Azure Data Lake Introduction

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Why Data Lake?

Why Data Warehouse is failing today?

Once upon a time ☺

Total Capacity – 1.44 MB

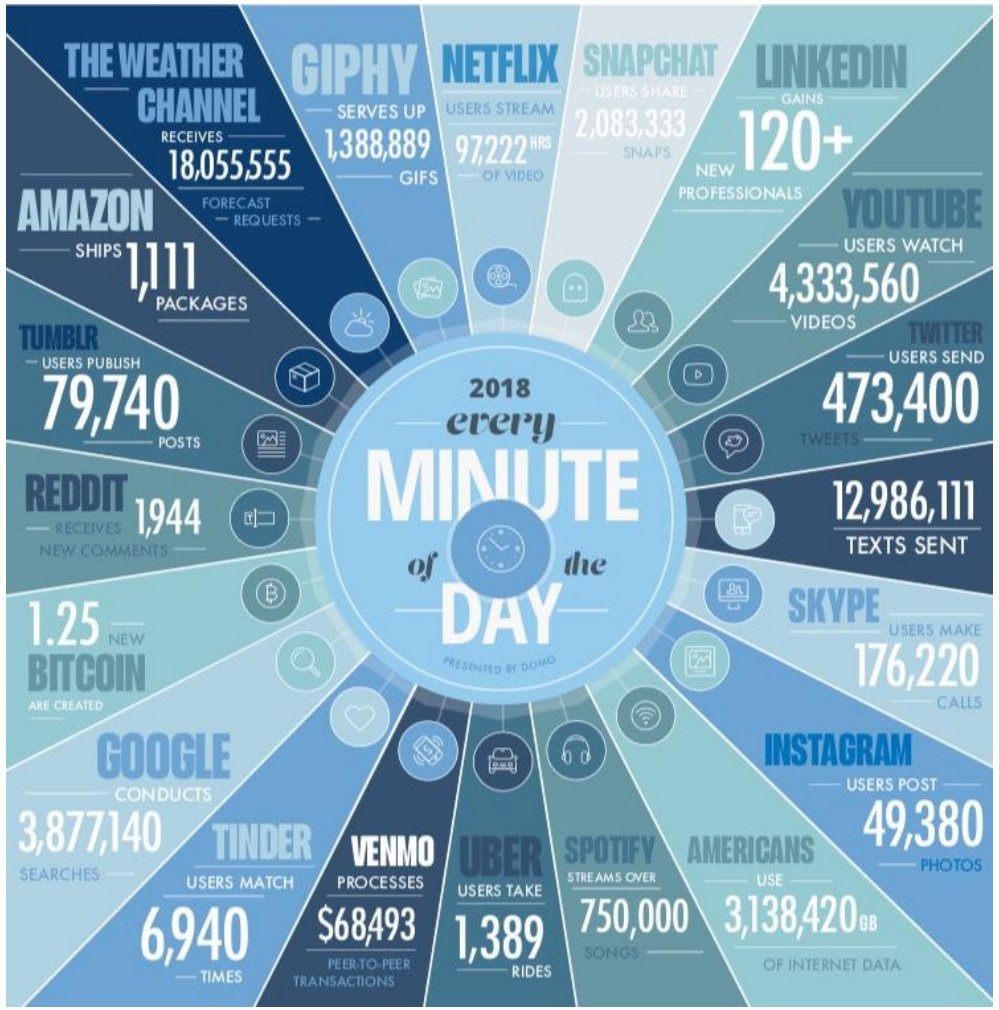
1990

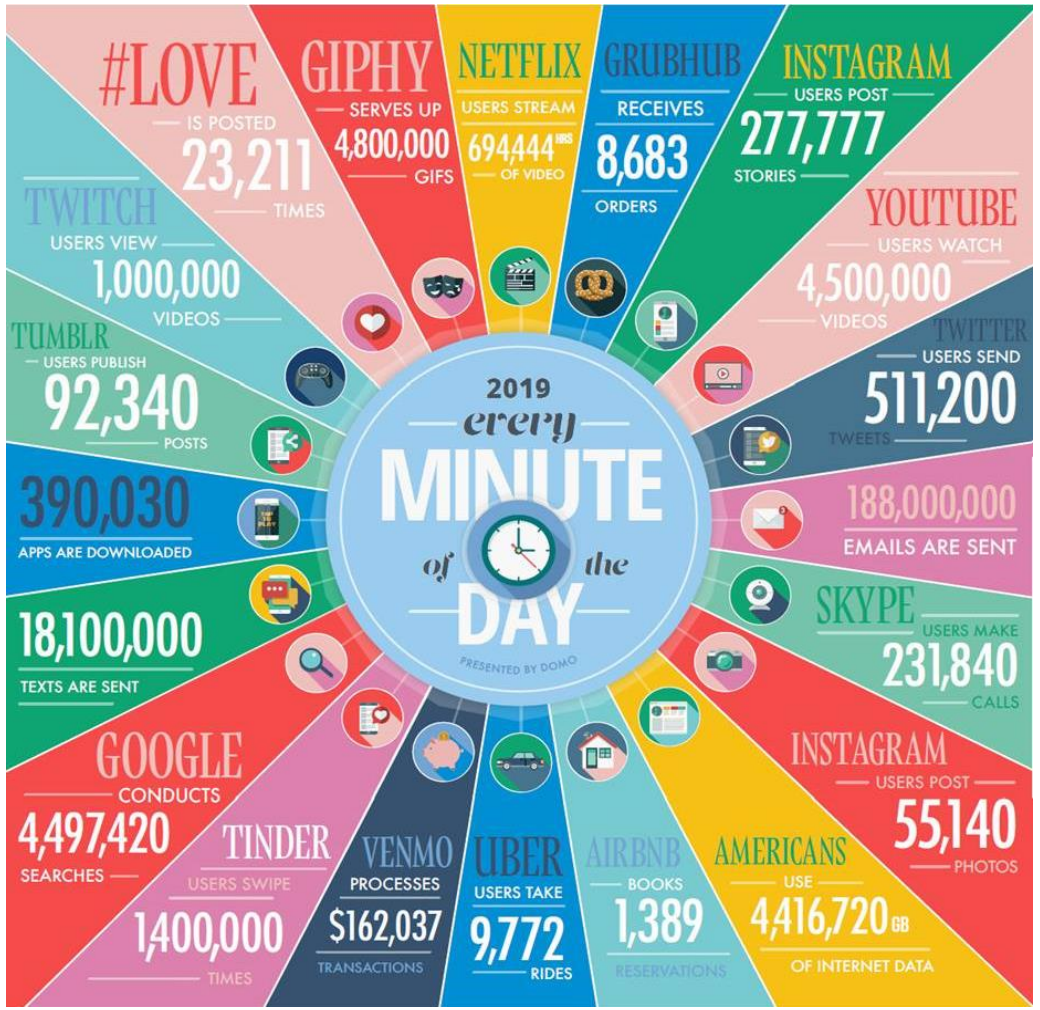
By 2020, it's estimated that 1.7MB of data will be created every second for every person on earth."

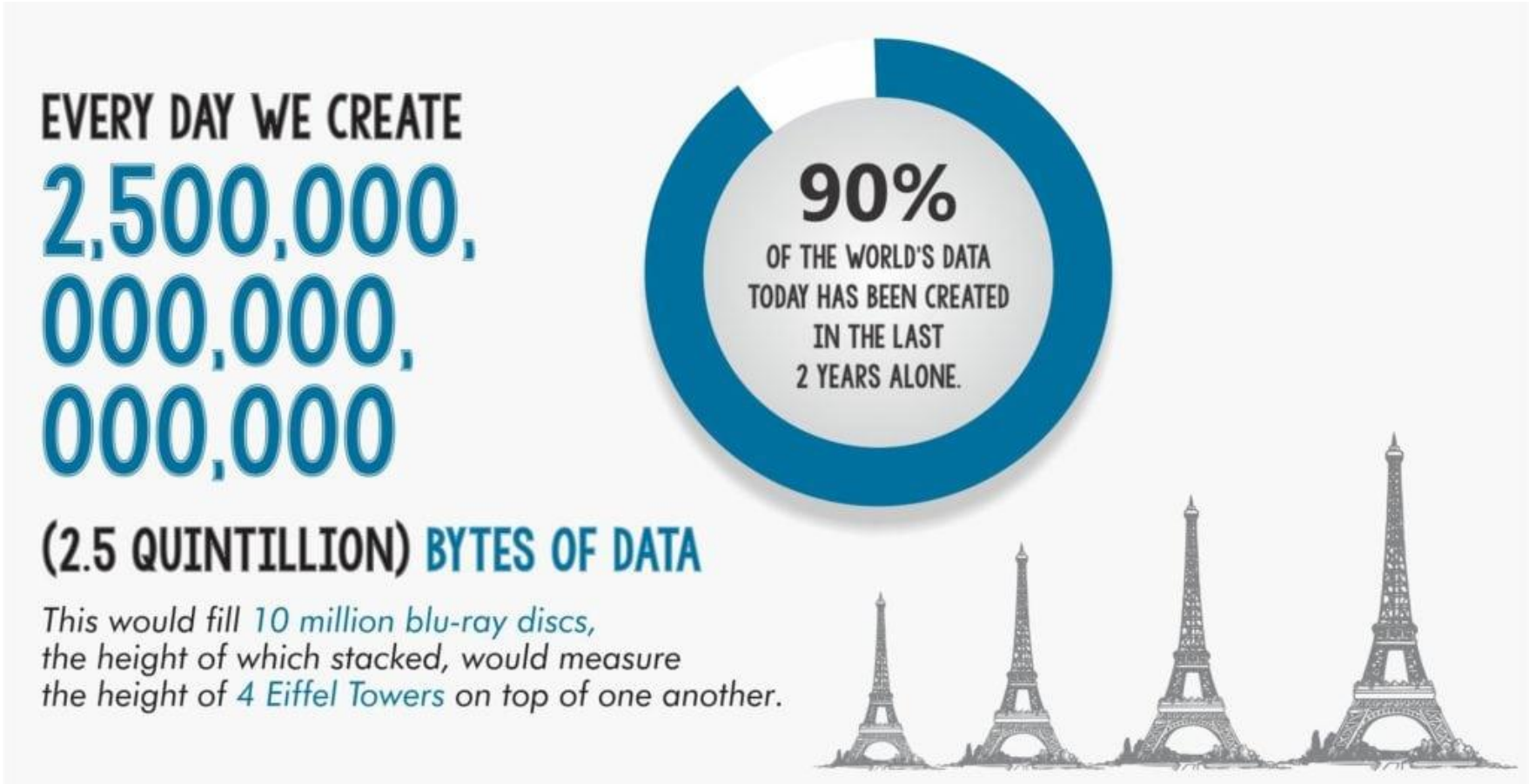
— *Domo report (6th edition)*

2020

How much data is generated every min?







1 Quintillion = 1 million terabyte

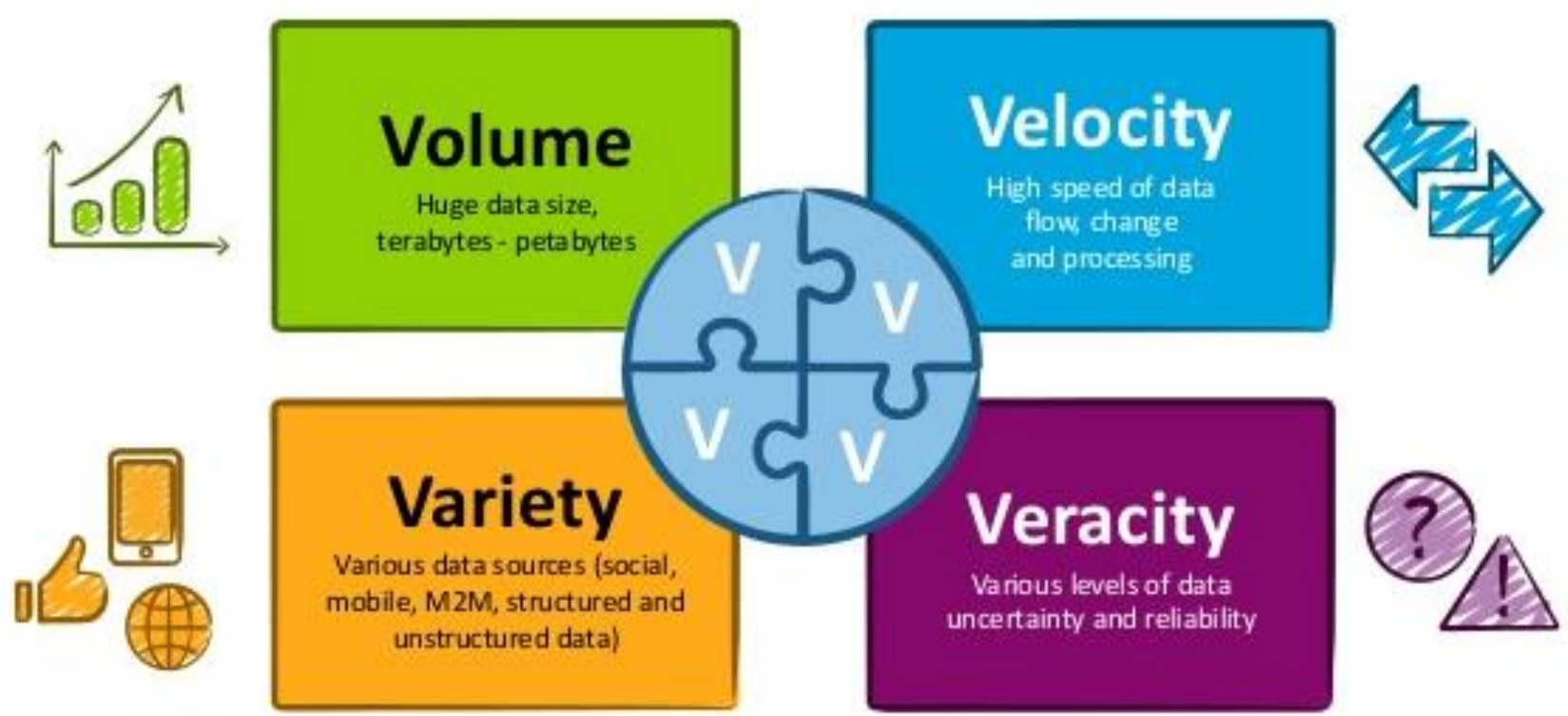
Data is new oil

We need to find it, extract it, refine it, distribute it and monetize it

– David Buckinham, Big data expert

Problem statement

- Need a solution which can handle below 4 V's of data.



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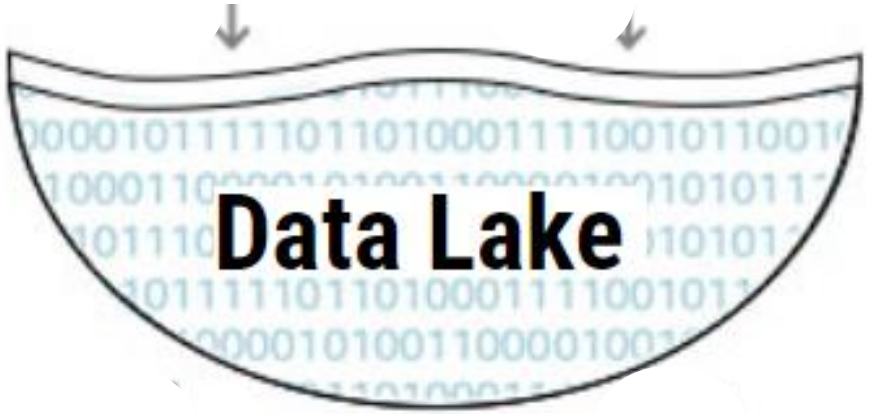
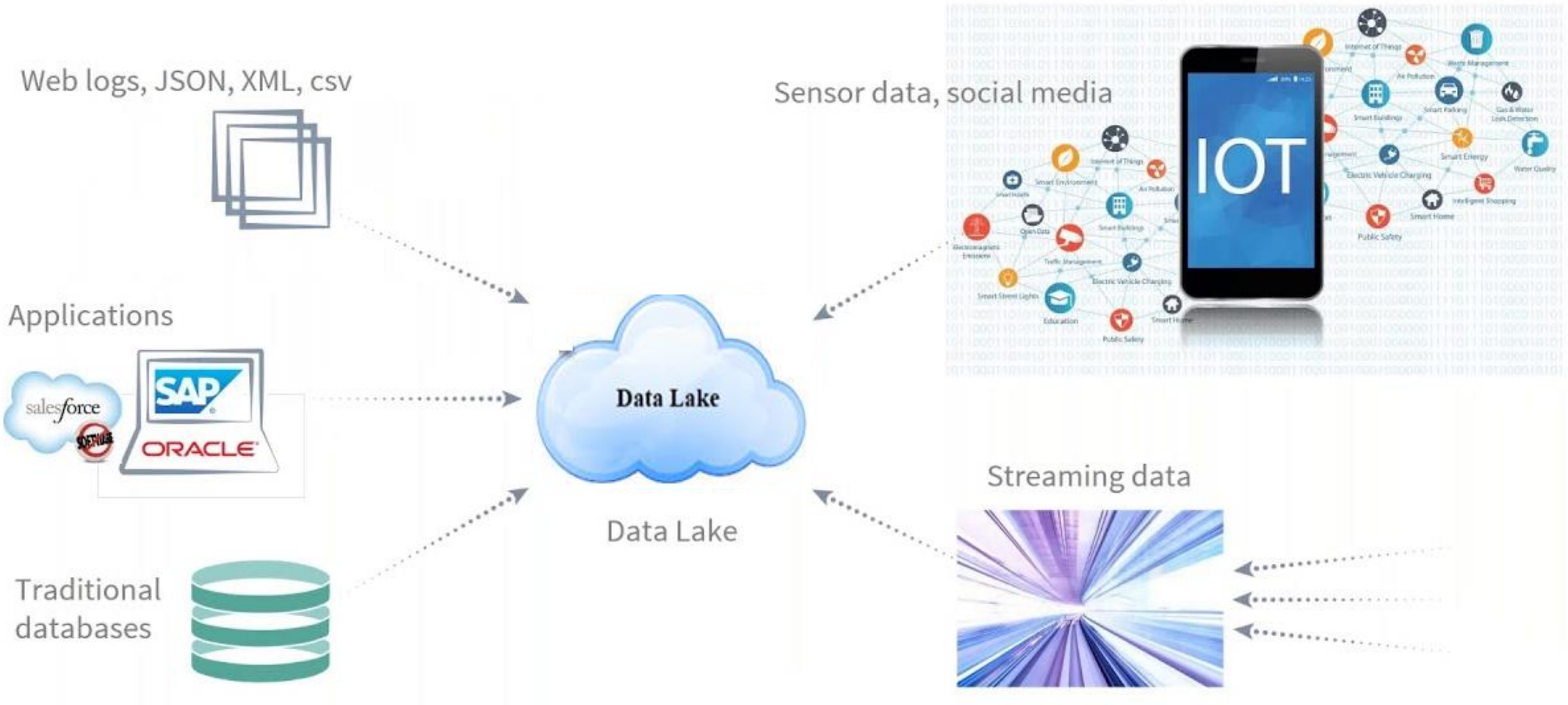


Data Lake is a big container to store data.

Data Lake Sources



What is Data Lake?

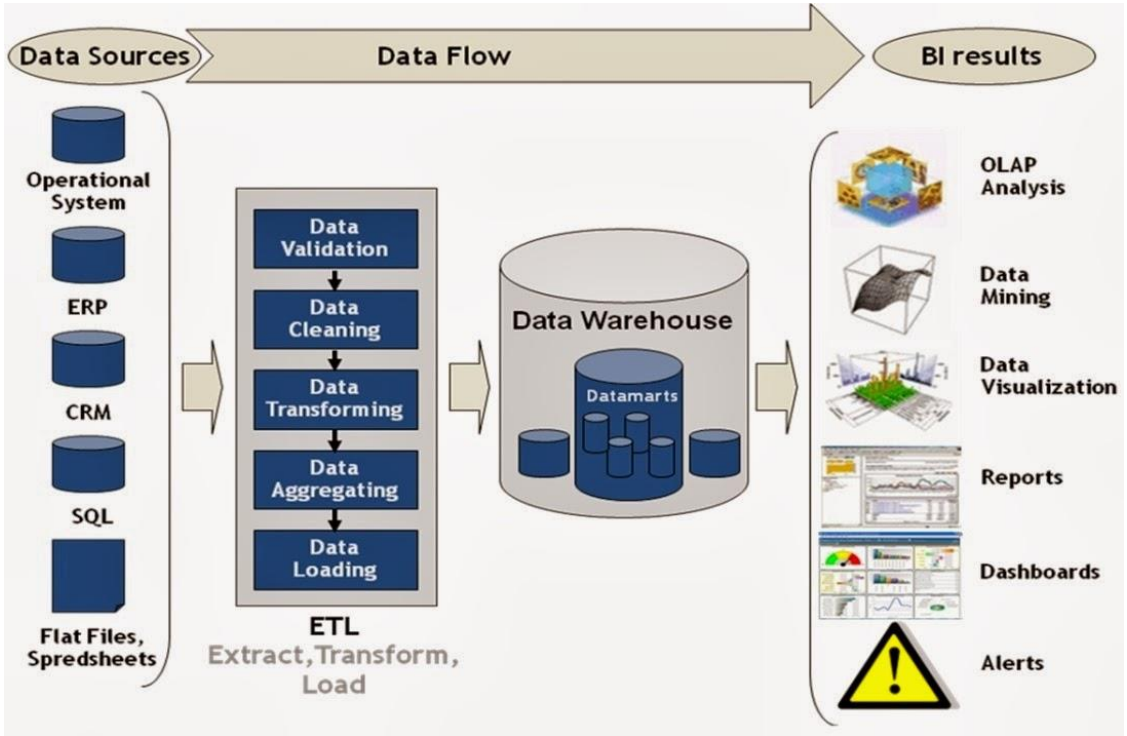
"If you think of a DataMart as a store of bottled water – clean and packaged and structured for easy consumption – the data lake is a large body of water in a more natural state. The contents of the data lake stream in from a source to fill the lake, and various users of the lake can come to examine, dive in, or take samples."

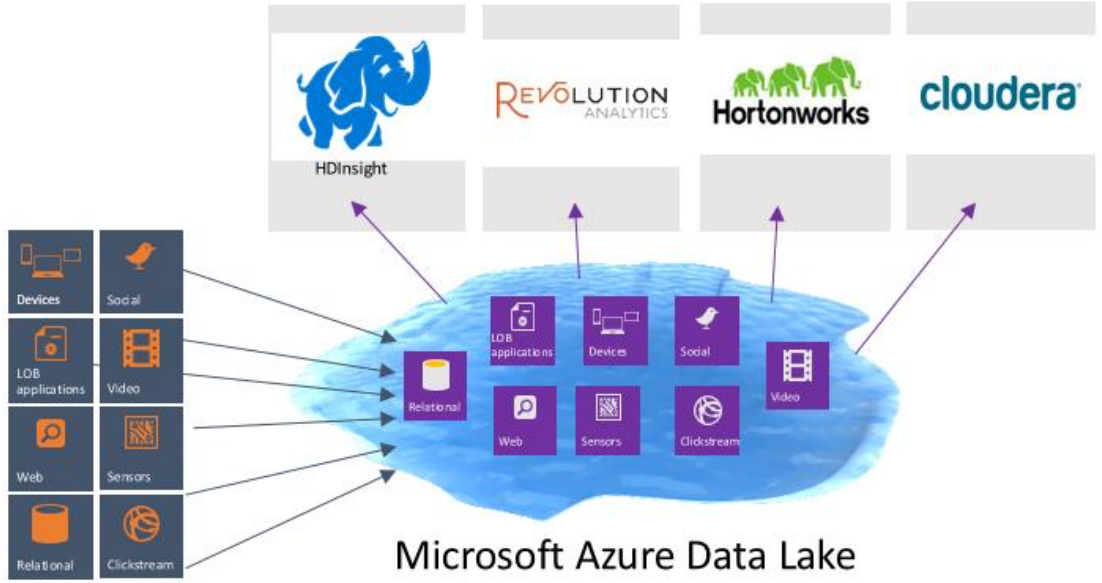
James Dixon
CTO, Pentaho

Data Warehouse

Data Lake

Data Warehouse vs Data Lake





Data Warehouse

Data Lake

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Warehouse vs. Data Lakes

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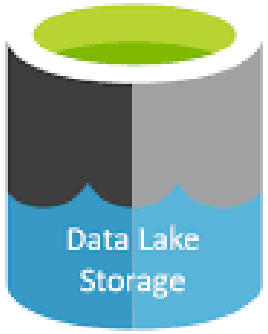
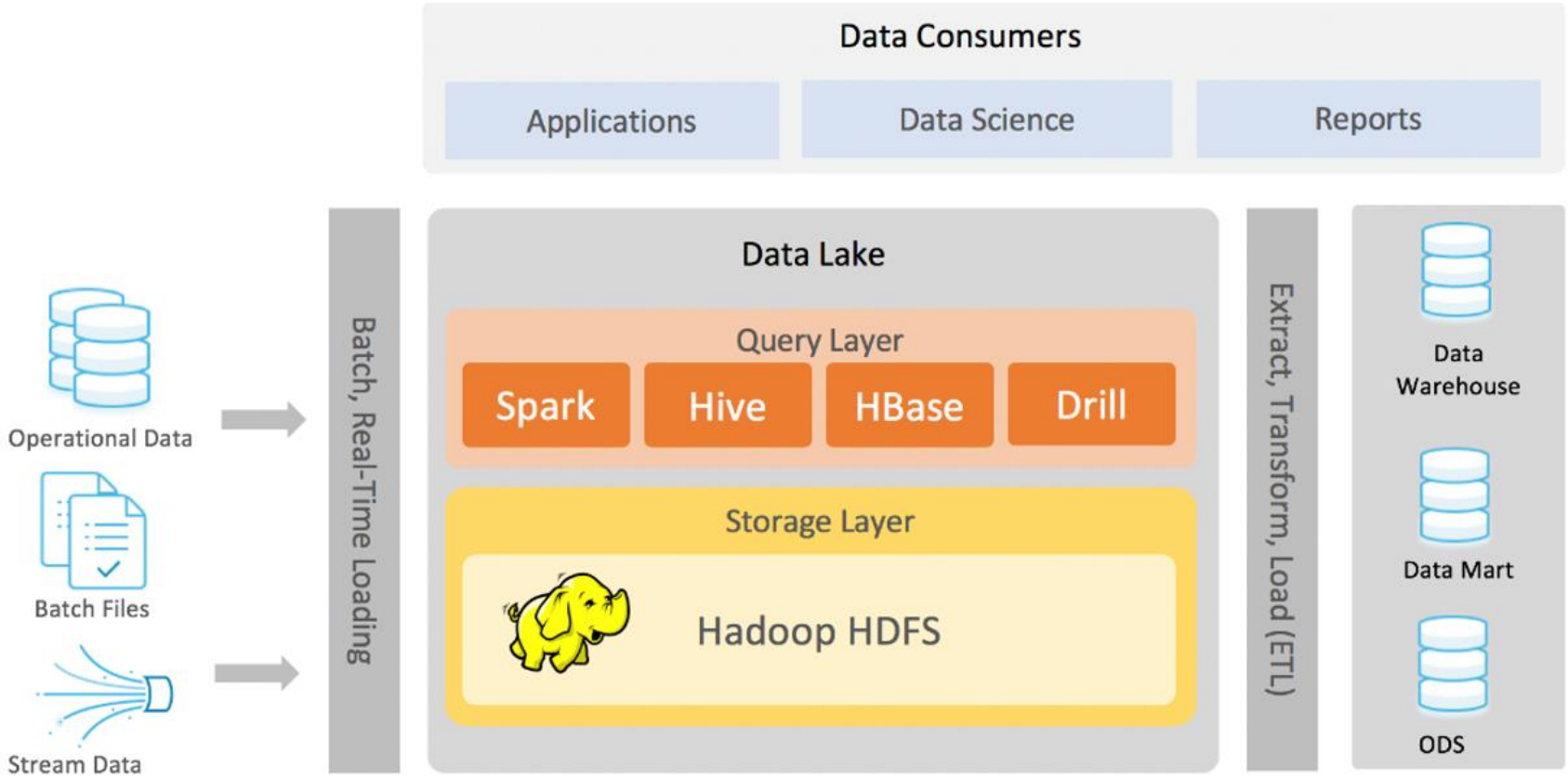
Data lake vs Hadoop

VS



Data lake vs Hadoop



Data Lake can use: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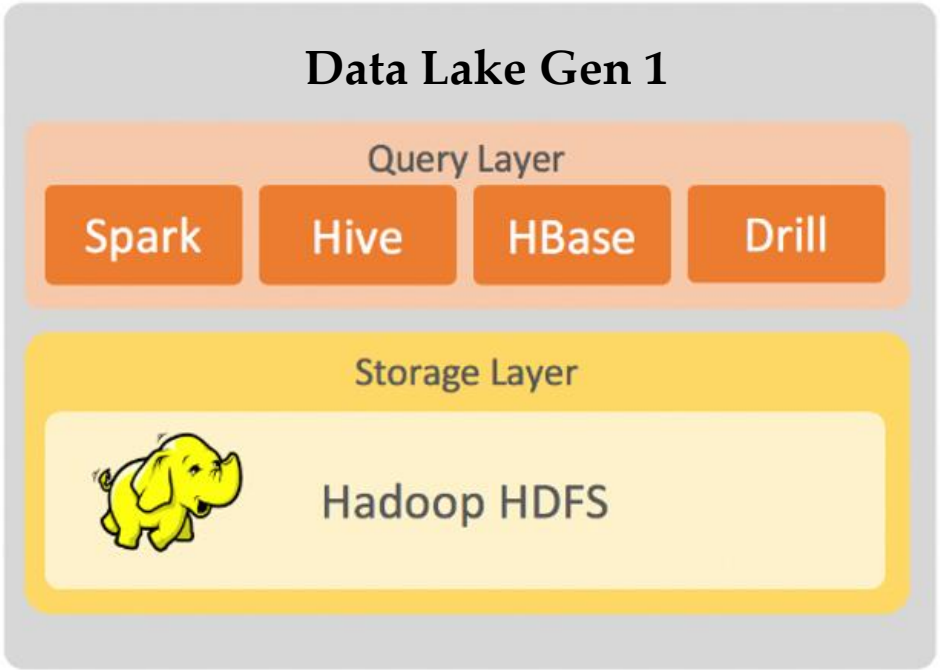
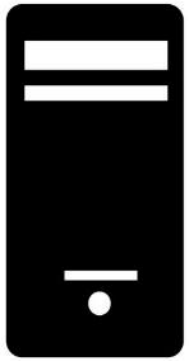
Azure Data Lake Gen1 evolution

- Fault tolerant file system
- Runs on commodity hardware
- MapReduce, Pig, Hive, Spark etc.
- HDFS in Cloud -> Data Lake Storage Gen1



Cloud storage challenge



Processing

- Easy to optimize processing by increasing vCPU and Ram

Storage

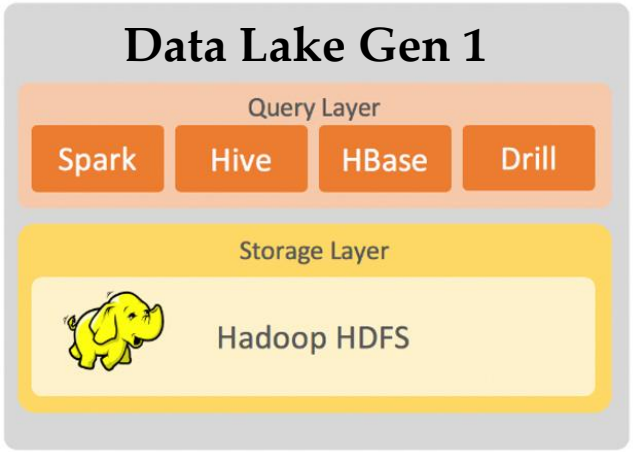
- Different requirements
- No direct solution

Azure Blob Storage

- Large object storage in cloud
- Optimized for storing massive amounts of unstructured data
  - Text or Binary Data
- General purpose object storage
- Cost efficient
- Provide multiple Tiers

Azure Data lake Gen 2

Blob Storage



Azure Data Lake Storage Gen2

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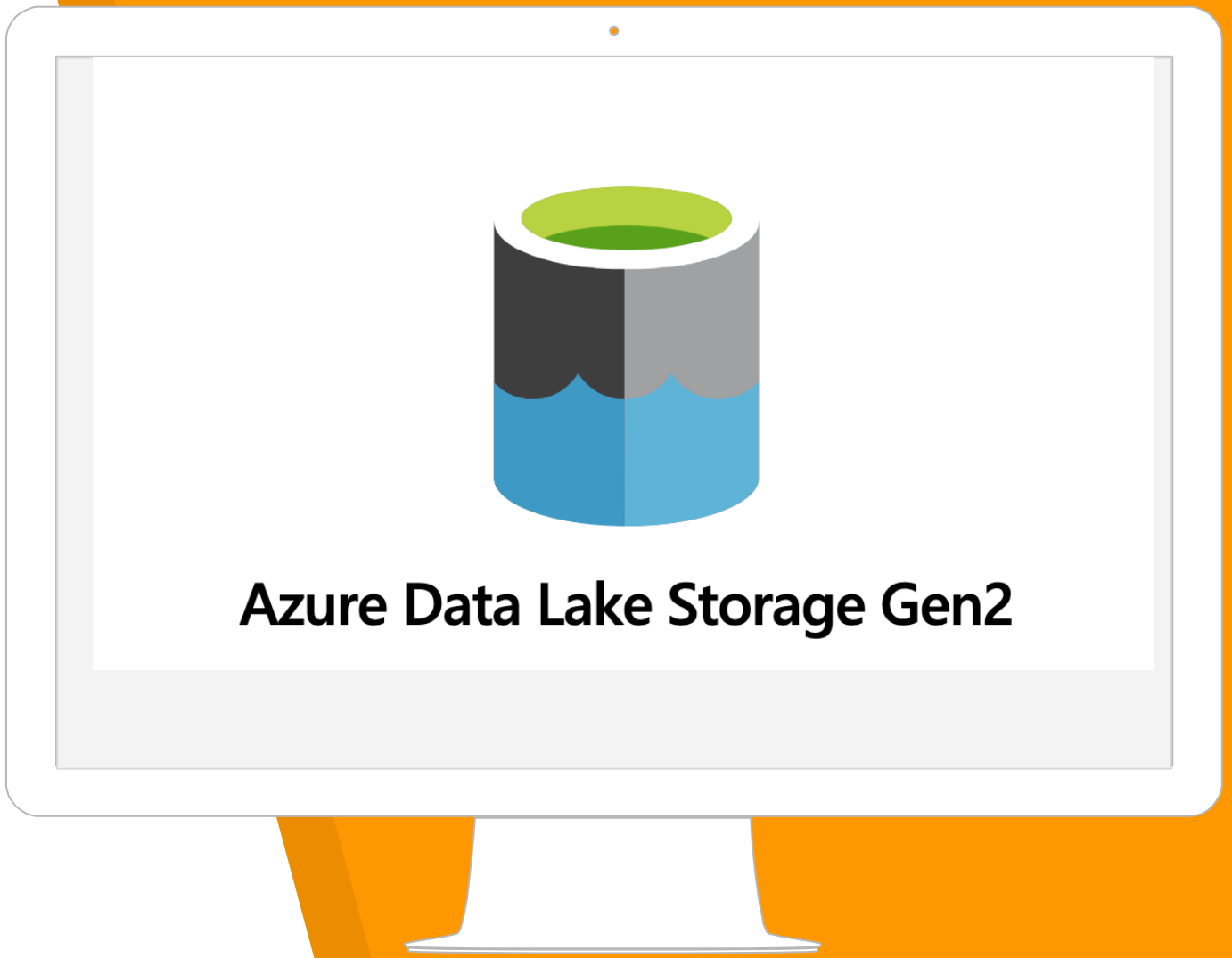
MICRSOFT RECOMMENDS

Data Lake Storage Gen2 for your big data storage needs.

Note: USQL currently not supported in Gen 2



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Blob Storage vs Data Lake Storage

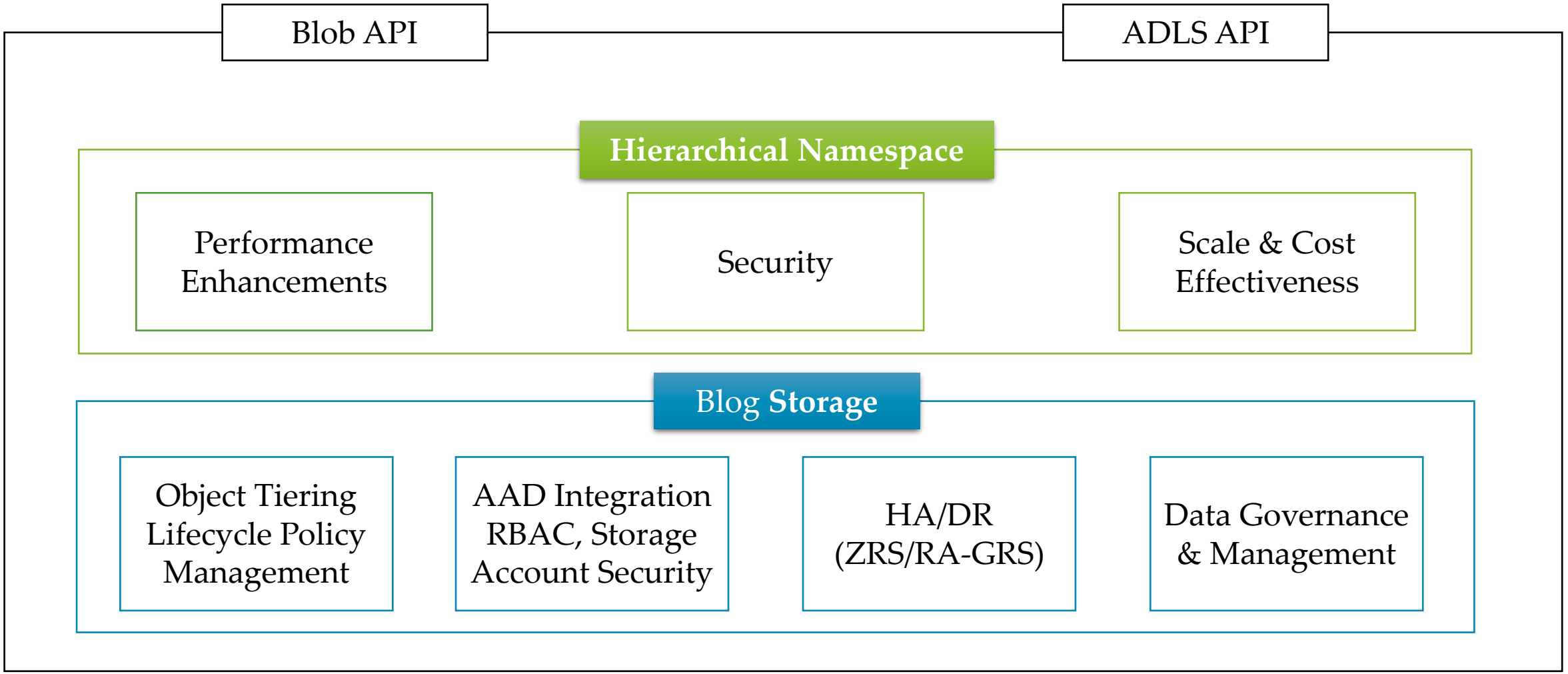
Azure Blob Storage

- General purpose data storage
- Container based object storage
- Available in every Azure region
- Local and global redundancy
- Processing performance limit

Azure Data Lake Storage (Gen 2)

- Optimized for big data analytics
- Hierarchical namespace on Blob Storage
- Available in every Azure region
- Local and global redundancy
- Supports a subset of Blob storage features
- Supports multiple Azure integrations
- Compatible with Hadoop

Data Lake Architecture



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https://expertslab.wordpress.com/2017/11/04/azure-storage-replication-options/

https://www.red-gate.com/simple-talk/cloud/cloud-data/understanding-azure-storage-options/

https://www.skylinesacademy.com/blog/2019/7/31/azure-storage-replication

Data redundancy for storage

LRS – Locally-redundant storage: Three copies of your data which is maintained within the same primary data center.

ZRS- Zone-redundant storage: Three copies of your data replicated synchronously to 3 Azure availability zones in a primary region. Zones are in different physical locations or different data centers.

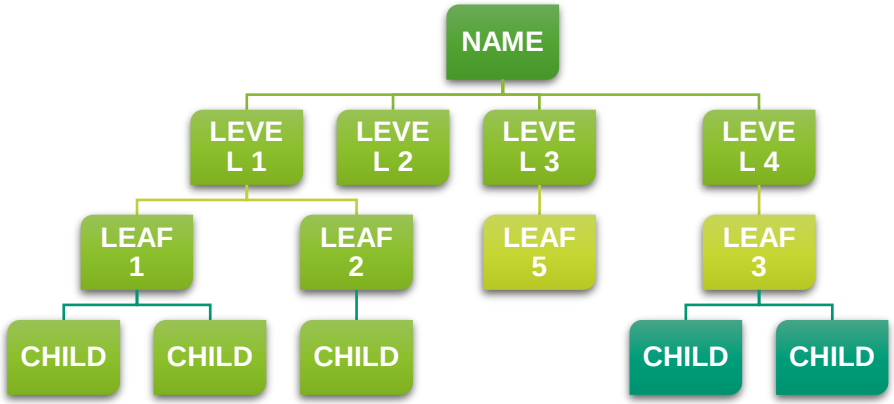
GRS- Geo-redundant storage: This allows your data to be stored in different geographic areas of the country or world. Again, you get three copies of the data within a primary region, but it goes one step further and places three additional asynchronous copies in another region. For example, you can now have a copy in Virginia and in California to protect your data from fires or hurricanes depending on the coast.

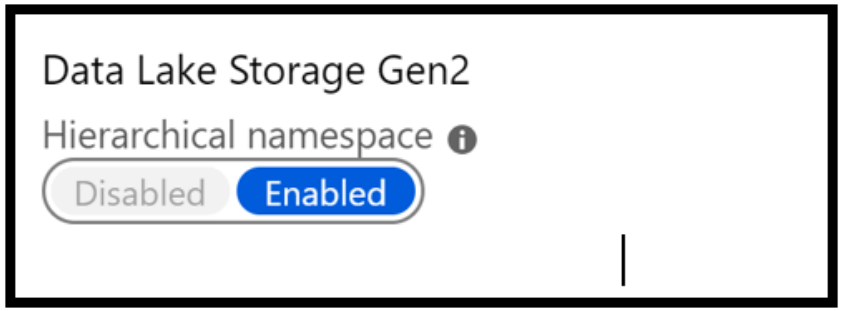
RA-GRS- Read Access Geo-redundant storage. This is GRS but adds a read-only element that allows you to have read access for things like reporting.

Geo-zone-redundant storage (GZRS): Copy your data synchronously over three primary region Azure availability zones using ZRS. It then asynchronously copies your data to a single physical location within the secondary region.

Read-access geo-zone-redundant storage (RA-GZRS): it adds a layer of readability to your secondaries.

Hierarchical namespace

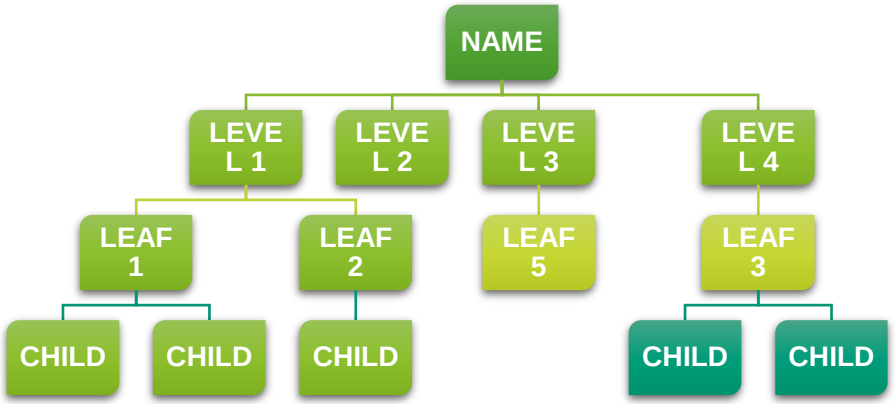


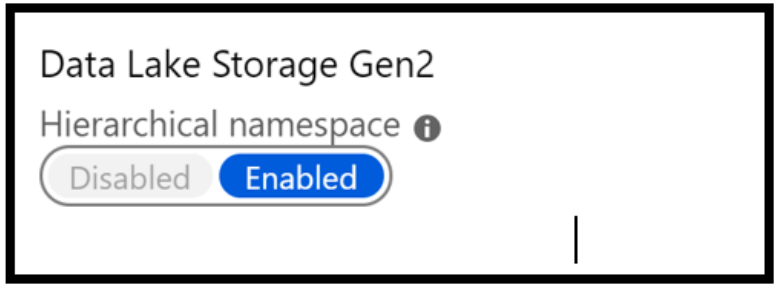


- Hierarchical namespace organizes objects/files into a hierarchy of directories for efficient data access.
- Blob storage is not hierarchical namespace
  - Use slashes in Blob storage file names to stimulate a tree like directory structure
- Blob can't integrate with Hadoop
  - Because Blob doesn't have hierarchical namespace

Hierarchical namespace

- Atomic directory manipulation
  - Manageable
  - Performance
  - Cost
  - Familiar interface style
- Why it was not done before in Blob?
  - Blob – limit scale
  - Lake Gen2 scale linearly so it does not degrade capacity or performance
- When you do not want to use Hierarchical namespace?
  - Where object organization stored separately
  - E.g.: Backups, image storage, etc.
- Note: Hierarchical namespace setting can't revert back





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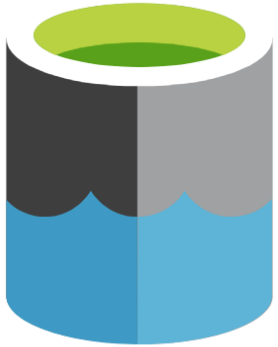
Important features of Data Lake Gen2

- Integration
  - POSIX complaint
  - Hadoop Integration (use ABFS driver)
  - Other Azure services integration
- Scalability
- Cost effective
  - Build on top of Azure low cost blob storage
  - No need to move data
  - Hierarchical namespace -> less compute -> save cost
- Performance – optimized for high speed throughput
- Security
- Fault tolerant/ High availability/ Disaster recovery
- Global footprint
- Challenges
  - Hard to query unstructured data
  - Hard to manage data quality



Azure Data Lake Storage Gen2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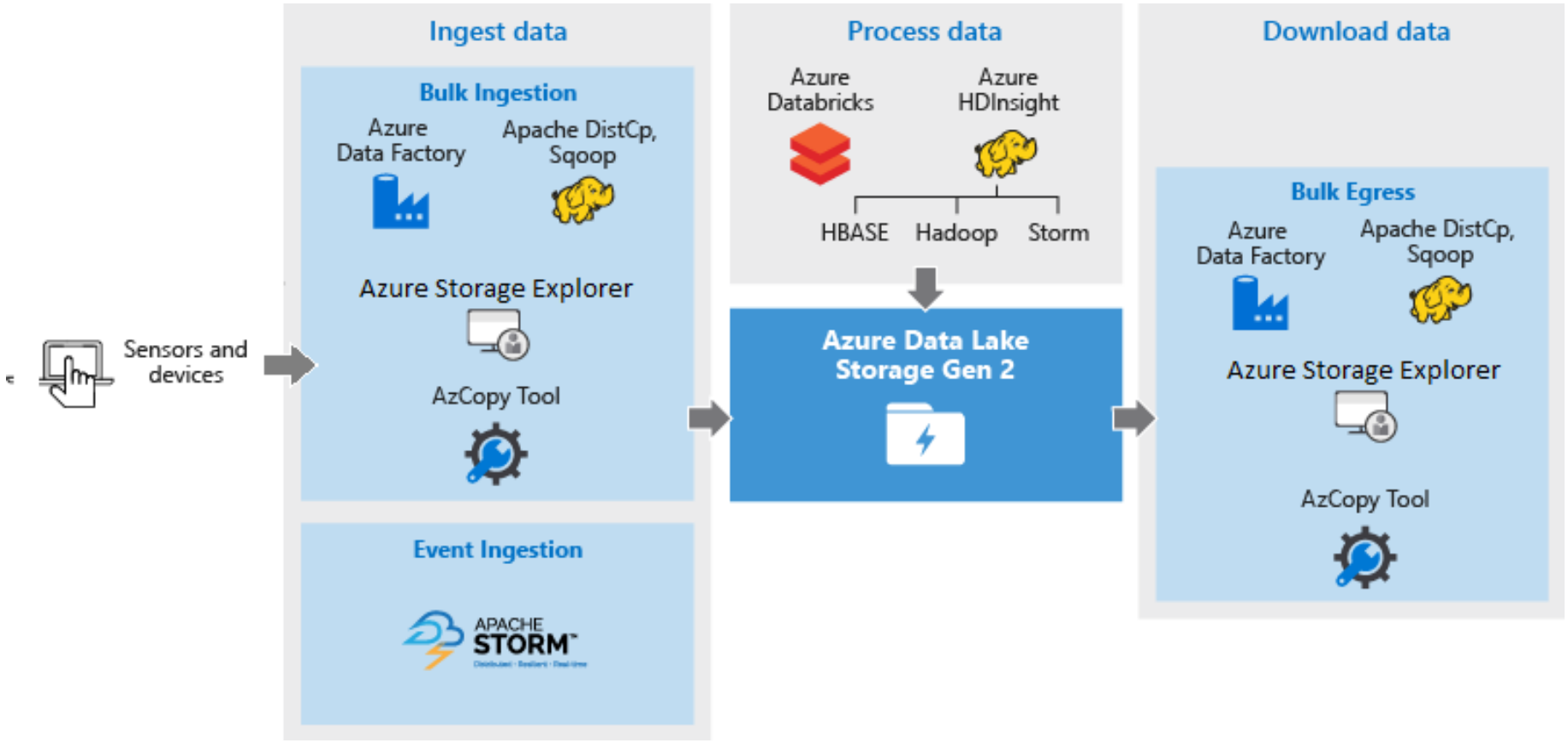
Data Lake Architecture



Data Ingestion

- Azure Data Factory

- Azure Powershell
- Azure CLI
- Azure Data Factory

- Azure Stream analytics
- HDInsight storm

- Azure Data Factory
- AzCopy tool
- DistCp running on HDInsight

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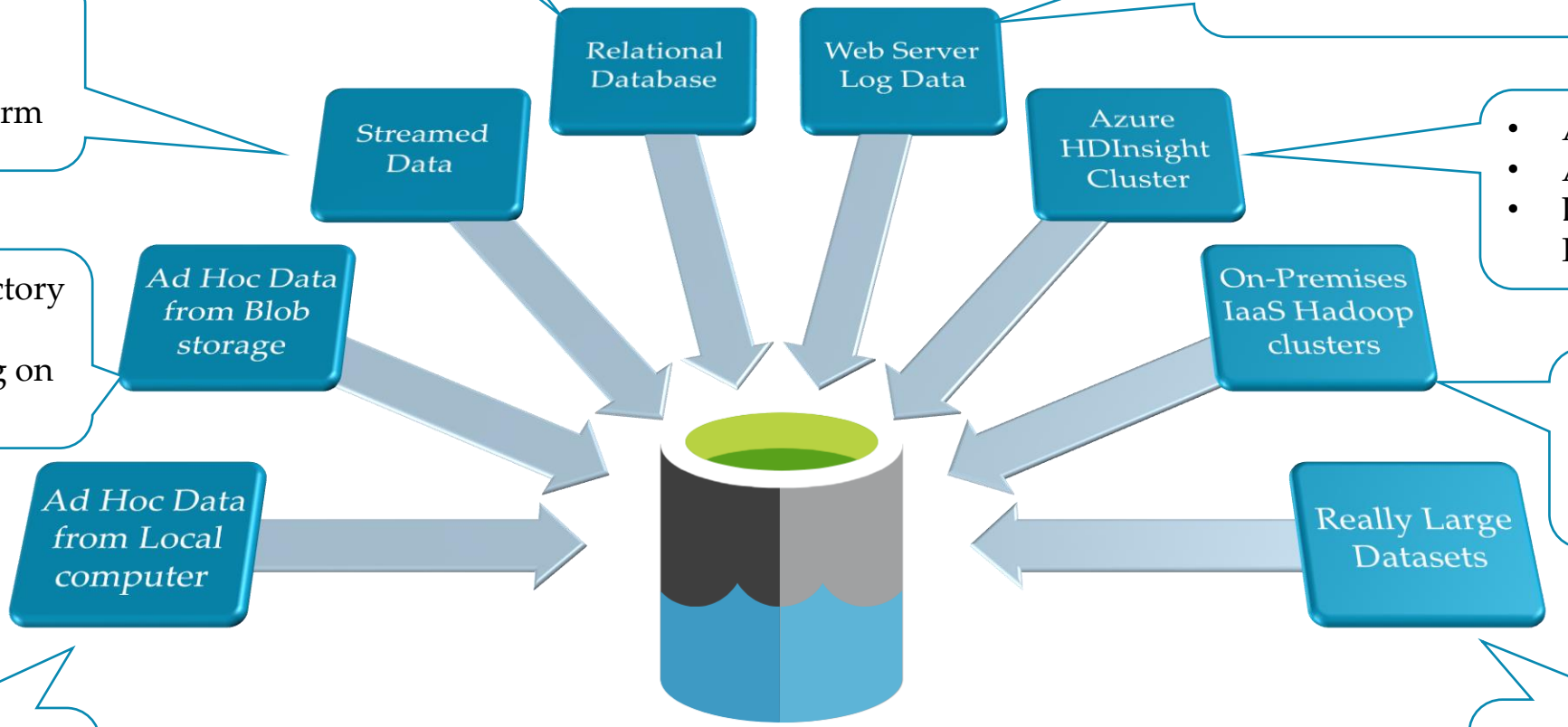
- Azure Powershell
- Azure CLI
- Storage Explorer
- AzCopy tool

- Azure Express route.



Azure Data Lake Storage Gen2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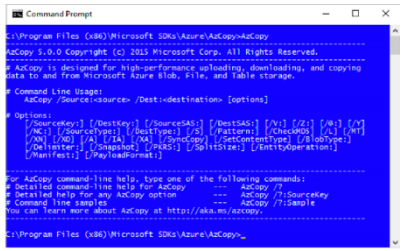
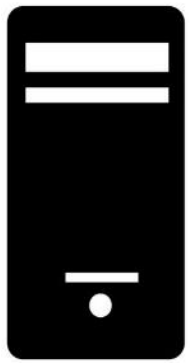
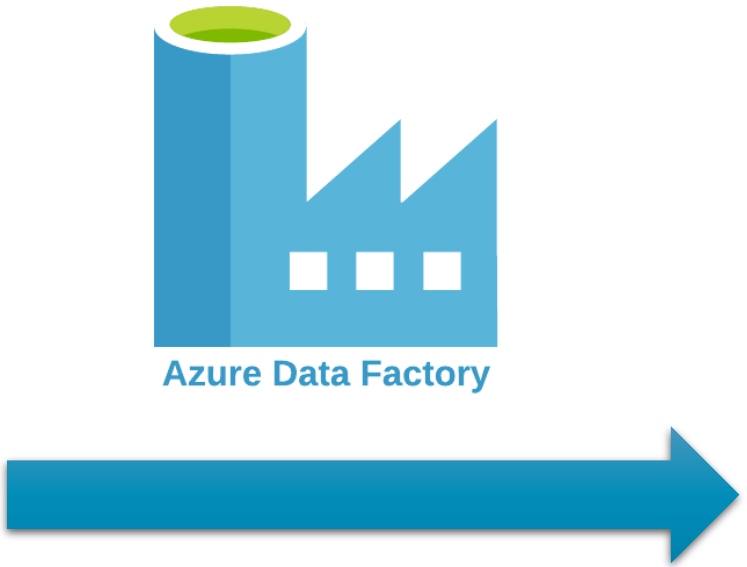




AzCopy

Azure Data Lake Storage Gen2



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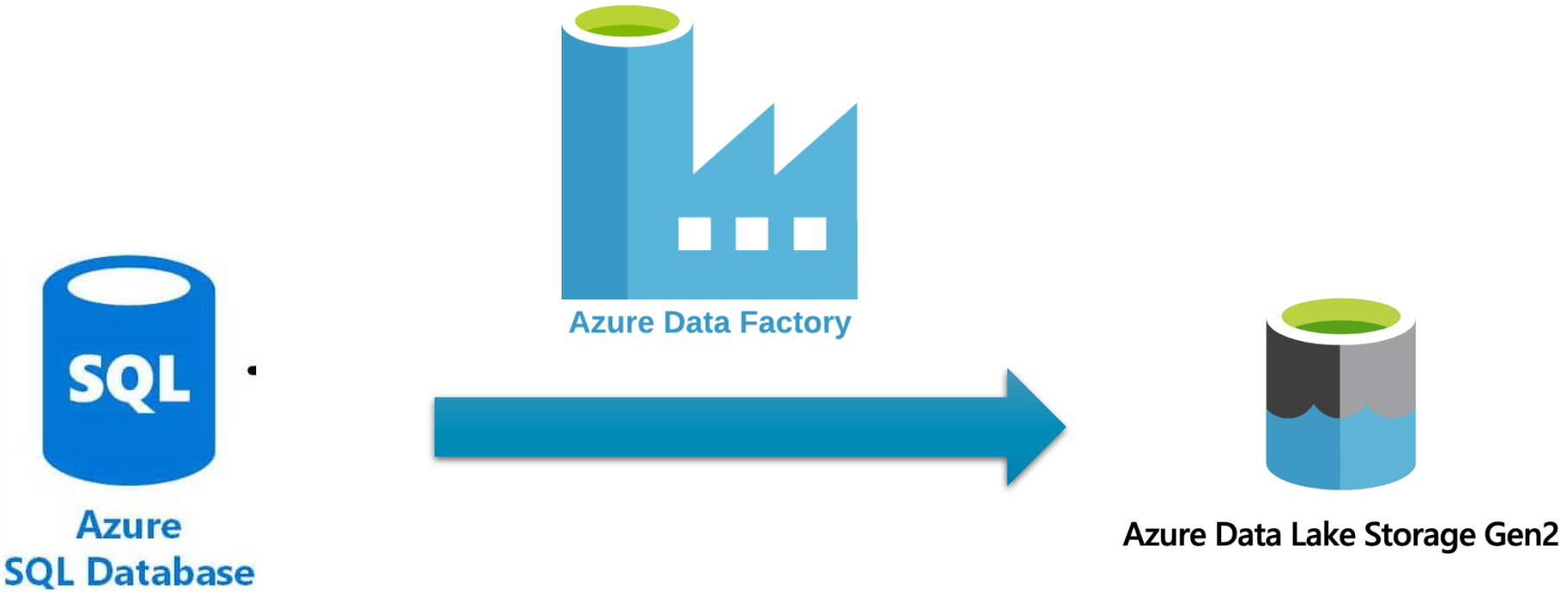
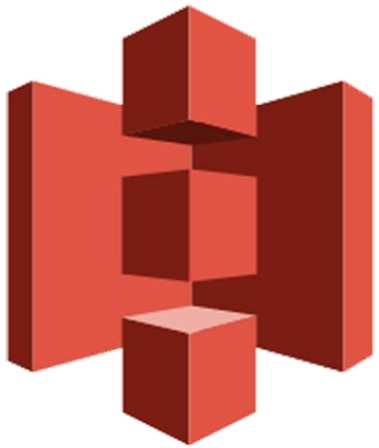
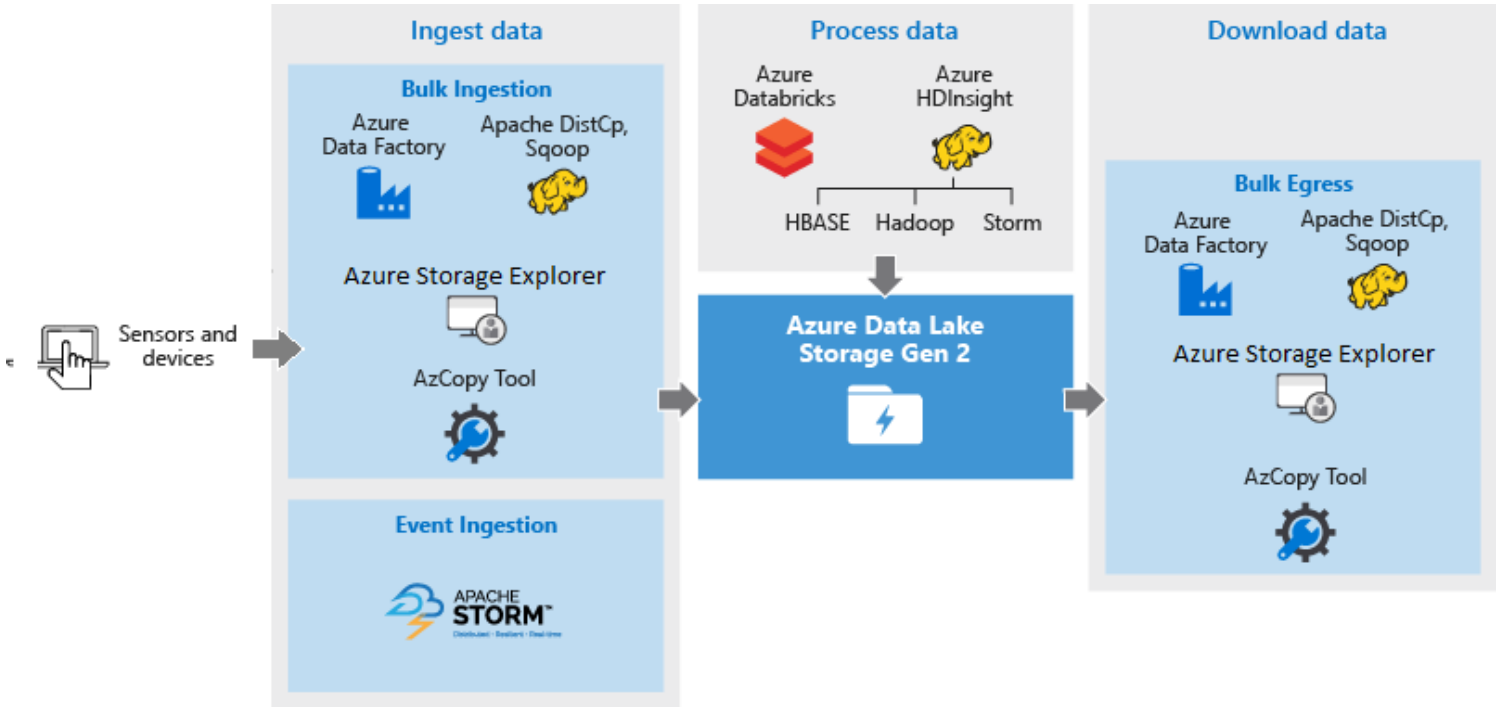


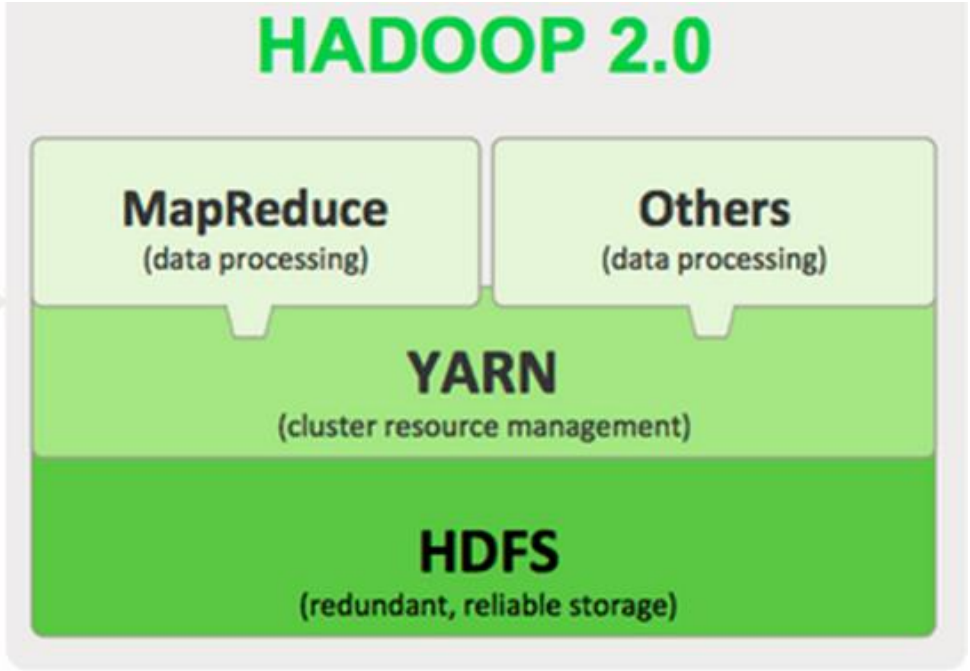


Azure Data Lake Storage Gen2

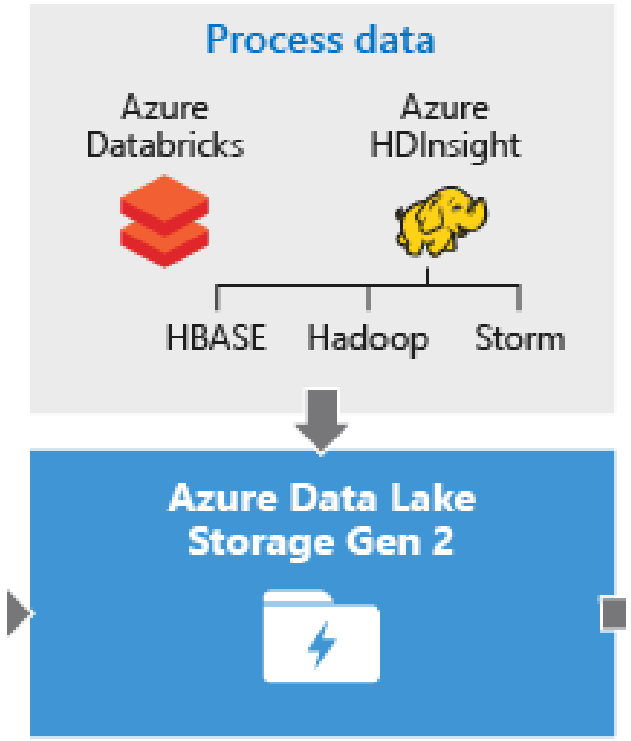
Data flow around Data Lake



Explore → Analyze → Clean → Transform → Load

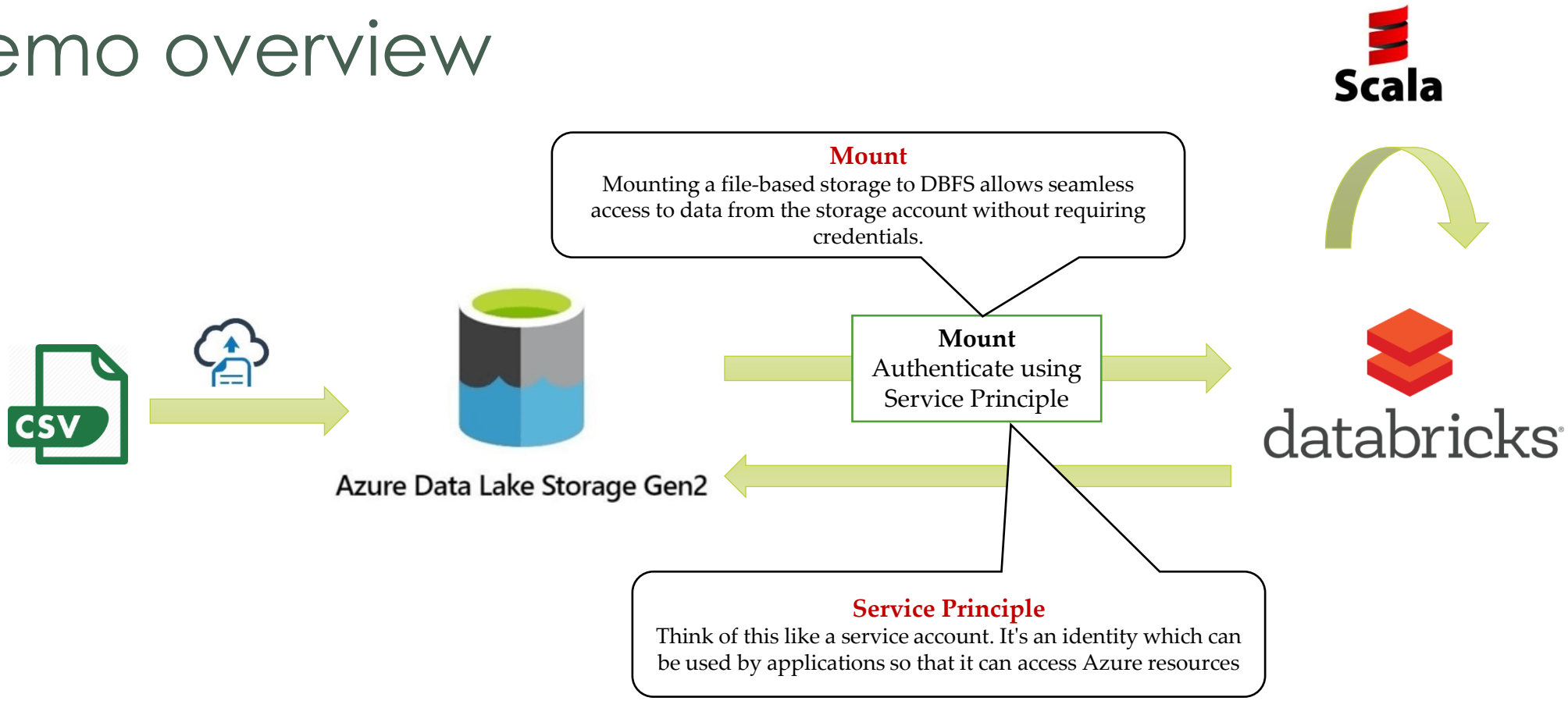


- Clusters are tightly coupled with HDFS
- If you stop cluster
  - storage will also gone
  - and you will lose all the data
- Costly
  - Clusters have to keep running even if there is no processing, and pay for both cluster and storage



- Storage is separate from clusters
- If you stop cluster
  - Data is stored in Data Lake separately
  - and you will NOT lose any data
- Cost efficient
  - You can terminate cluster when not required, and only pay for storage

Demo overview



Learning objective

- **Authentication**
  - Storage Account keys
  - Shared access signature (SAS)
  - Azure Active Directory (Azure AD)
- **Access Control**
  - Role based access control (RBAC)
  - Access control list (ACL)
- **Network access**
  - Firewall and virtual network
- **Data Protection**
  - Data encryption in transit
  - Data encryption at rest
- **Advanced threat Protection**

Storage Account Access Keys

Authentication

Shared Access Signature (SAS)

Authentication

Shared Access Signature (SAS)

Shared Access Signature

Security token string

“SAS Token”

Contains permission like start and end time

Azure doesn’t track SAS after creation

To invalidate, regenerate storage account key used to sign SAS

Stored access policy

Stored access policy

Reused by multiple SAS

Defined on a resource container

Permissions + validity period

Service level SAS only

Stored access policy can be revoked

Azure Active Directory

Authentication

Azure Active Directory

Azure Active Directory

Azure Active Directory (AD)

- Grand access to Azure Active directory (AD) Identities
- AD is an enterprise identity provider, Identity as a Service (IDaaS)
- Globally available from virtually any device
- Identities – user, group or application principle
- Assign role at Subscription, RG, Storage account, container level.
- No longer need to store credentials with application config files
- Similar to IIS Application pool identity approach

Azure Active Directory

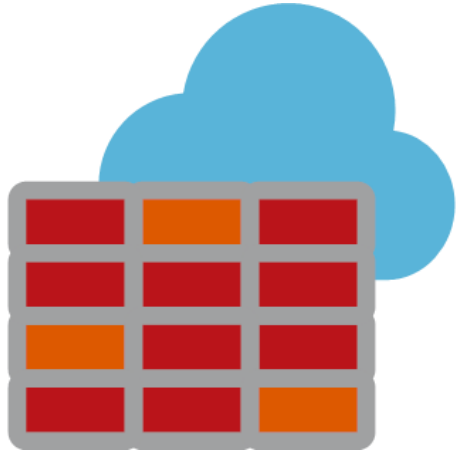
Role based access control (RBAC)

Access Control

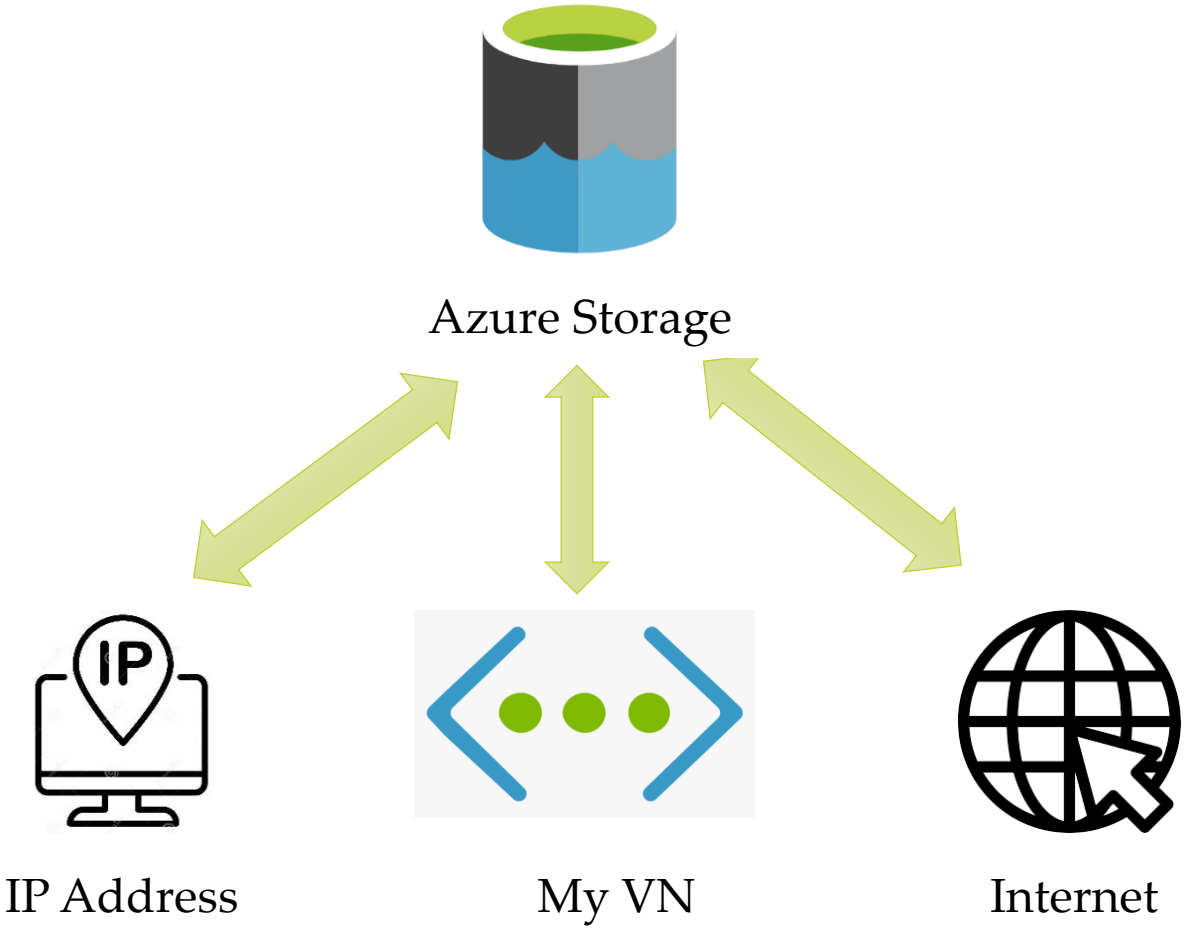
Role based access control (RBAC)

Access control

Firewalls and Virtual Networks



Firewalls and Virtual Networks



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Azure Active Directory

Encrypting Data in Transit

Data Protection

Encrypting Data in Transit – Advance

- Site-to-site VPN
- Point-to-site VPN
- Azure ExpressRoute

Client-side Encryption

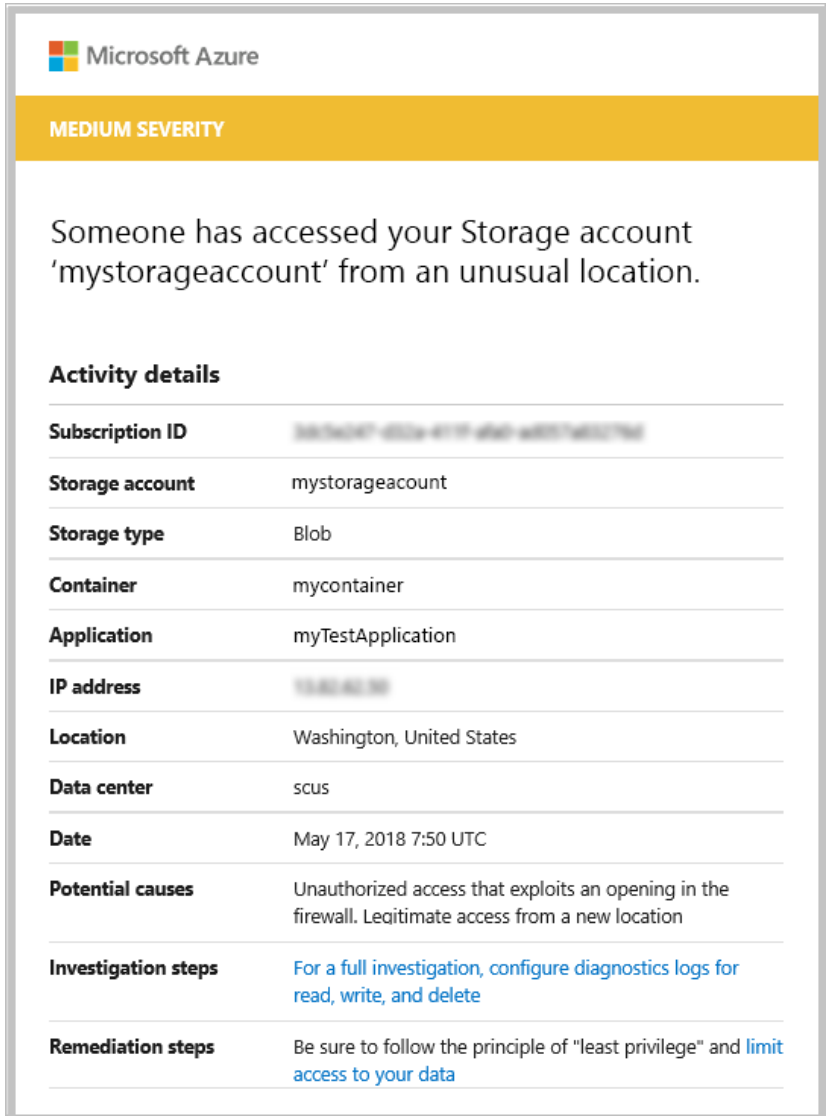
- Encrypt data within application
- Data is encrypted in transit and at rest
- Application decrypt data when retrieved
- HTTPS has integrity checks built-in
- .Net and Java storage client libraries
- Can leverage Azure Key Vault to generate and/or store encryption keys

Encrypting Data at Rest

Data Protection

Encrypting Data at Rest

- Encryption enabled by default
- Can't be disabled
- Storage Service Encryption (SSE)
  - Automatically encrypt and decrypt while writing and reading
  - It's free, no charge
  - Applied to both standard and premium tiers
  - 256 bit AES Encryption
- Option: Use your own encryption keys
  - Blobs and files only

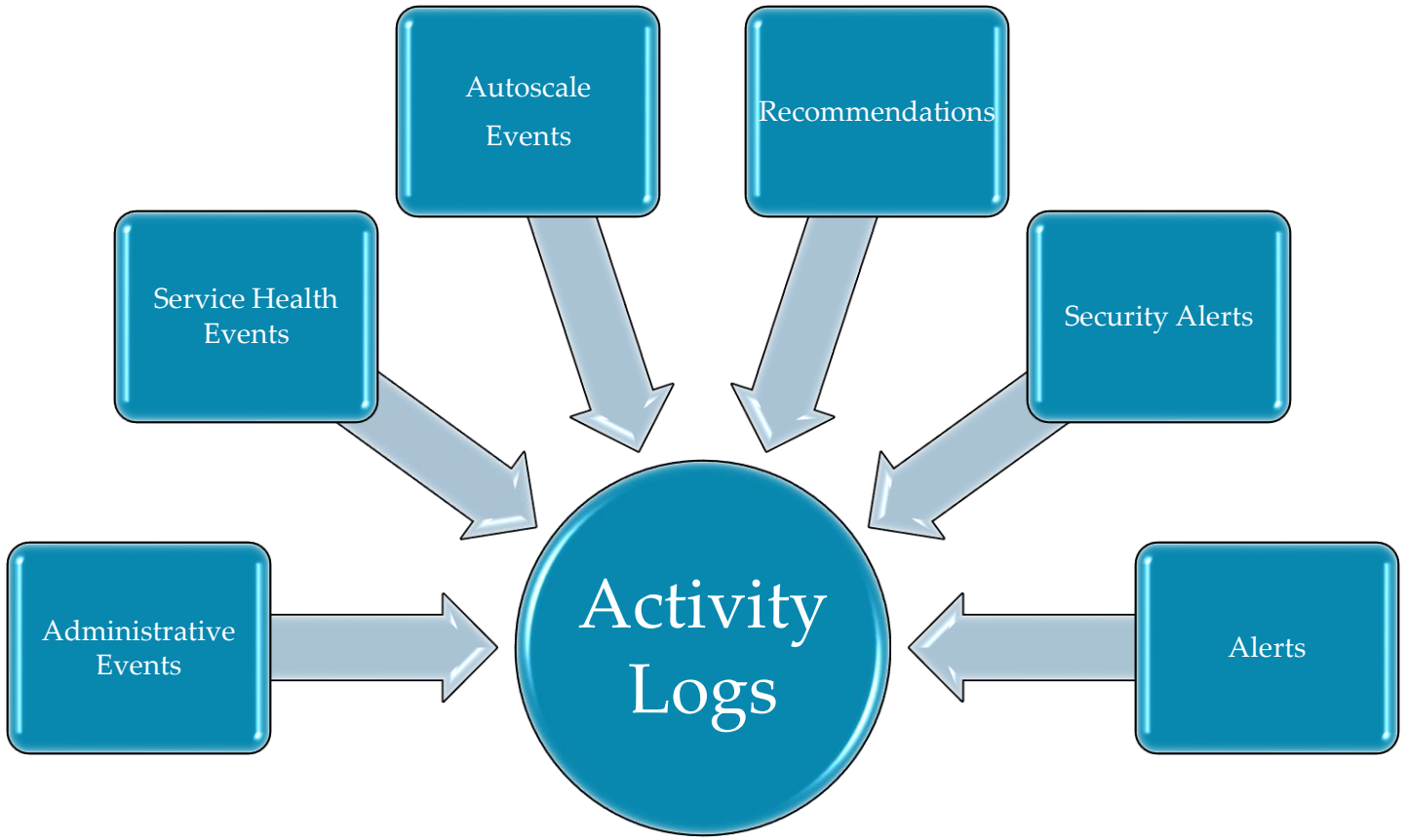


Advanced threat protection

Activity logs

- Logs operations performed on Storage Account itself (Management log)
  - Role assignments
  - Regenerating Storage Account keys
  - Changing Storage Account settings
- Does not include data related events
  - Diagnostic events are handled by Storage Analytics
- Subscription wide log

Activity Logs



Activity logs

- Events available in Azure Portal for 90 days
- Activity Log destinations
  - Storage Account
  - Event Hub
  - Log Analytics
- Query Activity Log data
  - Within Azure Portal
  - PowerShell, Azure CLI, REST API
  - Azure Log Analytics

Metrics

- Numerical values
- Collected at regular intervals
- Azure Storage
  - Capacity metrics
  - Transactions metrics
- Can set alerts on metrics

Metrics

- Time-series database
- Set of metric values contains:
  - Time value collected
  - Resource collected from
  - Category
  - Metric name
  - Metric value
  - Name/value pairs (multi-dimensional metrics)

Metrics

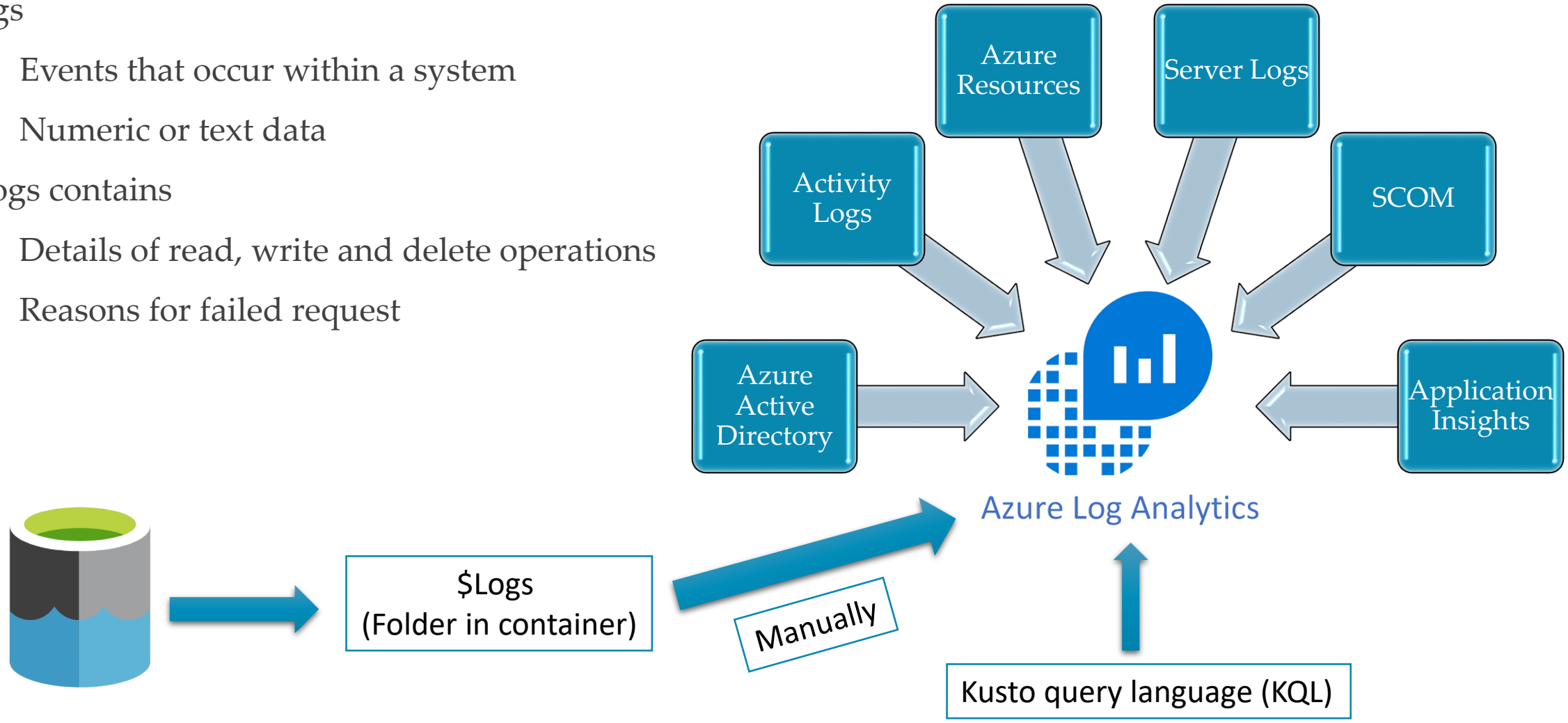
- Most metrics collected every minute
- Near real-time monitoring
- 93 day retention
- Alerts

Metrics

- Access Storage Account metrics
  - Storage Account
  - Azure Monitor
  - Azure Monitor REST Endpoints
  - .NET SDK
  - PowerShell
  - Azure CLI
  - Event Hubs

Diagnostic settings

- Logs
  - Events that occur within a system
  - Numeric or text data
- $Logs contains
  - Details of read, write and delete operations
  - Reasons for failed request



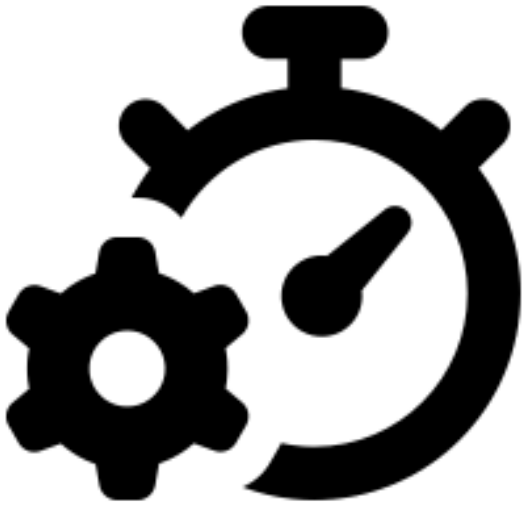
Storage Analytics Logs

- Type of Operation
- Success or Failure
- Object Key
- HTTP Status Code
- Start Time
- Server and E2E Latency
- Authentication Type
- IP Address of Caller
- Browser Information
- Type of Client
- Client Operation ID
- Server Operation ID

Storage Analytics Logs

- Blocks are written immediately
- Blob is not available until log writer is flushed by Azure
- “Last modified datetime” may not accurately reflect log contents
- Search +/-15 minutes
- Search based on Log metadata
- There are costs for logging
- 20 TB limit, independent of Storage Account total limit

Data Lake Optimization Techniques



- **Data Ingestion considerations**
  - Storage hardware
  - High speed internal network
  - Fast network connection b/w on-premises and cloud
- **Parallel read/write**
  - e.g. Data Factory parallel copies settings
- **Structure your data set**
  - File size vs number of files
    - File size b/w 256 MB to 100 GB
  - Folder and file structure
    - e.g. Dataset\YYYY\MM\DD\datafile_YYYY_MM_DD_HH_MM.tsv
- **Same region**
- **Batch Data**