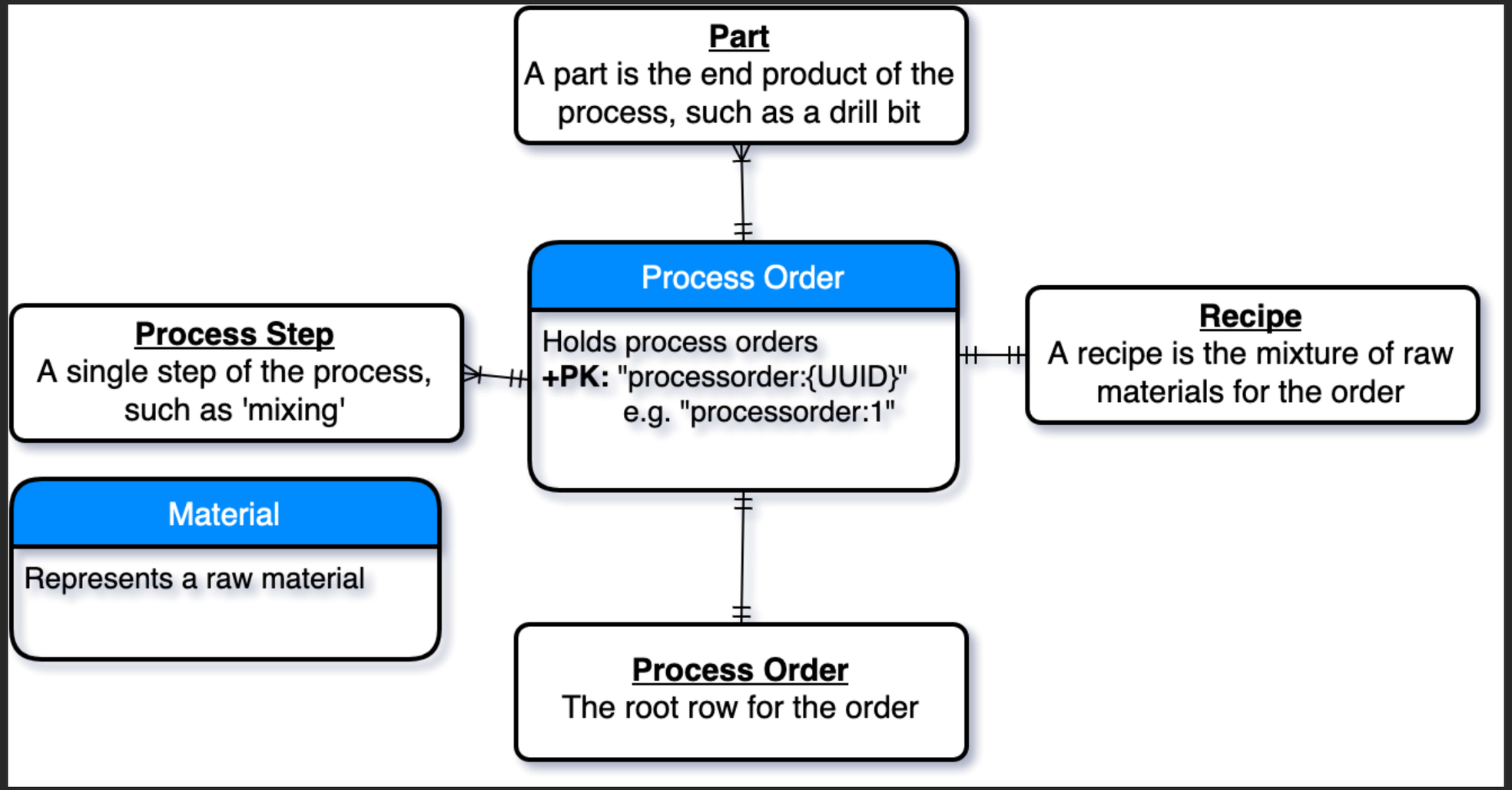
"Light the fires!"

Step 5: QC "Parts"

Microscopy

Measurement

Establish the entity relationships



Queries

- ✓ Get all steps for a `PROCESS ORDER`
- ✓ Get the AVERAGE density of a `MATERIAL`
- ✓ Find the `PROCESS ORDER` for a `PART`

Final schema

Primary Key		Attributes		
PK	SK			
processorder:1	part:1	porosity	mass	GSI_1_PK
		20%	122g	part:1
	processstep:materials:1	materialIds		
		[materialId:1, materialId:2]		
	processstep:mixing:2	mass	volume	density
		130g	26cm^3	5g/cm^3
	processstep:print:3	bedTemp	materiallTemp	adhesionSurface
		120	400	tape
	recipes	processstep:materials		
		recipe:1		

Primary Key		Attributes			
PK	SK				
materialid:1	processorder:1	mass	volume	density	timestamp
		45g	9cm^3	5g/cm^3	1575423000
	processorder:2	mass	volume	density	timestamp
		66g	13.2cm^3	5g/cm^3	1575477000
materialid:2	processorder:1	mass	volume	density	timestamp
		85g	17cm^3	5g/cm^3	1575423000
	processorder:2	mass	volume	density	timestamp
		64g	12.8cm^3	5g/cm^3	1575477000

Adjacency lists

Generic partition and sort key names

Often used with GSI overloading

Primary Key		Attributes		
PK	SK	porosity	mass	GSI_1_PK
processorder:1	part:1	20%	122g	part:1
	processstep:materials:1	materialIds		
	processstep:mixing:2	[materialId:1, materialId:2]	volume	density
	processstep:print:3	130g	26cm^3	5g/cm^3
		bedTemp	materiallTemp	adhesionSurface
		120	400	tape

Soft associations for n:m relationship

Primary Key		Attributes			
PK	SK	mass	volume	density	timestamp
materialid:1	processorder:1	*45g*	9cm^3	5g/cm^3	1575423000
	processorder:2	mass	volume	density	timestamp
materialid:2	processorder:1	*66g*	13.2cm^3	5g/cm^3	1575477000
		mass	volume	density	timestamp
	processorder:2	*85g*	17cm^3	5g/cm^3	1575423000
		mass	volume	density	timestamp
		64g	12.8cm^3	5g/cm^3	1575477000

Queries

Primary Key		Attributes		
PK	SK			
processorder:1	part:1	porosity	mass	GSI_1_PK
		20%	122g	part:1
	processstep:materials:1	materialIds		
		[materialId:1, materialId:2]		
	processstep:mixing:2	mass	volume	density
		130g	26cm^3	5g/cm^3
	processstep:print:3	bedTemp	materiallTemp	adhesionSurface
		120	400	tape
	recipes	processstep:materials		
		recipe:1		

Primary Key		Attributes			
PK					
materialid:1					timestamp
					1575423000
					timestamp
					1575477000
materialid:2					timestamp
					1575423000
					timestamp
					1575477000

Query #1: Get all steps for a `PROCESS ORDER`

Solution: Query with key_condition

```
PK = process_order:1
AND SK starts_with("processstep")
```

Queries

Primary Key		Attributes		
PK	SK			GSI_1_PK
processor				part:1
				density
				5g/cm^3
				adhesionSurface
				tape
	recipes			
		recipe:1		

Query #2: Get the AVERAGE density of a `MATERIAL`

Solution: Query with key_condition `PK = materialId:1` and on the client compute the `AVERAGE`

Primary Key		Attributes			
PK	SK				
materialid:1	processorder:1	mass	volume	density	timestamp
		45g	9cm^3	5g/cm^3	1575423000
	processorder:2	mass	volume	density	timestamp
		66g	13.2cm^3	5g/cm^3	1575477000
materialid:2	processorder:1	mass	volume	density	timestamp
		85g	17cm^3	5g/cm^3	1575423000
	processorder:2	mass	volume	density	timestamp
		64g	12.8cm^3	5g/cm^3	1575477000

Queries

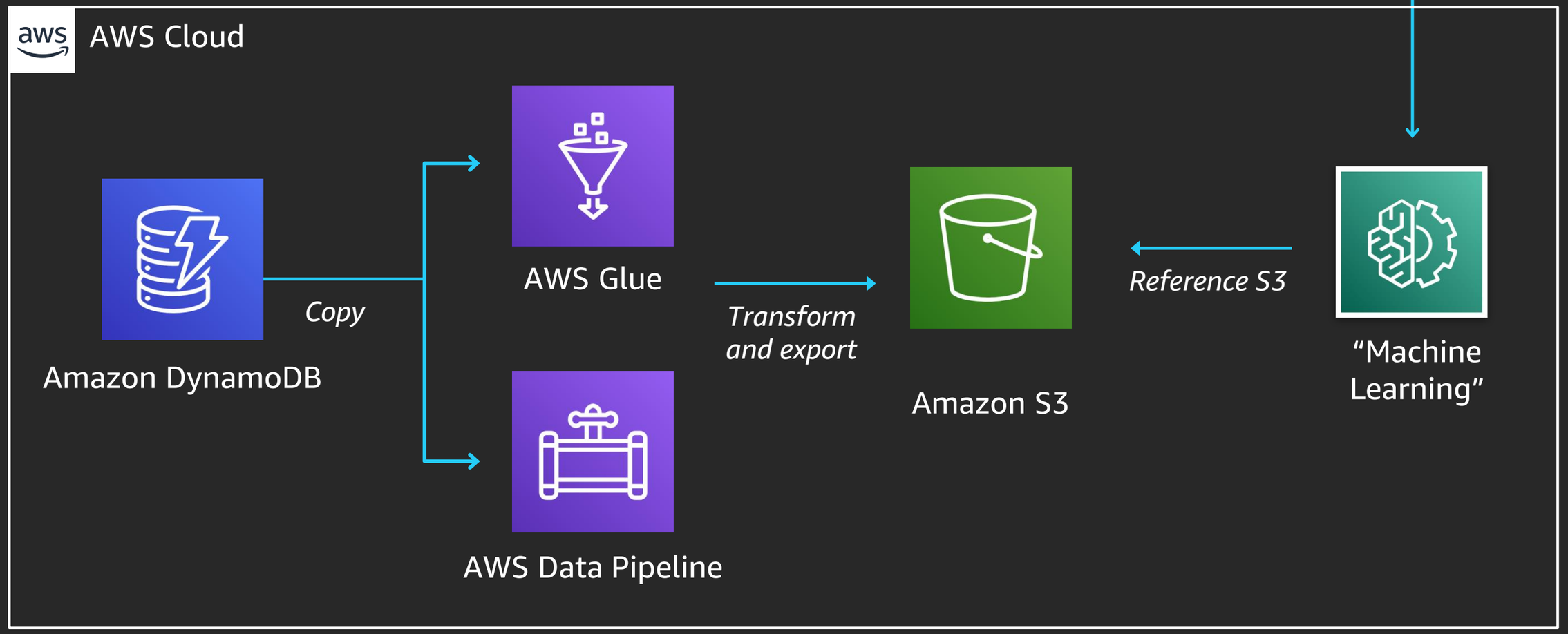
Primary Key		Attributes		
PK	SK			
processorder:1	part:1	porosity	mass	GSI_1_PK
		20%	122g	part:1
	processstep:materials:1	materialIds		
		[materialId:1, materialId:2]		
	processstep:mixing:2	mass	volume	density
		130g	26cm^3	5g/cm^3
	processstep:print:3	bedTemp	materiallTemp	adhesionSurface
		120	400	tape
	recipes	processstep:materials		
		recipe:1		

Primary Key					
PK					
materialid:1					timestamp
					1575423000
					timestamp
					1575477000
materialid:2					timestamp
					1575423000
					timestamp
		64g	12.8cm^3	5g/cm^3	1575477000

Query #3: Find the `PROCESS ORDER` for a `PART`

Solution: Query GSI 1 with key_condition `GSI_1_PK = part:1`

Data lake: Export to Amazon S3

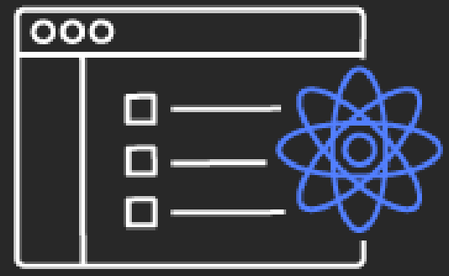


Recap

✓ Adjacency lists

Good for:

- n:m relationships
- Relational data



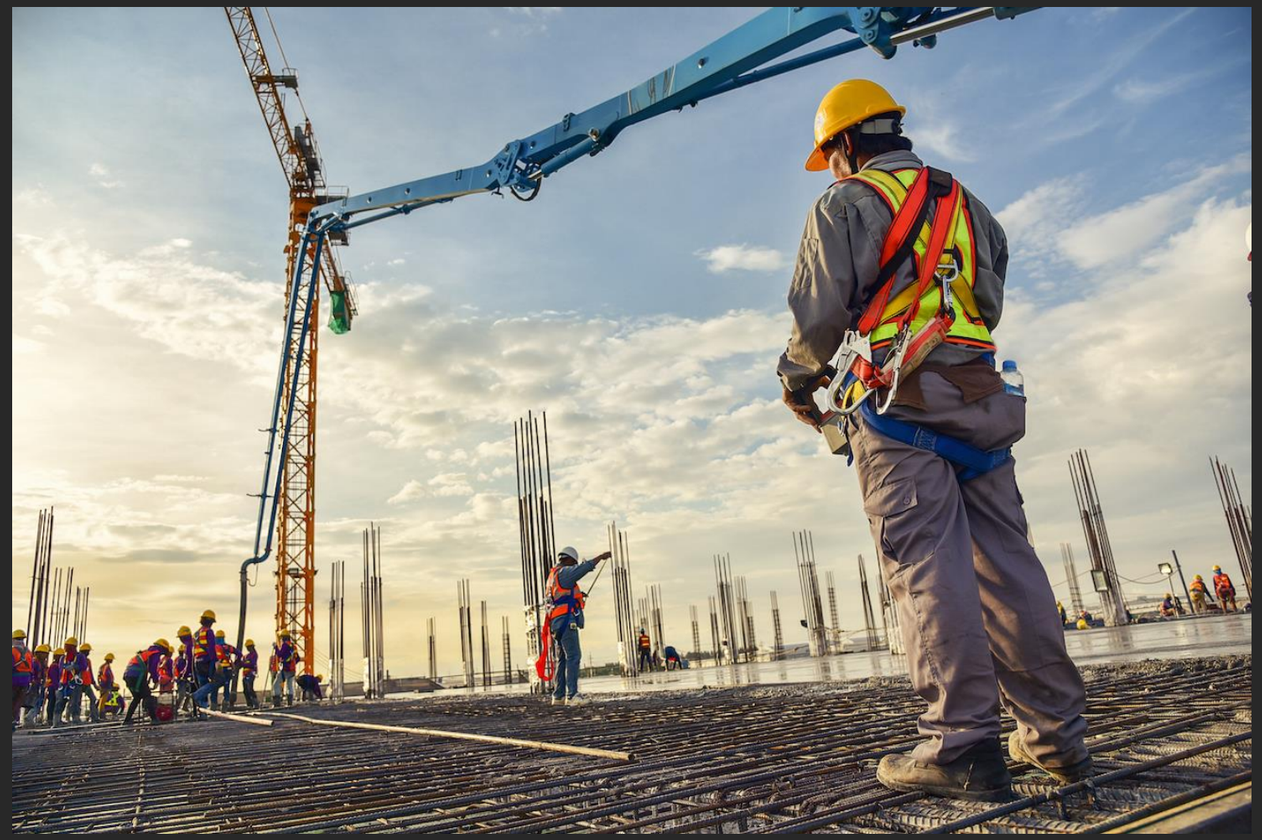
✓ Export data to S3 with AWS

Good for:

- Machine learning
- Data lakes

Customer #2: Heavy machinery

Use case: access control database, n:m consistency



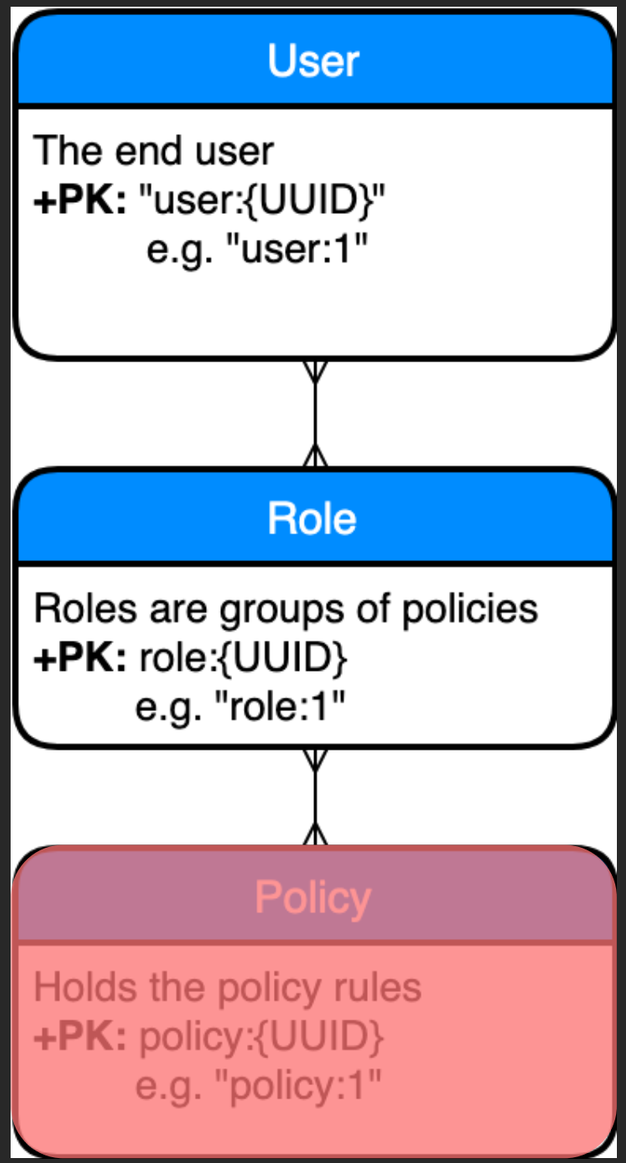
Use case

User

Role

Policy

Entity relationships (original)



Get user → Get roles for user → Get policies for role

10ms per read, limited scalability

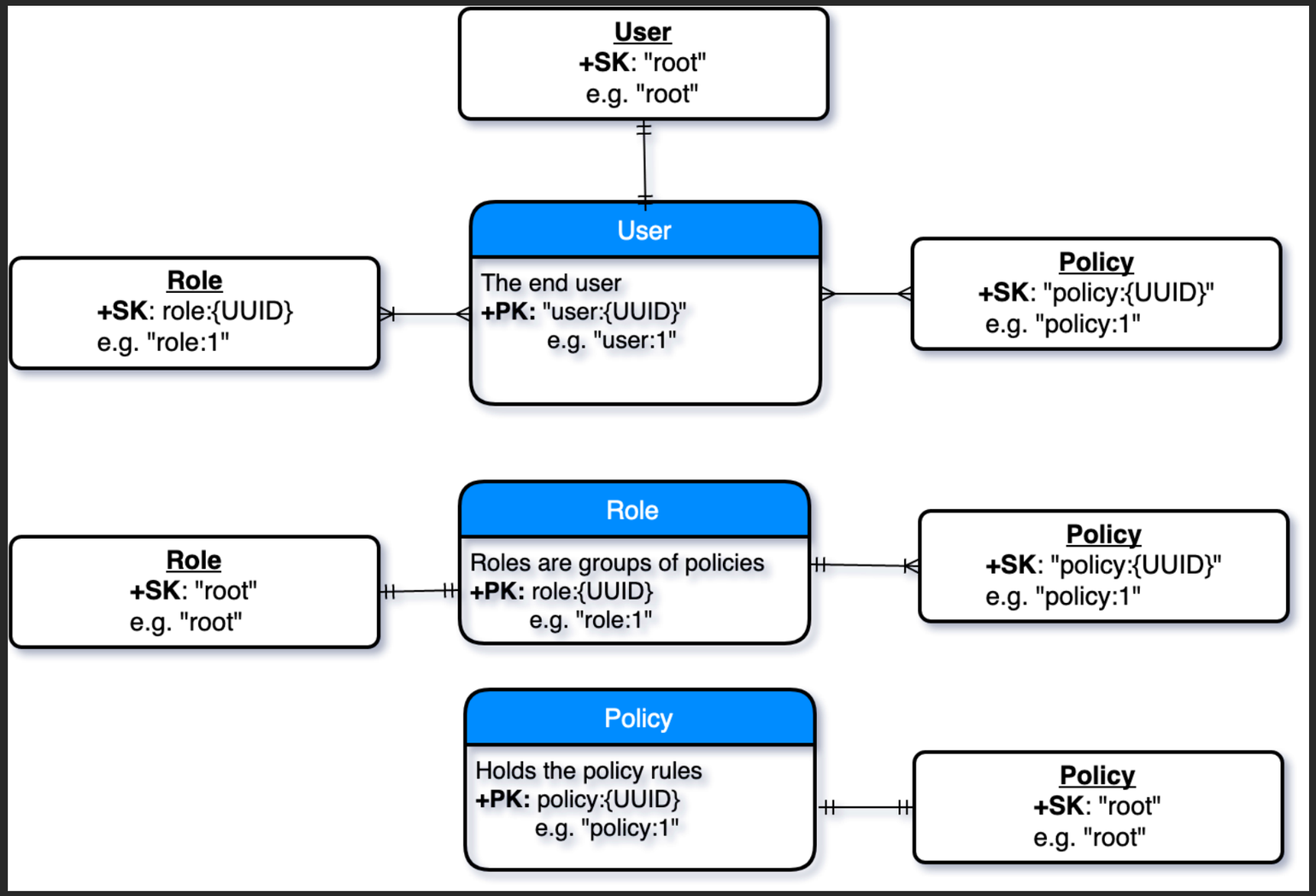
All data is relational

IT monitoring

Social graph

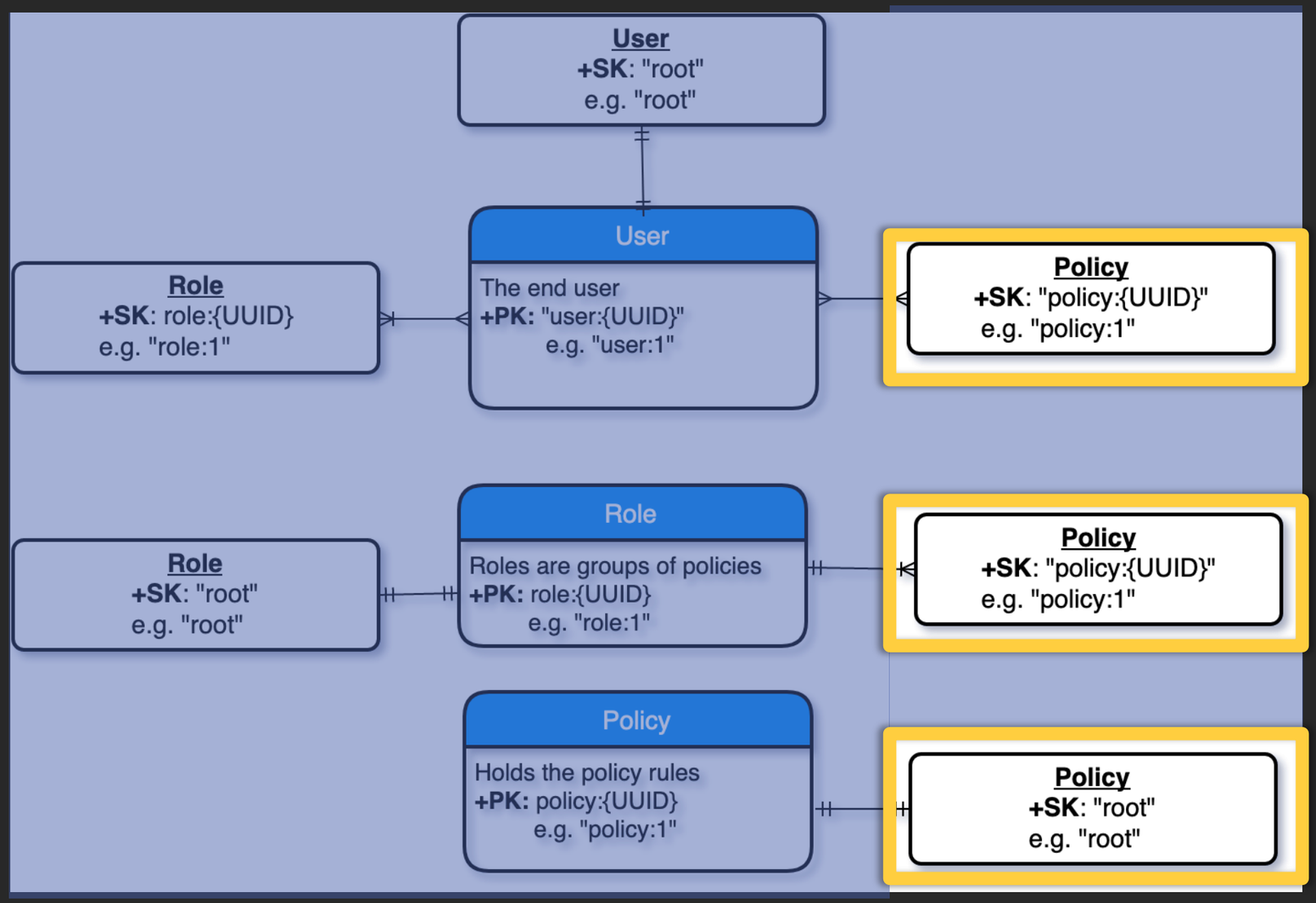
Documents

Entity relationships (fixed)



Aggregation → scalability

Entity relationships



Aggregation → scalability

Queries

- ✓ Get all policies for a `USER`
- ✓ Find all `POLICIES` for a `ROLE`
- ✓ Find all `USERS` in an OrgId

Final schema

Primary Key		Attributes	
PK	SK		
policy:1	root	policyName	policy
		Admin	{ … }
policy:2	root	policyName	policy
		RejectWrites	{ … }
policy:3	root	policyName	policy
		RevokeAssumeRole	{ … }

Primary Key		Attributes	
PK	SK		
role:1	root	roleName	
		Default role	
	policy:1	policyName	GSI_1_PK
		Admin	role:policy:1
	policy:2	policyName	GSI_1_PK
		RejectWrites	role:policy:2
	policy:3	policyName	GSI_1_PK
		RevokeAssumeRole	role:policy:3

Primary Key		Attributes		
PK	SK			
user:1	root	userName	orgId	GSI_1_PK
		John Doe	org:1	org:1
	role:1	roleName	GSI_1_PK	
		Default role	role:1	
	policy:1	policyName	policy	GSI_1_PK
		Admin	{ … }	user:policy:1
	policy:2	policyName	policy	GSI_1_PK
		RejectWrites	{ … }	user:policy:2
	policy:3	policyName	policy	GSI_1_PK
		RevokeAssumeRole	{ … }	user:policy:3

Queries

Query #1: Get all policies for a `USER`

Solution: Query with key_condition:
`PK = user:1 AND SK starts_with("policy")`

Primary Key		Attributes		
PK	SK			
	root	userName	orgId	GSI_1_PK
		John Doe	org:1	org:1
	role:1	roleName	GSI_1_PK	
		Default role	role:1	
user:1	policy:1	policyName	policy	GSI_1_PK
		Admin	{ … }	user:policy:1
	policy:2	policyName	policy	GSI_1_PK
		RejectWrites	{ … }	user:policy:2
	policy:3	policyName	policy	GSI_1_PK
		RevokeAssumeRole	{ … }	user:policy:3

Queries

Primary Key		Attributes	
PK	SK		
	root	roleName	
		Default role	
role:1	policy:1	policyName	GSI_1_PK
		Admin	role:policy:1
	policy:2	policyName	GSI_1_PK
		RejectWrites	role:policy:2
	policy:3	policyName	GSI_1_PK
		RevokeAssumeRole	role:policy:3

Query #2: Find all `POLICIES` for a `ROLE`

Solution: Query with key_condition:

```
PK = role:1 AND SK starts_with("policy")
```

Queries

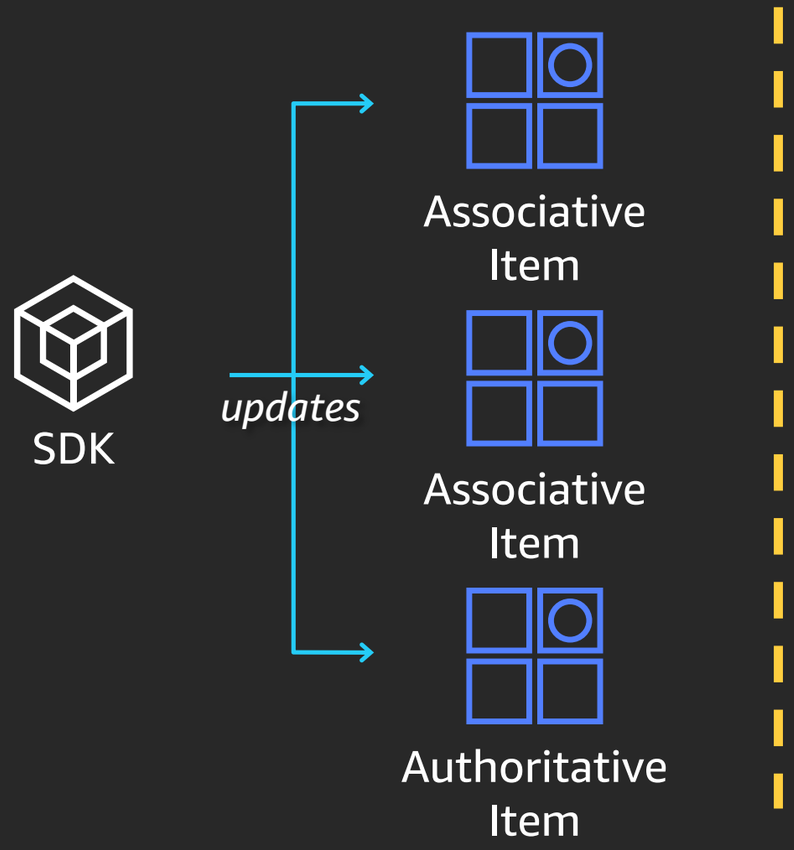
Query #3: Find all `USERS` in an OrgId

Solution: Query GSI 1 with key_condition: `PK = org:1`
Note: The full row is projected into the GSI

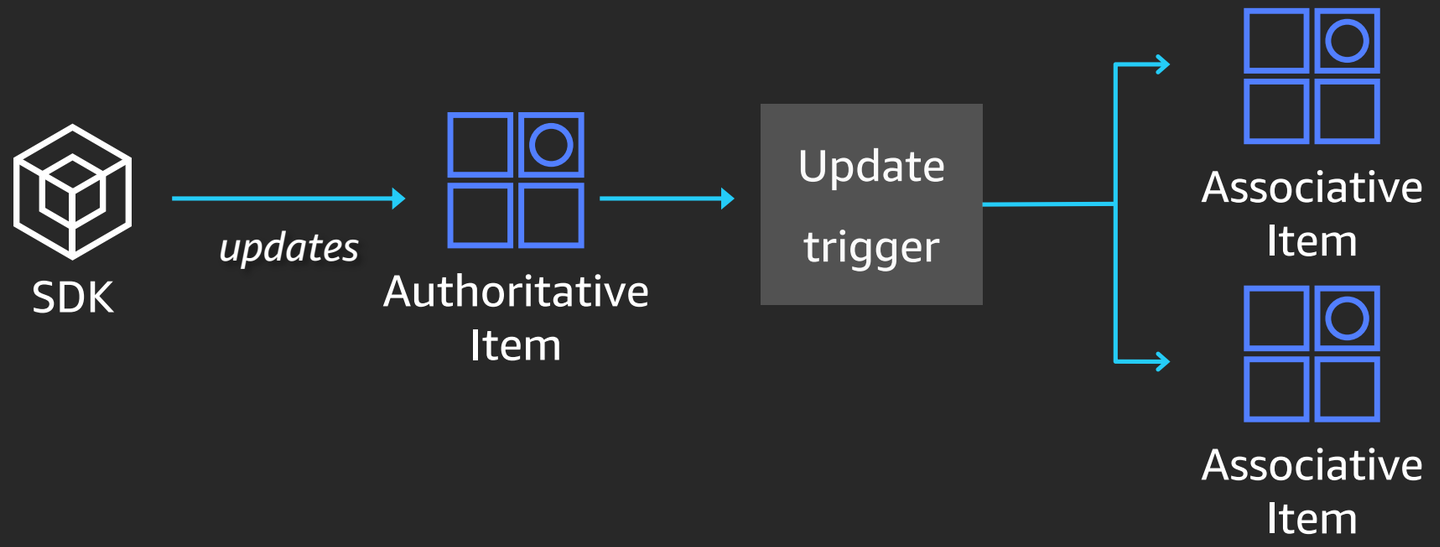
Primary Key		Attributes		
PK	SK			
	root	userName	orgId	GSI_1_PK
		John Doe	org:1	org:1
user:1	role:1	roleName	GSI_1_PK	
		Default role	role:1	
	policy:1	policyName	policy	GSI_1_PK
		Admin	{ … }	user:policy:1
	policy:2	policyName	policy	GSI_1_PK
		RejectWrites	{ … }	user:policy:2
	policy:3	policyName	policy	GSI_1_PK
		RevokeAssumeRole	{ … }	user:policy:3

Update strategies for references

Immediate writes

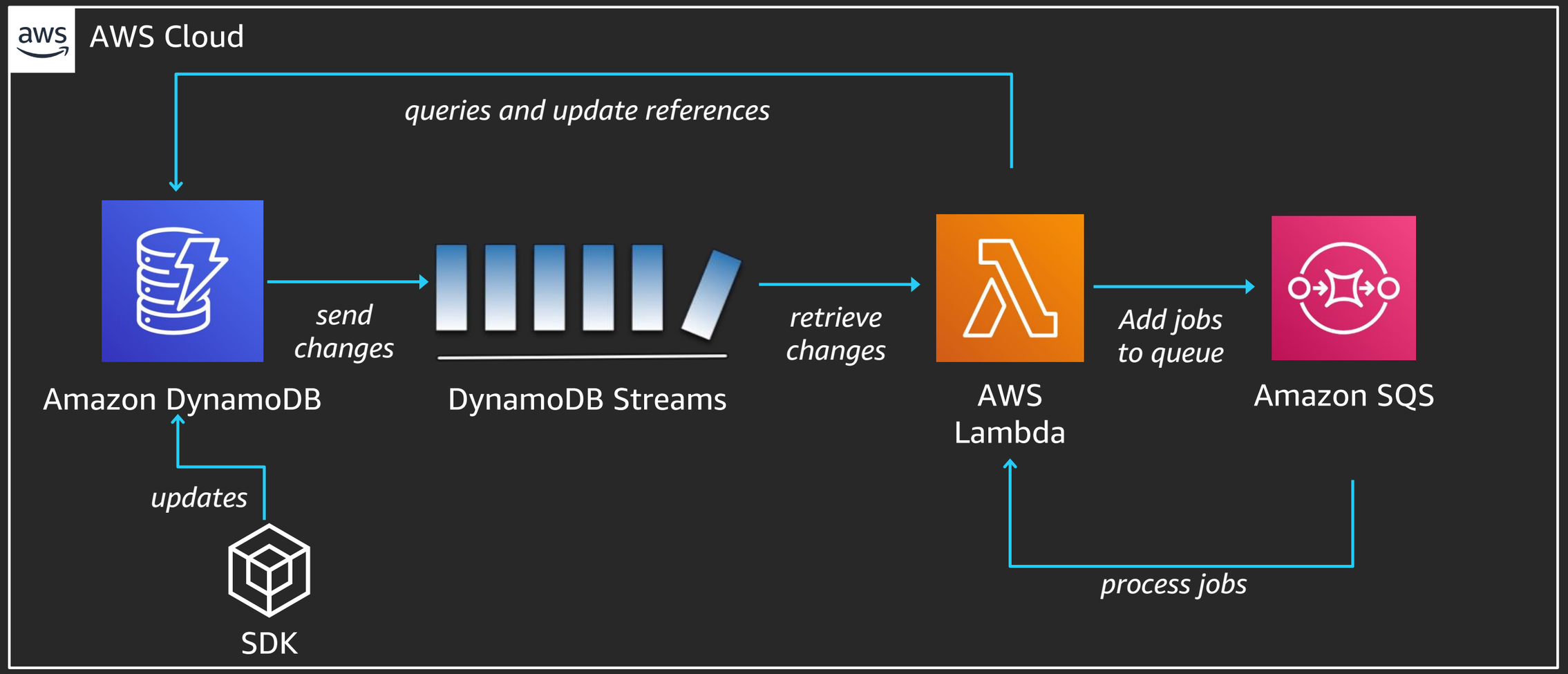


Triggers with DynamoDB streams



Update triggers

1. Update a `POLICY` in DynamoDB
2. Queue a job to update the references
3. Process the job
4. Update the references



Update triggers

1. Update a `POLICY` in DynamoDB
2. Queue a job to update the references
3. Process the job
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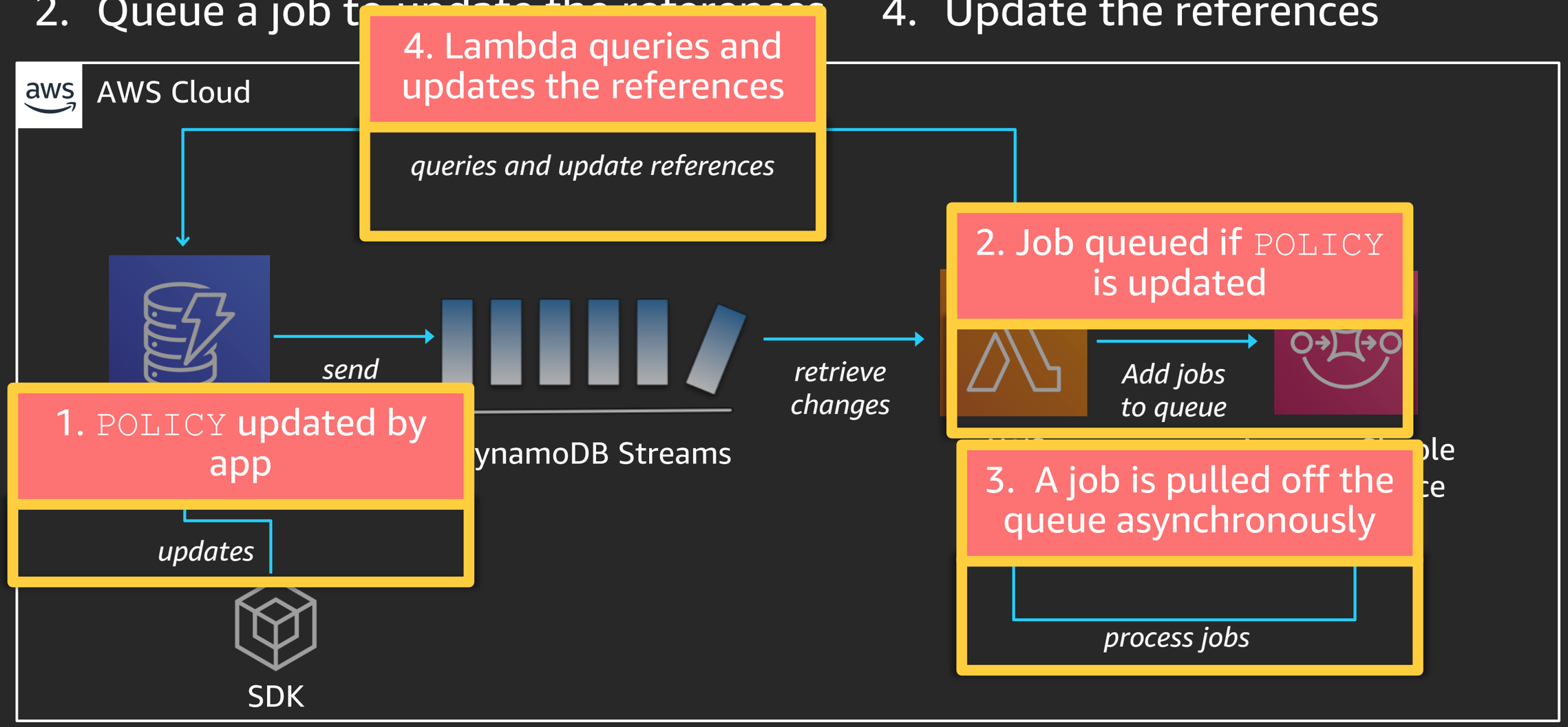


Recap

- ✓ Aggregate for performance

Good for:

- Relational data

- ✓ Trigger based updates

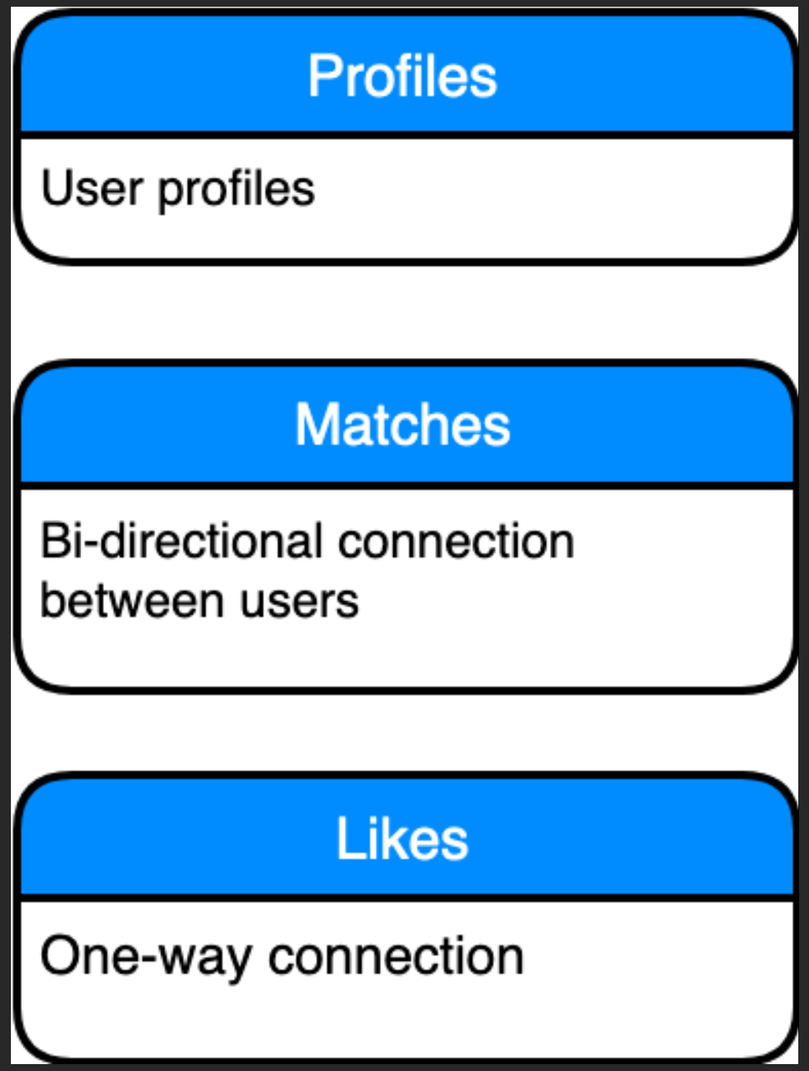
Good for:

- Horizontal scaling
- Relational data

Customer #3: Dating app

Use case: job scheduling

Entity relationships



Queries

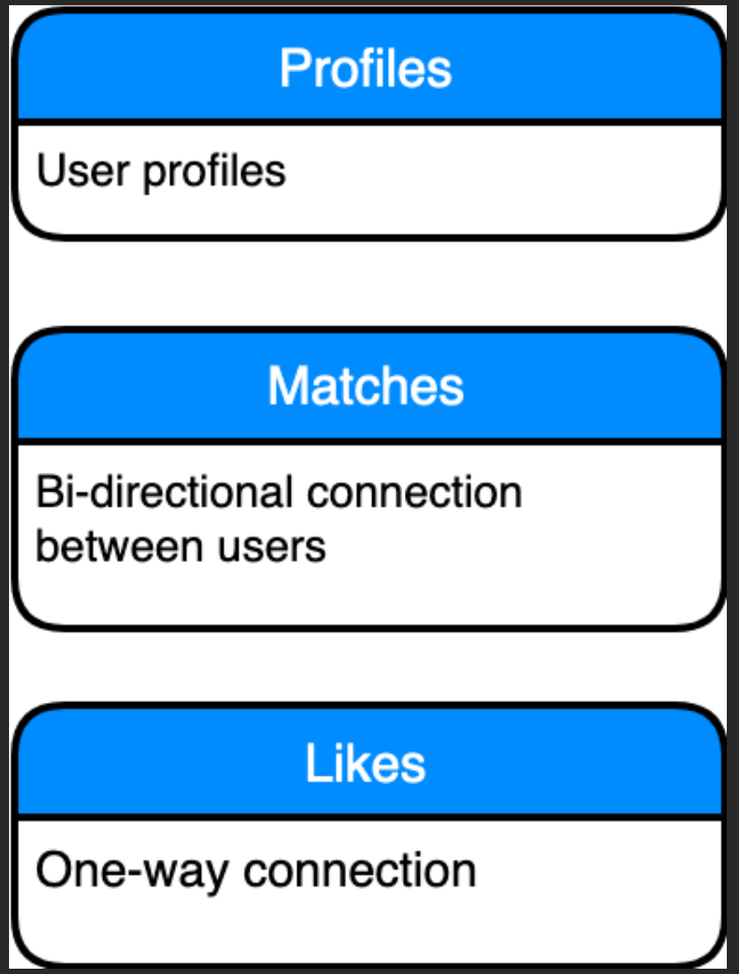
- ✓ Get `MATCHES` for a user
- ✓ For a user, find who `LIKED` them
- ✓ Find `MATCHES` that are stale

Table schema

All together, now

Keep in mind:

- Establish the primary keys first, and then add the GSIs
- Not all entities will be used to establish the queries
- The solution will use one or two queries
- A stale match is one that has not been seen by either party in the last 30 days



✓ Get `MATCHES` for a user

✓ For a user, find who `LIKED` them

✓ Find `MATCHES` that are stale

Final table schema

Primary Key		Attributes					
PK	SK						
match:1	root	user1	user2	GSI_1_PK	GSI_2_PK	GSI_3_PK	GSI_3_SK
		user:1234	user:4567	user:1234	user:4567	Match#(0-N)	2019-12-31T03:44
match:2	root	user1	user2	GSI_1_PK	GSI_2_PK	GSI_3_PK	GSI_3_SK
		user:9833	user:4590	user:9833	user:4590	Match#(0-N)	2019-12-31T03:44

Primary Key		Attributes			
PK	SK				
user:1234	user:4567	Status	deleted	GSI_1_PK	GSI_1_SK
		active	FALSE	user:like:4567	1577829985
user:4567	user:1234	Status	deleted	GSI_1_PK	GSI_1_SK
		active	FALSE	user:like:1234	1577833583

Table schema

Query #1: Get `MATCHES` for a user
Solution: : Query GSI 1 with key_condition `GSI_PK_1 = user:1234`, Query GSI 2 with key_condition `GSI_PK_2 = user:1234`

Primary Key		Attributes					
PK	SK						
match:1	root	user1	user2	GSI_1_PK	GSI_2_PK	GSI_3_PK	GSI_3_SK
		user:1234	user:4567	user:1234	user:4567	Match#(0-N)	2019-12-31T03:44
match:2	root	user1	user2	GSI_1_PK	GSI_2_PK	GSI_3_PK	GSI_3_SK
		user:9833	user:4590	user:9833	user:4590	Match#(0-N)	2019-12-31T03:44

#1

#3

Primary Key		Attributes			
PK	SK				
user:1234	user:4567	Status	deleted	GSI_1_PK	GSI_1_SK
		active	FALSE	user:like:4567	1577829985
user:4567	user:1234	Status	deleted	GSI_1_PK	GSI_1_SK
		active	FALSE	user:like:1234	1577833583

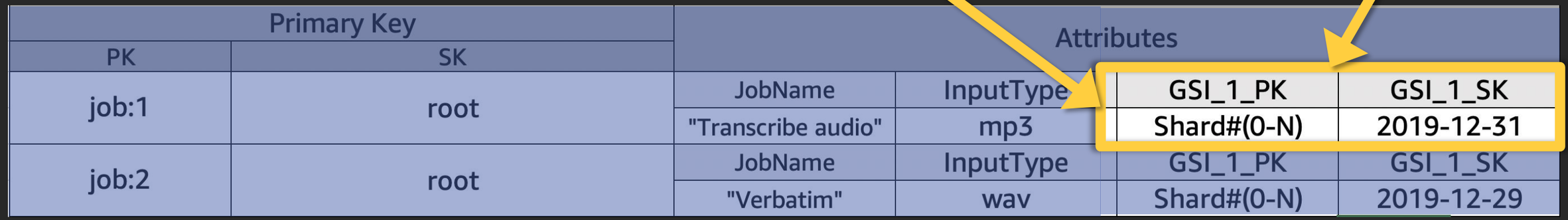
#2

Query #2: For a user, find who `LIKED` them
Solution: : Query GSI 1 with key_condition `GSI_PK_1 = user::like:1234`

Query #3: Find `MATCHES` that are stale
Solution: : Query every Match shard of GSI 3 with key_condition `GSI_PK_1 = Shard#(SHARDNUMBER) AND GSI_1_SK < 2020-01-15`

GSI overloading

Reuse generic index keys for different access patterns in the same table



Primary Key		Attributes			
PK	SK				
job:1	root	JobName	InputType	GSI_1_PK	GSI_1_SK
		"Transcribe audio"	mp3	Shard#(0-N)	2019-12-31
job:2	root	JobName	InputType	GSI_1_PK	GSI_1_SK
		"Verbatim"	wav	Shard#(0-N)	2019-12-29

Recap

- ✓ Migrate to DynamoDB

  Good for:

  - Operational workloads

- ✓ Scalable search with GSI write sharding

  Good for:

  - Scheduled jobs
  - Custom expiry rules

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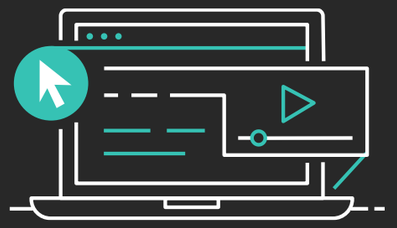

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Thank you!

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