Microsoft

Workshop

Azure Data Explorer

BASICS

July 28th 2022

9 – 12 CEST

Thomas Pickl

Cloud Solution Architect

Advanced Analytics & AI - Automotive Sector

Microsoft Azure Intelligent Cloud

Learning Objectives

- This is a Level 200 – Level 300 training.
- Understand basic concepts of Azure.
- Get to know Azure Data Explorer and get comfortable using it.
- Feel enabled to identify potential use cases in your daily work and apply your learned skills to prototype / implement them.
- Take away code snippets to work on your own use cases.
- Write your own code to make use of some of the services.
- Get to know people you can ask if you get stuck.

Logistics | Code Repositories & MDR ADX Cluster

- Breaks
  - 10:15 – 10:30 CEST Coffee Break
- GitHub
  - https://github.com/thpickl/adx-workshop-master
- MDR ADX Cluster
  - https://mdrdataadx.westeurope.kusto.windows.net/
- ADX Query Best Practices
  - https://docs.microsoft.com/en-us/azure/data-explorer/kusto/query/best-practices

Microsoft Azure

Be future ready | Build on your terms | Operate hybrid seamlessly | Trust your cloud


60+
Azure regions
More than AWS &
Google combined
165k+ miles of fiber

What is Azure?

Edge Devices

Azure Stack | Azure Data Box | Azure Sphere | Azure Kinect | HoloLens

Serverless

Web
Mobile
Mixed Reality
Containers
Events + Integration

Databases
Analytics
AI + Machine Learning
Internet of Things
Media

Infrastructure

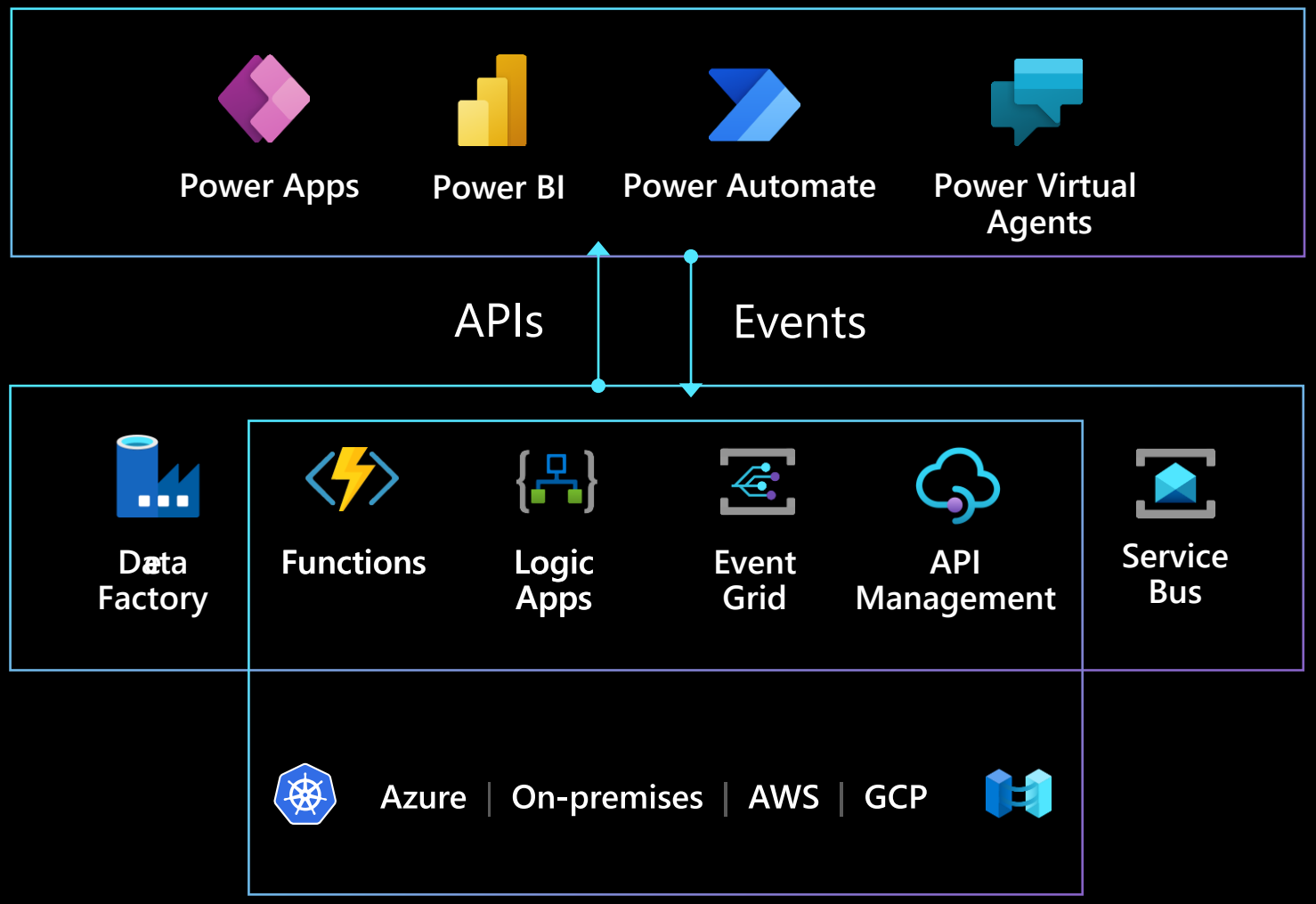
Compute | Networking | Storage | Security | Identity

Tools

Visual Studio
GitHub
PowerApps
Power BI

Azure Integration Services

Complete. Integrated. Citizen. Pro. Future ready.



- Low-barrier to entry pricing model
- Low-code business process automation and application integration
- 450+ out-of-the box connectors, AI for unstructured content, and UI automation (RPA)
- Enterprise-grade governance & security
- Citizen extensibility with Power Platform
- Low-code ETL with Azure Data Factory

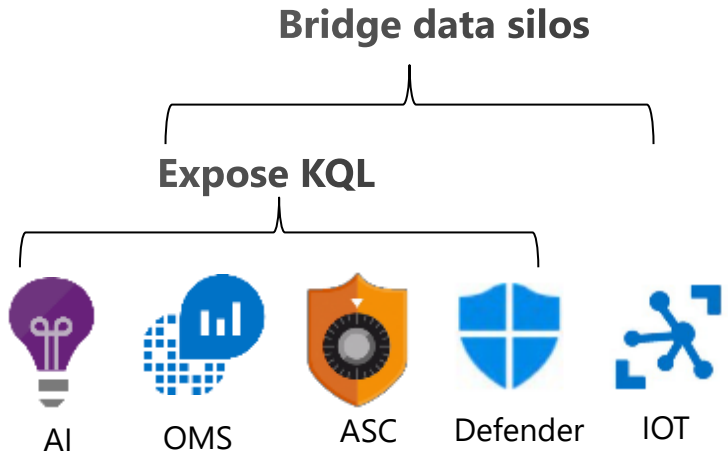
Microsoft Azure

Azure Data Explorer
Fast and highly scalable interactive analytics

Start exploring your data

L100_L200

Azure Data Explorer - Evolution



Kusto as a Platform

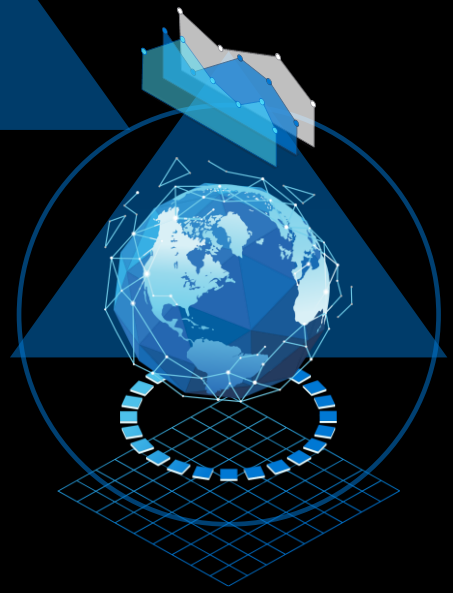
Telemetry Analytics for internal	Analytics Data Platform for products	Interactive Analytics Big Data Platform
2015 - 2016	2017	2019
Starting with 1st party validation Building modern analytics Vision of analytics platform for MSFT	Analytics engine for 3rd party offers Unified platform across OMS/AI Expanded scenarios for IOT timeseries Bridged across client/server security	GA - February 2019

Technical Use Cases

Near-real time big data analytics solutions

Near-real time logs analytics solutions for your observability, monitoring, and security data

- Replace infrastructure-based log search solutions
- Complement with your SIEM product
- Accelerate your AI Ops journey

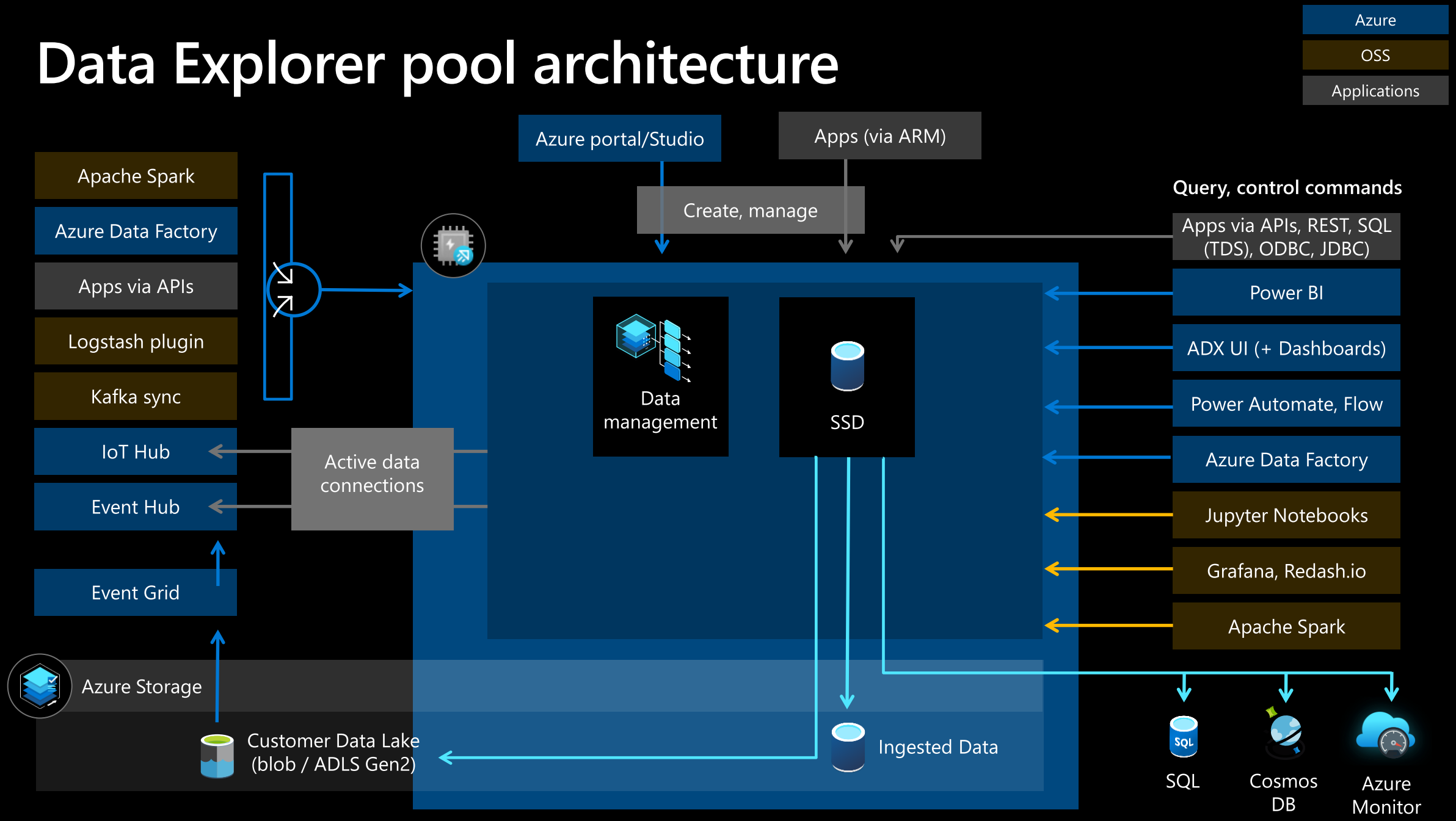


IoT Analytics solution

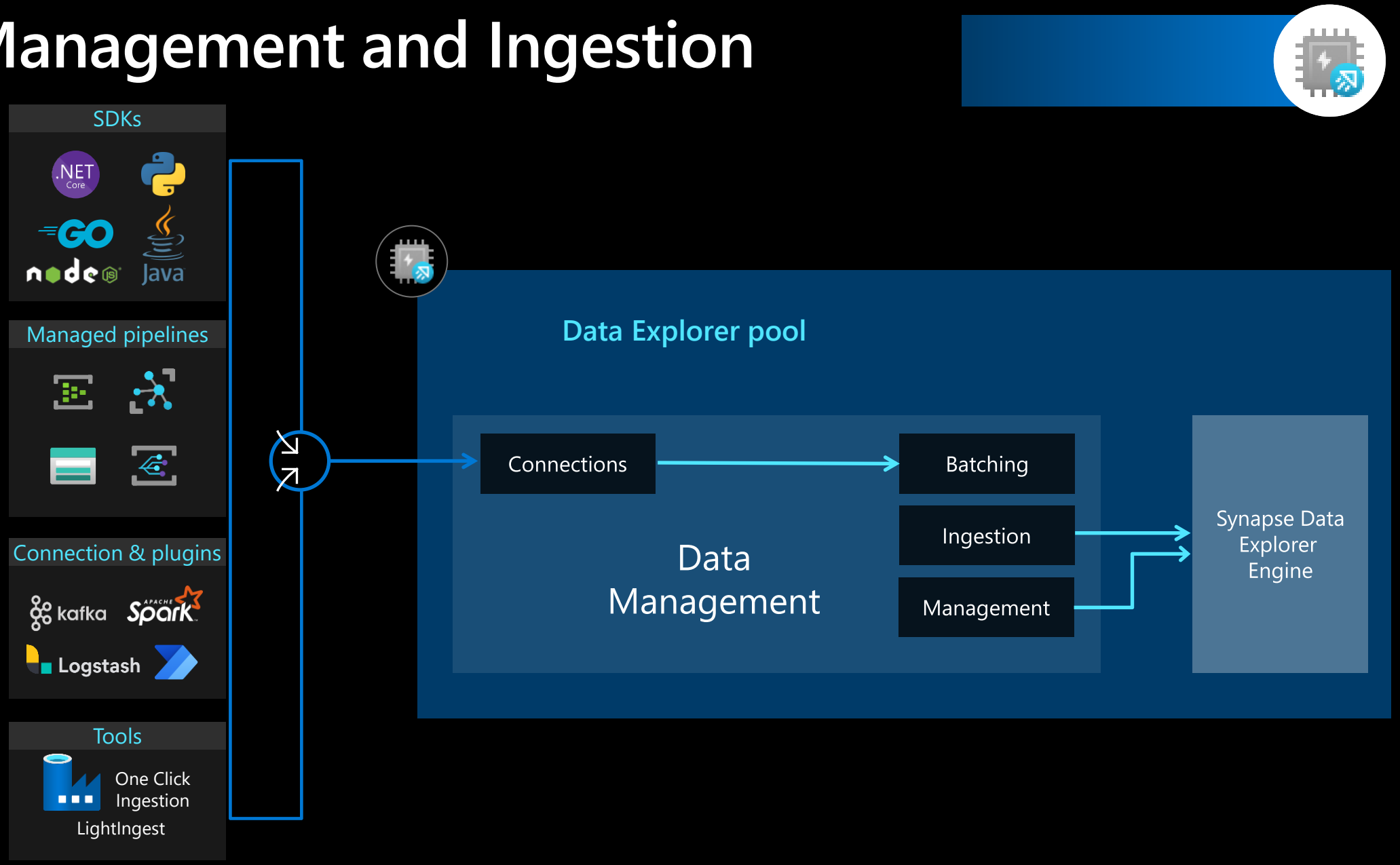
- Connected devices
- Build cloud base historian

Analytical SaaS solutions

Data Explorer pool architecture



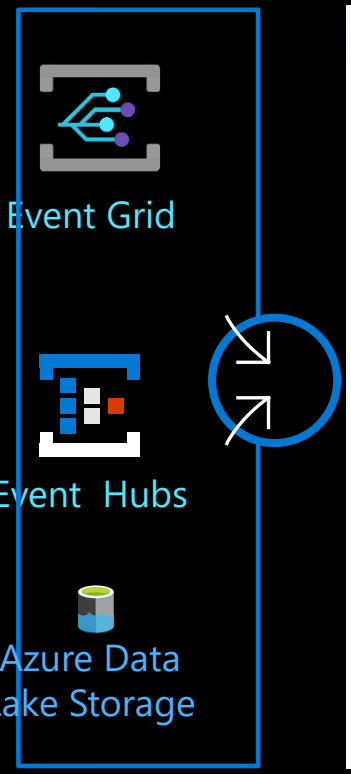
Data Management and Ingestion



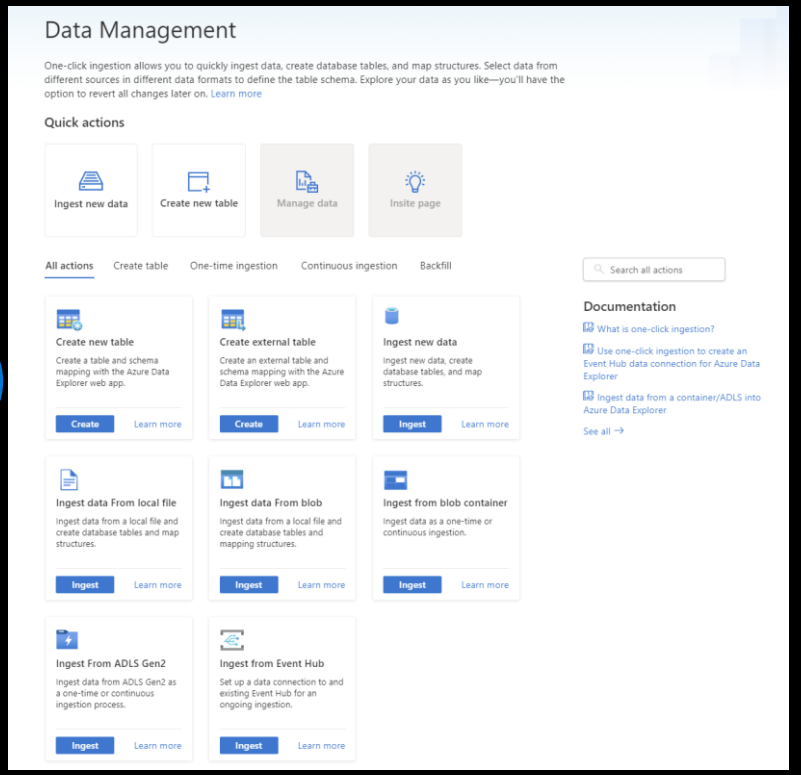
ADX Web UI One-Click (wizard)

Friction free on-boarding of your Azure data sources to Data Explorer

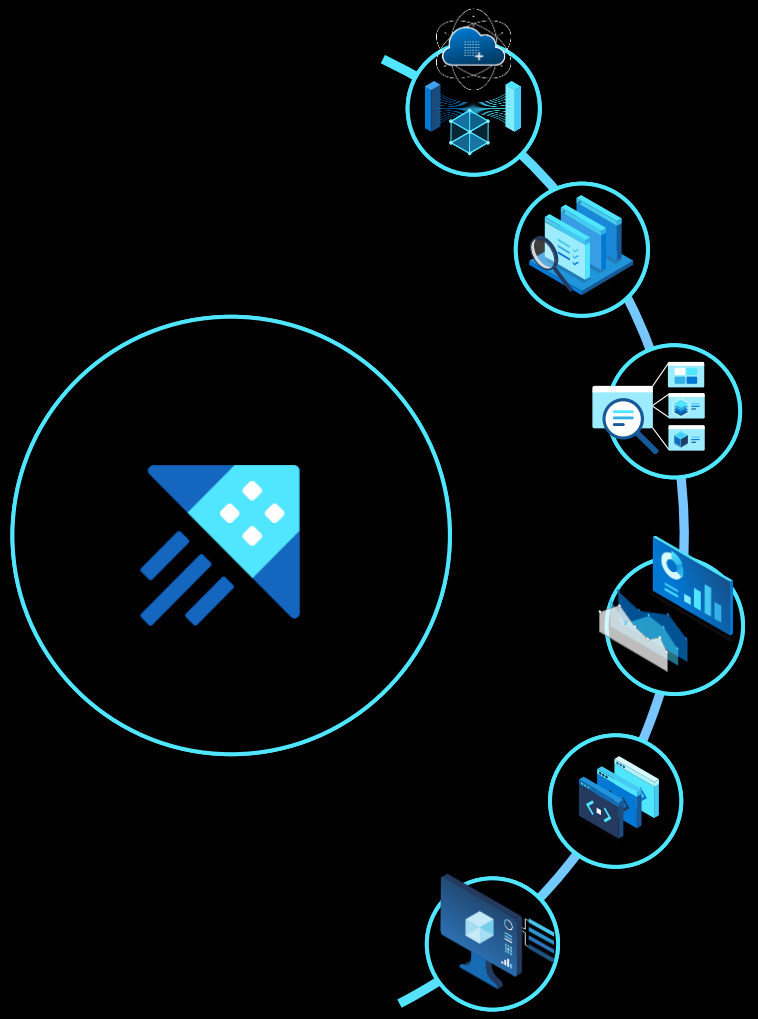
1. Get data from Azure Data Lake, Blob, Event Hub, or local file
2. Infer the schema automatically from source
3. Create table and mapping automatically from source
4. Generate custom code to start ADX project with one of the supported SDKs
5. Manage data-policies (e.g. retention, batching policies, streaming)
6. Get insight on your data management
7. Ingest one-time data or create connection for continuous data ingestion
   - Continuous (EventHub/EventGrid), one time or backfill (LightIngest)



Data Explorer Pools



Distributed Query Engine

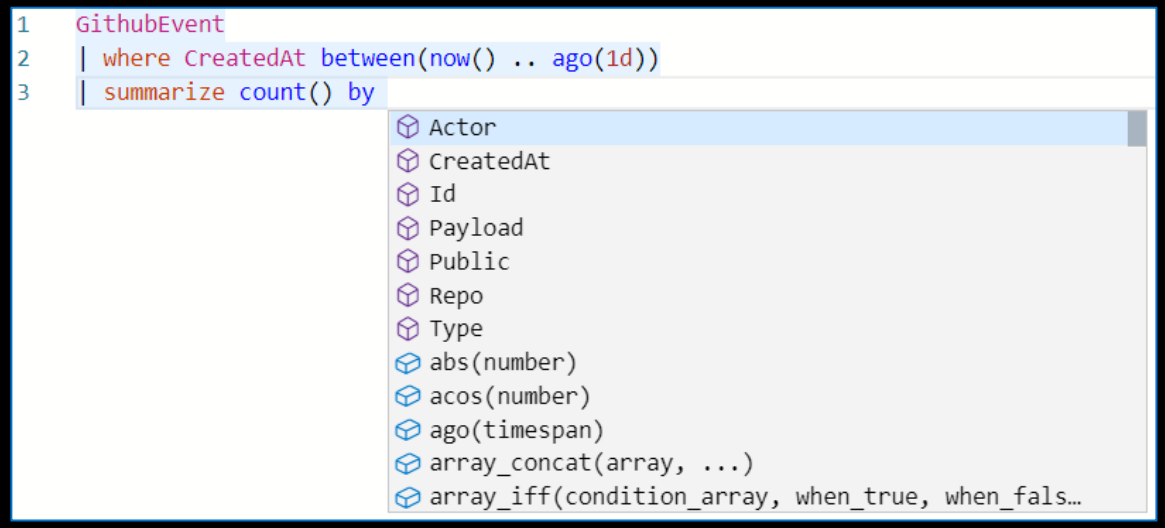


- Storage and Compute isolated
- Auto compression, indexing, optimization
- Semi-structure (JSON) and unstructured data (free text) indexing
- Data is sharded, distributed, cached across nodes on local SSDs and persisted on cloud storage
- Ingestion time-based partitioning + custom partitioning
- Hot and cold data management
- Table level caching + results set caching
- Workload management
- Partitioning
- Materialized views
- External tables for Blob, Data Lake, and SQL

Kusto Query Language (KQL)

Simple and powerful

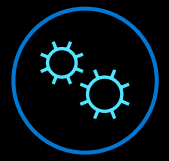
- Rich rational query language (filter, aggregate, join, calculated columns, and more)
- Built-in full-text search, time series, user analytics, geospatial, and machine learning operators
- Out-of-the box visualization
- Easy-to-use syntax + Microsoft IntelliSense
- Highly recognizable hierarchical schema entities



Extensible

- In-line Python and R
- T-SQL

Advanced Analytics – Built-in & Extendible



Out of the box

- Auto Clustering for Diagnosis and RCA
- Anomaly Detection
- Regression
- Forecasting
- Time Series Analysis library

Distributed Custom Code Execution

- Distributed Python and R execution
- Custom code is embedded in the KQL query

Spark Integration

- Native Spark connector for heavy duty model training
- Operationalize model into DX pool for scoring

Tools

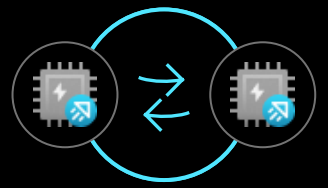
- Jupyter Integration with KQL Magic
- Python, Java SDKs

Geospatial query

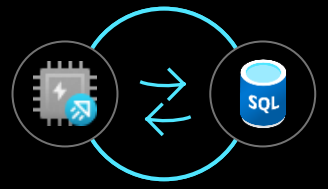
1. **Support for geospatial clustering**
   - Transformation from coordinates to geospatial clusters and back
   - Support for Geohash, S2 and H3 cells
2. **Distance**
   - Calculate the distance between two points or a point and a line
3. **Contains**
   - Check whether a point is in a given circle or polygon
4. **Advanced features**
   - Densification to control shape edges, geodesics or straight lines
   - H3-Rings

Geospatial coordinates are interpreted as represented per the WGS-84 reference system.

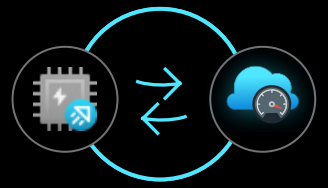
Cross Queries



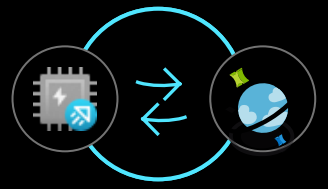
Between Data Explorer databases and pools



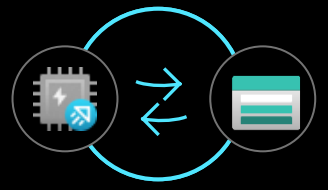
Query SQL pool from Data Explorer pool



Query Azure Monitor from Data Explorer pool



Query CosmosDB from Data Explorer pool



Query Data Lake from Data Explorer pool

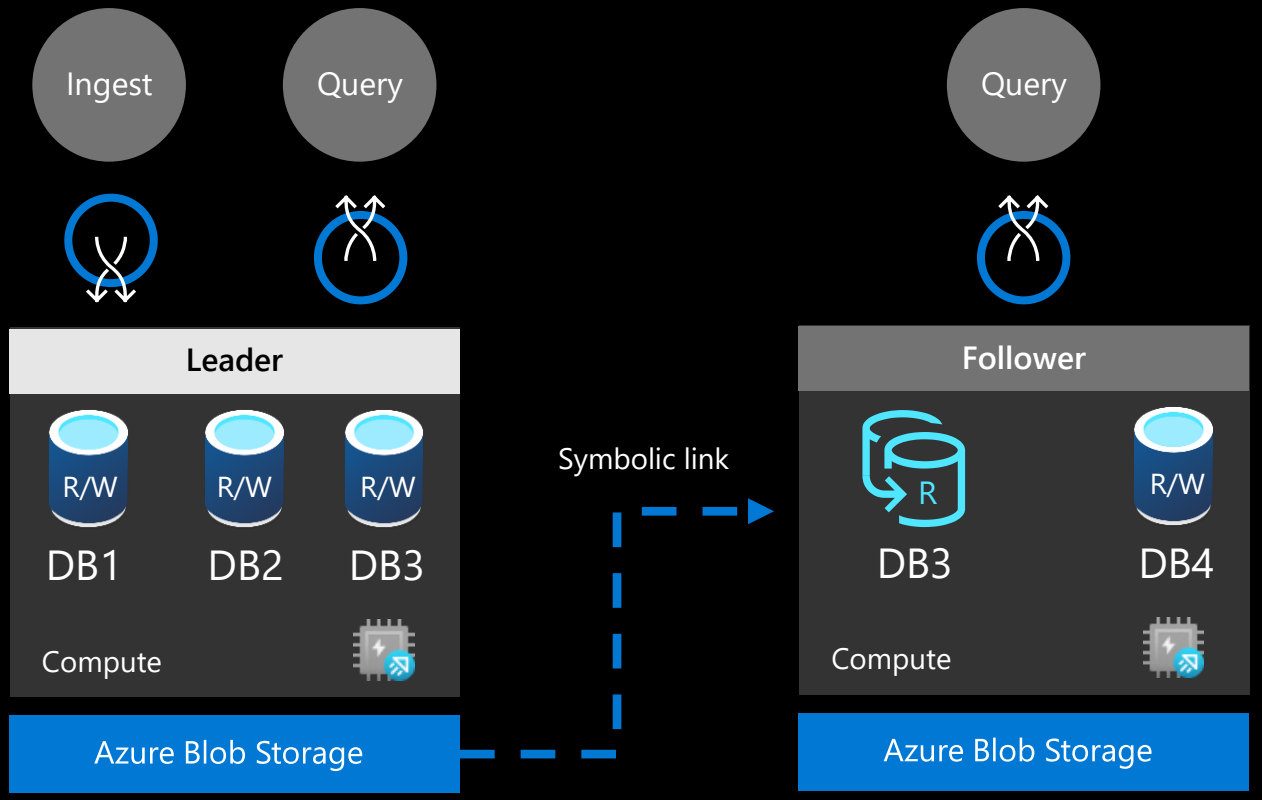
Data Sharing

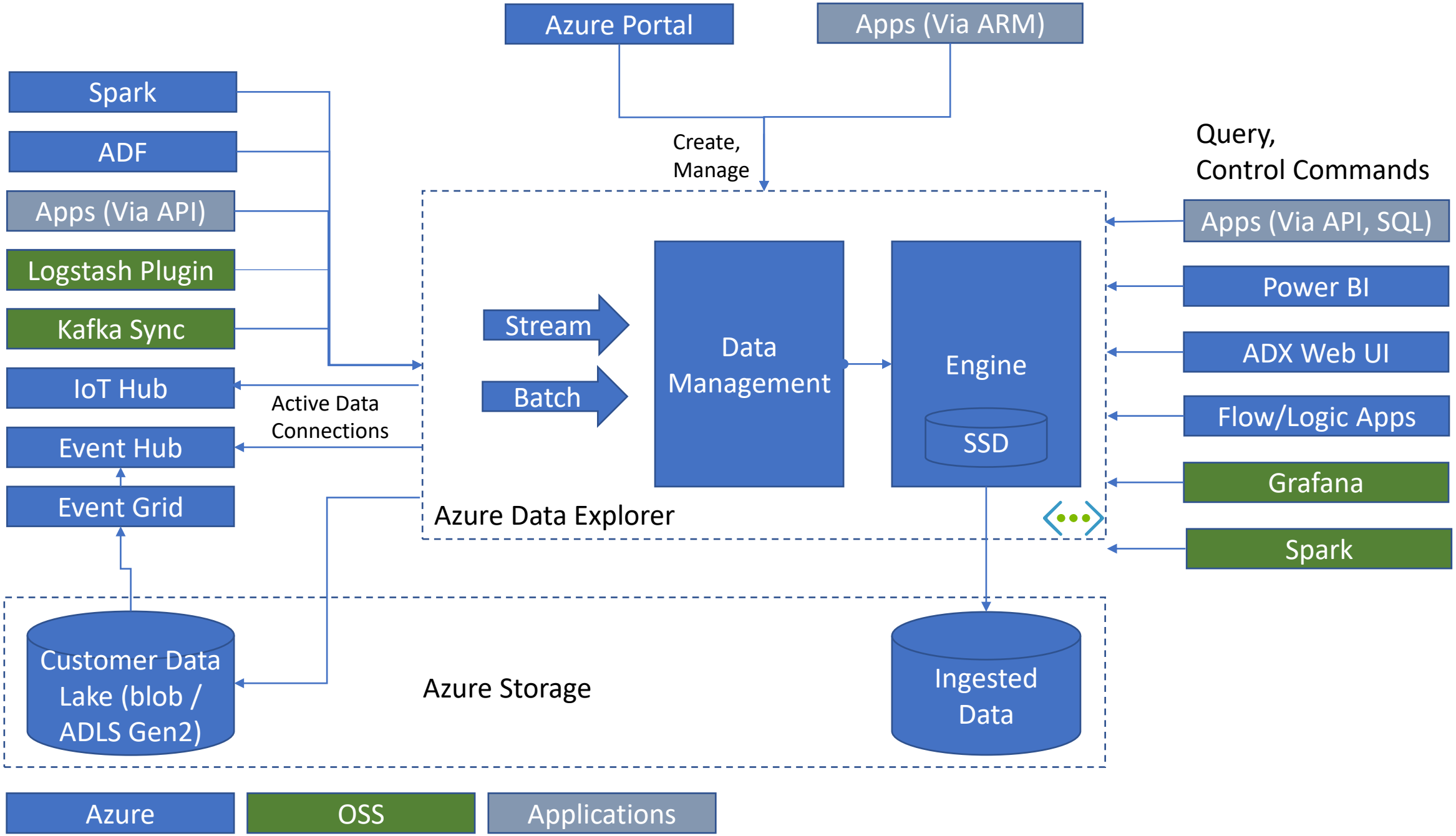
Share data within the company

- Load balancing
- Data-as-a-service
- Hub and Spoke model
- Chargeback

No Maintenance

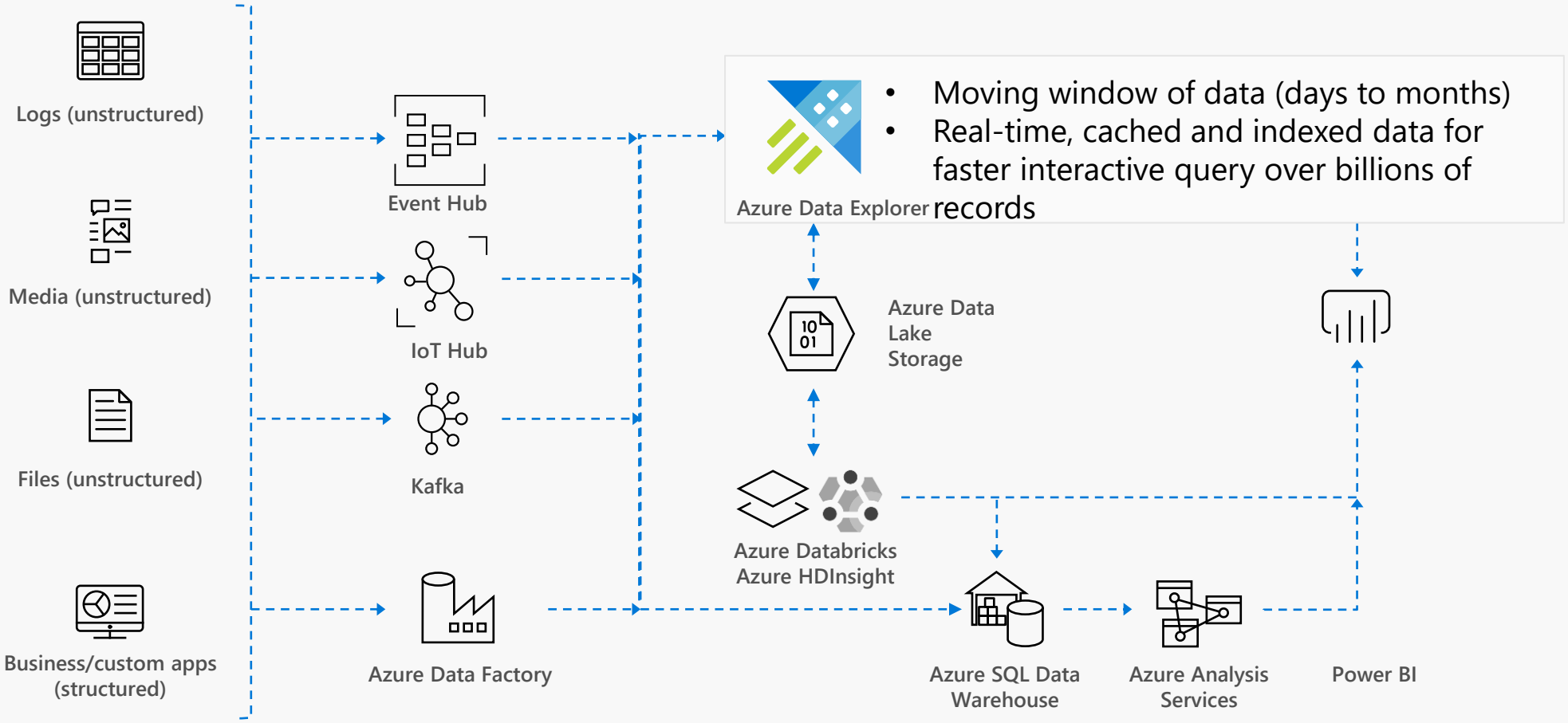
- In-Place Data Sharing
- No data pipeline to maintain
- Near real-time updates




Azure Portal
Apps (Via ARM)
Create,
Manage
Spark
ADF
Apps (Via API)
Logstash Plugin
Kafka Sync
IoT Hub
Event Hub
Event Grid
Active Data
Connections
Stream
Batch
Data
Management
Engine
SSD
Azure Data Explorer
Query,
Control Commands
Apps (Via API, SQL)
Power BI
ADX Web UI
Flow/Logic Apps
Grafana
Spark
Customer Data
Lake (blob /
ADLS Gen2)
Azure Storage
Ingested
Data
Azure
OSS
Applications

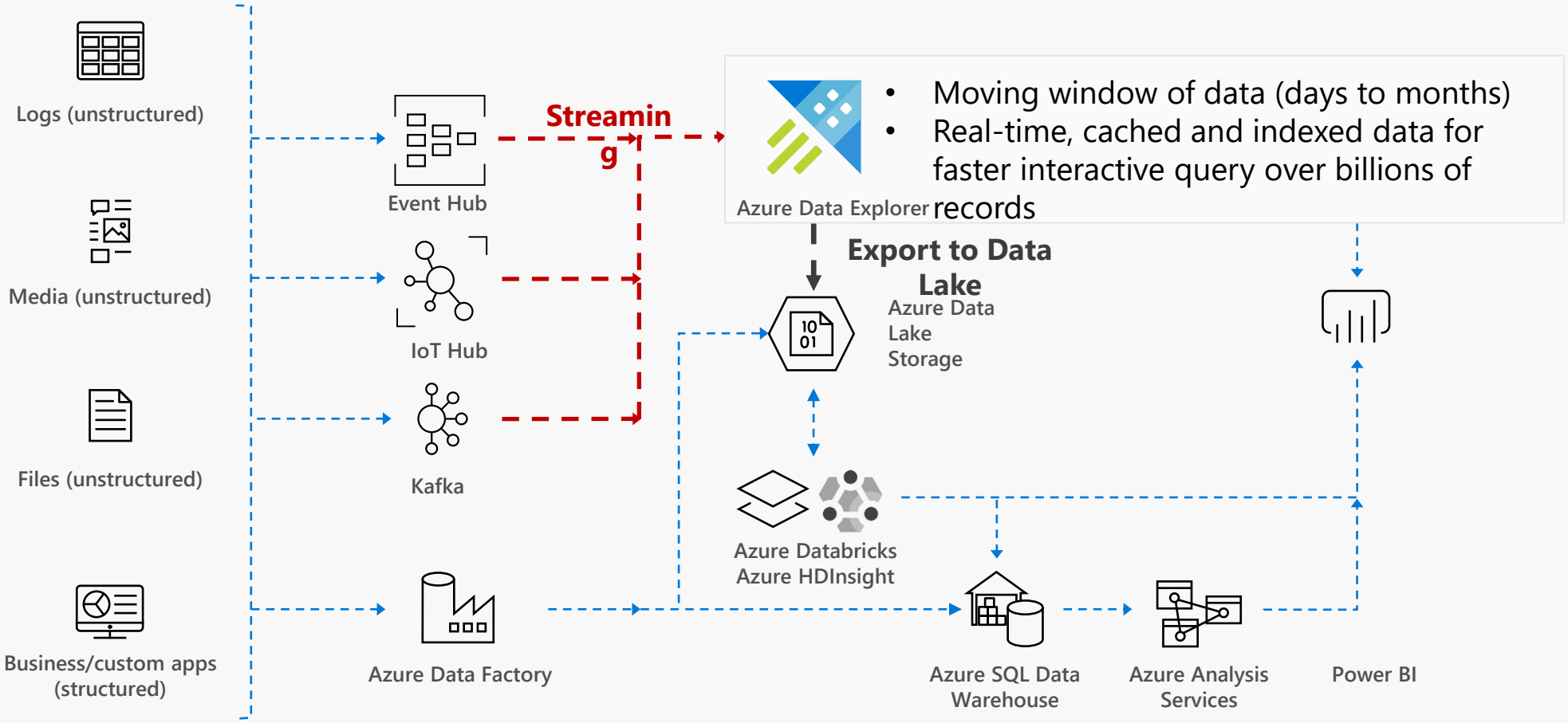
Where will you fit ADX in Data Lake and Analytics?

Cached and Indexed data for fast interactive query



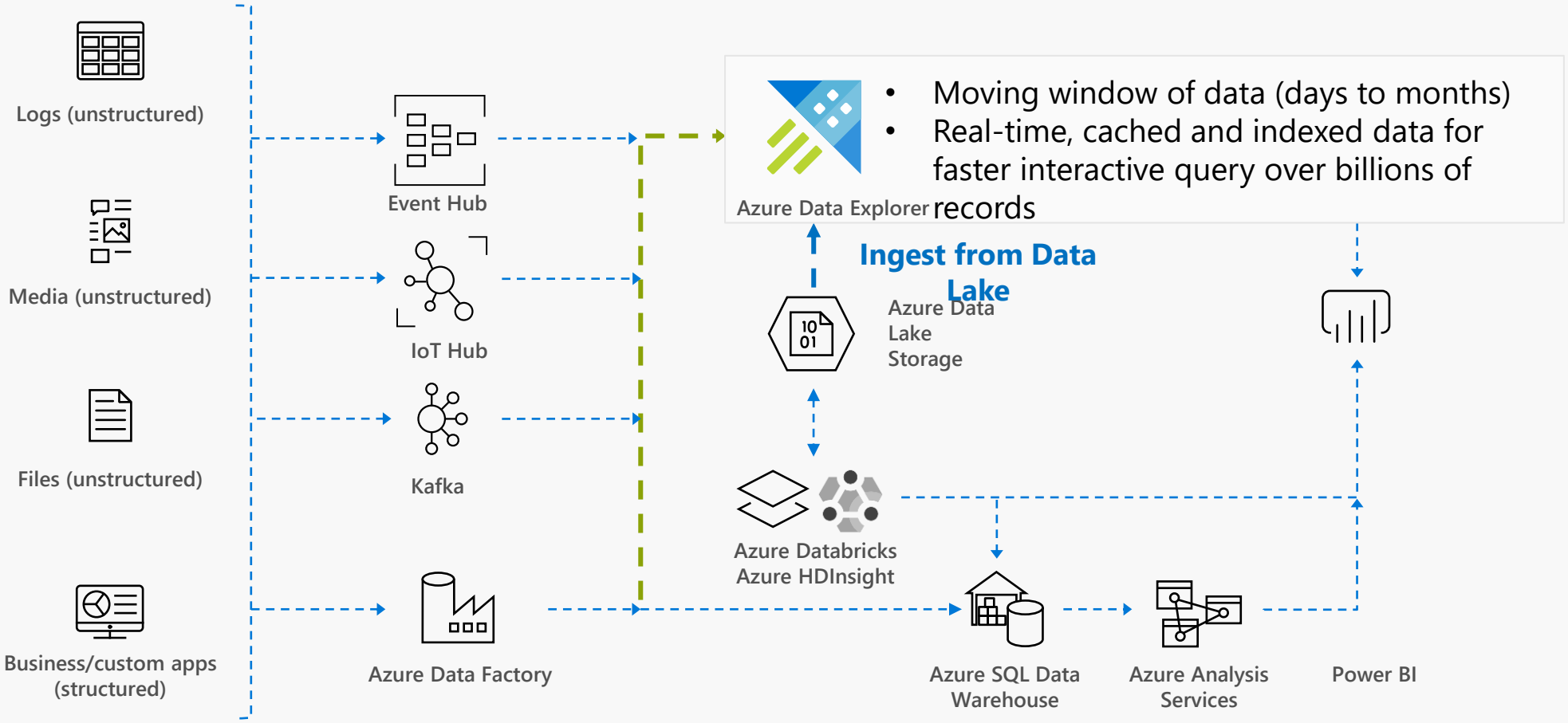
Integration: Streaming Ingestion

Land your data in ADX and then export to the data lake



Integration: Batch Ingestion

Ingest data from Data Lake or other sources in batch mode



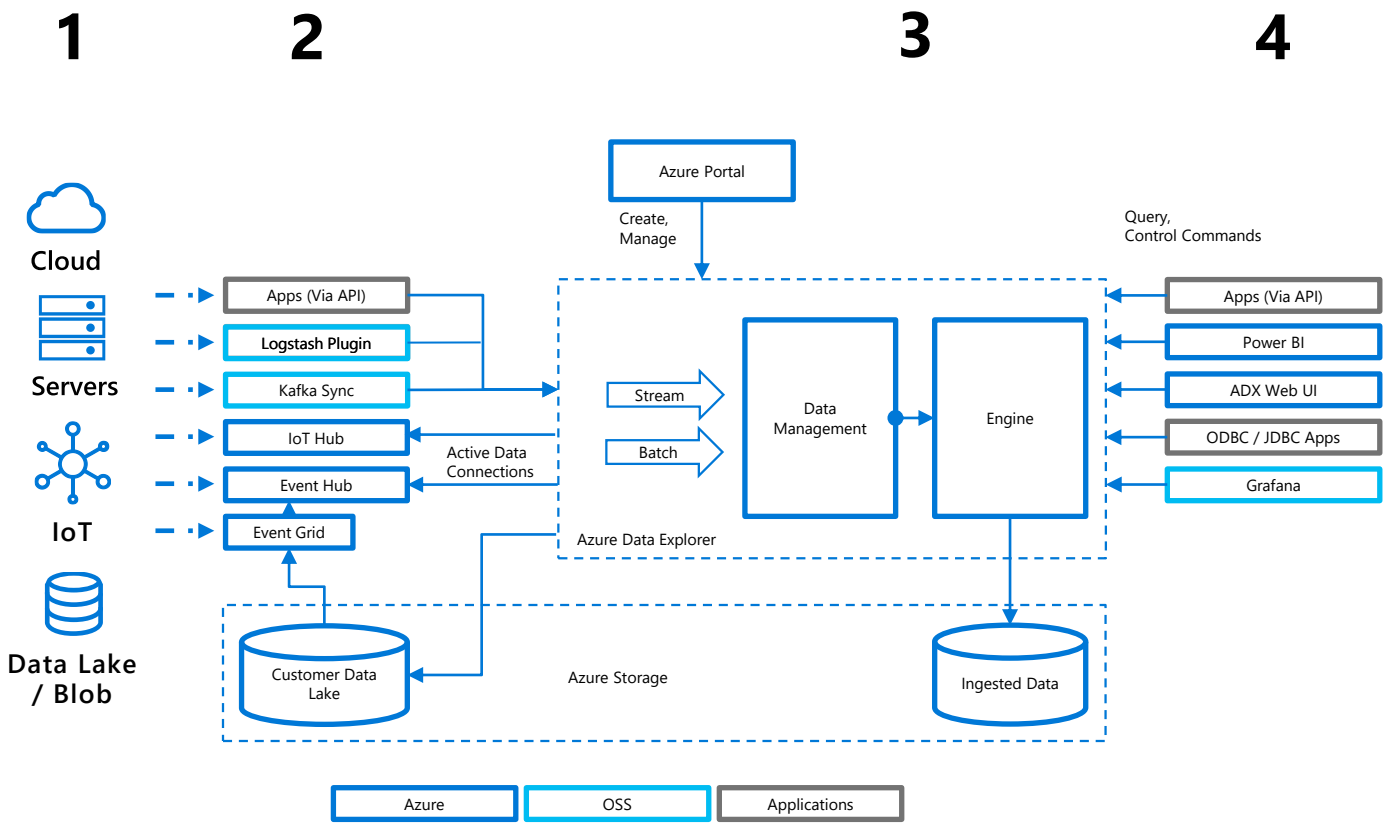
Azure Data Explorer overview

1. **Capability for many data types, formats, and sources**
   Structured (numbers), semi-structured (JSON\XML), and free text

2. **Batch or streaming ingestion**
   Use managed ingestion pipeline or queue a request for pull ingestion

3. **Compute and storage isolation**
   - Independent scale out / scale in
   - Persistent data in Azure Blob Storage
   - Caching for low-latency on compute

4. **Multiple options to support data consumption**
   Use out-of-the box tools and connectors or use APIs/SDKs for custom solution



Intuitive querying

Designed for data exploration

Simple and powerful

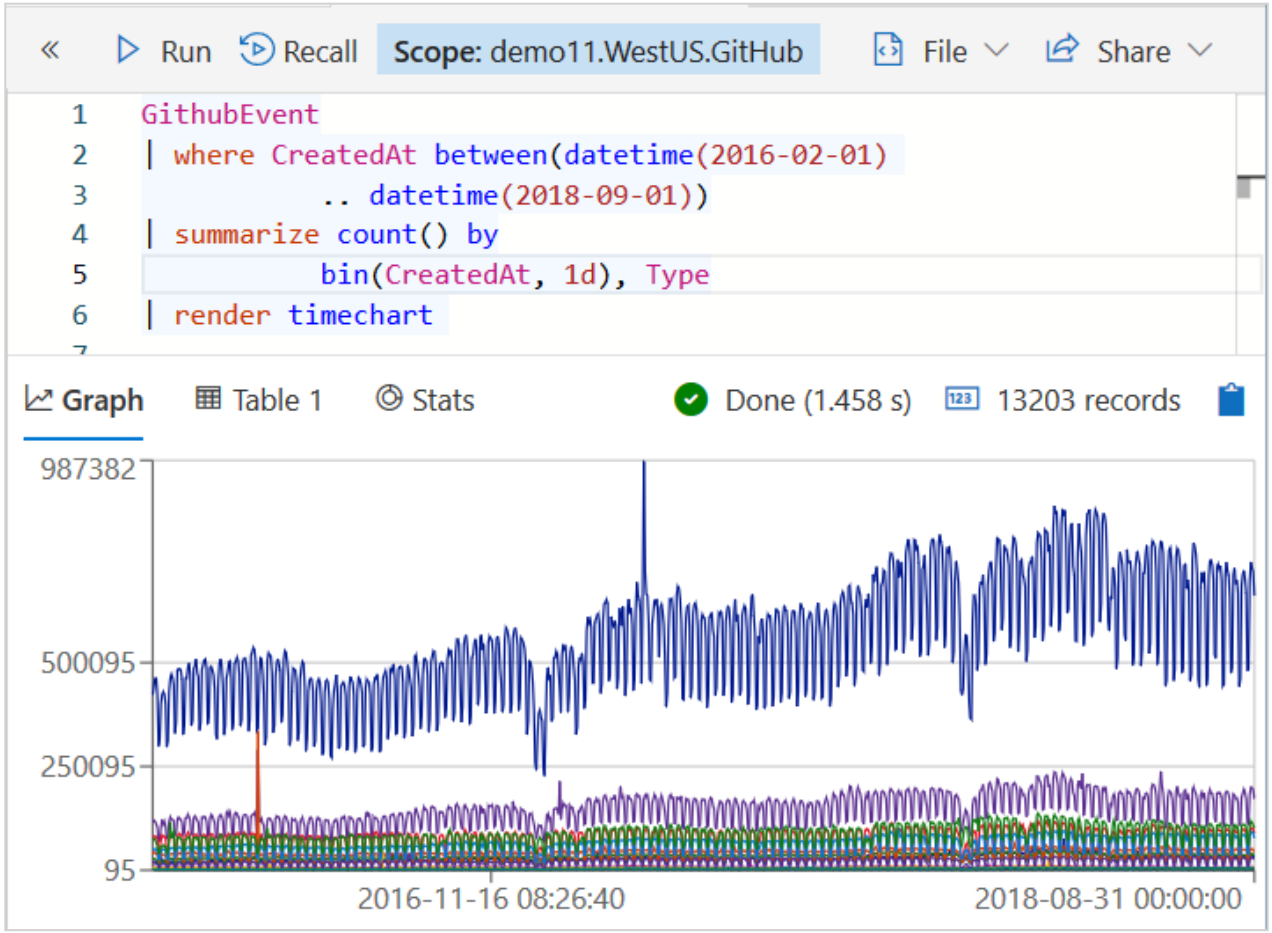
- Rich rational query language (filter, aggregate, join, calculated columns, and more)
- Built-in full-text search, time series, user analytics, and machine learning operators
- Out-of-the box visualization (render)
- Easy-to-use syntax + Microsoft IntelliSense
- Highly recognizable hierarchical schema entities

Comprehensive

- Built for querying over structured, semi-structured and unstructured data simultaneously

Extensible

- In-line Python
- SQL



Azure Data Explorer customers

BÜHLER

ECOLAB

snelstart

esri

INMOBI

ZOOMD
KNOW MORE, DO MORE.

DocuSign

"In terms of usability it is beyond compare any other database query language we have used so far."

Emilian Ertel
Senior Key Expert

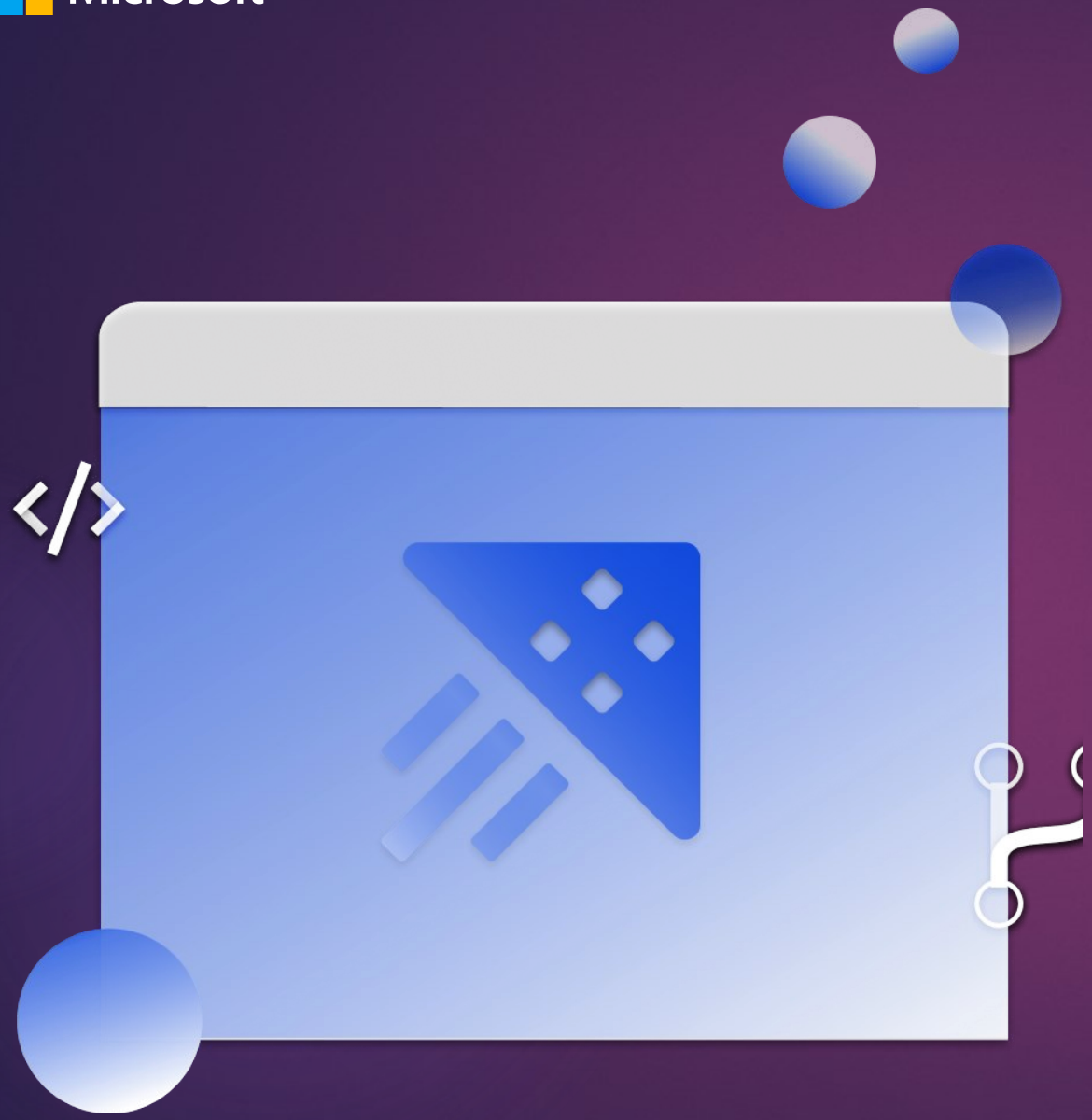
SIEMENS Healthineers

"The solution was so simple that we were up and running in a week, ingesting and analyzing 17 TB of data per day."

Ariel Pisetzky
Vice President of IT

Taboola

Microsoft



Visualizing data with Azure Data Explorer

-MITUL KACHERIA, RONY LIDERMAN

Supported dashboarding solutions

1. **Native connectors**
   - Power BI
   - Grafana
   - Kibana (K2)
   - Redash
   - **ADX Dashboards (new!)**
2. **ODBC/JDBC connectors**
   - Power BI (ODBC)
   - Tableau (ODBC)
   - Qlik (ODBC)
   - Sisense (JDBC)

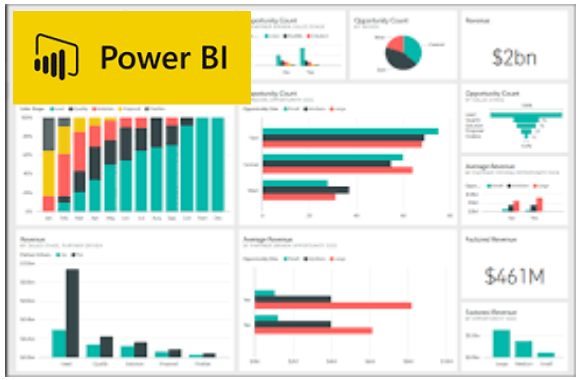
Power BI

Highlights

- Easy-to-use
- General-purpose BI platform
- Affordable pricing
- Highly interactive

Kusto integration

- Data retrieval modes
  - Import mode
  - DirectQuery mode
- Composite model
  - Allows a combination of data from import and DirectQuery datasets
  - Triggers filter operations instead of costly joins
- Parameters – WIP
- Important to read best practices to get the right perf



Grafana

Highlights

- Open source
- Real-time
- Metric visualization service
- Commonly used for visualizing time series data

Kusto integration

- Query Language Intellisense
- Parameters – parameters injection to queries enable performant query execution
- NRT – frequent dashboard refresh (down to 1 sec intervals) for up-to-date data
- Alerts – Integrated alert logic unlocks operational workflows based on the data collected

Redash

Highlights

Open source

- Data visualization tool with a good fit for **real-time analytics**
- Supports alerts but carries a limited set of visualization types

Kusto integration

- **Integration by Dodo Pizza** – a Russian ADX user who's using both ADX and Redash
- Future improvements for supporting Intellisense and additional performance improvements are being discussed

Kibana

Highlights

Open source data visualization plugin for Elasticsearch

- Provides ***real-time, time series*** analytics visualizations
- Advanced ***search*** capabilities

Kusto integration

- **Elastic migration enabler** – Kibana is a heavily used Elastic frontend in organizations that use Elastic
- **Search** – Powerful search capabilities allow semi ‘query like’ data exploration
- Dashboards not currently supported

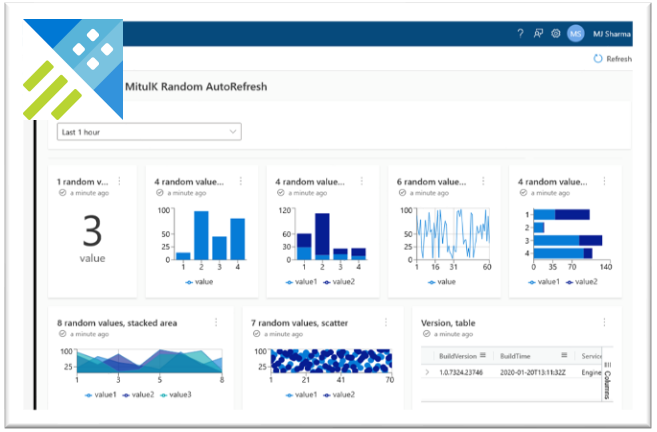
ADX Dashboards

Highlights

- Dashboarding integrated into the ADX web explorer
- Freely available for all ADX customers
- Performance focused
- Will support interactivity and real-time scenarios

Kusto integration

- **Dashboards in ADX web explorer**
  - Import existing queries into a dashboard
  - Explore queries from a dashboard
- **Parameters** – parameter injection into queries enables performant query execution
- **Interactivity (WIP)** – support for cross filtering, drill throughs



Real-Time Interactive Analytics with Azure Data Explorer

Focus: Geospatial capabilities

Real-Time Analytics Use Cases

Retail
Consumer Engagement

Pricing optimization, IoT

Financial
Risk And Revenue Management

Risk and Fraud, Due diligence, Audit

Oil/Gas & Energy
Grid Ops, Asset Optimization

Industrial IoT

Security
Signal correlation

Security Intelligence, Threat detection

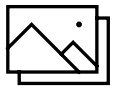
Healthcare
Sensor Data

IoT device analytics

Advertising
Recommendation Engine

Personalized offers, campaign management

Media Entertainment
Consumer Engagement Analysis



Sentiment analysis, Content recommendation

Automotive
Manufacturing, AI

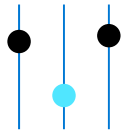
Connected cars, Fleet management

Azure Data Explorer

Interactive analytics service for fast-flowing data

Cuts down time-to-insight

Get real-time insights from fast-flowing data



Fully managed

PaaS, Autoscale and maintenance-free indexing

Enables data-driven culture

Proven intuitive and easy-to-use query language

Proven Technology

In production since 2015 for internal Microsoft workload, GA since Feb 2019.

Battle tested for Microsoft internal workload

The platform for analytical solutions (SaaS)

Azure Monitor

Security Products

IoT

Gamin g

Available as PaaS

#PoweredByADX

Common Use Cases

Time Series, Logs, Events, Transactions Data analytics platform

- Consolidate and correlate your logs and events data across on-prem, cloud, 3rd party
- Replace legacy log search solutions - save cost, infra, and index management overhead
- Accelerate your AI Ops journey (pattern recognition, anomaly detection, forecasting, etc.)
- IoT Analytics on Time Series and Telemetry data
- Replace HBase and Time Series databases

Build Analytical SaaS Solutions

- Build multi-tenant or single-tenant SaaS analytics solution for Time Series, Logs, Events, Transactions, and security data

Analytic sandboxes

- Short term ad hoc exploratory analysis

Geospatial Use Cases

Public sector

- Calculate the impact of natural disasters
- Geofencing – raise alarms if individuals leave or enter a certain area
- Crime prediction

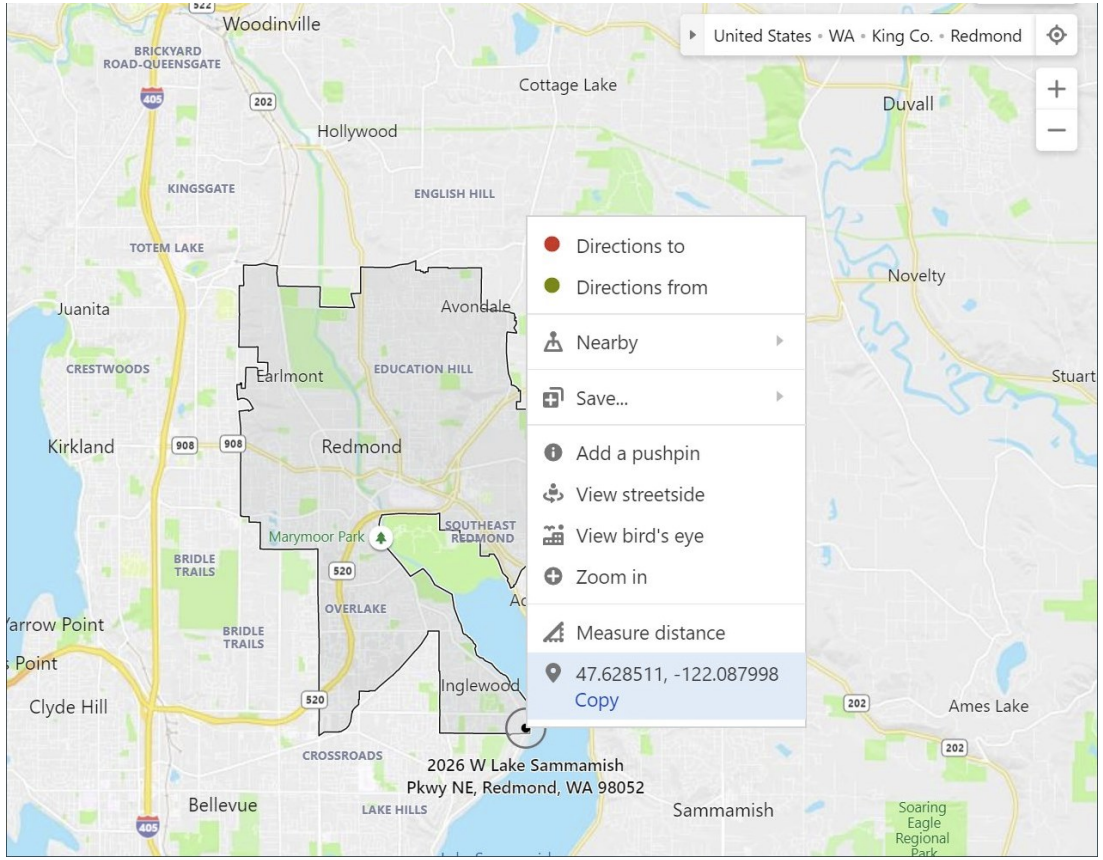
Logistics & Transportation

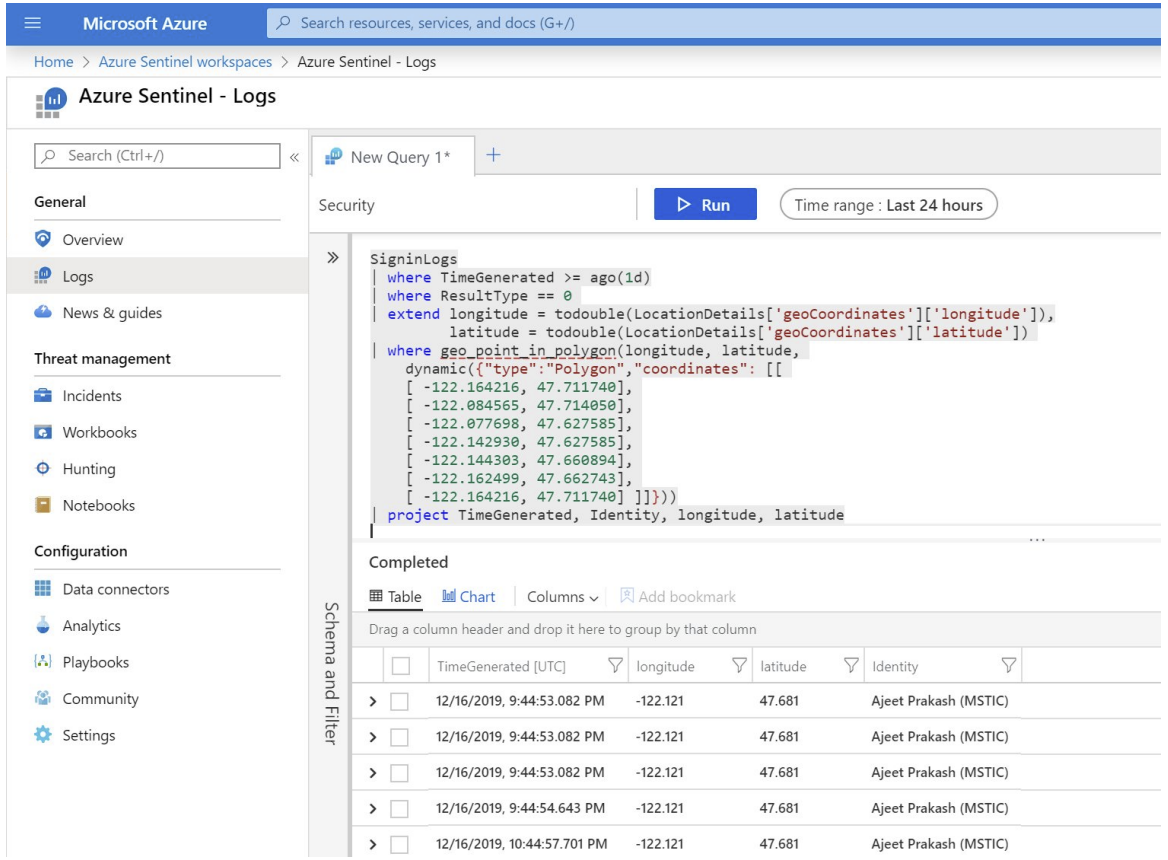
- Add the geo-clustering secret sauce to timeseries analytics to create better predictions for the supply chain
- Predict road segments (line strings) conditions as a base component for autonomous driving
- Raise events if a vehicle is not on its route (automotive)

Financial sector

- Tracking changes to real estate development over time
- Analyze demographic data in conjunction with geographical regions

Customer cases – Azure Sentinel





https://gist.github.com/JohnLaTwC/cadc94bb8c9bd3d67dc3db56bfc829ae
https://twitter.com/JohnLaTwC/status/1206787684678524928

Basic functions – geo_distance_2points()

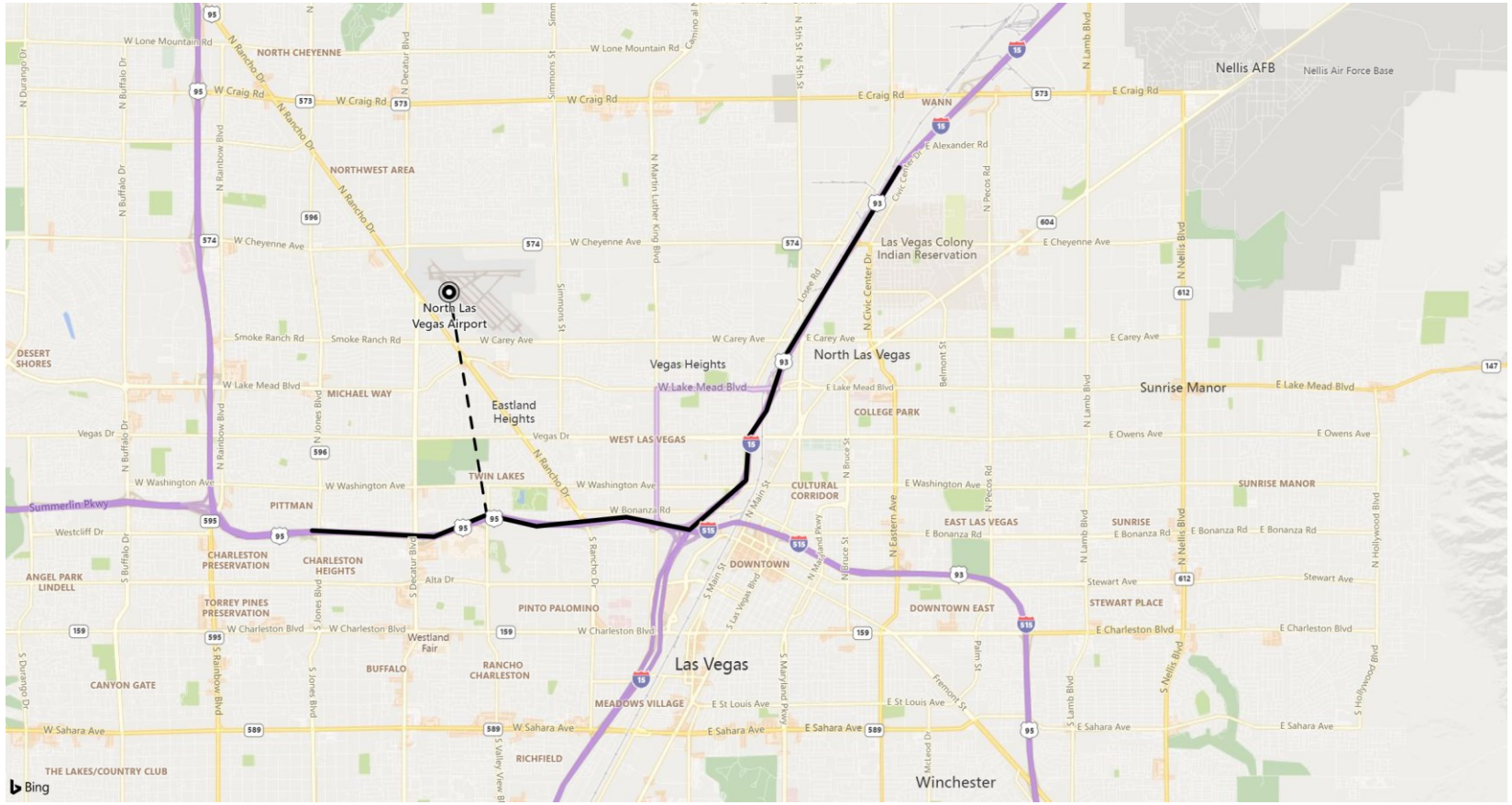
- Calculates distance between 2 coordinates on earth
- Earth is approximated as a perfect sphere and the coordinates should be in WGS-84
- The calculation is done using the Haversine formula

- Example: distance from Stuttgart to Munich in km:


```
let stuttgart = dynamic({"longitude":9.182552, "latitude":48.771449});
let munich = dynamic({"longitude":11.582676, "latitude":48.130847});
print strcat(toint(geo_distance_2points(
  todouble(stuttgart.longitude), todouble(stuttgart.latitude),
  todouble(munich.longitude), todouble(munich.latitude)) / 1000), ' km')
```

Basic functions – geo_distance_point_to_line()

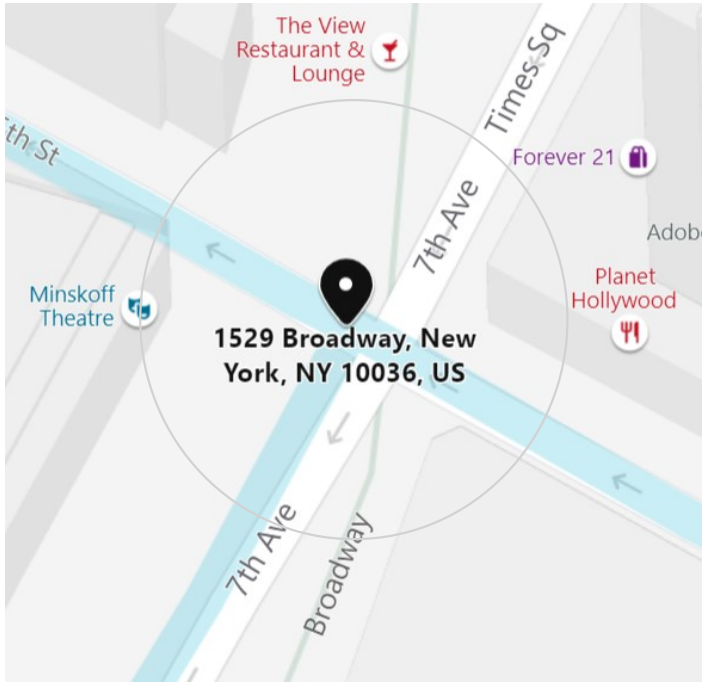
- Calculates the shortest distance between a coordinate and a line on Earth.
- Example: shortest distance between North Las Vegas Airport and nearby road:




```
print distance_in_meters = geo_distance_point_to_line(-115.199625, 36.210419,
dynamic({ "type":"LineString","coordinates":[[lon, lat]]}))
```

Basic functions – geo_point_in_circle()

- Use it for Nearby, Proximity queries
- Earth is approximated as a perfect sphere and the coordinates should be in WGS-84
- Circle is a spherical cap on earth
- The radius of the cap is measured along the surface of the sphere



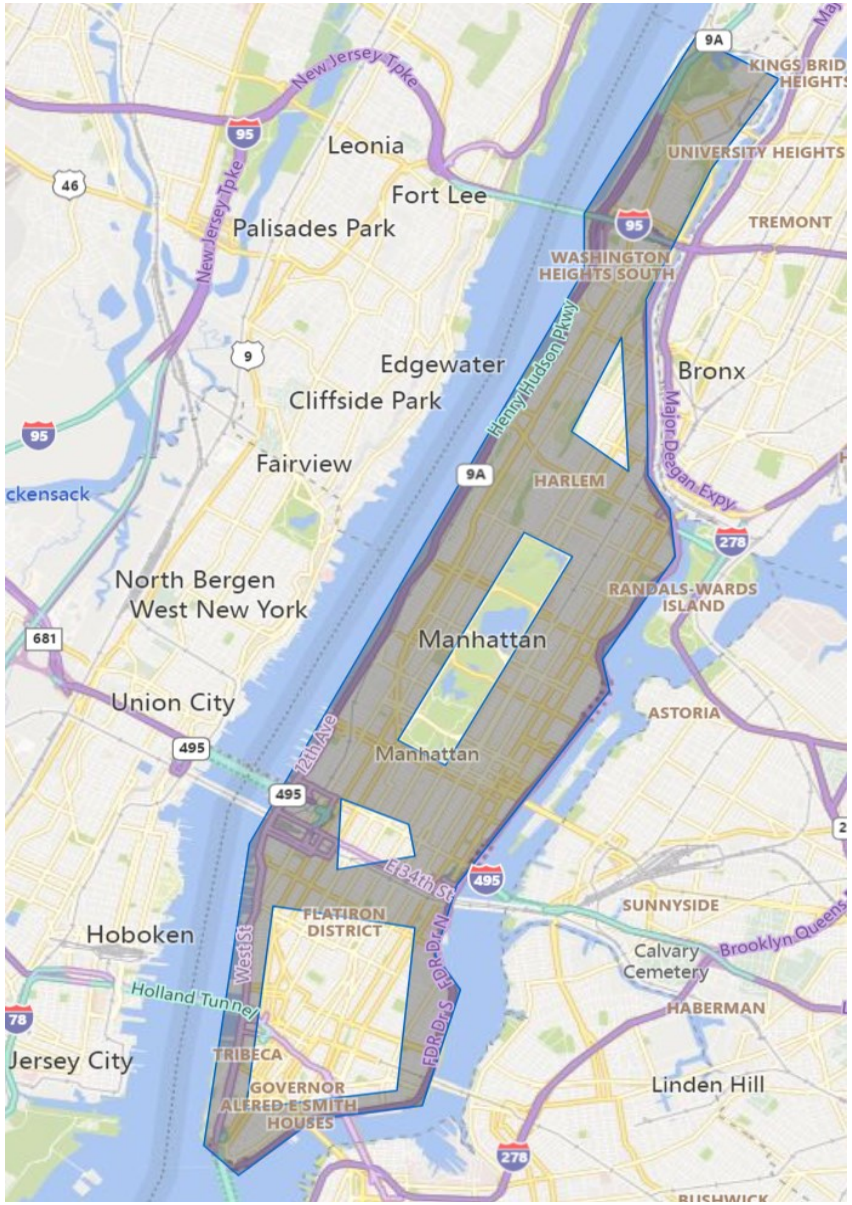
- Example: Find all New York Taxi pick-ups near Times Square, within 50 meters:

```
let times_square = dynamic({"longitude":-73.985552, "latitude":40.757960});
Trips
| where geo_point_in_circle(pickup_longitude, pickup_latitude,
  todouble(times_square.longitude), todouble(times_square.latitude), 50) > 0
```

Basic functions – geo_point_in_polygon()

- Use it for coordinates containment test within a complex shape

```
print in_polygon =
  geo_point_in_polygon(-73, 40,
  dynamic({"type": "Polygon",
    "coordinates": [[[0,0],[10,10],[10,1],[0,0]]]}))
```



Geospatial clustering

Extend with a cluster

Summarize

Get centroid

Visualize

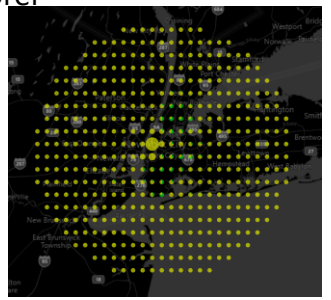
```
Weather
| where …
```

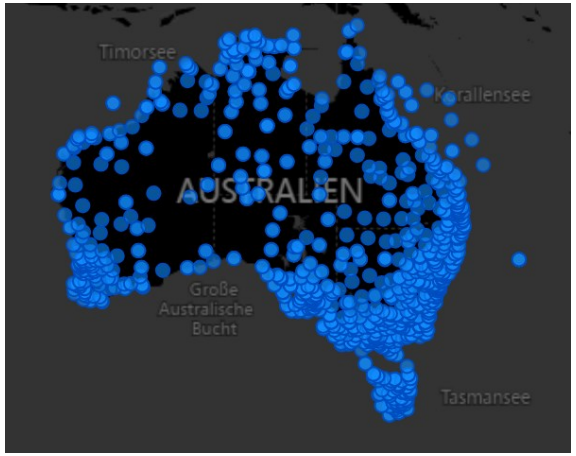
```
| extend
    cluster = …
```

```
| summarize
    count() by
    cluster
```

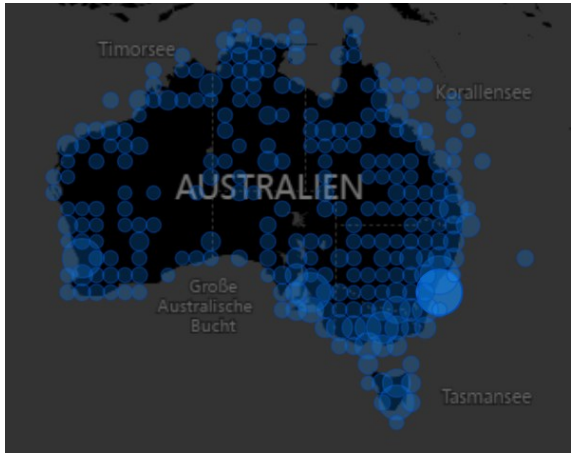
```
| extend
    centroid = …
```

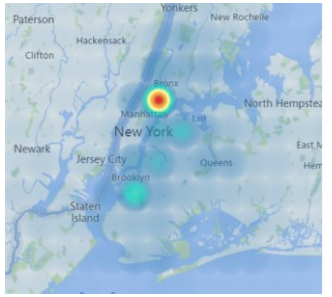
- PowerBI
- Kusto Explorer
- …





clustering





All visuals have been implemented using the map visualization in PowerBI

Geospatial clustering – Geohash vs S2 cells

Geohash

- **18** accuracy levels
- Rectangular area on a **plane** surface
- **Common prefix** of Geohashes indicate on **proximity**

S2 Cell

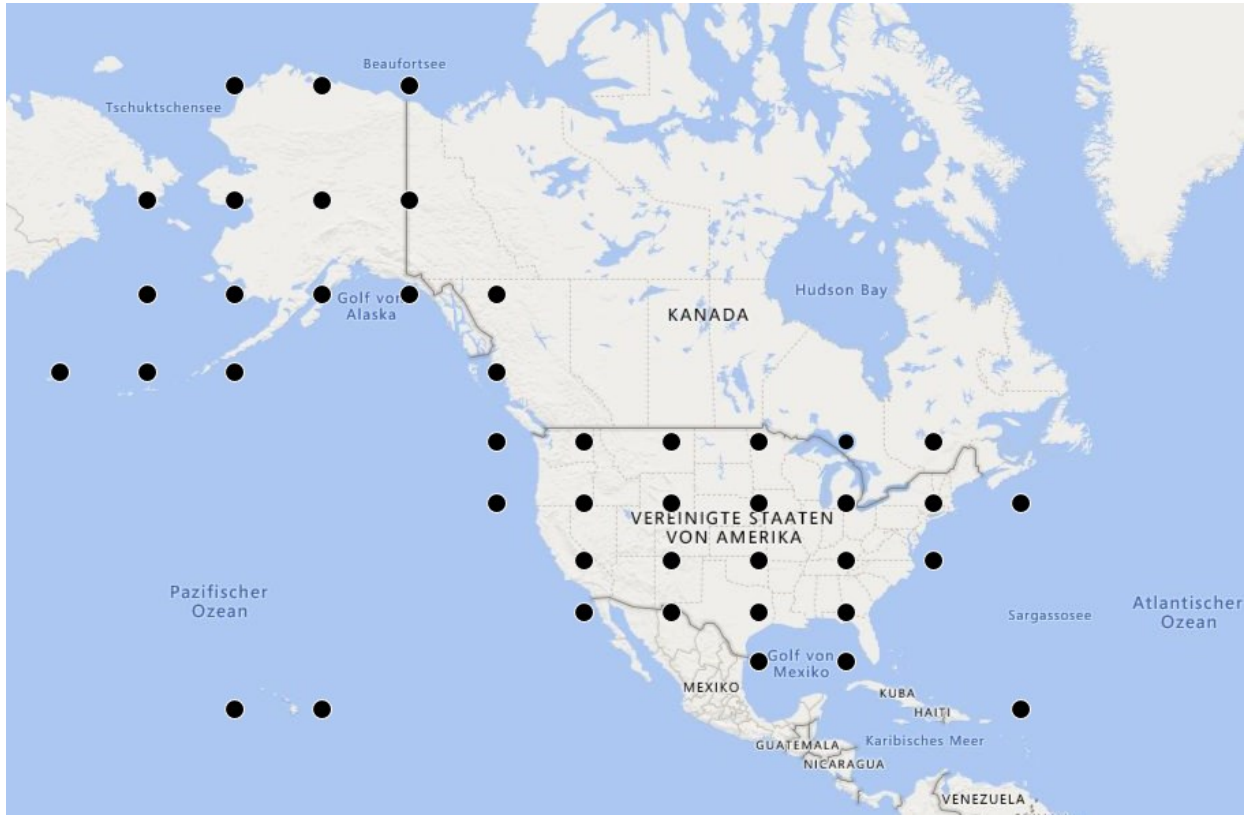
- **31** levels of hierarchy
- Cell on a **sphere** surface and its edges are geodesics
- Good **preserveness** of the **cell center** during level increase

https://en.wikipedia.org/wiki/Geohash

http://s2geometry.io/devguide/s2cell_hierarchy

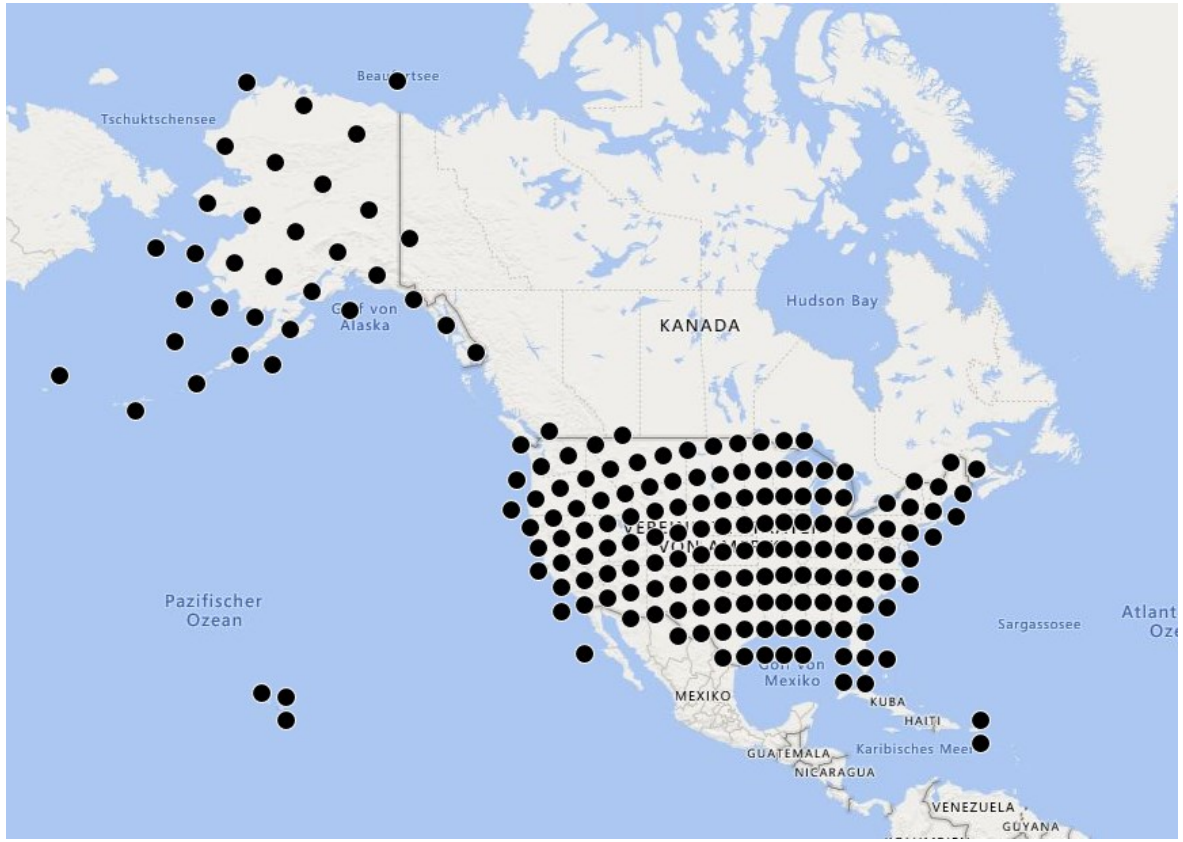
Geospatial – clustered by geohash

```
GeospatialDemoData()
| extend geohash = geo_point_to_geohash(lng, lat, 2)
| summarize count() by geohash
| extend point = geo_geohash_to_central_point(geohash)
| project-reorder point, count_
```



Geospatial – clustered by s2 cells

```
GeospatialDemoData()
| extend s2cell = geo_point_to_s2cell(lng, lat, 5)
| summarize count() by s2cell
| extend point = geo_s2cell_to_central_point(s2cell)
| project-reorder point, count_
```



Geo-clustering – geo_point_to_geohash()

- Calculates the Geohash string value for a geographic location
- Use it to find points in proximity to each other, based on a common prefix
- Up to level 18

```
print geohash = geo_point_to_geohash
  (-80.195829, 25.802215, 8)
```

geohash
dhwfz15h

Accuracy	Width	Height
1	5000 km	5000 km
2	1250 km	625 km
3	156.25 km	156.25 km
4	39.06 km	19.53 km
5	4.88 km	4.88 km
6	1.22 km	0.61 km
7	152.59 m	152.59 m
8	38.15 m	19.07 m
9	4.77 m	4.77 m
10	1.19 m	0.59 m
11	149.01 mm	149.01 mm
12	37.25 mm	18.63 mm
13	4.66 mm	4.66 mm
14	1.16 mm	0.58 mm
15	145.52 µ	145.52 µ
16	36.28 µ	18.19 µ
17	4.55 µ	4.55 µ
18	1.14 µ	0.57 µ

Geo-clustering – geo_geohash_to_central_point()

- Use it to retrieve coordinates of the center of Geohash rectangular area
- Needed for visualization tools to draw a point on a map

```
print point = geo_geohash_to_central_point("sunny")
| extend coordinates = point.coordinates
| extend longitude = coordinates[0]
| extend latitude = coordinates[1]
```

point	coordinates	longitude	latitude

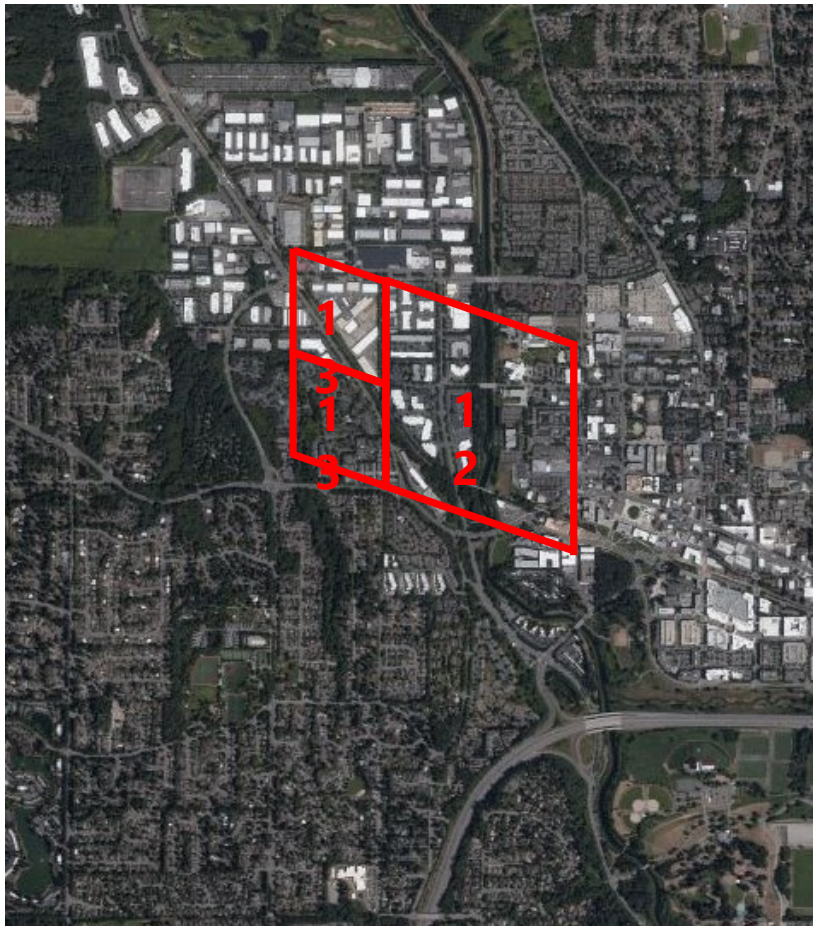
{
"type": "Point",
"coordinates": [
42.47314453125,
23.70849609375
]
}
	[
	42.47314453125,
	23.70849609375
	]
		42,47314453125	23,70849609375

Geo clustering – geo_point_to_s2cell()

- Calculates the S2 cell token string value for a geographic location.
- Up to level 31

```
print s2token = geo_point_to_s2cell
  (-80.195829, 25.802215, 5)
```

s2token
88dc



S2 Cell area coverage per level value:

Level	Min area	Max area	Average area	Units
0	85011012.19	85011012.19	85011012.19	km²
1	21252753.05	21252753.05	21252753.05	km²
2	4919708.23	6026521.16	5313188.26	km²
3	1055377.48	1646455.5	1328297.07	km²
4	231564.06	413918.15	332074.27	km²

Geo-clustering – geo_s2cell_to_central_point()

- Calculates the geospatial coordinates that represent the center of S2 cell.
- Needed for visualization tools to draw a point on a map

```
print point = geo_s2cell_to_central_point("88dc")
| extend coordinates = point.coordinates
| extend longitude = coordinates[0]
| extend latitude = coordinates[1]
```

point	coordinates	longitude	latitude

{
"type": "Point",
"coordinates": [
-80.810094787025363,
26.873943041714885
]
}
	[
	-80.810094787025363,
	26.873943041714885
	]
		-80,8100947870254	26,8739430417149

Thank you!