



# From Data to Insights: Cosmos DB in IoT workload

Divakar Kumar

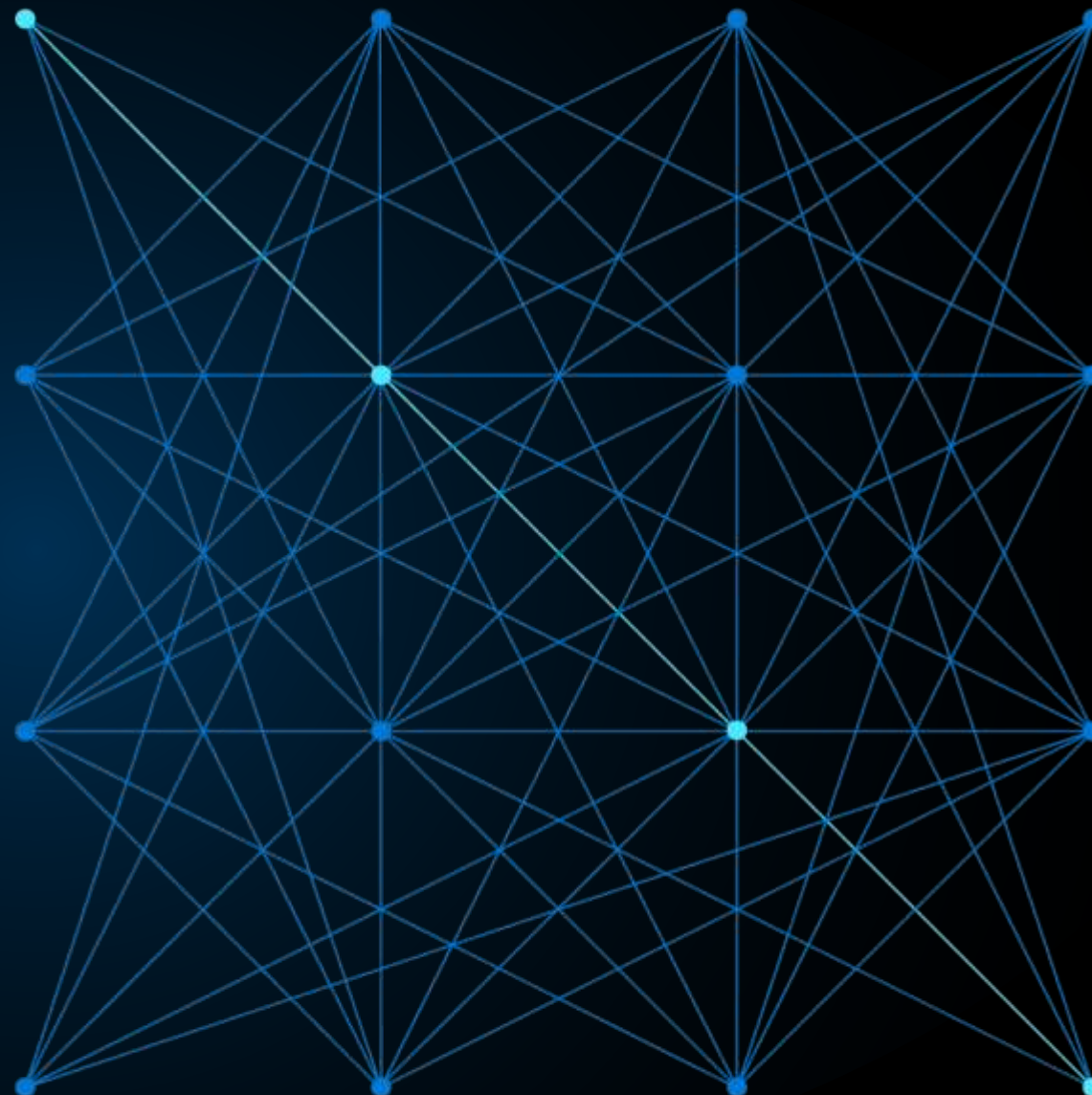
<https://iamdivakarkumar.com>



<https://www.linkedin.com/in/divakar-kumar/>



<https://github.com/Divakar-kumar>



# Agenda



Get familiar with IoT concepts



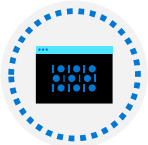
Azure Cosmos DB & Partition key



Azure Synapse link

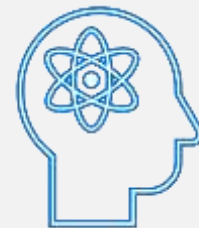


Visualize data in Power BI

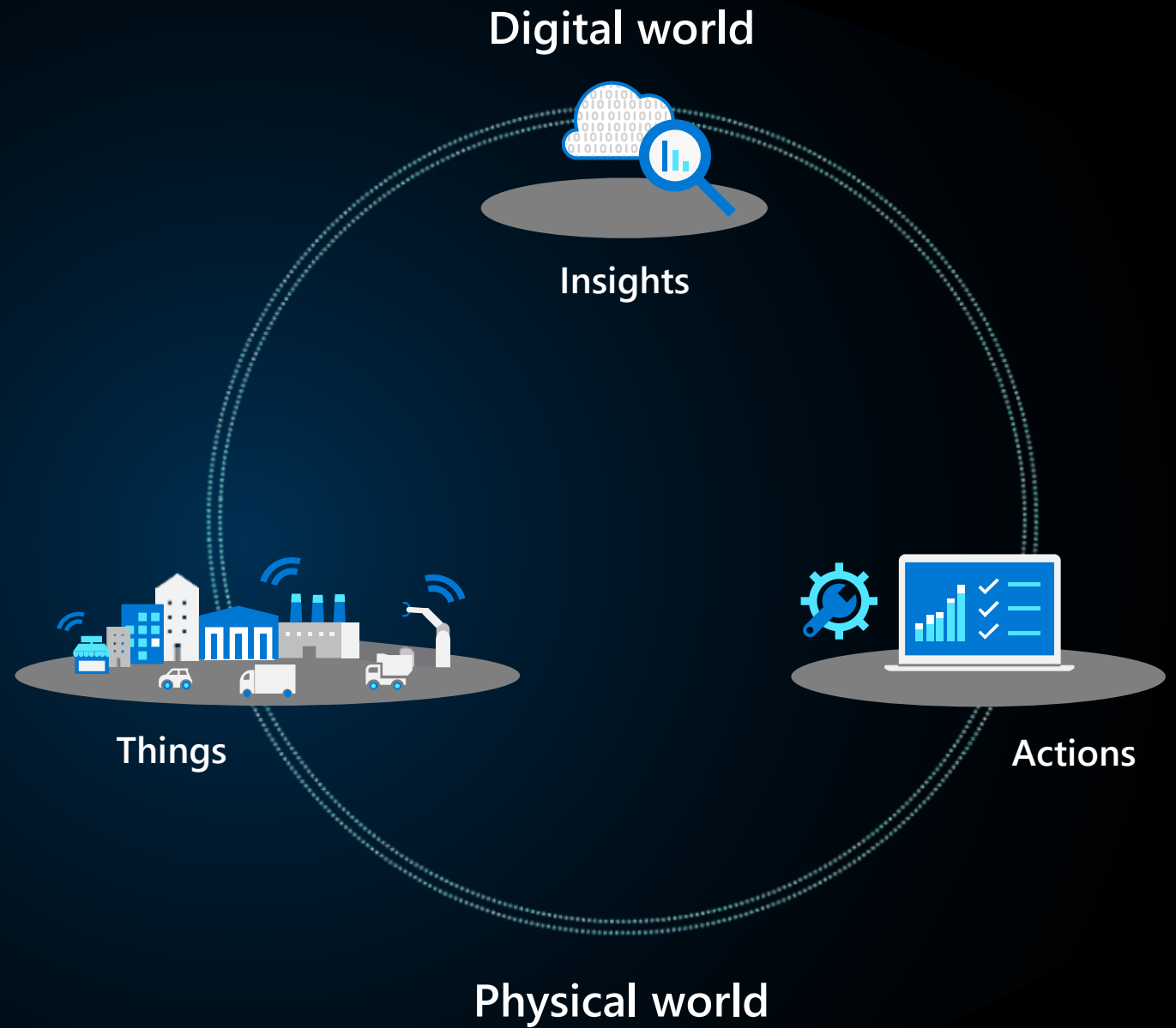


Demo

# IoT

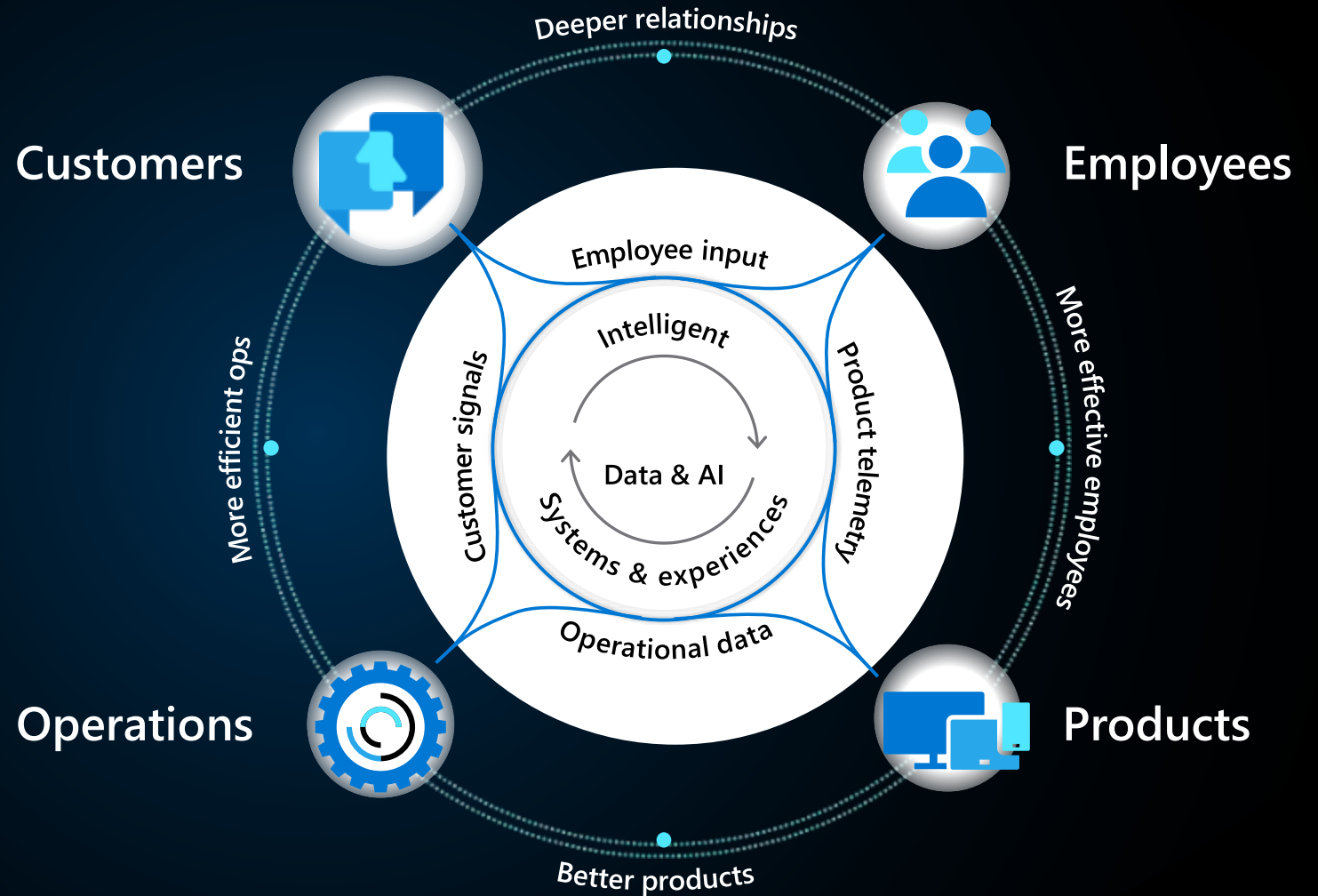


# What is IoT?

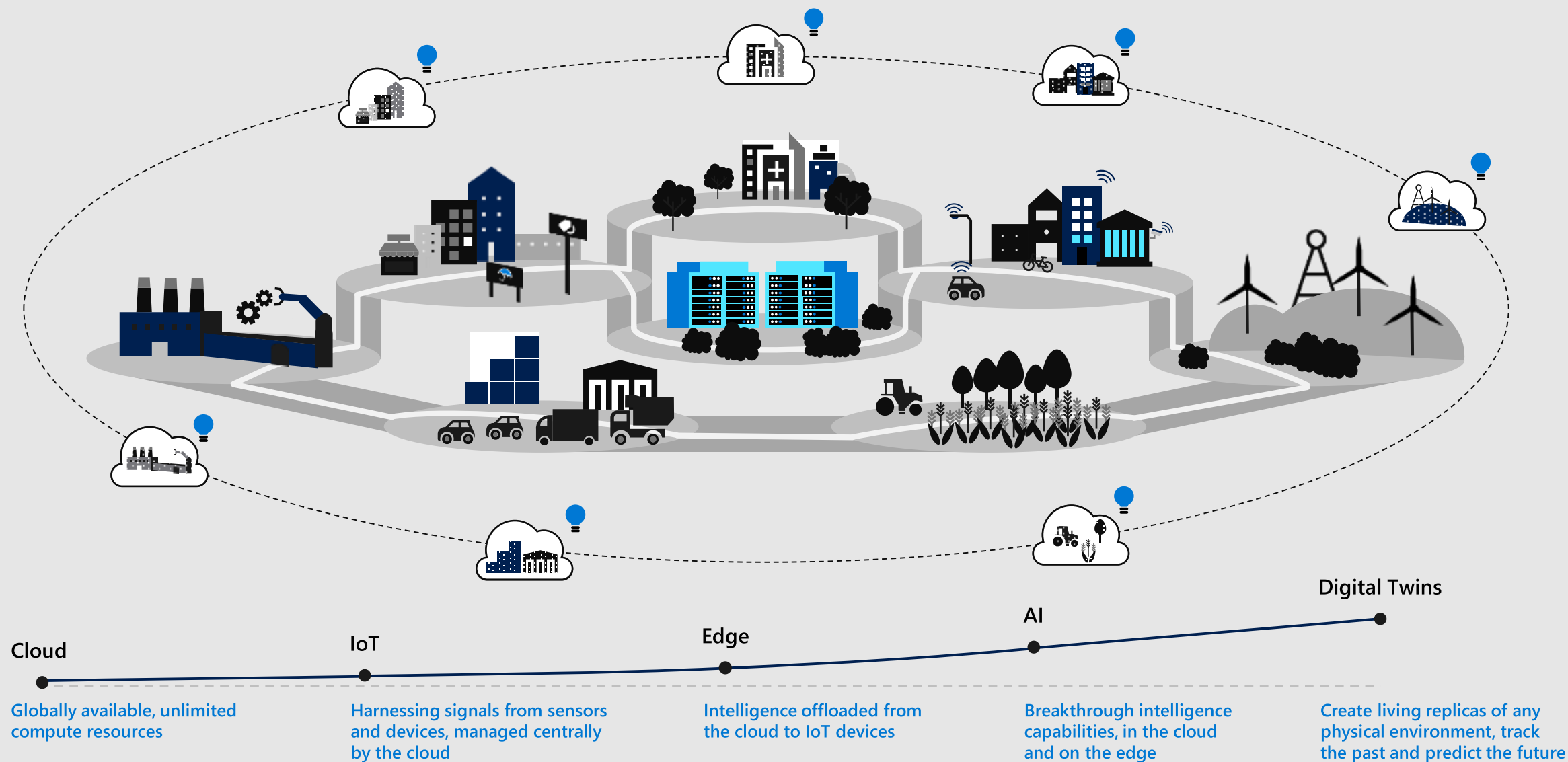


# What IoT is really about:

Enabling a digital  
feedback loop



# Innovations enabling new opportunities



AQMD





# Problem Statement

- Health impacts due to increase in Air pollution
- An ambient monitoring station can represent an area covering 2 km radius, which translates to 15 sq.km (rounded off)



Audio

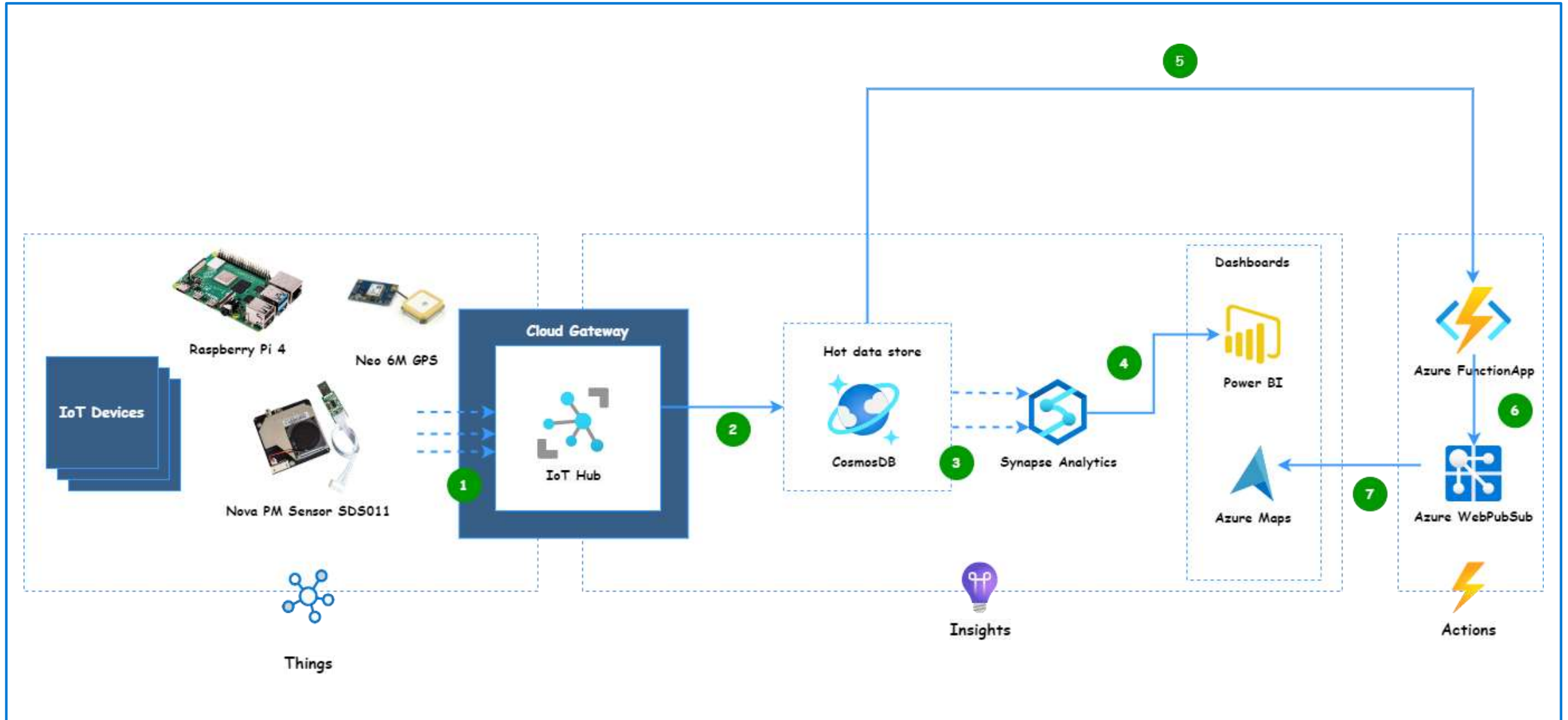


# Solution

- Make use of BOV Garbage Collector, food delivery partners/ Cabs (Ola, Uber, Swiggy, Zomato ...etc.) to mount the air quality sensor that detects PM 2.5, 10 concentrations in the air and visualize it as a live heat map.
- It will be an effective solution than ambient monitoring station as it shows us exactly where the intensity of air pollution is higher on street basis



# Air Quality Monitoring Delivery- AQMD



# Agenda



Get familiar with IoT concepts



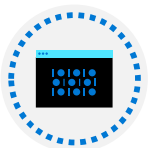
Azure Cosmos DB & Partition key



Azure Synapse link



Visualize data in PowerBI



Demo

# What is Azure Cosmos DB?



Microsoft's ~~NoSQL~~ database on Azure



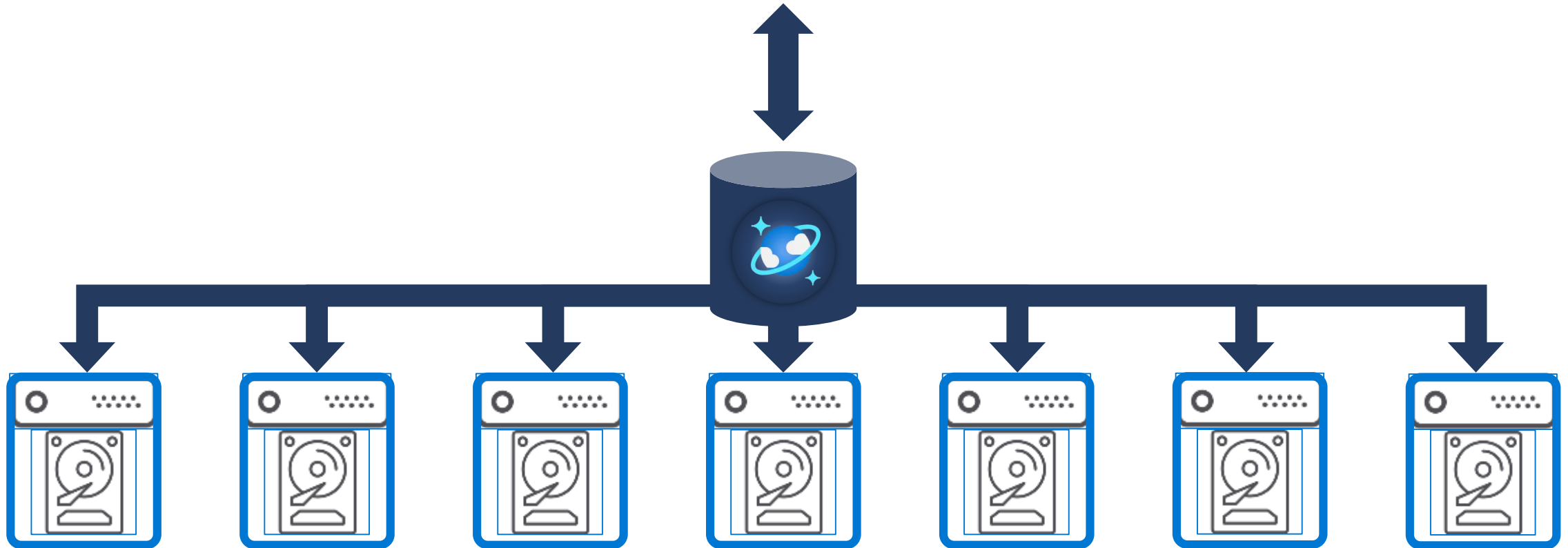
Non-relational and horizontally scalable





# What is Azure Cosmos DB?

horizontally scalable



Unlimited storage capacity  
Unlimited throughput

# What is Azure Cosmos DB?

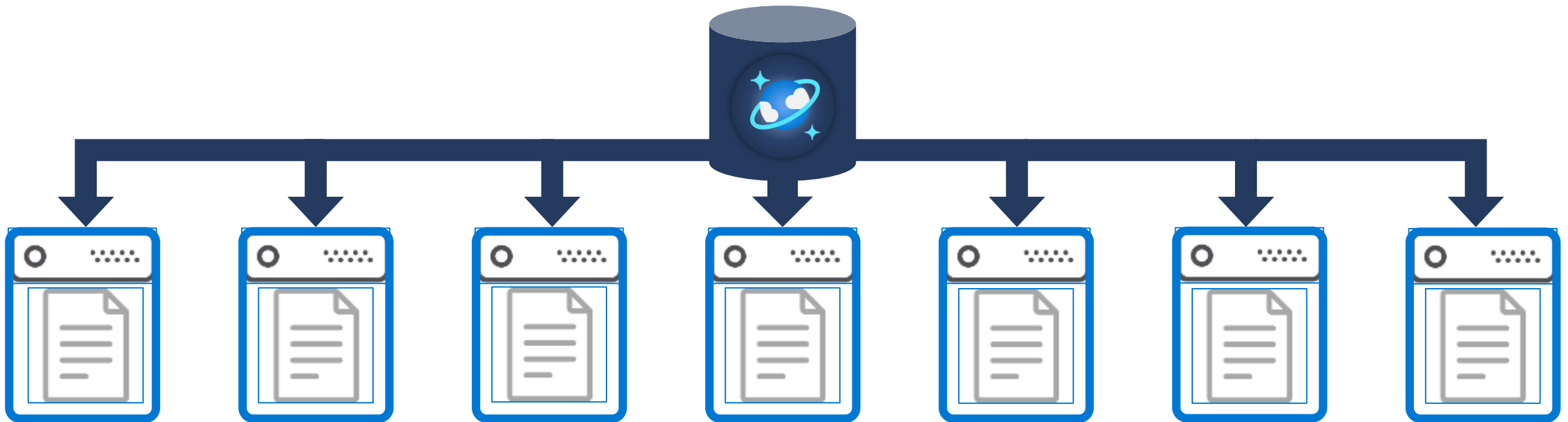
non-relational



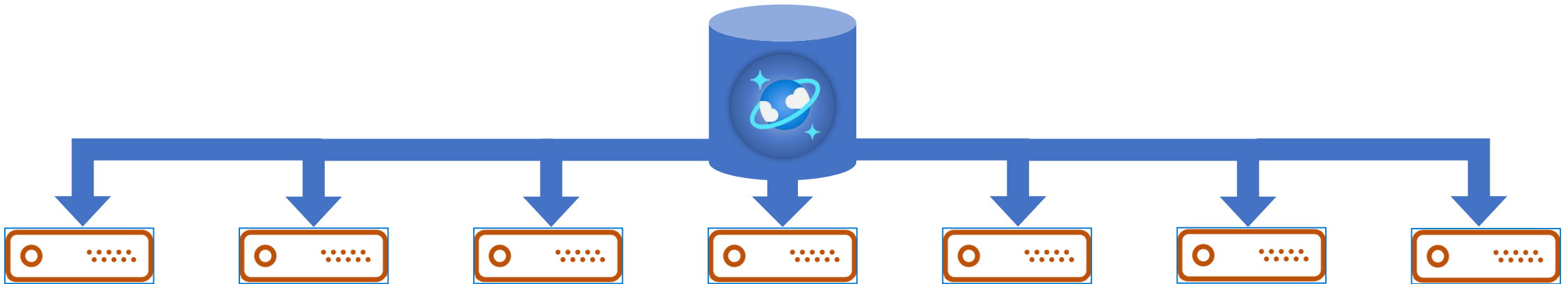


# What is Azure Cosmos DB?

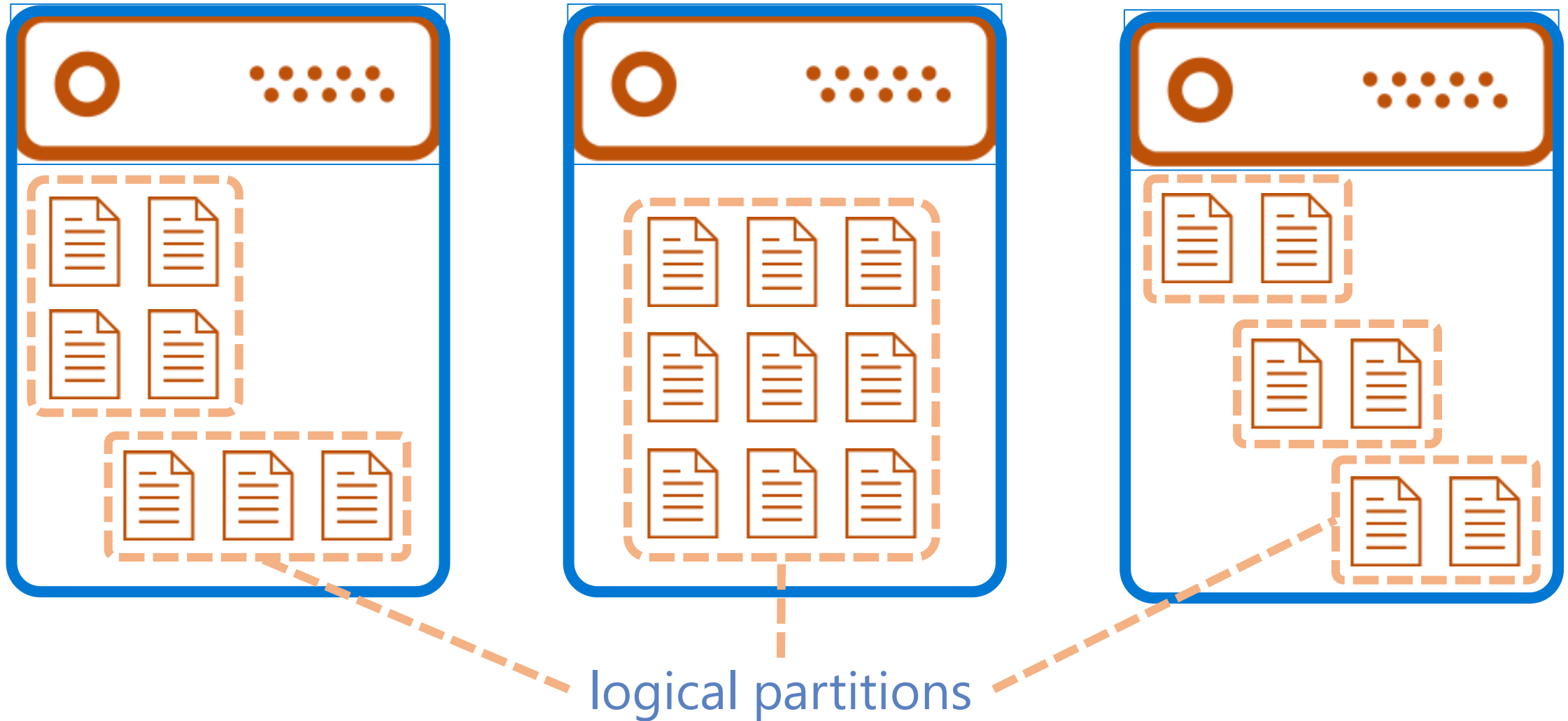
non-relational  
*and*  
horizontally scalable



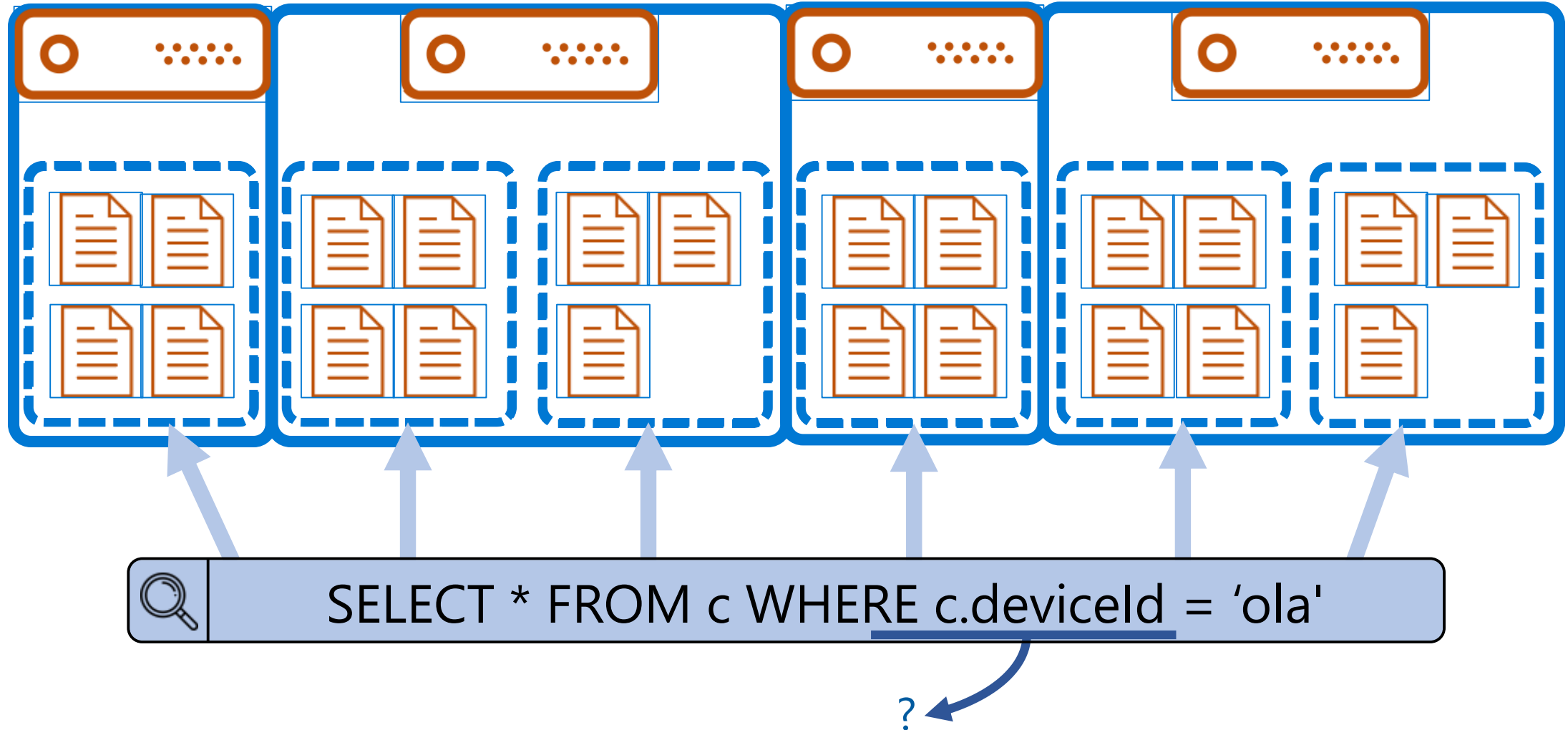
# What is partitioning?



# Logical Partitions



# What if partition key is guid?



# Choose deviceId as PartitionKey



New Container



\* Database id ⓘ

☒ Create new ☐ Use existing

airqualitymonitoringdelivery

\* Container id ⓘ

telemetry

\* Partition key ⓘ

For small workloads, the item ID is a suitable choice for the partition key.

/deviceId

Ola



Uber



Swiggy

BoV

Zomato



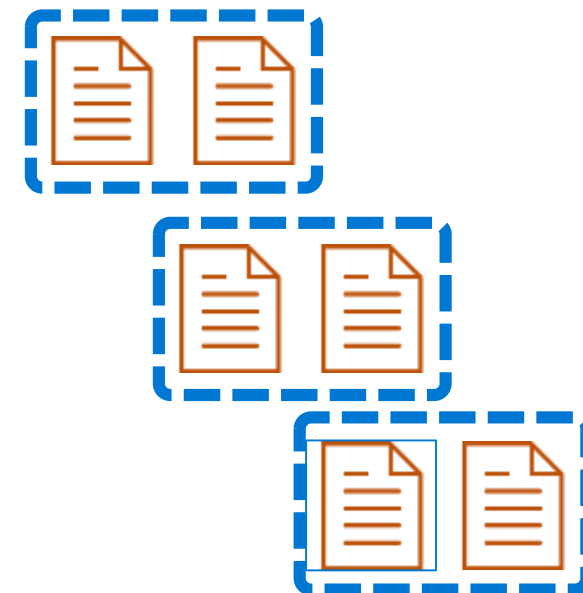
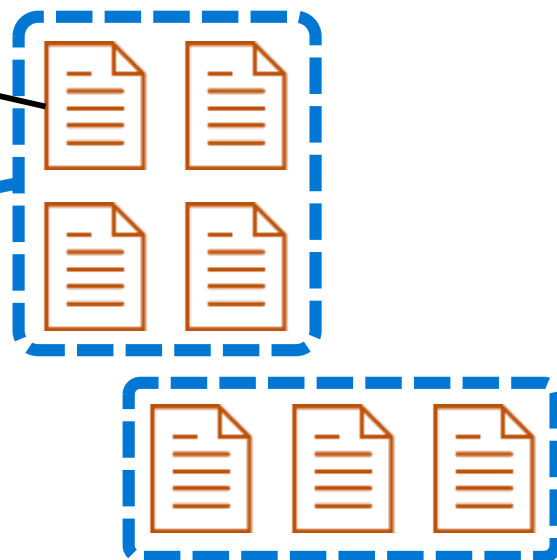
Dunzo

# Limits

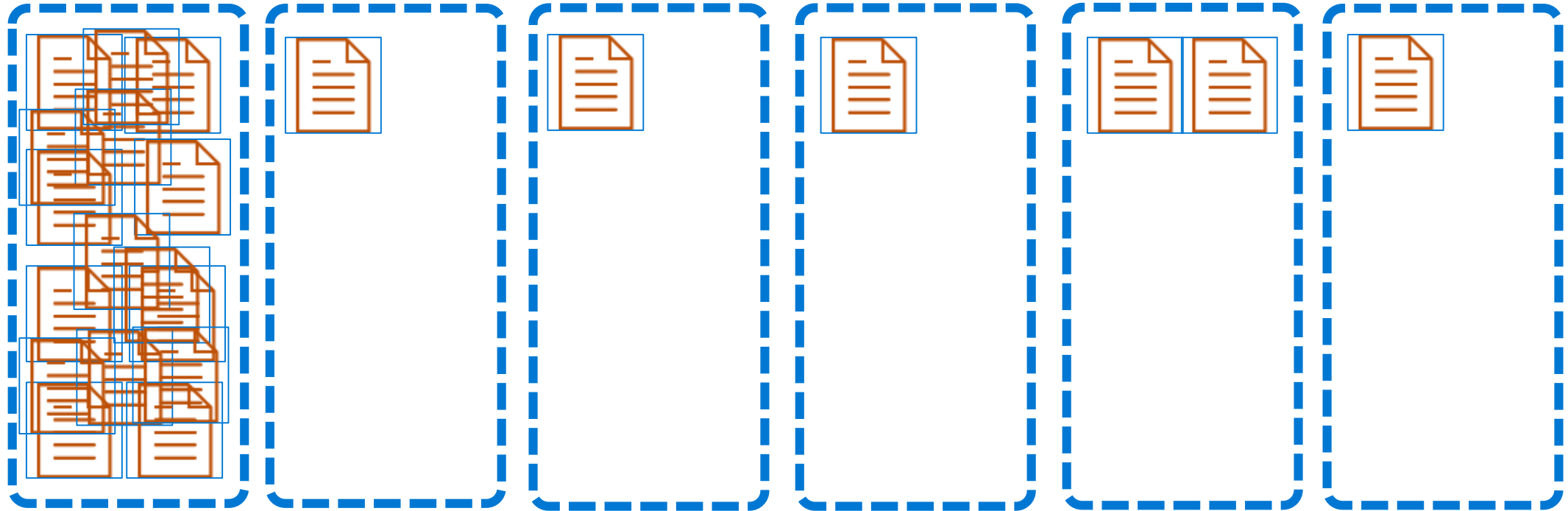


Max size: 2 MB

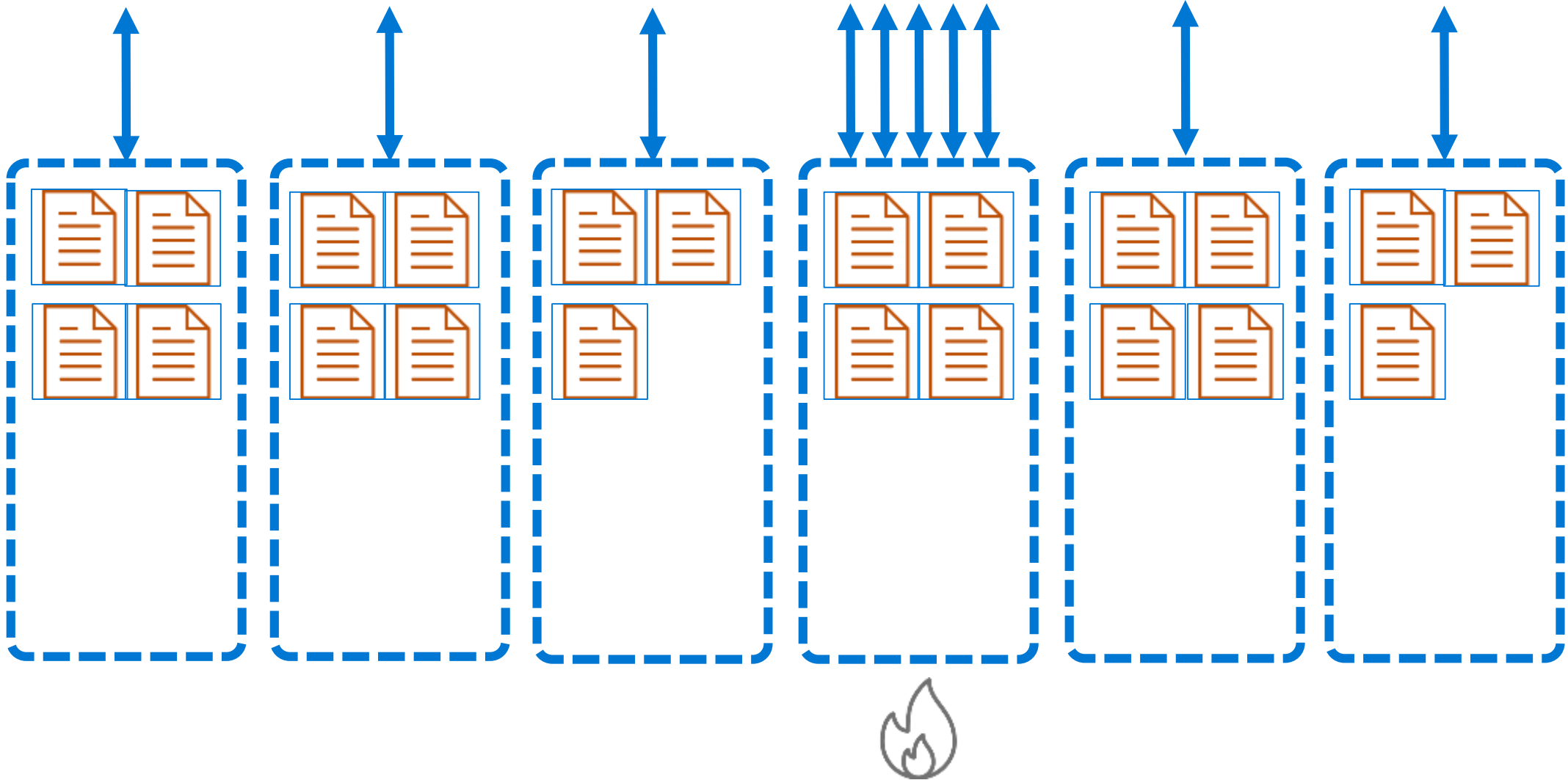
Max size: 20 GB



# Hot Partition



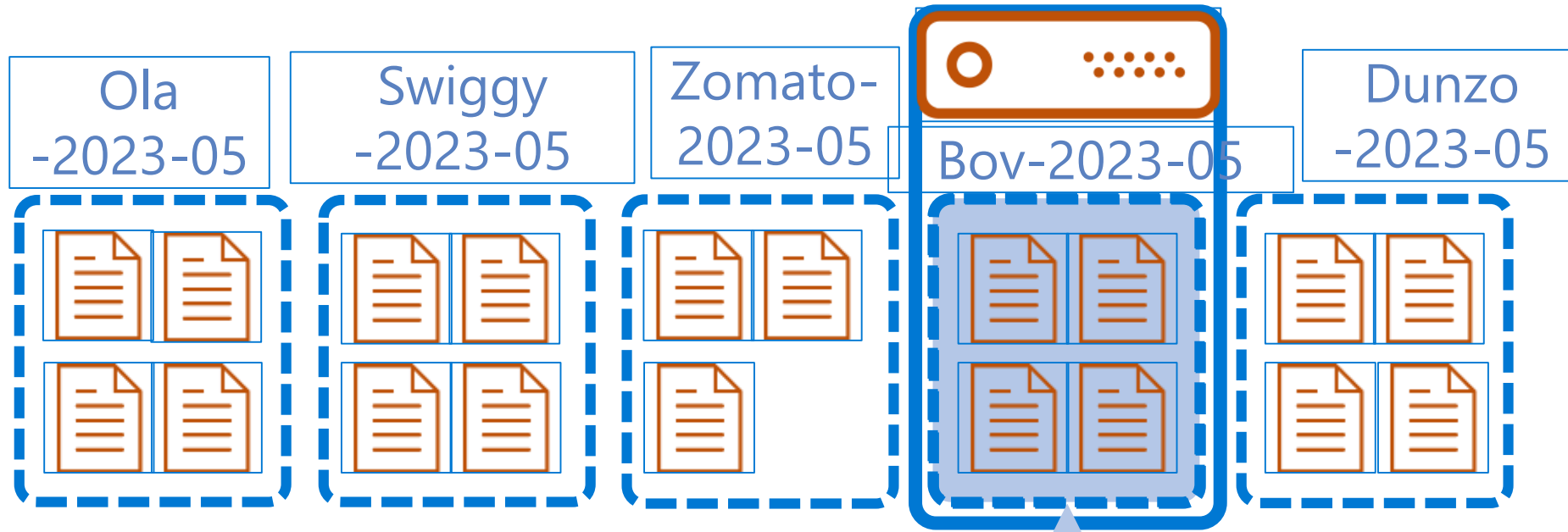
# Hot Partition







# Synthetic Partition Key



 `SELECT * FROM c WHERE c.synthetic_key = 'Bov-2023-05'`

Synthetic key

# Partition Key Choices



## DEVICE ID (e.g. Device123)

Each device would have a unique device ID. This creates a large number of partition key values and would have a significant amount of granularity.

Depending on how many transactions occur per vehicle, it is possible to a specific partition key that reaches the storage limit per partition key

## SYNTHETIC KEY (Device ID + yyyy-mm)

This composite option increases the granularity of partition key values by combining the current month and a device ID. Specific partition key values have less of a risk of hitting storage limitations as they only relate to a single month of data for a specific vehicle.

Throughput in this example would be distributed more to logical partition key values for the current month.

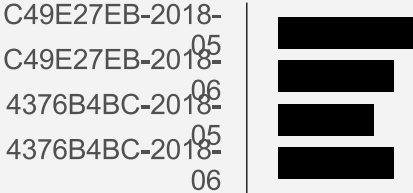
### Storage Distribution



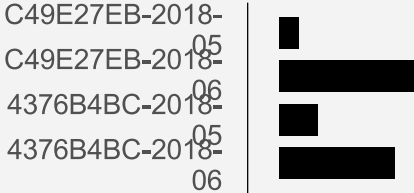
### Throughput Distribution



### Storage Distribution



### Throughput Distribution



# Agenda



Get familiar with IoT concepts



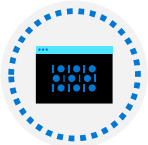
Azure Cosmos DB & Partition key



Azure Synapse link

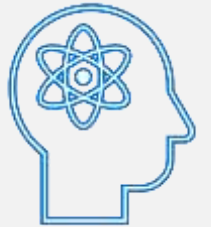


Visualize data in PowerBI



Demo

# Azure Synapse Link for Azure Cosmos DB

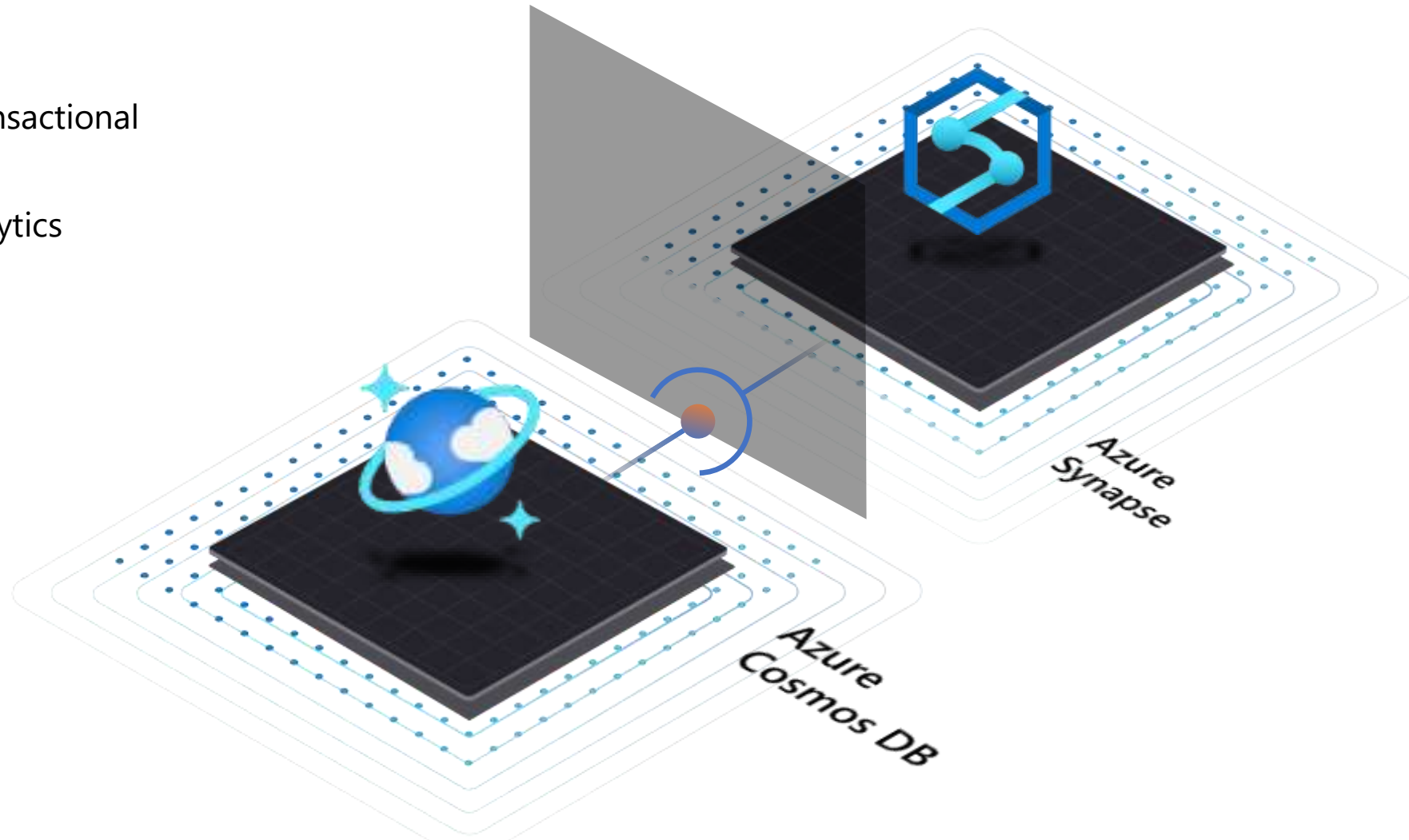


# Azure Synapse Link for Azure Cosmos DB

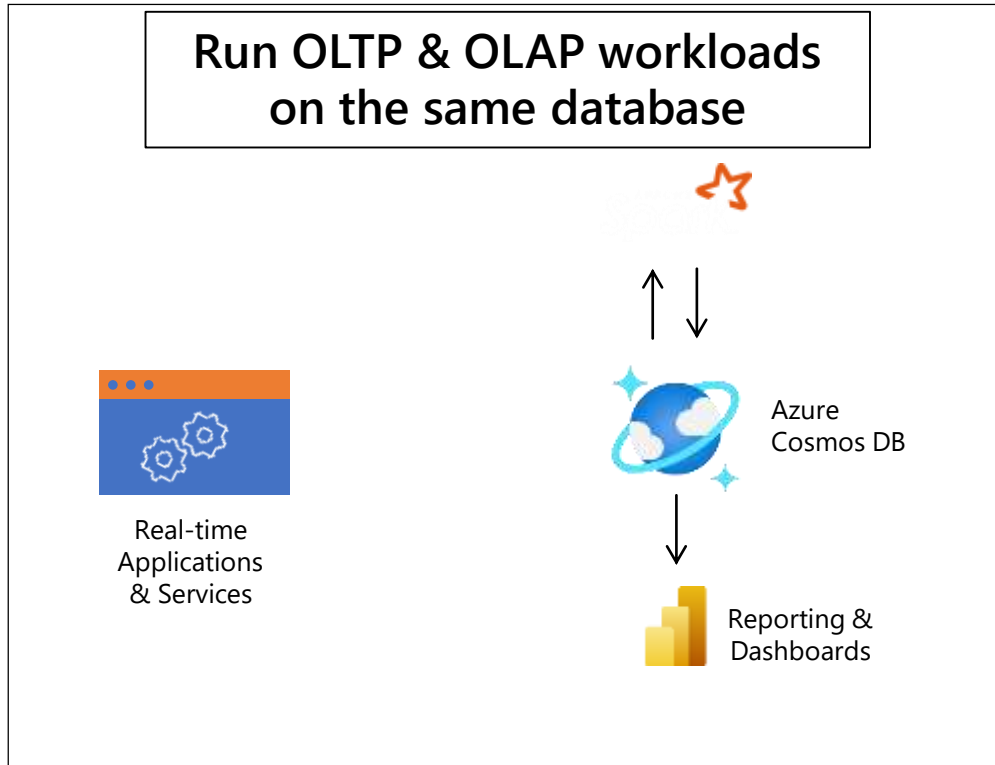


## HTAP = Breaking down the barrier between OLTP & OLAP

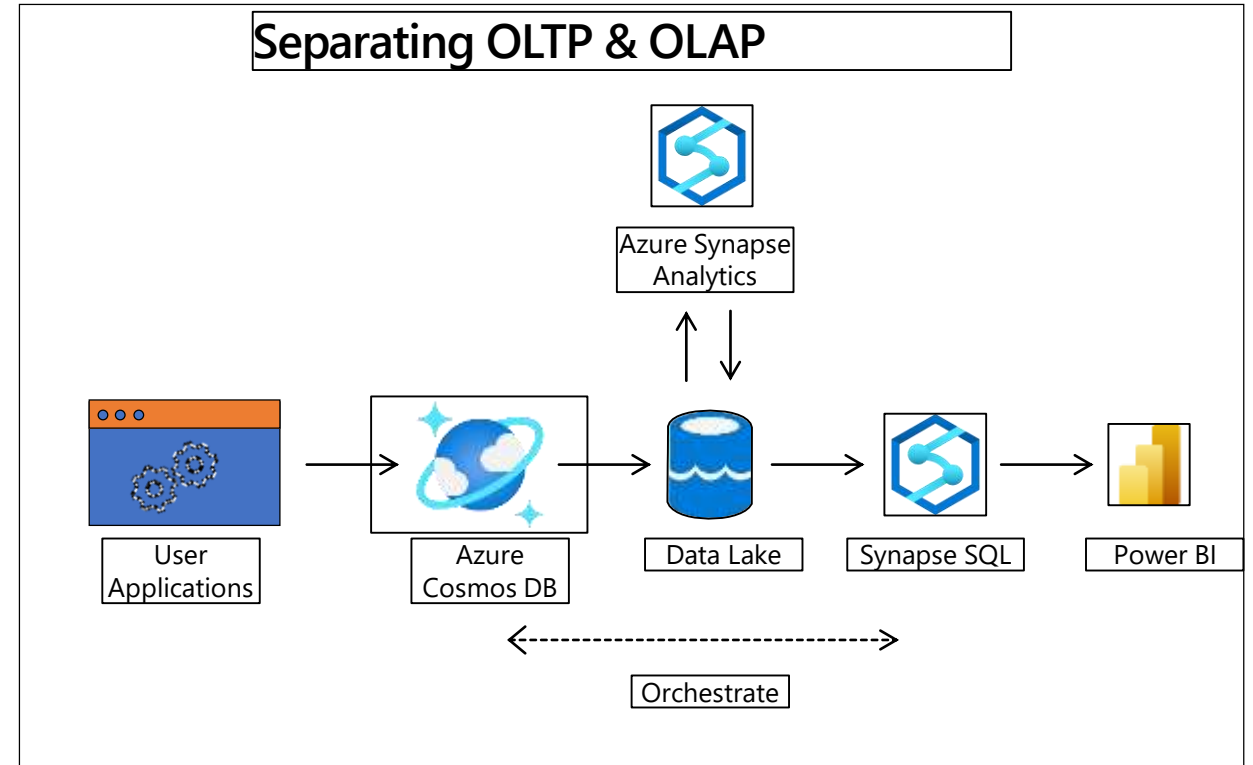
- Near real-time data analytics
- No performance impact on transactional workloads
- Costs reduction for BI and Analytics workloads
- Simplified management



# Azure Cosmos DB Analytics Before Synapse Link



- Performance impact on both workloads at scale
- Data archiving is delayed to meet analytics demands
- Costs and latency increase as the data volume grows



- Ingest data periodically from Azure Cosmos DB to Data Lake
- Delayed insights and reports
- Management complexity: data formats, ETL jobs, and storage

# Azure Cosmos DB Analytics Before Synapse Link

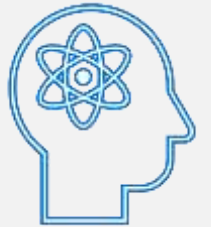


Change Feed and materialized views would also be used for reporting. But..



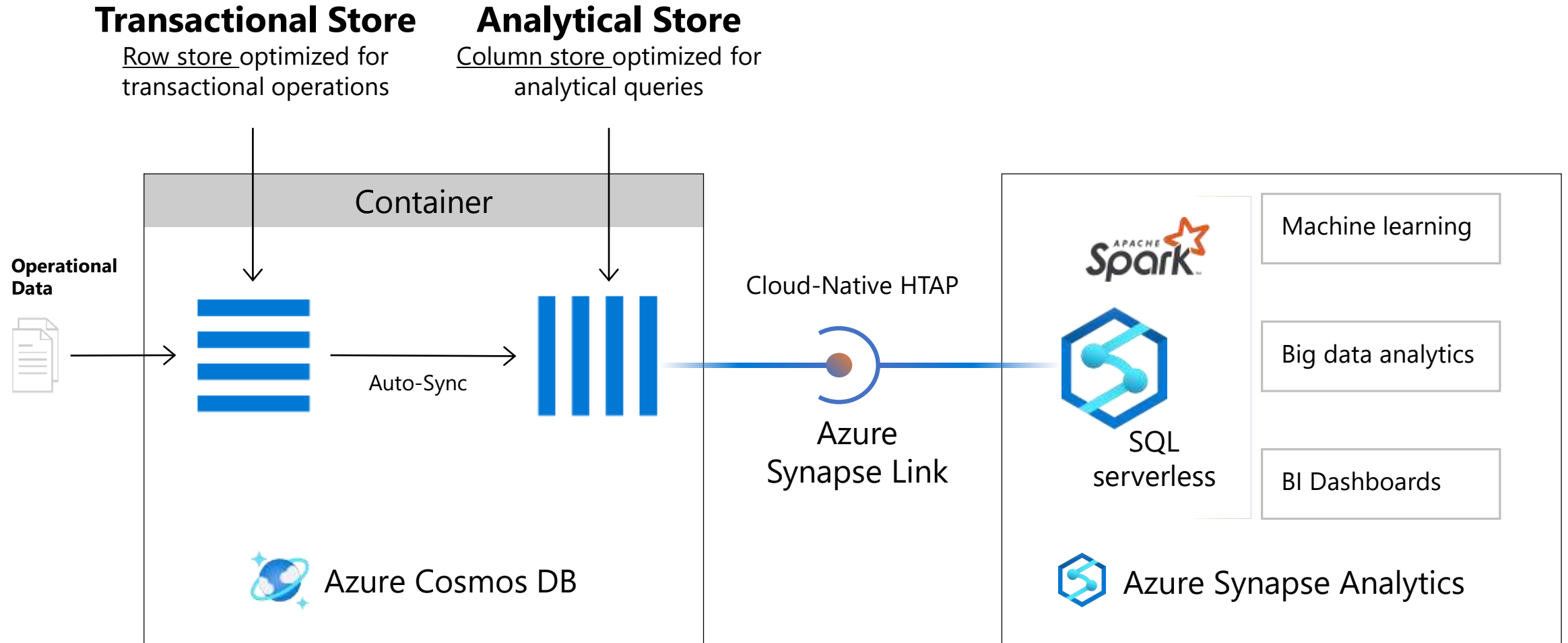
- Customers still have to deal with a partition key
- Customers still have to use RUs and transactional store
- Different aggregations demand new Azure Functions programming
- Azure Functions is billed by execution, possible cost issue for big data volume
- Doesn't address analytics: full scans, joins, complex queries, etc

# Azure Synapse Link Under the hood



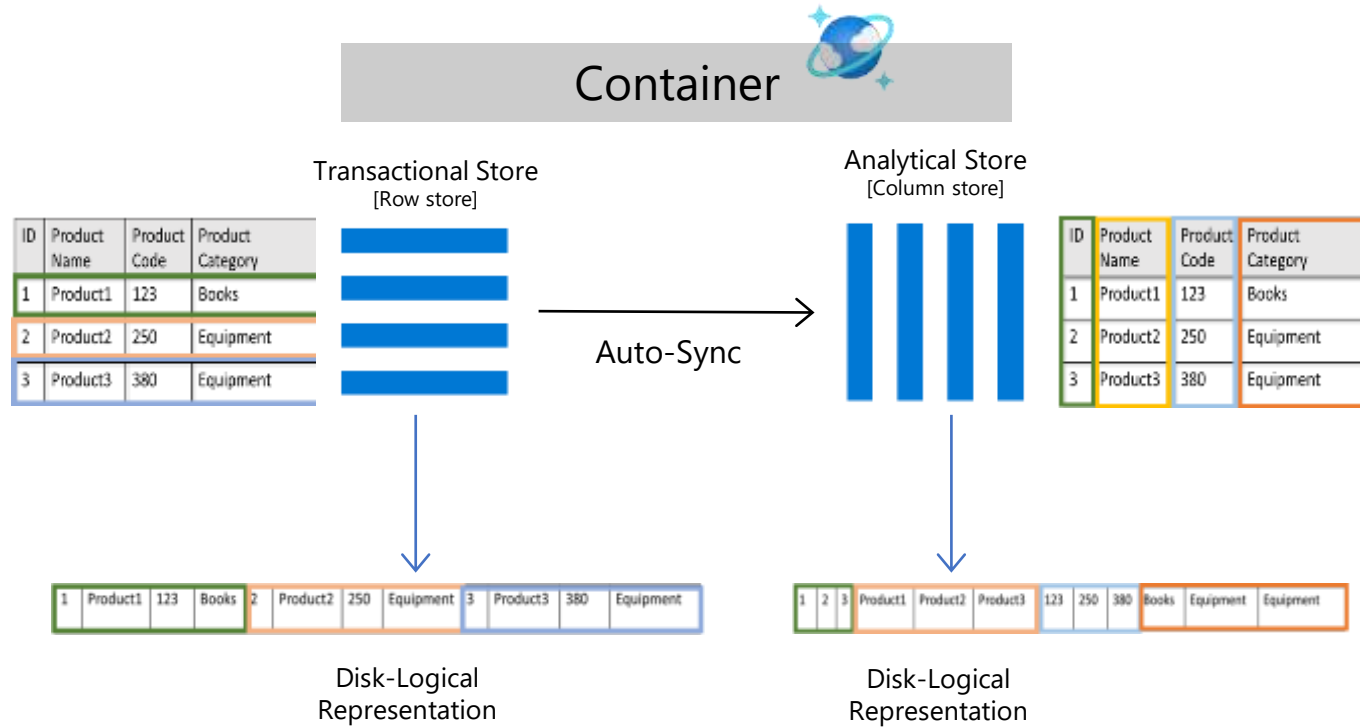


# Azure Synapse Link for Cosmos DB



**Generate near real-time insights on your operational data**

# Analytical store | Enabling No-ETL HTAP



- "Auto-Sync": Your transactional data is automatically synced to analytical store within 2 mins
- Self-managed compute, throughput, and storage, without any downtime
- No performance or costs impact on your transactional workloads
- Automatic schema inference
- Native integration with Synapse to analyze the data directly with SQL & Spark runtimes
- Cosmos DB data is available for analytics in any global region where the Cosmos DB account is replicated

# Analytical Time-To-Live (TTL)



- You can choose how long data should be retained in your analytical store (like transactional TTL for transactional store)
- Analytical TTL set on a container:

Value	Analytical data retention	When to use?
0 or null	No data replicated from transactional store	Use the container only for transactional workloads Default, when analytical store is turned off
-1	Infinite retention of analytical data in your container	Retain all historical data for analysis
'n'	Items will expire from the analytical store "n" seconds after their last modified time in the transactional store.	Expire items in analytical store independent of transactional data Cost-effective for storage

# Seamless data tiering using Analytical & Transactional TTL



**You can specify analytical TTL and transactional TTL on a container independently**

Value	When to use?
Analytical TTL > Transactional TTL	Retain your data longer in analytical store
Analytical TTL same as Transactional TTL	Mirror data in transactional store
Analytical TTL < Transactional TTL	Expire items in analytical store earlier than in transactional store

# Cosmos DB Synapse Link | TCO comparison



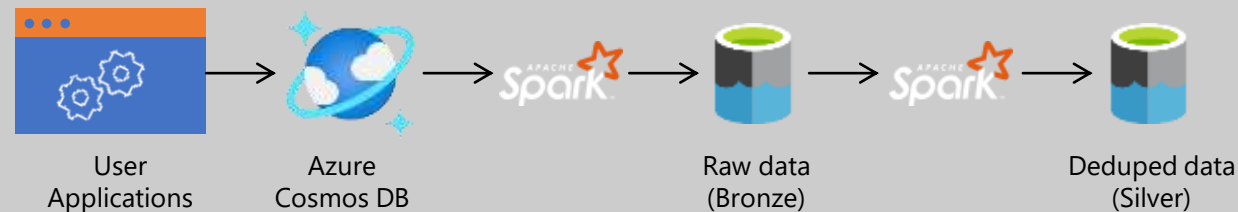
## Inserts/Updates with Cosmos DB HTAP (Synapse Link)



Provisioned RU/s 1000000

Cost of Cosmos DB RU/s for 9.5 hours (ingestion)	\$800.000
Cost of Cosmos DB Transactional Storage	<b>\$483.63</b>
Cost of Cosmos DB Analytical Storage	\$28.82
Cost of Cosmos DB Analytical Store Write Operations	\$26.85
Cost of Analytical Store Partitioning execution (take out for base case)	\$23.09
<b>Total</b>	<b>\$1,339.29</b>

## Inserts/Updates using CDC directly on OLTP store

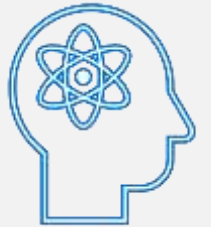


Provisioned RU/s 1250000

Cost of Cosmos DB RU/s for 9.5 hours (ingestion + change feed)	\$1,000.000
Cost of Cosmos DB Transactional Storage	<b>\$483.63</b>
Cost of Spark compute to Stream to Bronze Delta Lake	\$230.94
Cost of Spark compute to Stream to Silver Delta Lake	\$1,847.52
Cost of Delta Lake storage	\$21.23
<b>Total</b>	<b>\$3,583.33</b>

**63% cost reduction with Synapse Link**

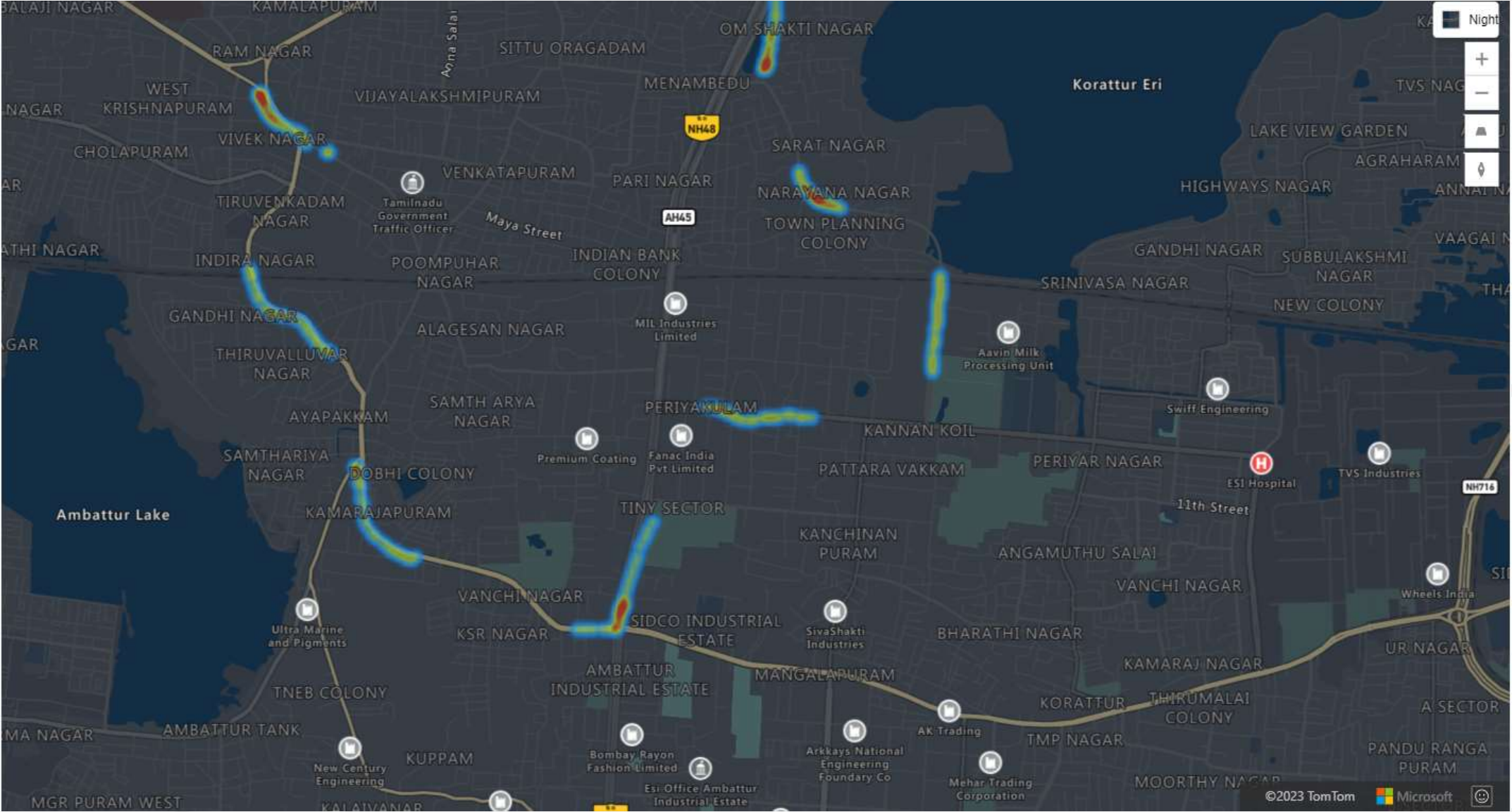
# Visualization in Power BI



# SQL script

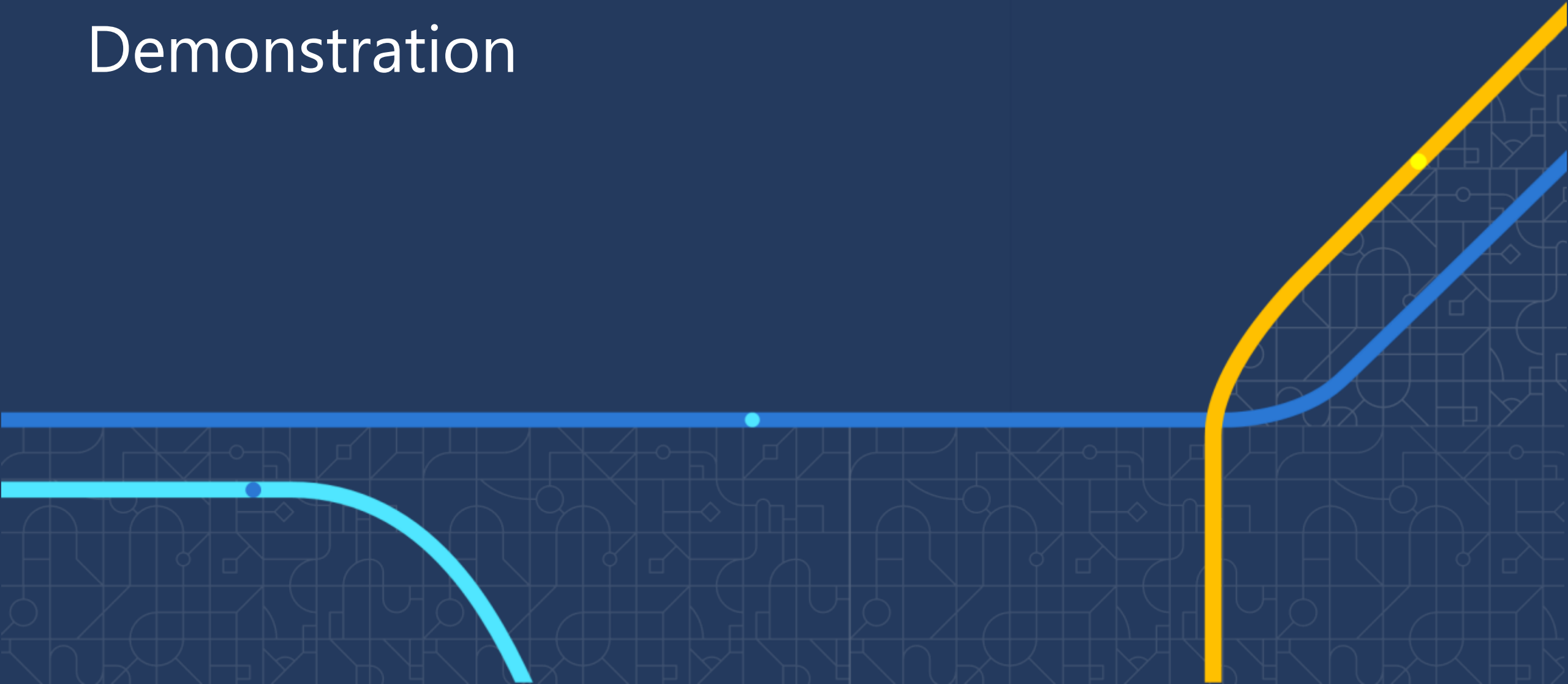
```
Create view aggregatetelemetry as
SELECT avg(pm_25) as pm_25,avg(pm_10) as pm_10,ROUND(lat,3) as lat,ROUND(lng,3) as lng
FROM OPENROWSET(
    'CosmosDB',
    'Account=cosmos-raspberrypi;Database=airqualitymonitoringdelivery;Key=YOUR_KEY',telemetry)
WITH (
    pm_25          float '$.Body.pm_25',
    pm_10          float '$.Body.pm_10',
    lat            varchar(100) '$.Body.lat',
    lng            varchar(100) '$.Body.lng'
) AS docs Group by lat,lng;
```

# Heat Map





# Demonstration



## Air quality monitoring Insights

### Link

[Dr. Sarath Guttikunda study on Ambient monitoring system](#)

[Experts say five air quality monitoring stations not enough, seek 3 more](#)

[Interview with Dr. Sarath Guttikunda who wins AGU Award](#)

[Live Air Quality monitoring stations](#)

[Chennai Metropolitan Area to be trifurcated, will cover 5,904 sqkm](#)

[PM2.5, PM10 safe levels breached in Delhi throughout summer](#)

## Raspberry Pi

### Link

[Setting up your Raspberry Pi](#)

Ευχαριστώ

Grazie

Kiitos

Спасибо

Dzięk

Gracias

唔該

感謝你

Teşekkürler

Merci

धन्यवाद

شكر

Obrigado

Takk

감사합니다

Danke

ありがとう

مرسي

Thank  
you!