Rudi Bruchez

From relational to Multimodel Azure Cosmos DB

Yes, it's me

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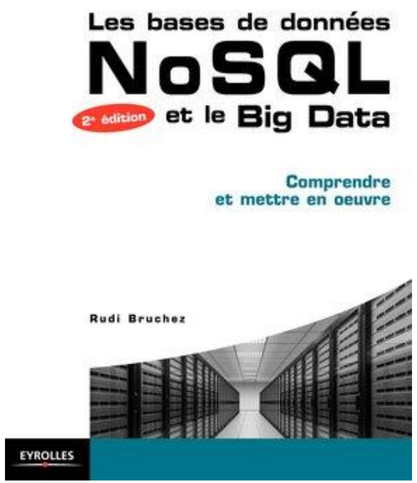

Les bases de données

NoSQL

2e édition et le Big Data

Comprendre
et mettre en oeuvre

Rudi Bruchez

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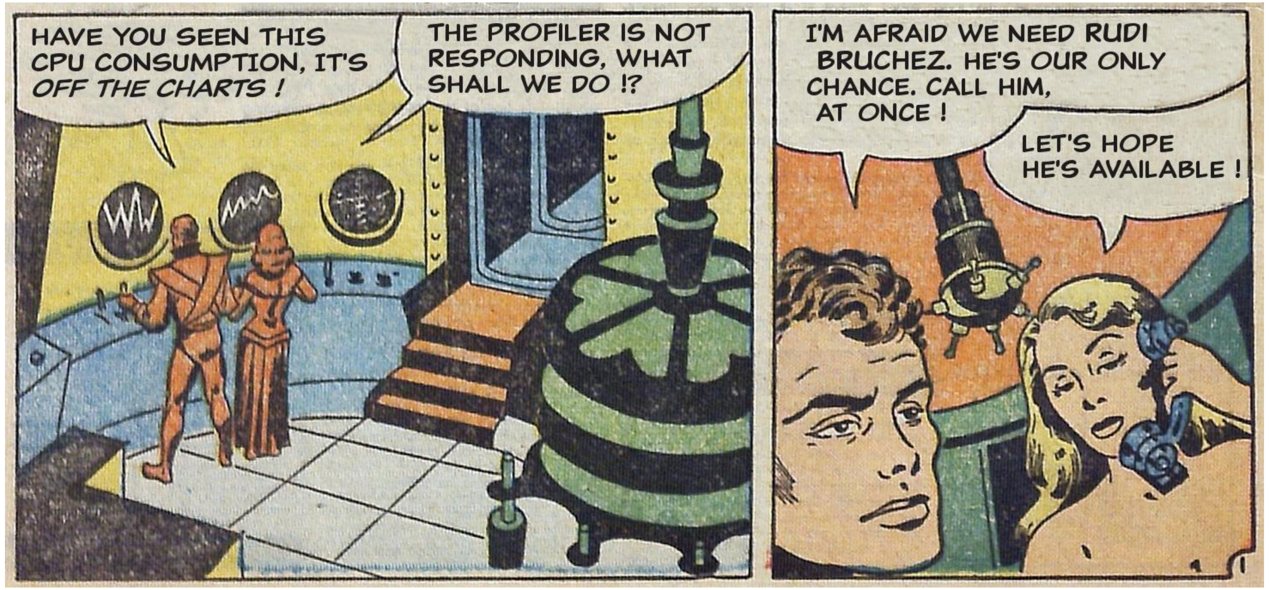
HAVE YOU SEEN THIS CPU CONSUMPTION, IT'S OFF THE CHARTS !
THE PROFILER IS NOT RESPONDING, WHAT SHALL WE DO !?
I'M AFRAID WE NEED RUDI BRUCHEZ. HE'S OUR ONLY CHANCE. CALL HIM, AT ONCE !
LET'S HOPE HE'S AVAILABLE !

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DATABASE CONTROL

Session Feedback Day 1 (not optional!)

http://bit.ly/DataGrillen2019Day1

Overview

Introduction to CosmosDB

Data Models

Operations

Introduction to CosmosDB

What is Azure CosmosDB

Cosmos DB started in 2010 as "Project Florence"

First availability in 2015 as DocumentDB

Full Cosmos DB released in 2017

What is Azure CosmosDB

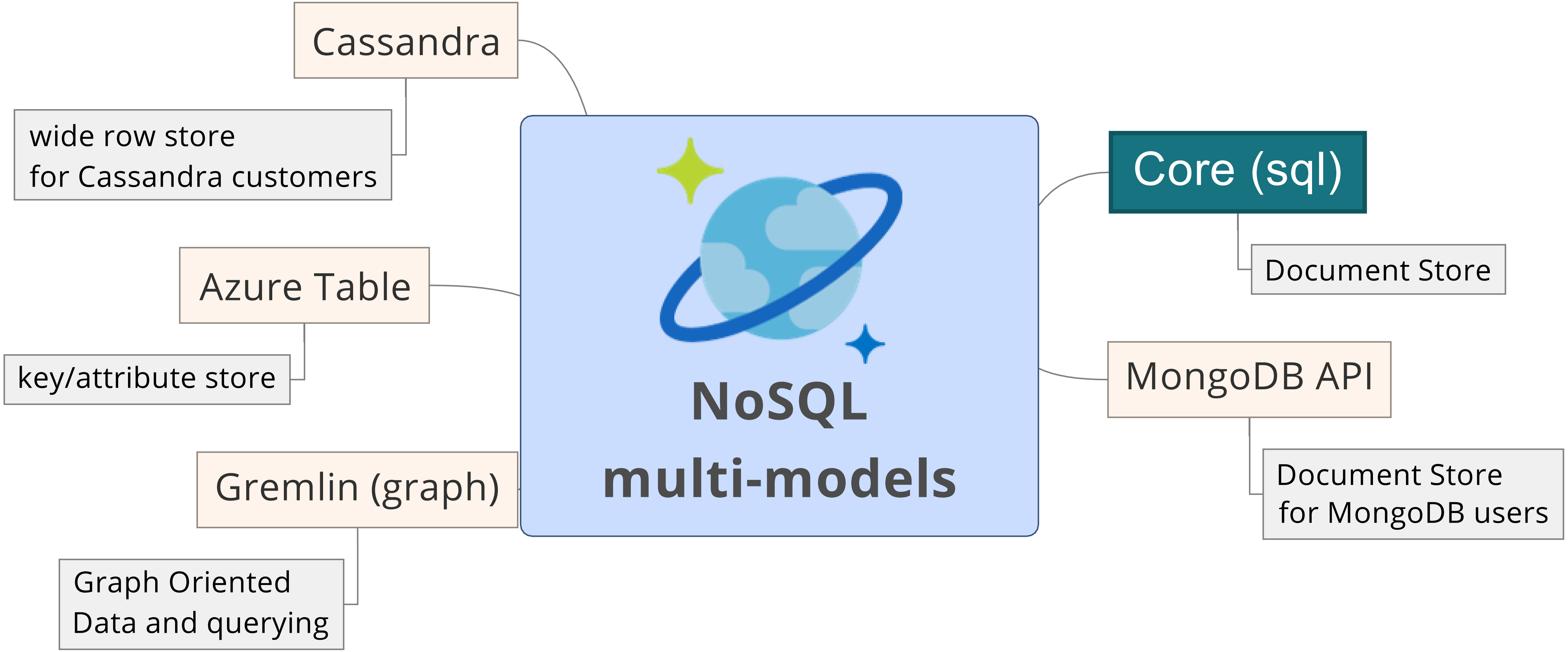
Microsoft
Azure

Distributed to regions

Database As A Service

Multi models
Multi APIs

Multi-Model APIs



NoSQL multi-models

Cassandra

wide row store
for Cassandra customers

Azure Table

key/attribute store

Gremlin (graph)

Graph Oriented
Data and querying

Core (sql)

Document Store

MongoDB API

Document Store
for MongoDB users

What is the model?

CosmosDB Account

Database — a group of containers

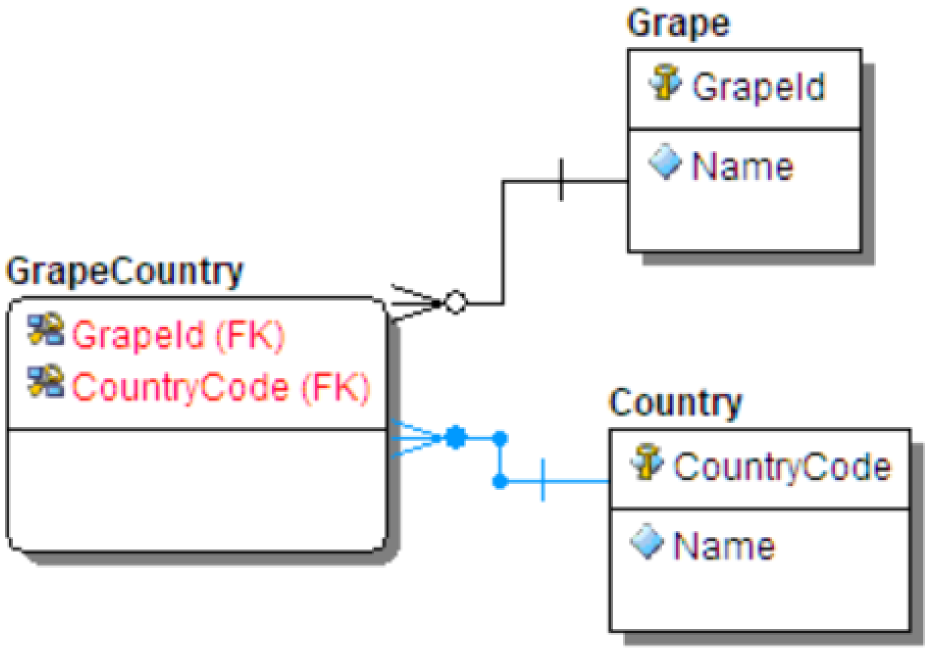
Containers — Contains items

Items — Schema-agnostic data

What is it Good For?

- Semi-structured or unstructured data
- Document-like data
- IOT
- Messages processing
- High throuput writes of log or events

Why is it NoSQL?



Self-contained items in JSON

document embedding

```
{
    "Grape": "Vionnier",
    "Countries" :
    [
        "France",
        "Germany",
        "Italy"
    ]
}
```

What is in the container?

Containers

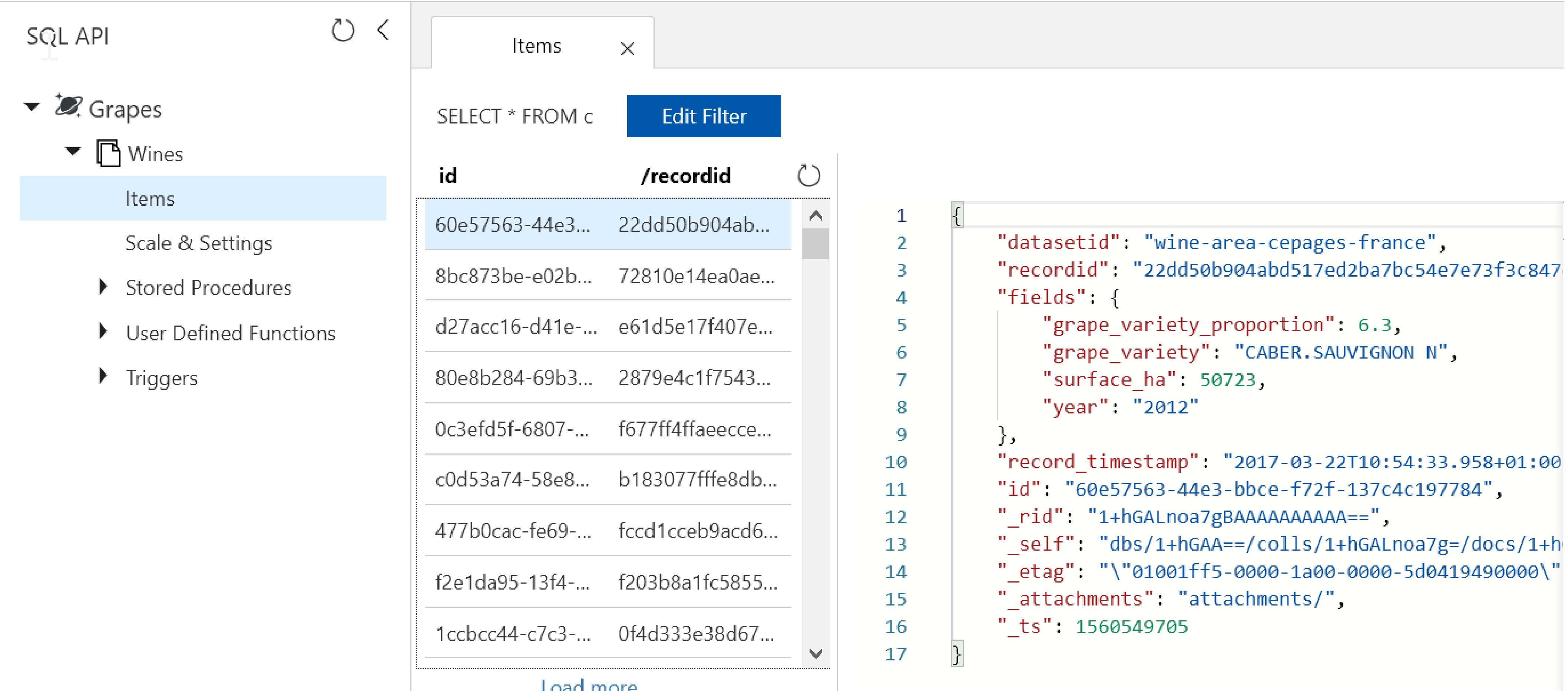
Items

Contain fields, internally stored in JSON

Fields

By default, each field is indexed

How you see it in the Data Explorer?



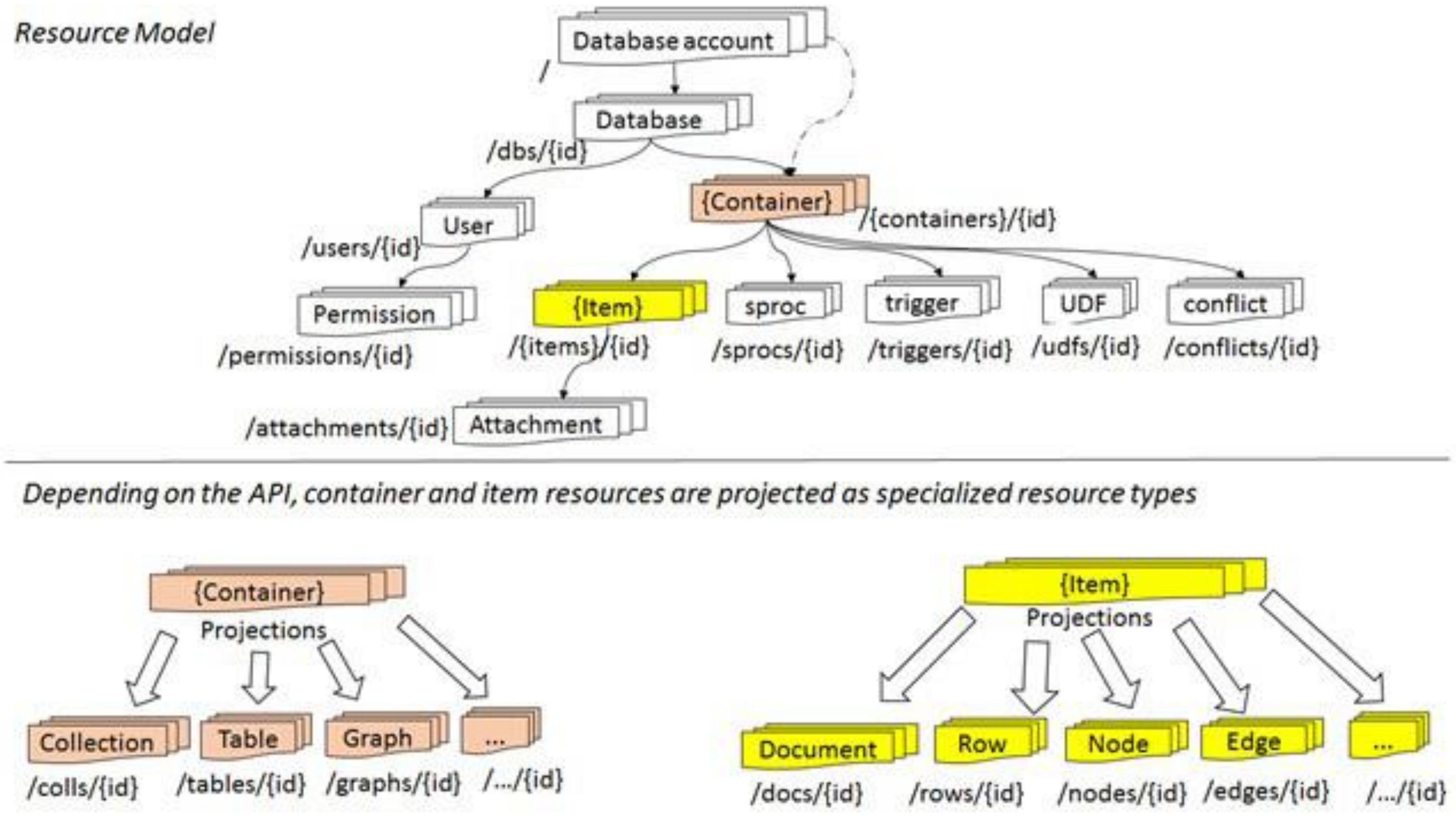
SELECT * FROM c

id	/recordid
60e57563-44e3...	22dd50b904ab...
8bc873be-e02b...	72810e14ea0ae...
d27acc16-d41e-...	e61d5e17f407e...
80e8b284-69b3...	2879e4c1f7543...
0c3efd5f-6807-...	f677ff4ffaeecce...
c0d53a74-58e8...	b183077fffe8db...
477b0cac-fe69-...	fccd1cceb9acd6...
f2e1da95-13f4-...	f203b8a1fc5855...
1ccbcc44-c7c3-...	0f4d333e38d67...

```
{
    "datasetid": "wine-area-cepages-france",
    "recordid": "22dd50b904abd517ed2ba7bc54e7e73f3c847
    "fields": {
        "grape_variety_proportion": 6.3,
        "grape_variety": "CABER.SAUVIGNON N",
        "surface_ha": 50723,
        "year": "2012"
    },
    "record_timestamp": "2017-03-22T10:54:33.958+01:00
    "id": "60e57563-44e3-bbce-f72f-137c4c197784",
    "_rid": "1+hGALnoa7gBAAAAAAAAAA==",
    "_self": "dbs/1+hGAA==/colls/1+hGALnoa7g=/docs/1+h
    "_etag": "\"01001ff5-0000-1a00-0000-5d0419490000\"
    "_attachments": "attachments/",
    "_ts": 1560549705
}
```

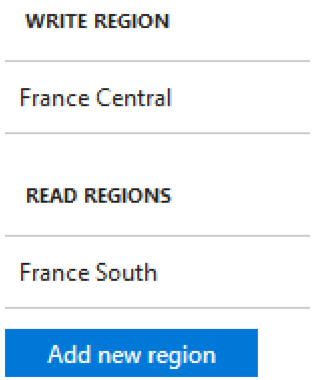
How is it stored?

Schema-agnostic containers



Global distribution

Read-only replicas



WRITE REGION

France Central

READ REGIONS

France South

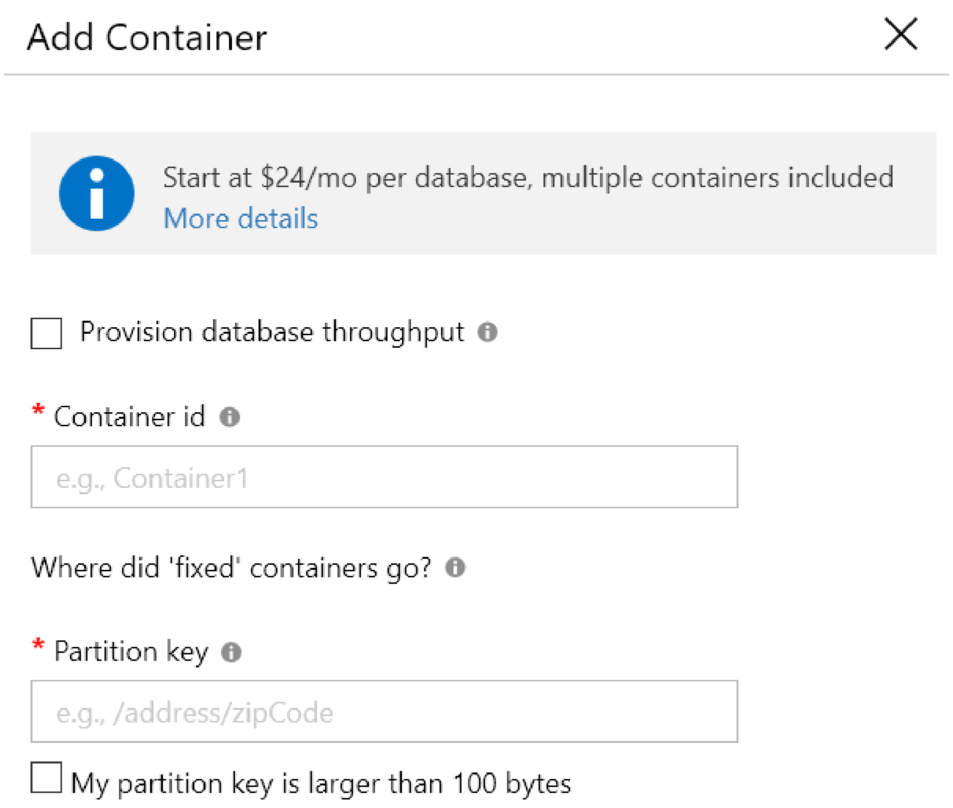
Multi-master for NoSQL API

new Azure Cosmos DB accounts only

September 2018

single digit millisecond write latency at the 99th percentile anywhere in the world

Automatic Partitioning (Sharding)



Add Container

Start at $24/mo per database, multiple containers included
More details

□ Provision database throughput

* Container id

e.g., Container1

Where did 'fixed' containers go?

* Partition key

e.g., /address/zipCode

□ My partition key is larger than 100 bytes

- Logical partitions (vnodes)
- Physical partitioning based on hash is transparent
- Queries in the same partition are more cost

allowed only in one partition

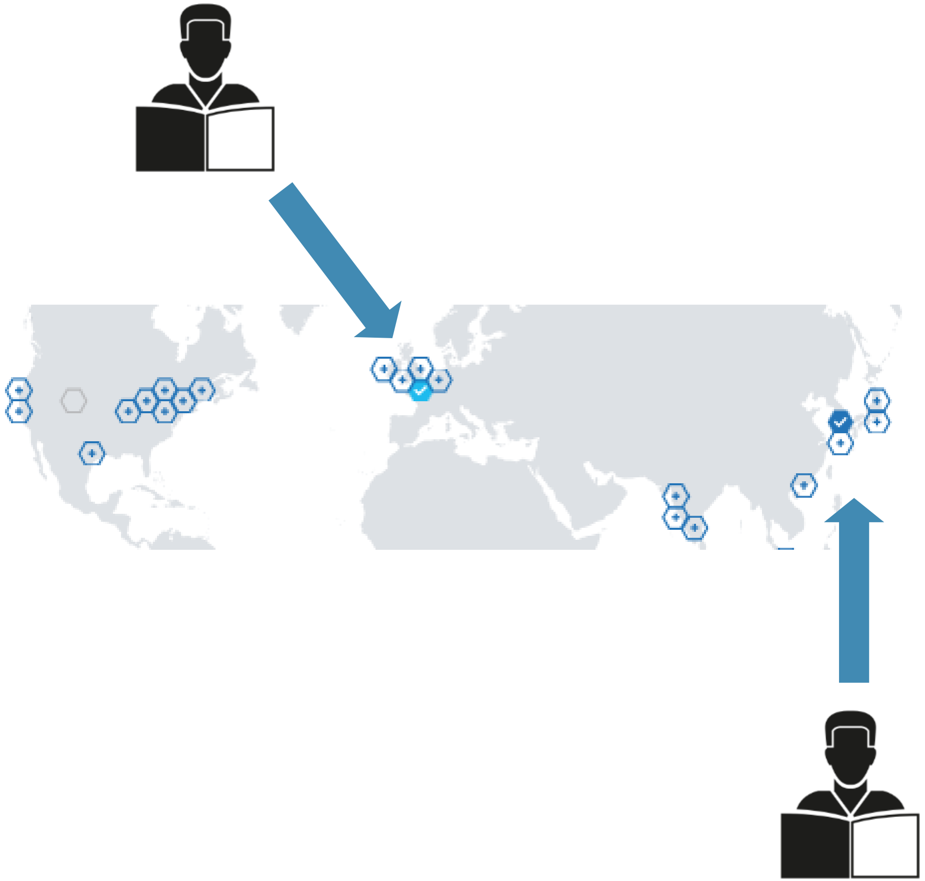
Model your data from your queries

Partitioning

Automatic physical partitioning if RU/s >= 1000

API	Partition key	Row key
SQL	Custom partition key path	Fixed id
MongoDB	Custom shard key	Fixed _id
Gremlin	Custom partition key property	Fixed id
Table	Fixed PartitionKey	Fixed RowKey

Distributed Consistency?



Consistency levels

Consistency level	Description	%
Eventual	No read consistency guaranteed	
Consistent prefix	Eventual, with write-order consistency	
Session	RYOW – consistent inside the same session	73
Bounded Staleness	Set a time or # of operations’ lag	20
Strong	Only one region	

2x cheaper

What is a Session ?

```
public async Task GetAsync()
        {
            var response = await this.client.ReadDocumentAsync(...));
            string sessionToken = response.SessionToken;

            RequestOptions options = new RequestOptions();
            options.SessionToken = sessionToken;
            var response2 = await
                client.ReadDocumentAsync(..., options);
        }
```

Per-request consistency level

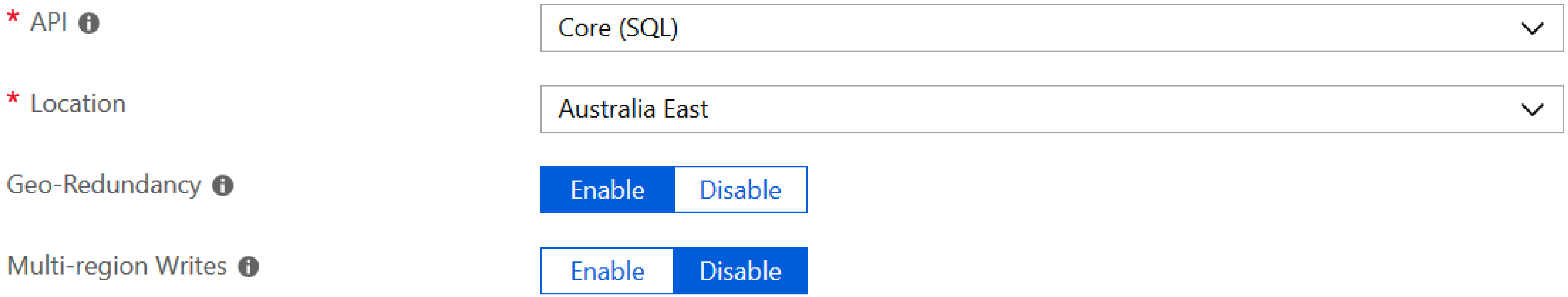
```
Document doc = client.ReadDocumentAsync(
    documentLink,
    new RequestOptions {
        ConsistencyLevel =
        ConsistencyLevel.Eventual
    }
);
```

2% of Azure Cosmos DB tenants

Multi-Master Databases

September 2018; in Preview before

New accounts only



* API	Core (SQL)
* Location	Australia East
Geo-Redundancy	[✓ Enable] Disable
Multi-region Writes	Enable [✓ Disable]

Multi-Master Databases

```
ConnectionPolicy policy = new ConnectionPolicy
{
   ConnectionMode = ConnectionMode.Direct,
   ConnectionProtocol = Protocol.Tcp,
   UseMultipleWriteLocations = true,
};
policy.PreferredLocations.Add("West US");
policy.PreferredLocations.Add("North Europe");
policy.PreferredLocations.Add("Southeast Asia");
```

Multi-homing API

Global conflict resolution modes

Core (SQL) API has 3 modes:

- **Last-Writer-Wins** (LWW) – the largest value in a ConflictResolutionPath wins
- **Custom – User-Defined Procedure** – add an UDP with a special signature to the collection
- **Custom – Asynchronous** – conflicts are not committed, but registered in the read-only conflicts feed for deferred resolution by the application.

For all other API models: LWW only.

Choosing conflict resolution mode

```
DocumentCollection c = await
Client.CreateDocumentCollectionIfNotExistsAsync(
    UriFactory.CreateDatabaseUri("Wines"),
    new DocumentCollection
    {
        Id = "Italy",
        ConflictResolutionPolicy = new ConflictResolutionPolicy
        {
            Mode = ConflictResolutionMode.LastWriterWins,
            ConflictResolutionPath = "/Timestamp"
        }
    }
);
```

https://docs.microsoft.com/fr-fr/azure/cosmos-db/multi-master-conflict-resolution#code-samples

Pricing

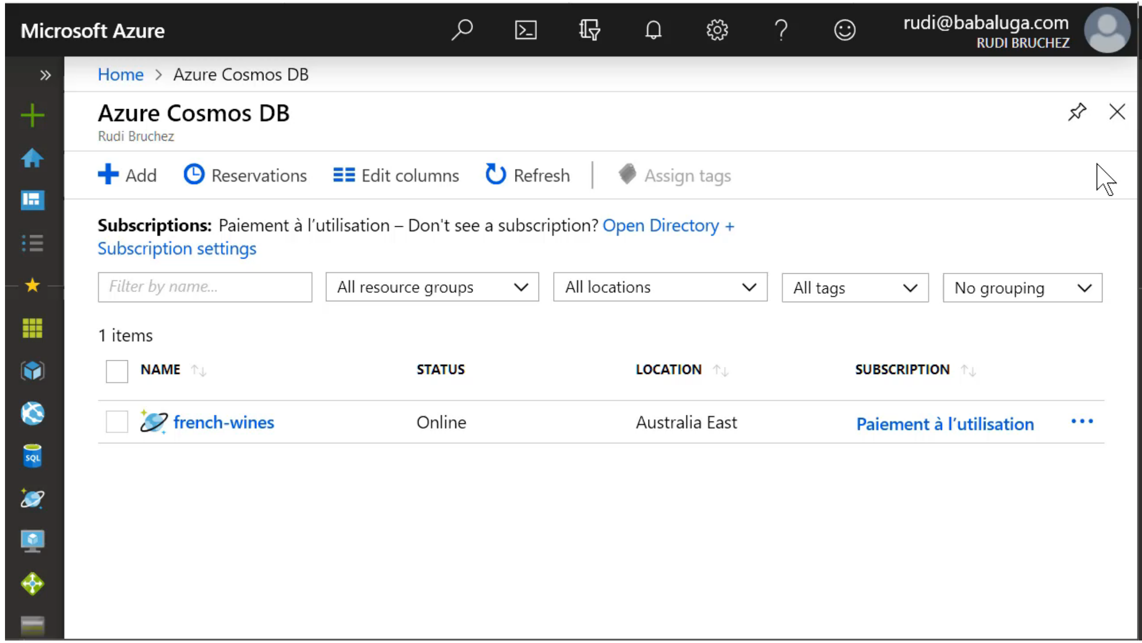
By collection

- size
- RU per hour (reserved, not effectively used)

RU – Request Units

- The capacity of your system
- 1 RU = 1 Kb for 1 request

Demos – Creating a Database



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Azure Cosmos DB

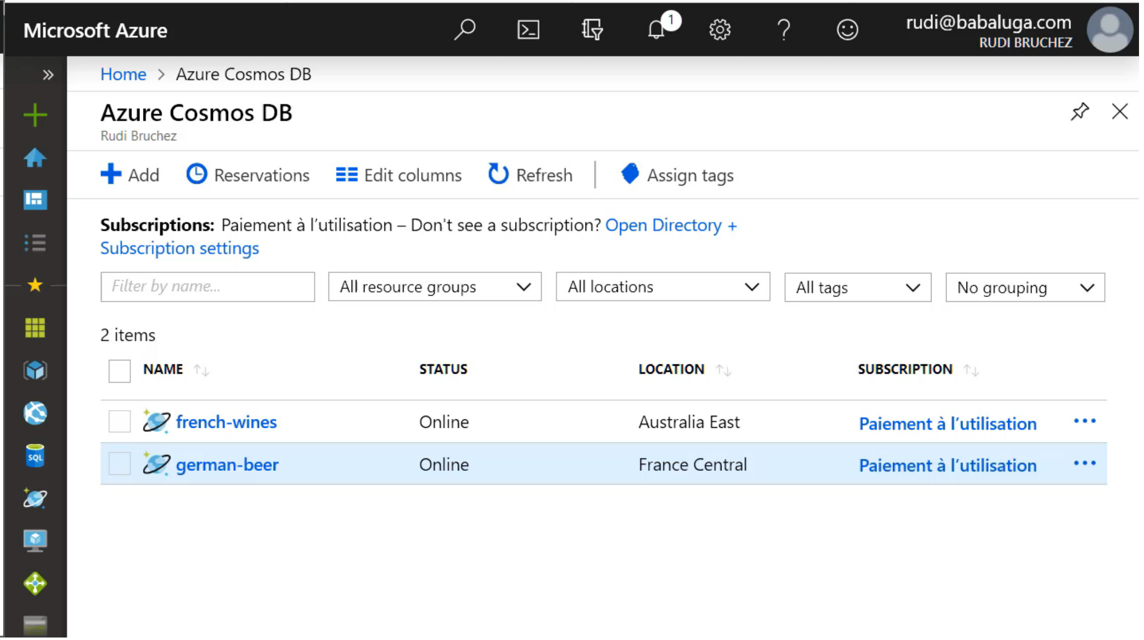
Rudi Bruchez

Subscriptions: Paiement à l'utilisation – Don't see a subscription? Open Directory + Subscription settings

Filter by name... | All resource groups | All locations | All tags | No grouping

1 items

NAME	STATUS	LOCATION	SUBSCRIPTION
french-wines	Online	Australia East	Paiement à l'utilisation



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Subscriptions: Paiement à l'utilisation – Don't see a subscription? Open Directory + Subscription settings

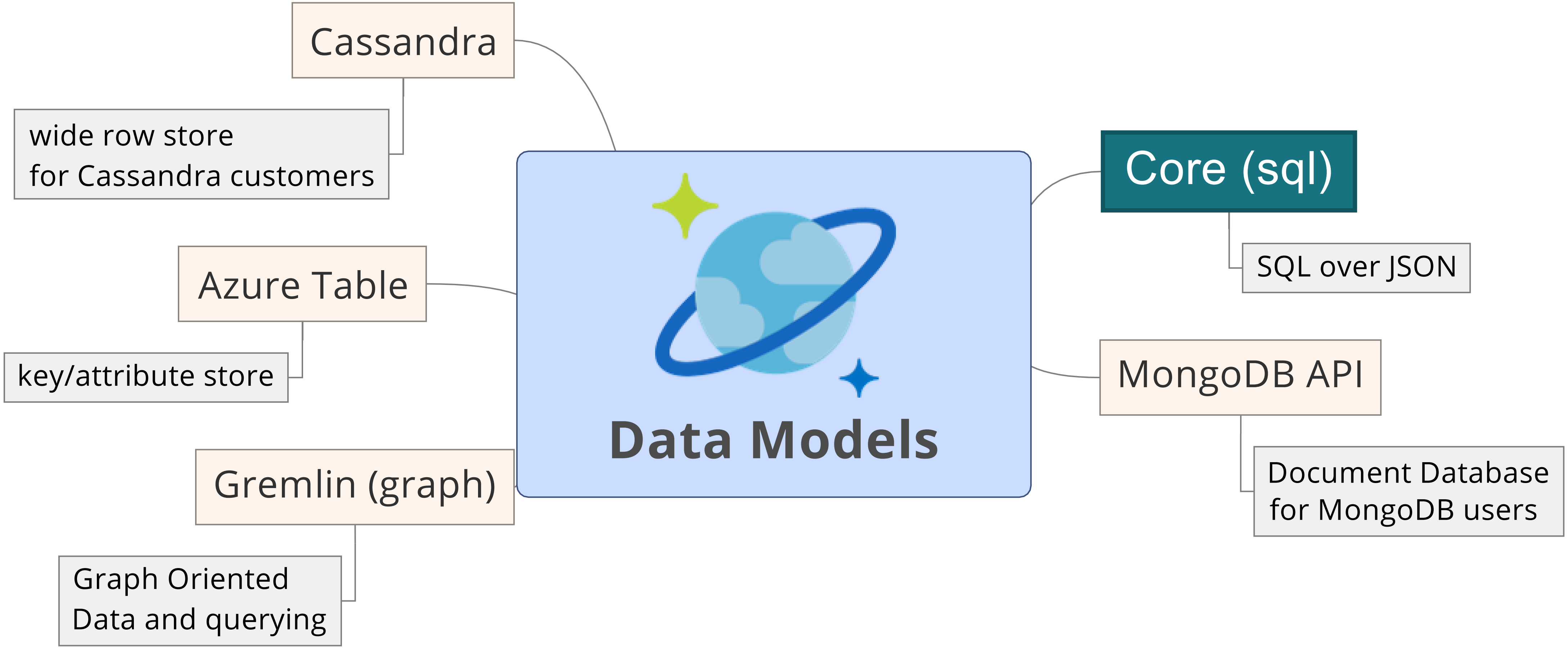
Filter by name... | All resource groups | All locations | All tags | No grouping

2 items

NAME	STATUS	LOCATION	SUBSCRIPTION
french-wines	Online	Australia East	Paiement à l'utilisation
german-beer	Online	France Central	Paiement à l'utilisation

Data Models

Multi-Model APIs



Data Models

Cassandra

wide row store
for Cassandra customers

Azure Table

key/attribute store

Gremlin (graph)

Graph Oriented
Data and querying

Core (sql)

SQL over JSON

MongoDB API

Document Database
for MongoDB users

Multi-Models APIs

API	Mapping		Compatibility
Core	Containers	Items	
MongoDB	Collections	Documents	MongoDB 3.2, some 3.4 features in preview
Gremlin	Graphs	Nodes, Edges	Gremlin 3.2
Cassandra	Tables	Rows	CQL 4
Azure Table Storage	Table	Item	

SQL API

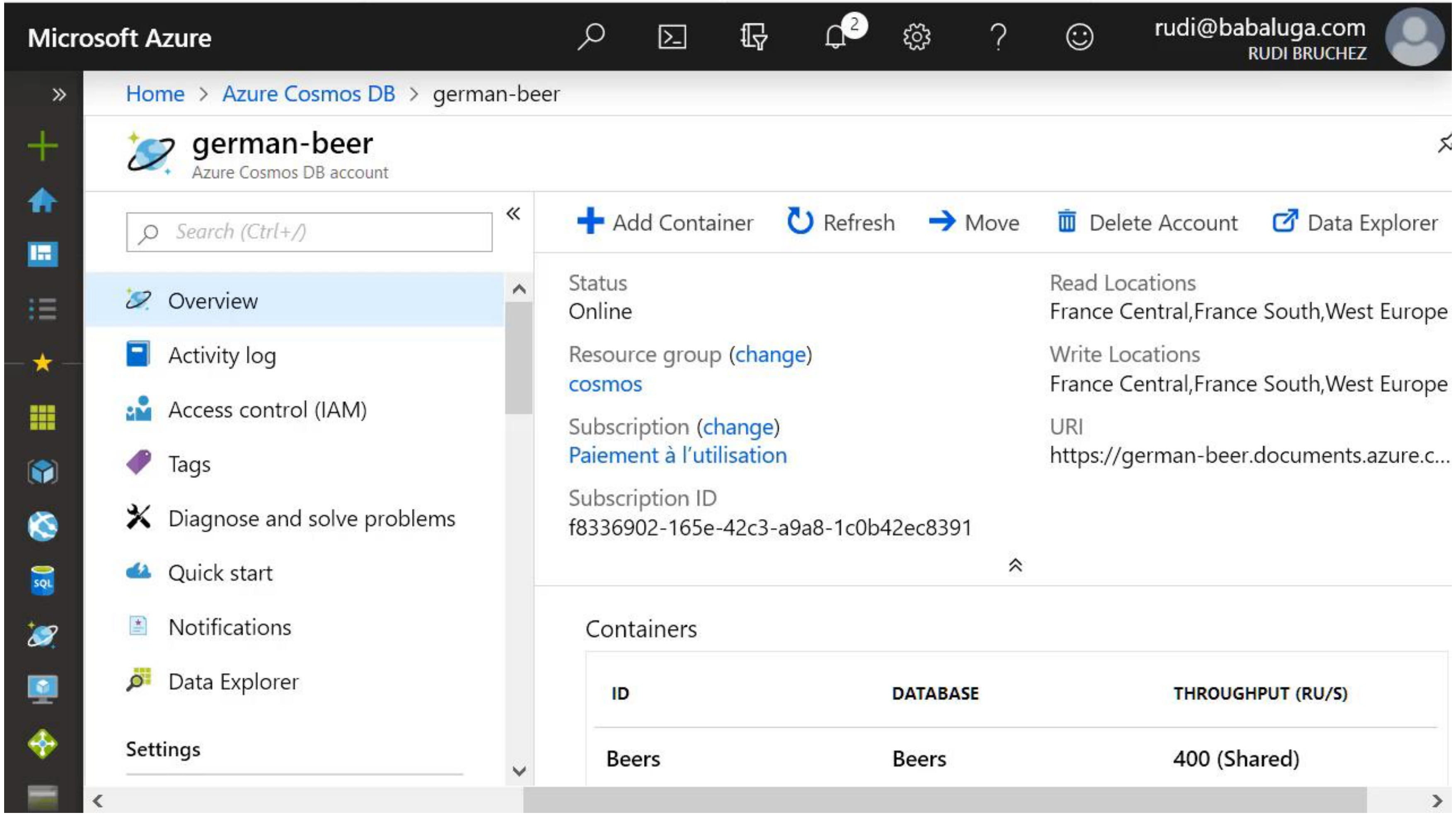
Document Database (JSON)

documentDB API

“id” column mandatory, manually or automatically set

SQL language for documents

Demo – Creating an Item



german-beer

Azure Cosmos DB account

Status
Online

Resource group (change)
cosmos

Subscription (change)
Paiement à l'utilisation

Subscription ID
f8336902-165e-42c3-a9a8-1c0b42ec8391

Read Locations
France Central,France South,West Europe

Write Locations
France Central,France South,West Europe

URI
https://german-beer.documents.azure.c...

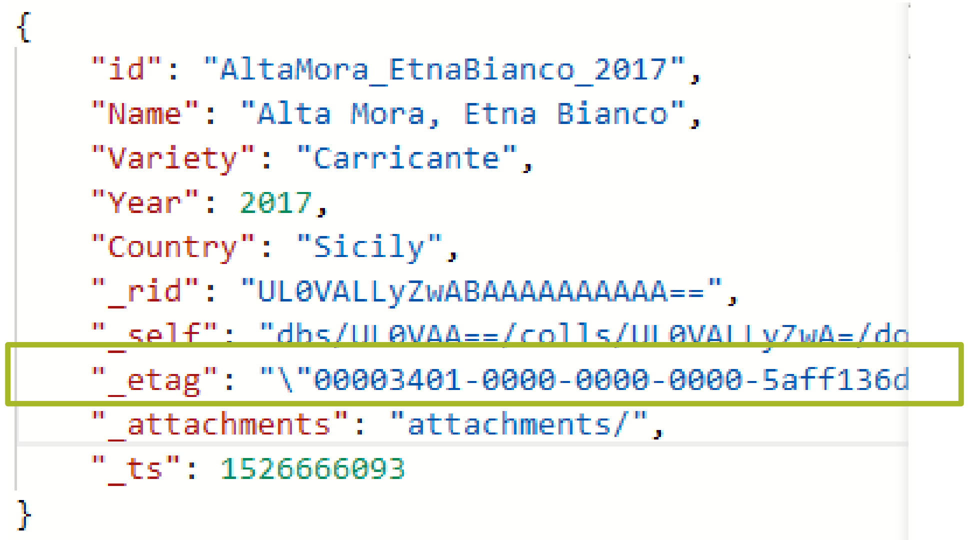
Containers

ID	DATABASE	THROUGHPUT (RU/S)
Beers	Beers	400 (Shared)

What is in the Document?

Property	User settable ?	Purpose
_rid	System	unique, hierarchical identifier of the resource
_etag	System	for optimistic concurrency control
_ts	System	Last updated timestamp (epoch)
_self	System	Unique addressable URI of the resource
id	Either	If the user does not specify, system generated

eTag Management – OCC, MVCC



```
{
    "id": "AltaMora_EtnaBianco_2017",
    "Name": "Alta Mora, Etna Bianco",
    "Variety": "Carricante",
    "Year": 2017,
    "Country": "Sicily",
    "_rid": "UL0VALLyZwABAAAAAAAAAA==",
    "_self": "dbs/UL0VAA==/colls/UL0VALLyZwA=/do
    "_etag": "\"00003401-0000-0000-0000-5aff136d
    "_attachments": "attachments/",
    "_ts": 1526666093
}
```

```
var ac = new AccessCondition {
    Condition = doc.ETag, Type = AccessConditionType.IfMatch};

this.client.ReplaceDocumentAsync(doc.SelfLink, wine,
    new RequestOptions {AccessCondition = ac}
);
```

060.etag.cs

SQL Queries

- Subset of SQL implemented in Javascript
- Javascript support
- JSON projection
- Intra-document joins
- Support for array iteration in the From clause

SQL Queries

```
SELECT Name as "Wine Name"
FROM "all-wines"
-- returns a JSON list

SELECT {"Wine Name": Name} as "Wines"
FROM "all-wines"
-- returns a JSON object
```

SQL Queries

```
SELECT Name as "Seller Name"
FROM wines.sellers
-- accessing a subdocument

SELECT Name as "Seller Name"
FROM w IN wines.sellers
-- iterating through a JSON array
```

Intra-document joins

- Only INNER JOIN
- Complete cross product of the sets participating in the join

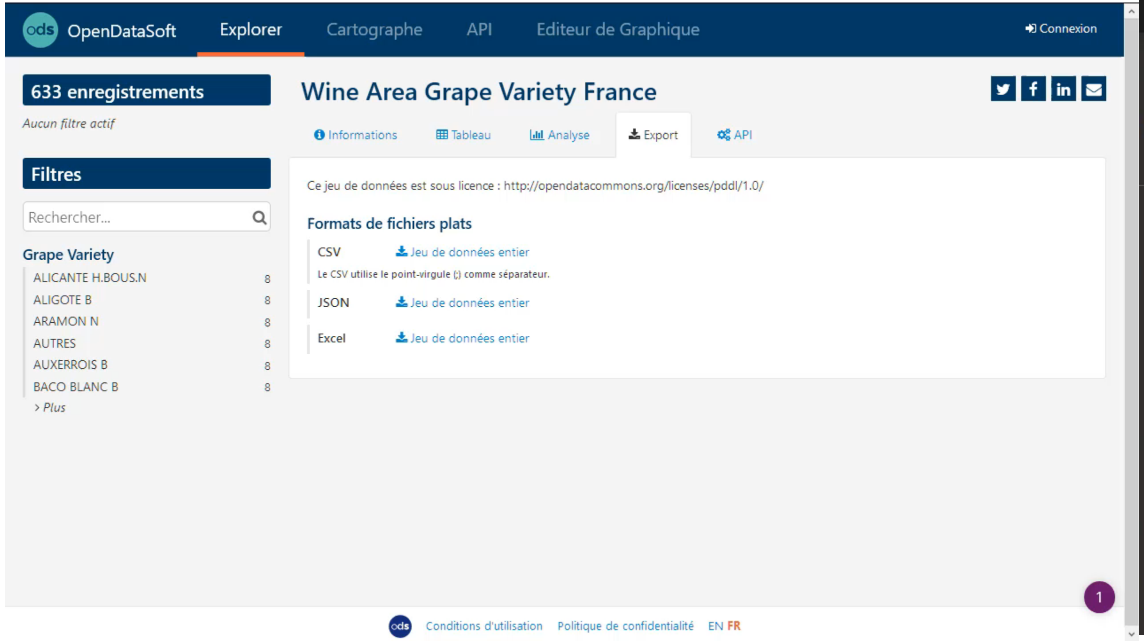
```
SELECT tag.name
FROM food
JOIN tag IN food.tags
WHERE food.id = "09052"
```

Builtin Functions

Function group	Operations
Mathematical functions	ABS, CEILING, EXP, FLOOR, POWER, ROUND, SIGN, SQRT, SQUARE, …
Type checking functions	IS_ARRAY, IS_BOOL, IS_NULL, IS_NUMBER, IS_OBJECT, IS_STRING, IS_DEFINED, and IS_PRIMITIVE
String functions	CONCAT, CONTAINS, ENDSWITH, INDEX_OF, LEFT, LENGTH, LOWER, LTRIM, REPLACE, REPLICATE, REVERSE, RIGHT, RTRIM, STARTSWITH, SUBSTRING, UPPER
Array functions	ARRAY_CONCAT, ARRAY_CONTAINS, ARRAY_LENGTH, and ARRAY_SLICE
Spatial functions	ST_DISTANCE, ST_WITHIN, ST_INTERSECTS, ST_ISVALID, and ST_ISVALIDDETAILED

Demos – SQL API

Importing JSON



633 enregistrements

Aucun filtre actif

Filtres

Grape Variety

ALICANTE H.BOUS.N	8
ALIGOTE B	8
ARAMON N	8
AUTRES	8
AUXERROIS B	8
BACO BLANC B	8

› *Plus*

Wine Area Grape Variety France

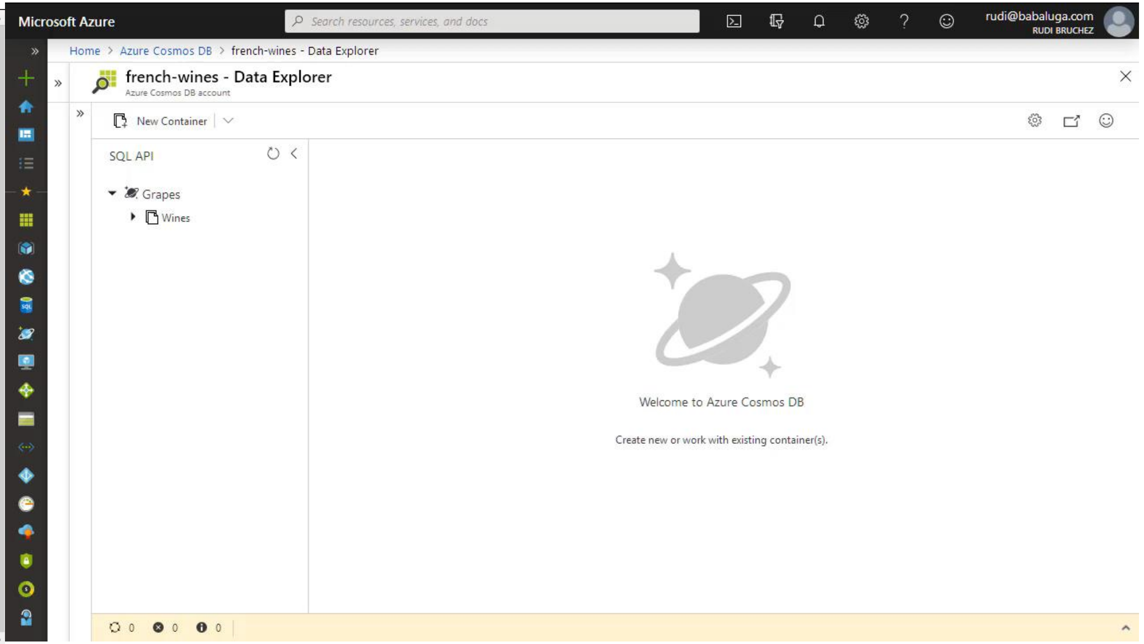
Ce jeu de données est sous licence : http://opendatacommons.org/licenses/pddl/1.0/

Formats de fichiers plats

CSV	Jeu de données entier
JSON	Jeu de données entier
Excel	Jeu de données entier

Le CSV utilise le point-virgule (;) comme séparateur.

Querying The Wines Container


Microsoft Azure
Search resources, services, and docs
rudi@babaluga.com
RUDI BRUCHEZ
Home > Azure Cosmos DB > french-wines - Data Explorer
New Container
SQL API
Grapes
Wines

french-wines - Data Explorer

Azure Cosmos DB account

Welcome to Azure Cosmos DB

Create new or work with existing container(s).

Spatial Data with the SQL API

- GeoJSON specification (rfc 7946)
- Points, LineStrings, and Polygons
- WGS-84 CRS only
    - World Geodetic System used by GPS, Google Map, Bing Map
- OGC functions : ST_DISTANCE, ST_WITHIN, ST_INTERSECTS

```
{
    "type":"Polygon",
    "coordinates":[ [
        [ 31.8, -5 ],
        [ 31.8, -4.7 ],
        [ 32, -4.7 ],
        [ 32, -5 ],
        [ 31.8, -5 ]
    ] ]
}
```

020.spatial.cs

MongoDB API

JSON Like the SQL API

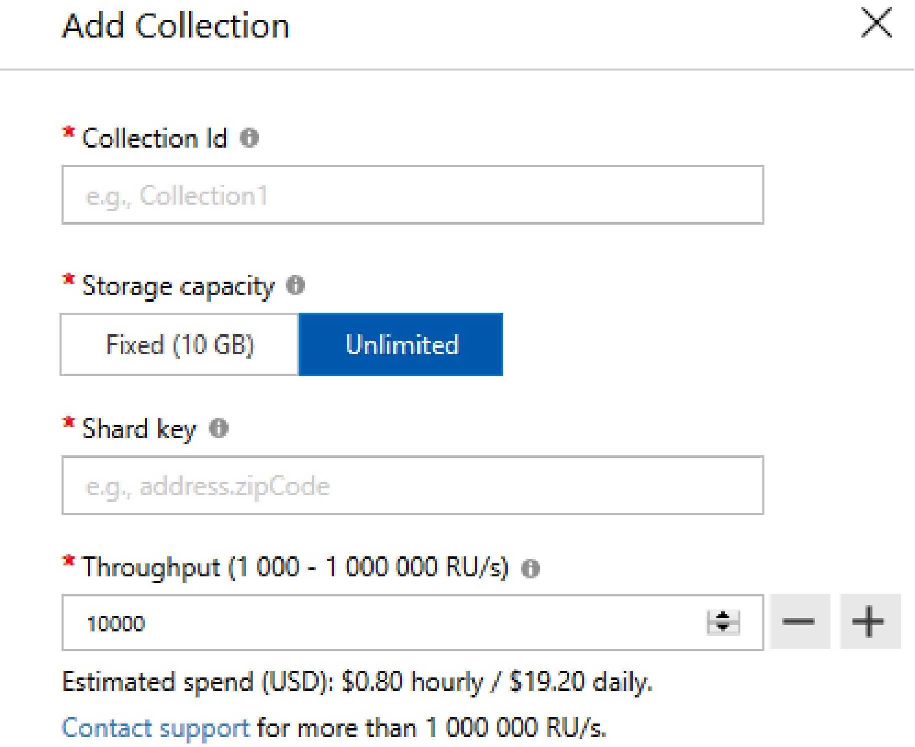
MongoDB compatible

You can use the MongoDB tools and the mongo clients

Add an _id identifier to be MongoDB compatible

https://docs.microsoft.com/en-us/azure/cosmos-db/mongodb-feature-support

MongoDb Sharding



Add Collection

* Collection Id

* Storage capacity

Fixed (10 GB) [✓ Unlimited]

* Shard key

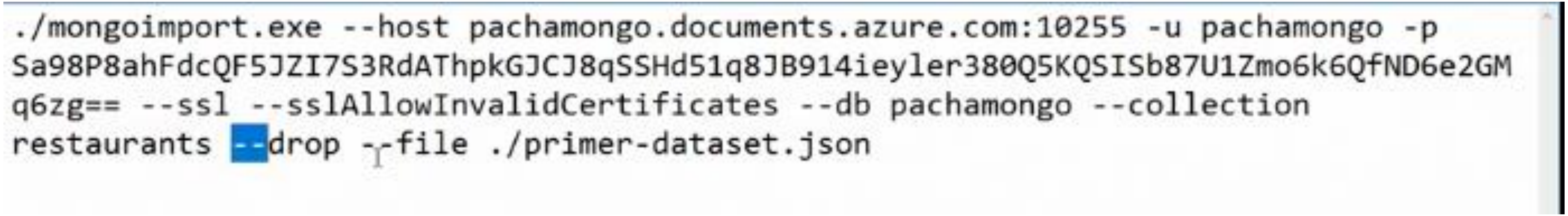
* Throughput (1 000 - 1 000 000 RU/s)

10000

Estimated spend (USD): $0.80 hourly / $19.20 daily.

Contact support for more than 1 000 000 RU/s.

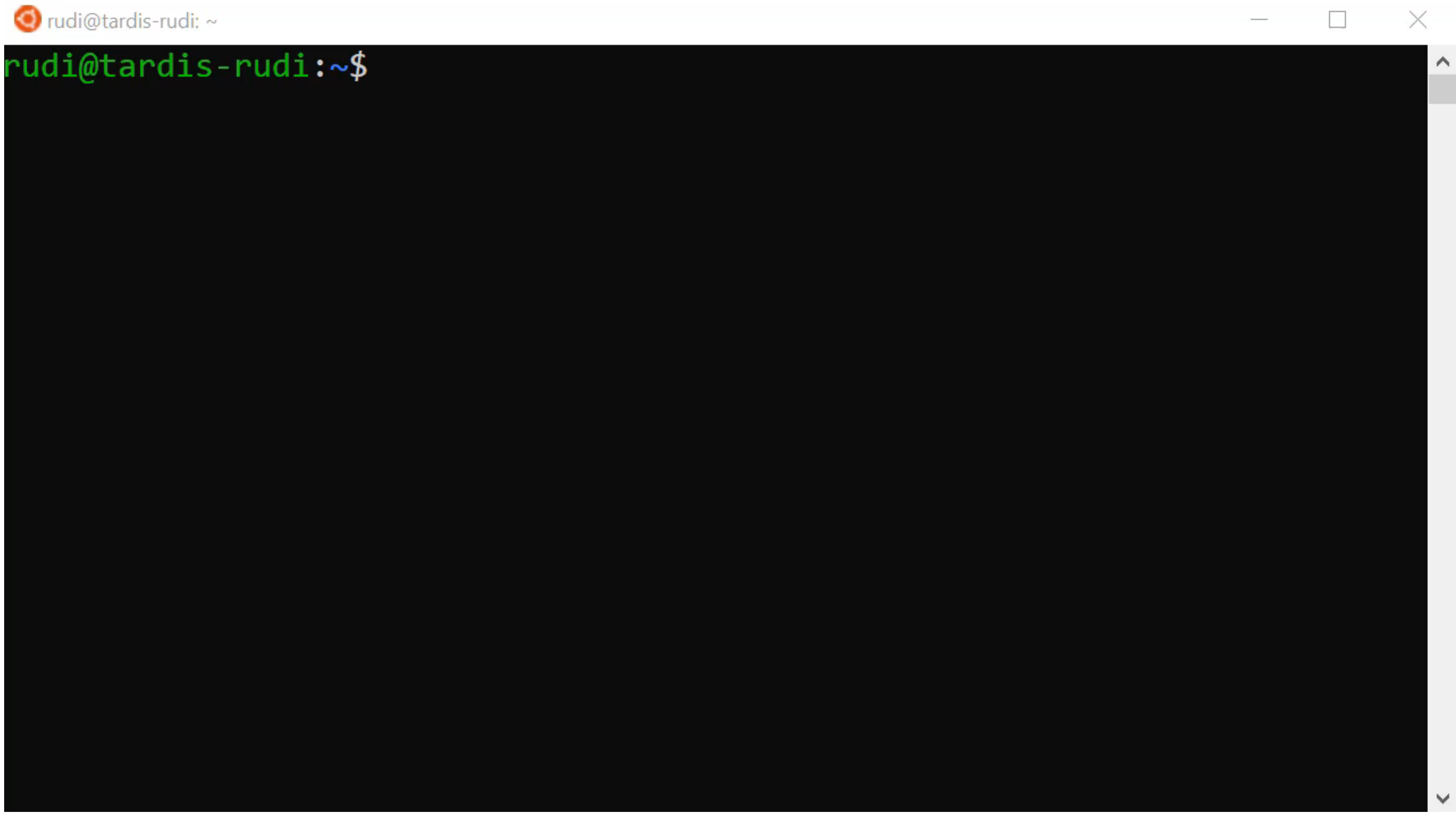
Importing into Mongo CosmosDB



```
./mongoimport.exe --host pachamongo.documents.azure.com:10255 -u pachamongo -p
Sa98P8ahFdcQF5JZI7S3RdAThpkGJCJ8qSSHd51q8JB914ieyler380Q5KQSISb87U1Zmo6k6QfND6e2GM
q6zg== --ssl --sslAllowInvalidCertificates --db pachamongo --collection
restaurants --drop --file ./primer-dataset.json
```

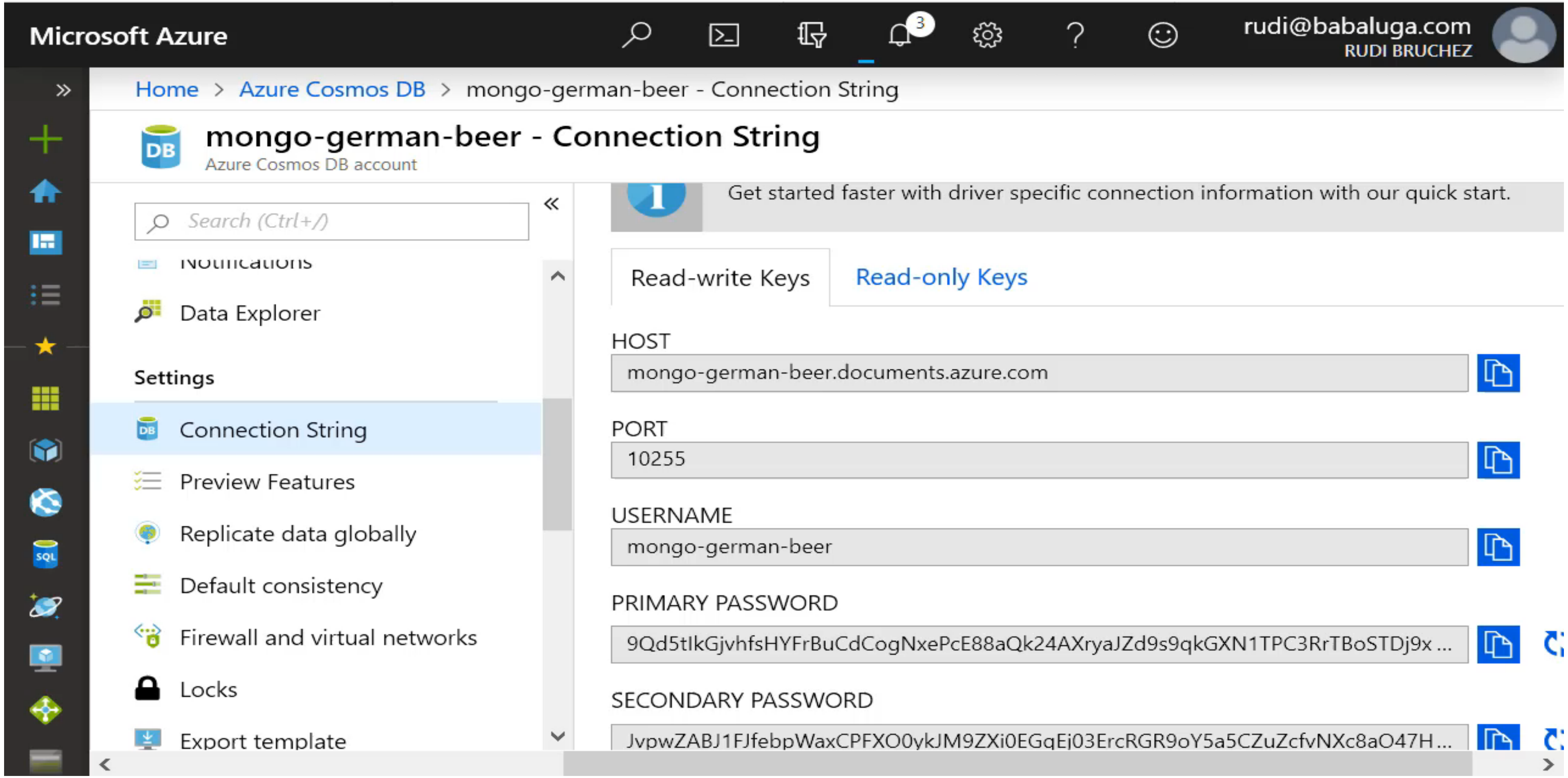
Mongo
MongoImport
MongoExport

Demo – MongoDB API



```
rudi@tardis-rudi:~$
```

Demo – GUI and Aggregation Framework



mongo-german-beer - Connection String

Azure Cosmos DB account

Get started faster with driver specific connection information with our quick start.

HOST

mongo-german-beer.documents.azure.com

PORT

10255

USERNAME

mongo-german-beer

PRIMARY PASSWORD

9Qd5tIkGjvhfsHYFrBuCdCogNxePcE88aQk24AXryaJZd9s9qkGXN1TPC3RrTBoSTDj9x ...

SECONDARY PASSWORD

JvpwZABJ1FJfebpWaxCPFXO0ykJM9ZXi0EGqEj03ErcRGR9oY5a5CZuZcfvNXc8aO47H ...

https://community.qlik.com/t5/Technology-Partners-Ecosystem/White-Paper-Connecting-to-CosmosDB-Mongo-API-using-Qlik-MongoDB/ta-p/1527975

Table API

Simple Key-Value (KV) store

Get and Set

You can search in values, everything is indexed

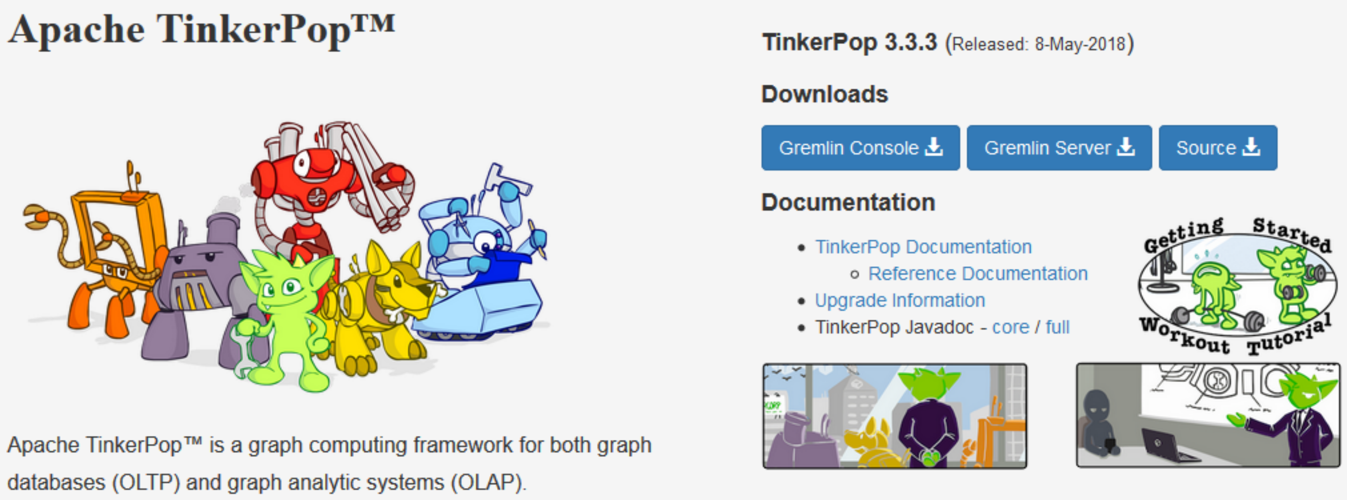
Hash table, very fast for keys

API is recent : https://docs.microsoft.com/en-us/azure/cosmos-db/table-sdk-dotnet

No support yet for .NET Core (use the old one)

Graph API

Based on Tinkerpop, Gremlin language



Apache TinkerPop™

Apache TinkerPop™ is a graph computing framework for both graph databases (OLTP) and graph analytic systems (OLAP).

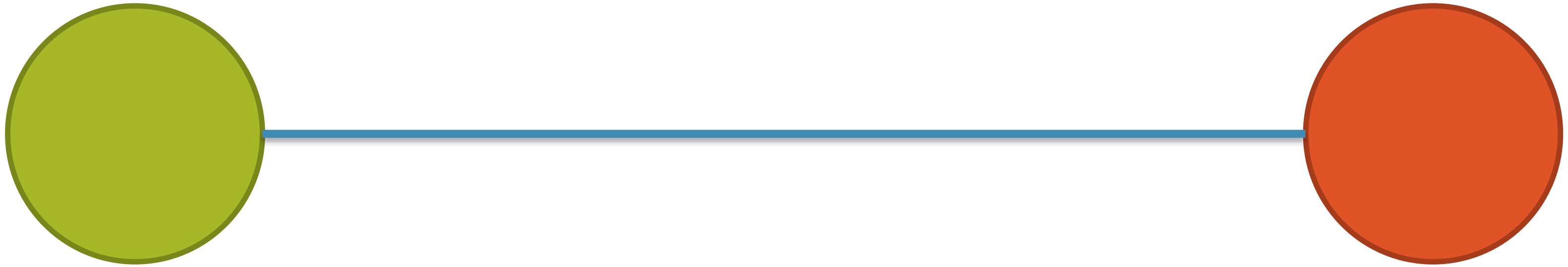
TinkerPop 3.3.3 (Released: 8-May-2018)

Downloads

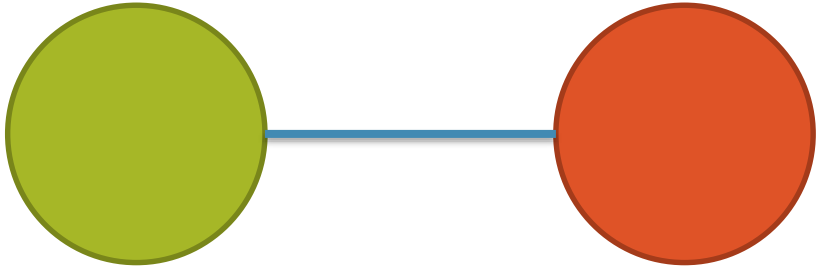
Documentation

- TinkerPop Documentation
  - Reference Documentation
- Upgrade Information
- TinkerPop Javadoc - core / full

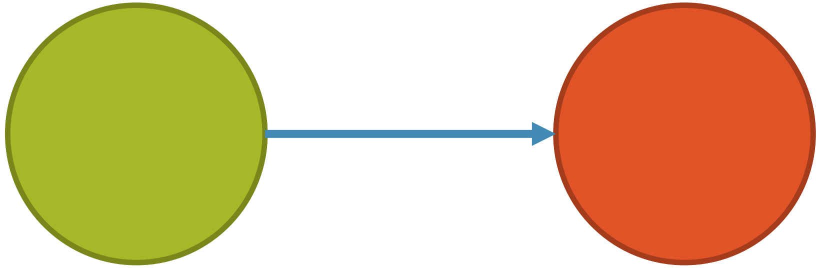
Edge / arc



Undirected

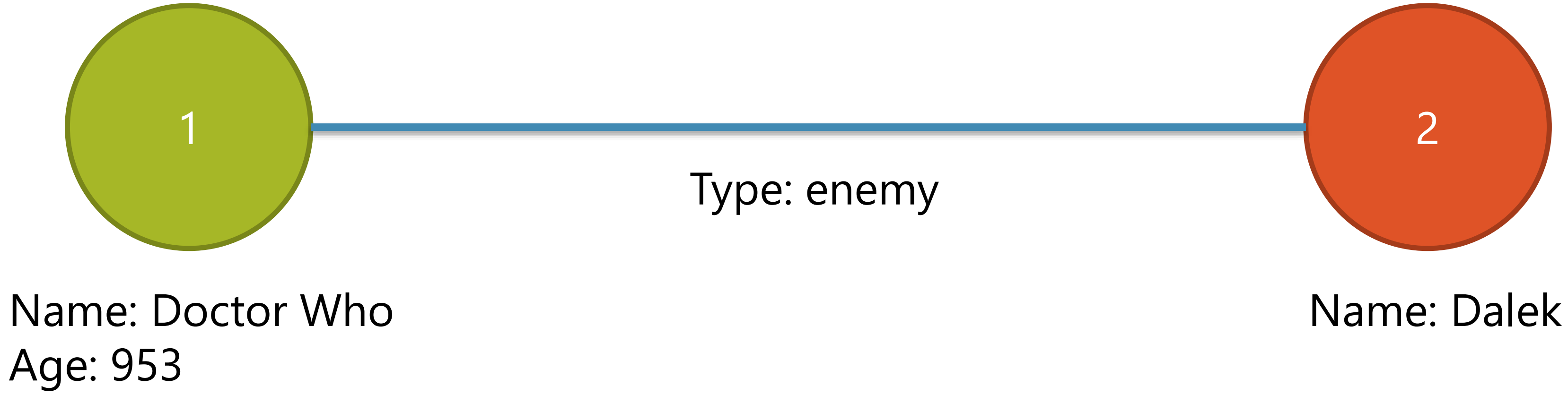


Directed



Property graph

A graph database is a property graph



Domain Specific Languages

Cypher

Neo4J

```
MATCH (actor:Person)-[:ACTED_IN]->(movie:Movie)
WHERE movie.title STARTS WITH "T"
RETURN movie.title AS title, collect(actor.name) AS cast
ORDER BY title ASC LIMIT 10;
```

Gremlin

$G = (V, E)$

Apache Tinkerpop

```
g.V().as("a").out("knows").as("b").
  select("a","b").
    by("name").
    by("age")
```

040.movie.gremlin

Cassandra API

Apache drivers compliant with CQLv4

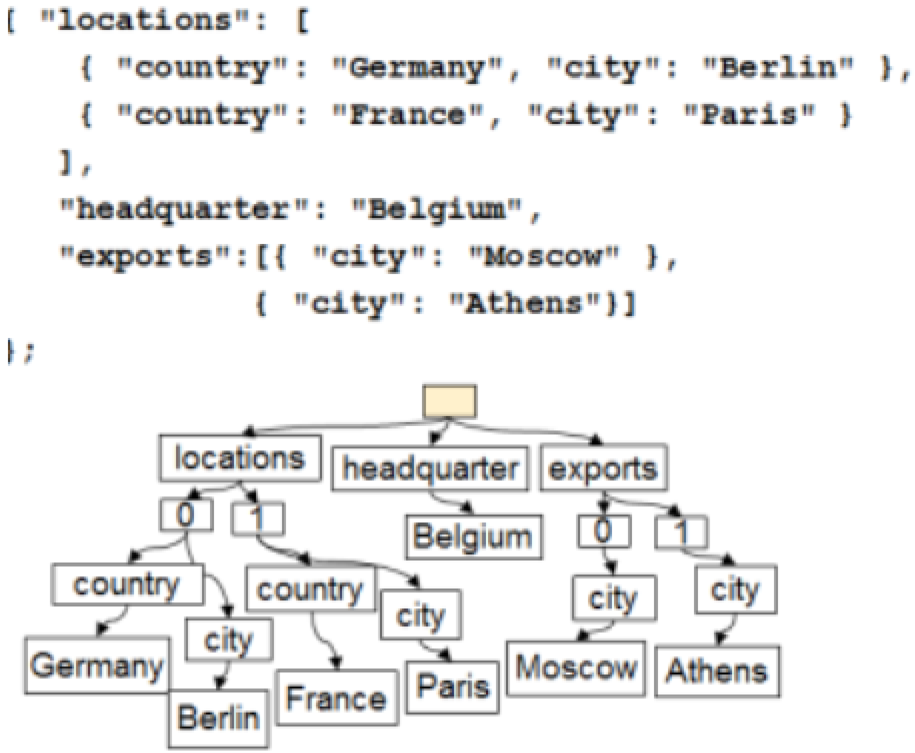
All CQL command supported

All Data Types supported

All functions supported

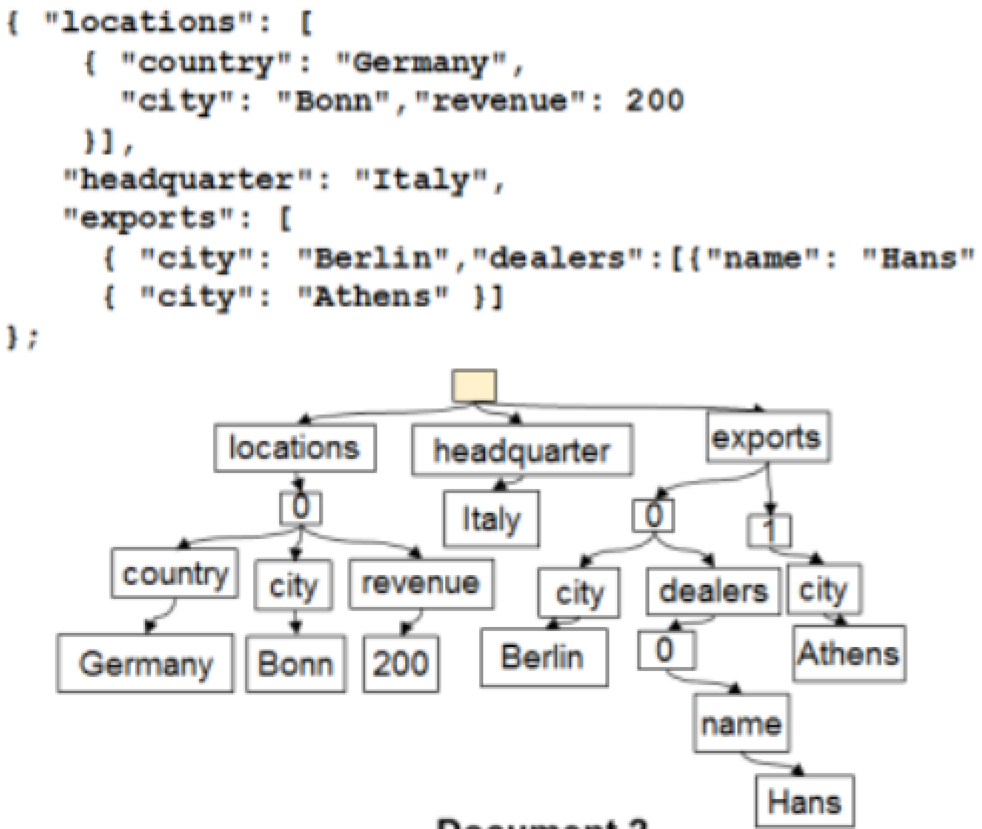
Operations

Documents are stored as a tree



```
{ "locations": [
    { "country": "Germany", "city": "Berlin" },
    { "country": "France", "city": "Paris" }
  ],
  "headquarter": "Belgium",
  "exports":[{ "city": "Moscow" },
             { "city": "Athens"}]
};
```

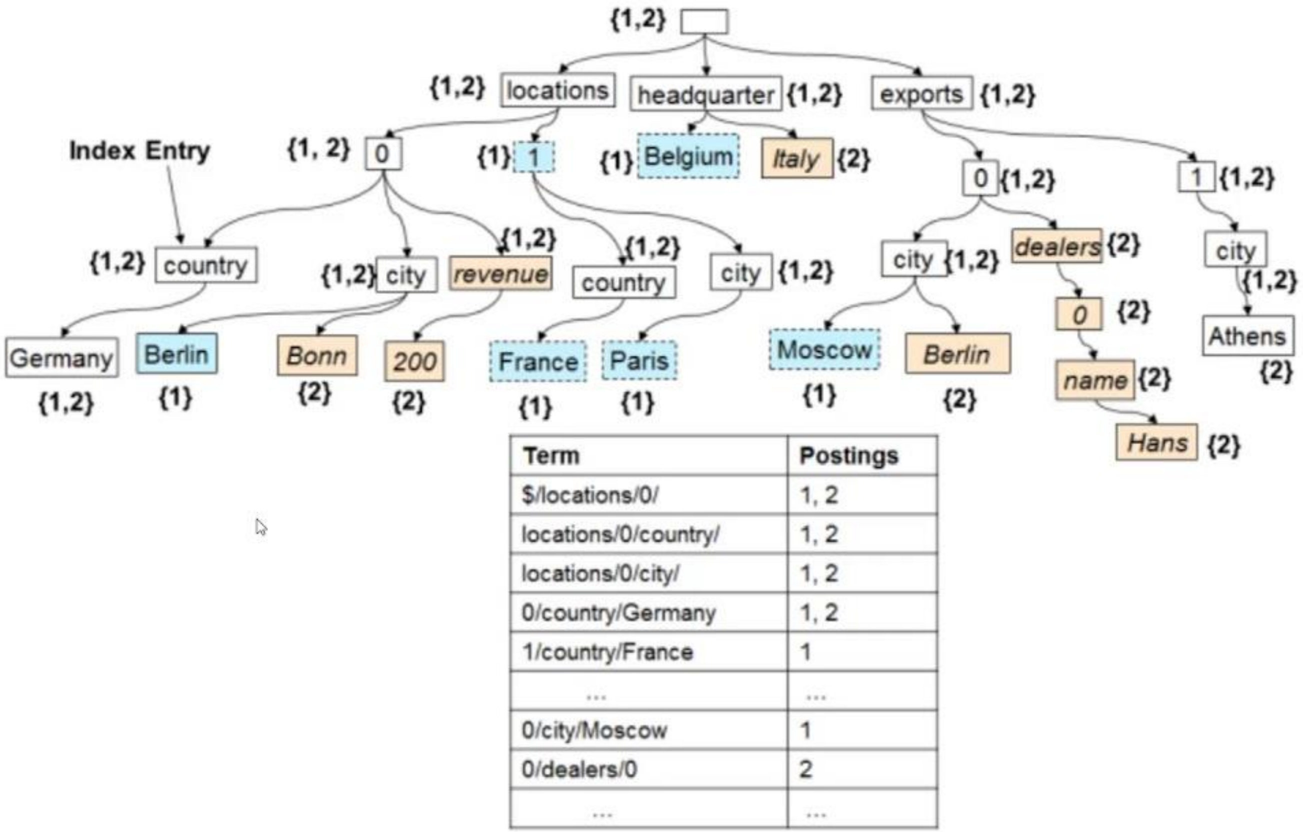
Document 1



```
{ "locations": [
    { "country": "Germany",
      "city": "Bonn","revenue": 200
    }],
   "headquarter": "Italy",
   "exports": [
     { "city": "Berlin","dealers":[{"name": "Hans"
     { "city": "Athens" }]
};
```

Document 2

Automatic indexing the tree



Term	Postings
$/locations/0/	1, 2
locations/0/country/	1, 2
locations/0/city/	1, 2
0/country/Germany	1, 2
1/country/France	1
...	...
0/city/Moscow	1
0/dealers/0	2
...	...

Automatic. All fields are indexed.

Can be set manually, even by document

Online strategy changes, no impact on RUs

Indexing

Consistent: changes happen immediately. higher RU consumption

Lazy: asynchronous changes, background process. Query consistency is eventual and RU consumption is lower.

Index Types

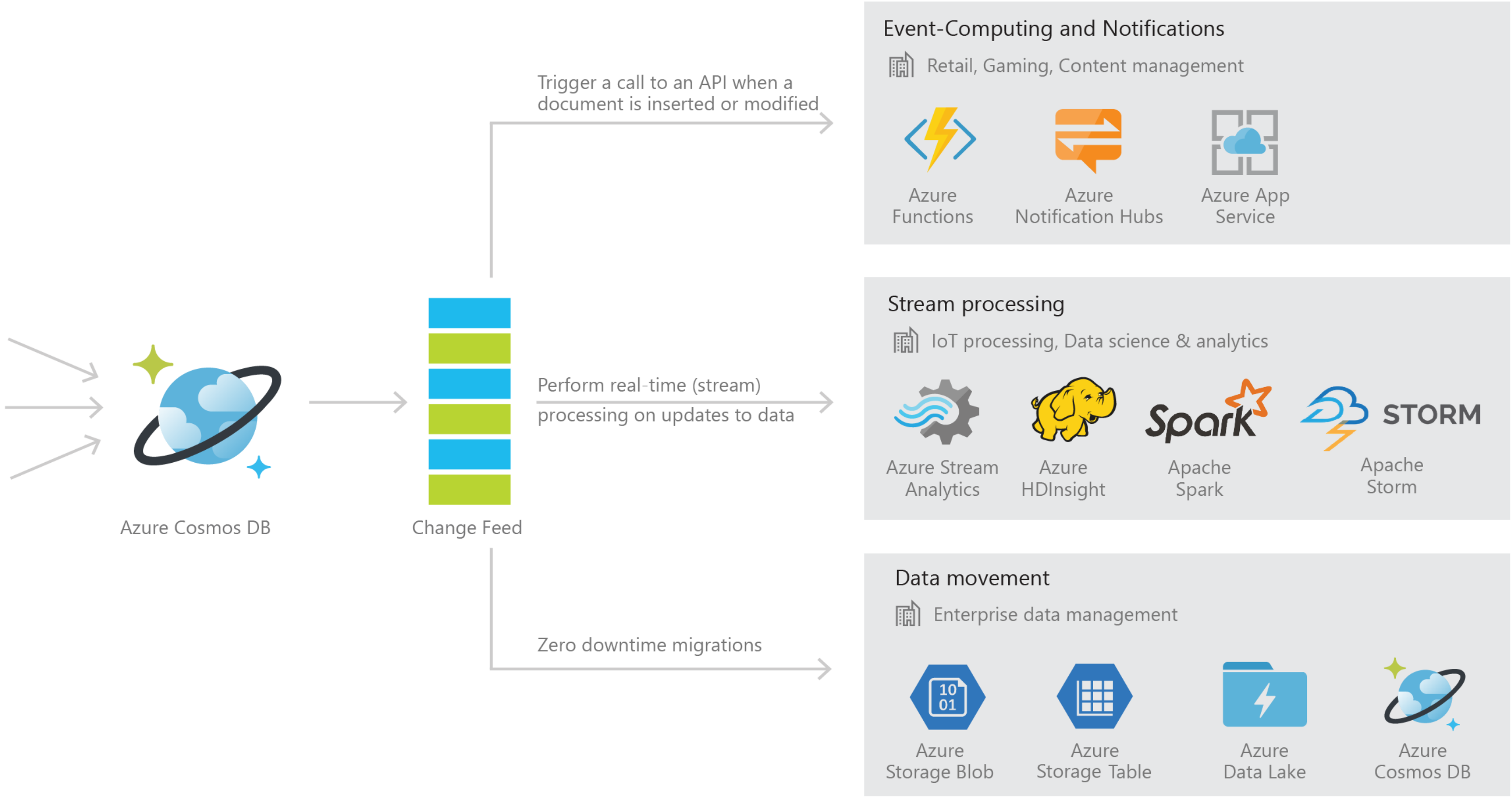
Hash: useful for equality and inequality predicates.

Range: useful for ordering and range searches.

Spatial: useful for spatial queries (within, distance, etc.)

070.Index.cs

Demo – indexing



Trigger a call to an API when a document is inserted or modified

Perform real-time (stream) processing on updates to data

Zero downtime migrations

Event-Computing and Notifications

Retail, Gaming, Content management

Stream processing

IoT processing, Data science & analytics

Data movement

Enterprise data management

Attachments

For binaries

REST API – POST using AtomPub (rfc 5023)

- stored in CosmosDB: POST with the raw attachment as body. 2 headers: Content-Type (MIME type) and Slug (name)
- External: post just the attachment metadata

Internally stored: 2 GB limit per account.

Change feed

Supported now for .NET, Java, Python and Node/JS SDKs and for Core and Gremlin APIs.

SP, Triggers, UDF

Javascript

```
UserDefinedFunction regexMatchUdf = new UserDefinedFunction
  {
     Id = "REGEX_MATCH",
     Body = @"function (input, pattern) {
                return input.match(pattern) !== null;
            };",
  };

  UserDefinedFunction createdUdf = client.CreateUserDefinedFunctionAsync(
     UriFactory.CreateDocumentCollectionUri("testdb", "families"),
     regexMatchUdf).Result;
```

050.ServerSideScripts.cs

Offline emulator

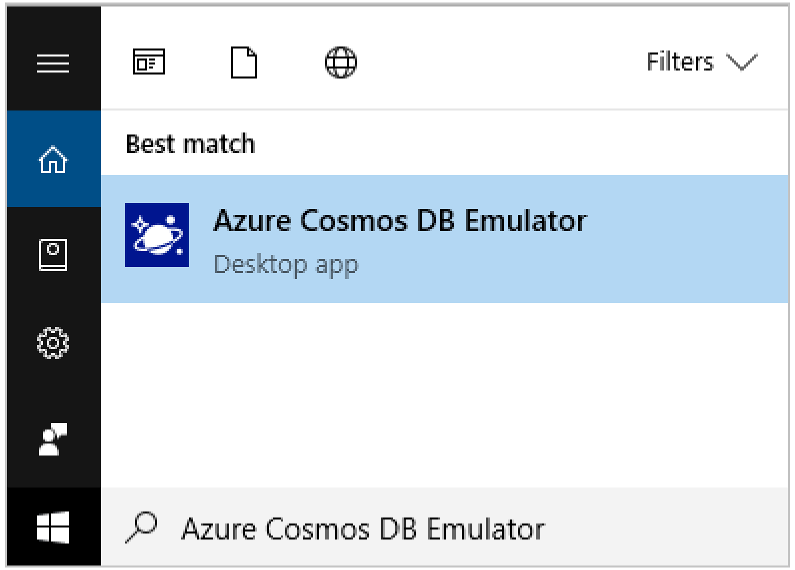
Msi or Docker

Fully supports SQL API and MongoDB collections

Table, Graph, Cassandra not fully supported (yet)

No scalability, obviously

localhost:8081



Using the local emulator

Develop for free without an Azure account

Docker :

microsoft/azure-cosmosdb-emulator

Docker Windows Container

Data migration tool

From

JSON files, MongoDB

SQL Server, CSV

Azure Table storage

Amazon DynamoDB

HBase

Azure Cosmos DB collections

To

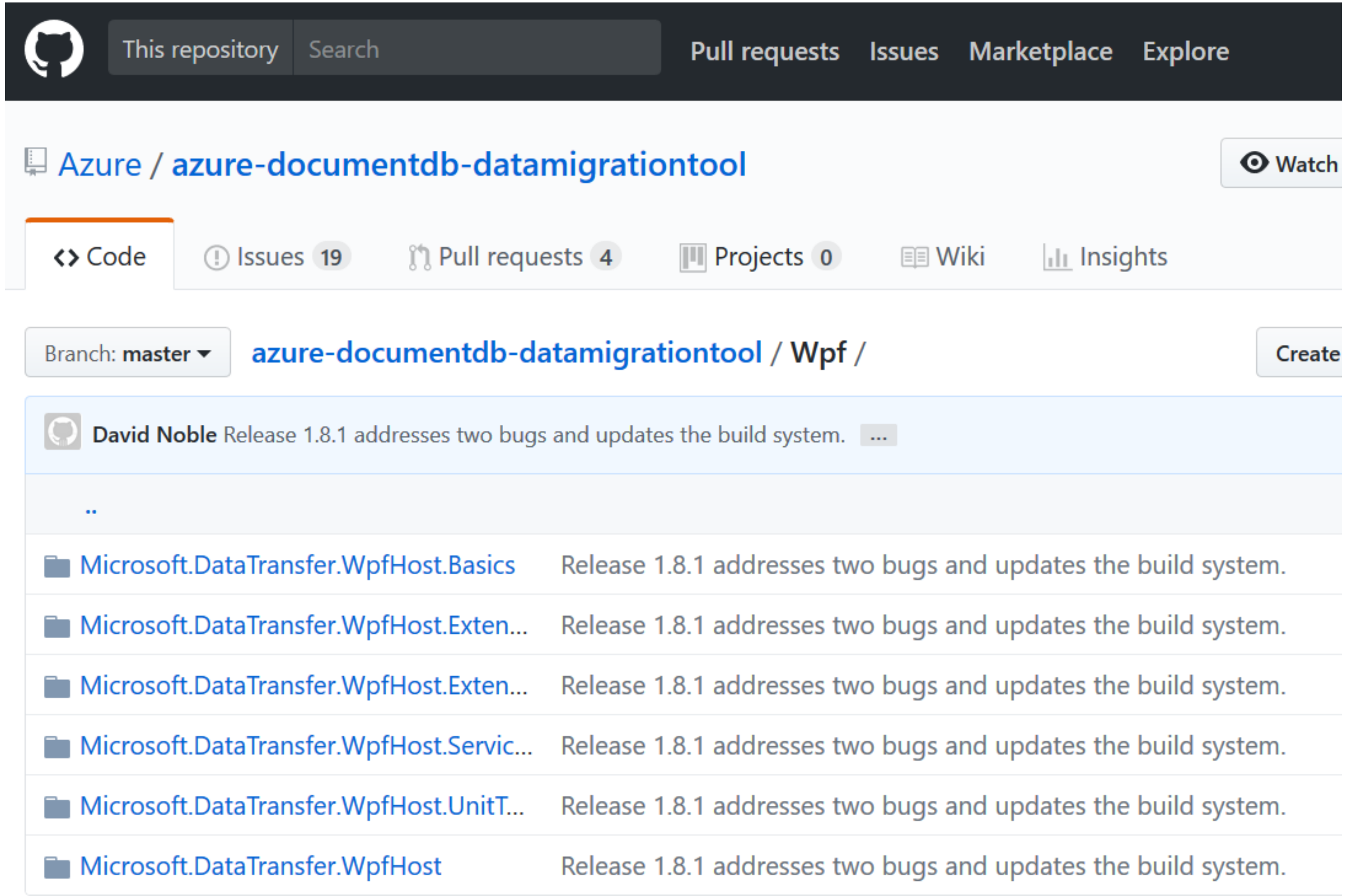
SQL API – all sources

Table API - Data Migration tool or AzCopy.

MongoDB API - export only, import using MongoDB tools

Graph API - not supported yet

Data migration tool



Azure / azure-documentdb-datamigrationtool

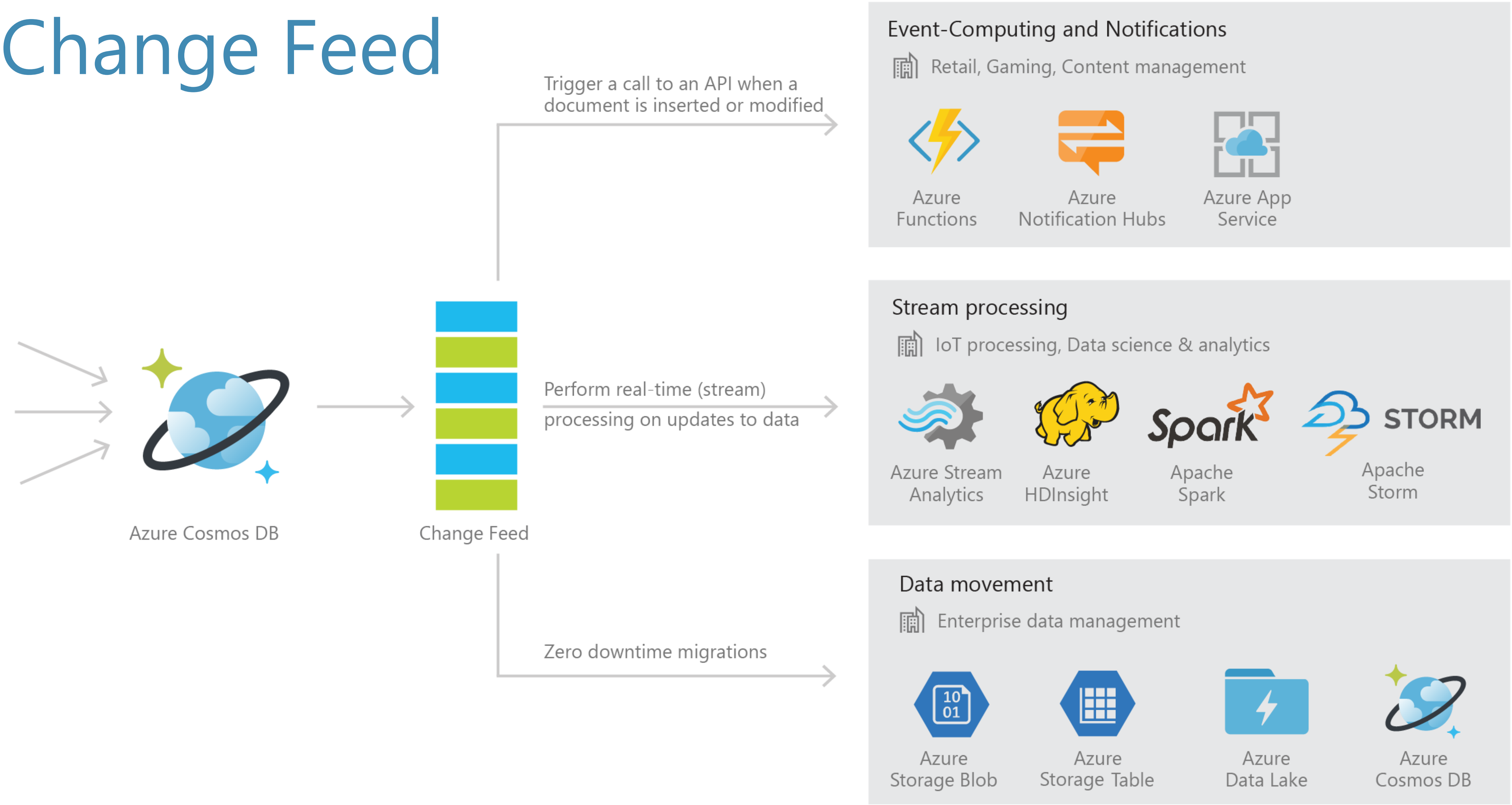
azure-documentdb-datamigrationtool / Wpf /

David Noble Release 1.8.1 addresses two bugs and updates the build system. …

..	
Microsoft.DataTransfer.WpfHost.Basics	Release 1.8.1 addresses two bugs and updates the build system.
Microsoft.DataTransfer.WpfHost.Exten…	Release 1.8.1 addresses two bugs and updates the build system.
Microsoft.DataTransfer.WpfHost.Exten…	Release 1.8.1 addresses two bugs and updates the build system.
Microsoft.DataTransfer.WpfHost.Servic…	Release 1.8.1 addresses two bugs and updates the build system.
Microsoft.DataTransfer.WpfHost.UnitT…	Release 1.8.1 addresses two bugs and updates the build system.
Microsoft.DataTransfer.WpfHost	Release 1.8.1 addresses two bugs and updates the build system.

https://github.com/azure/azure-documentdb-datamigrationtool

Change Feed



Azure Cosmos DB

Change Feed

Trigger a call to an API when a document is inserted or modified

Perform real-time (stream) processing on updates to data

Zero downtime migrations

Event-Computing and Notifications

Retail, Gaming, Content management

- Azure Functions
- Azure Notification Hubs
- Azure App Service

Stream processing

IoT processing, Data science & analytics

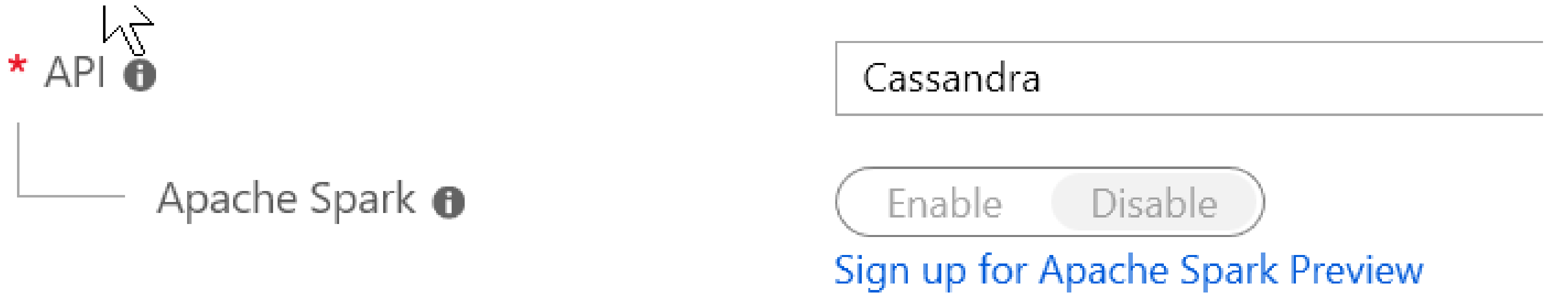
- Azure Stream Analytics
- Azure HDInsight
- Apache Spark
- Apache Storm

Data movement

Enterprise data management

- Azure Storage Blob
- Azure Storage Table
- Azure Data Lake
- Azure Cosmos DB

New – Apache Spark Execution



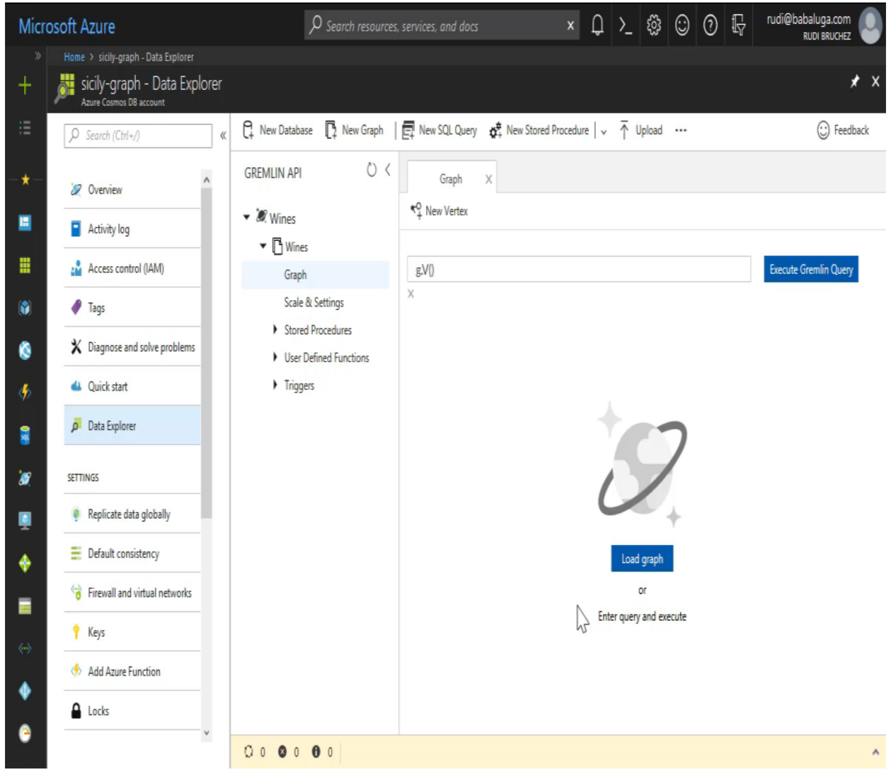
* API Cassandra

Apache Spark Enable [✓ Disable]

Sign up for Apache Spark Preview

Resources

Azure Cosmos DB query cheat sheets



g.V()

https://docs.microsoft.com/en-us/azure/cosmos-db/query-cheat-sheet

Session Feedback Day
(not optional!)

http://bit.ly/DataGrillen2019Day

Event Feedback (not optional!)

http://bit.ly/DataGrillen2019Ever

That’s all folks!