AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

STG304

Building a data lake on Amazon S3

Oleg Lvovitch (he/him)
Principal Software Engineer
AWS

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Agenda

- What is a data lake and why do I need one?
- A brief history of data “reservoirs”
- Building a data lake on Amazon S3

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Why do you need a data lake?

Sep 15, 2020, 09:00am EDT | 8,807 views

Data Is The Biggest Asset On Your Balance Sheet: How Well Do You Manage It?

Forbes

Digital Insights Are the New Currency of Business

Forrester

Oct 15, 2020, 11:57am EDT | 5,019 views

Rise of the Analytical Executive

Forbes

Big picture

https://www.forbes.com/sites/sap/2020/09/15/data-is-the-biggest-asset-on-your-balance-sheet-how-well-do-you-manage-it/?sh=28a67b14b25e
https://www.forrester.com/blogs/15-04-27-digital_insights_are_the_new_currency_of_business/
https://www.forbes.com/sites/sisense/2021/10/15/rise-of-the-analytical-executive/?sh=52a4ff90639f

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Why do you need a data lake?

DATA ▶ INFORMATION ▶ INSIGHT



Centralized repository that allows you to store all your structured and unstructured data at any scale

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The rise of data “reservoirs”

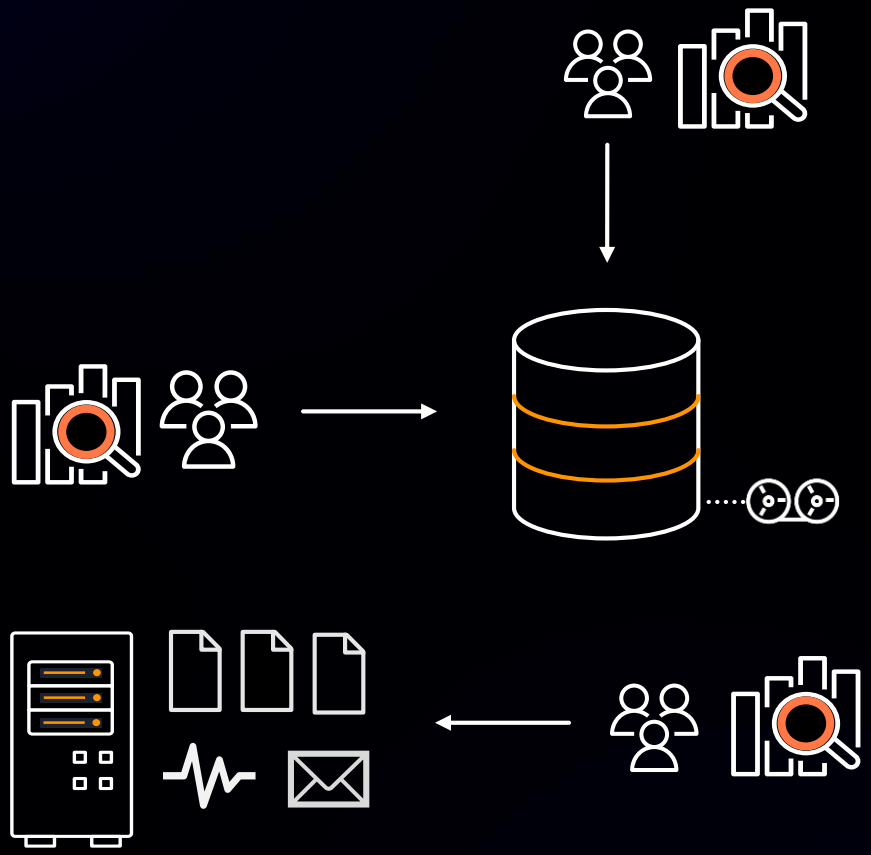
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Data “puddle”



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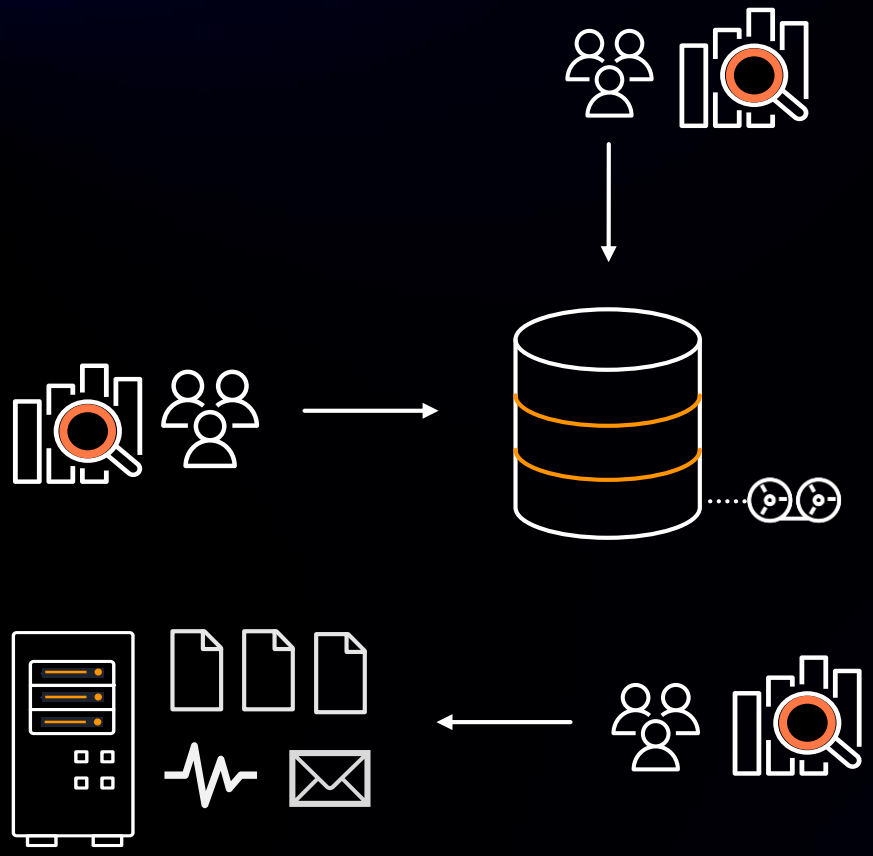
Data “puddle”



Insights = query of raw data

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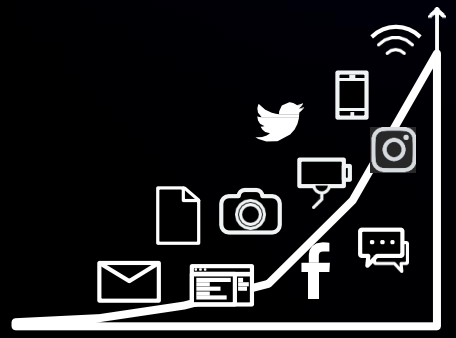
Data “puddle”



Insights scorecard	
Quality	✓
Complexity	✓
Performance	✓
Cost	✓

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Businesses and data – More, more, more



Explosion of data



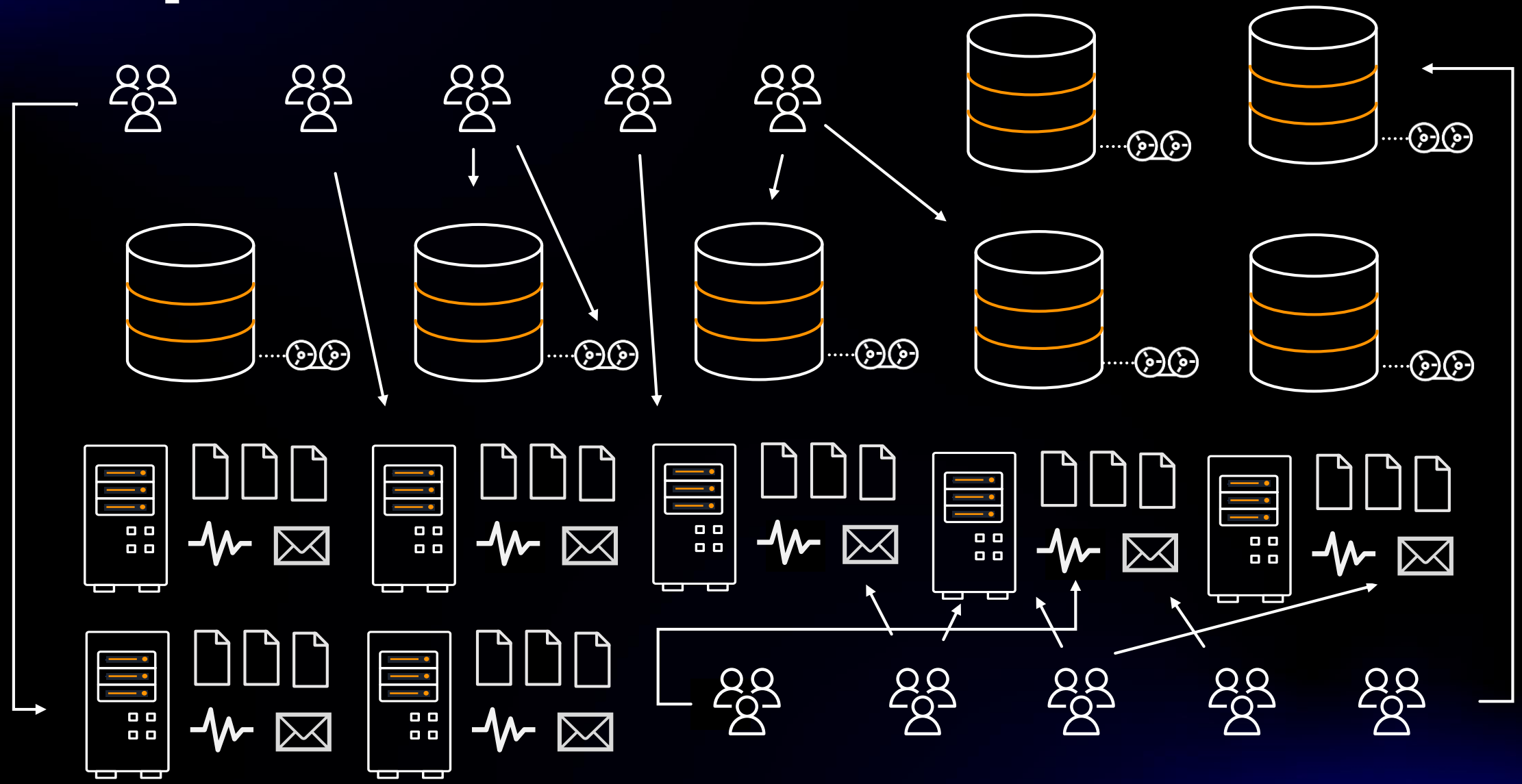
Explosion of personas



Business is accelerating

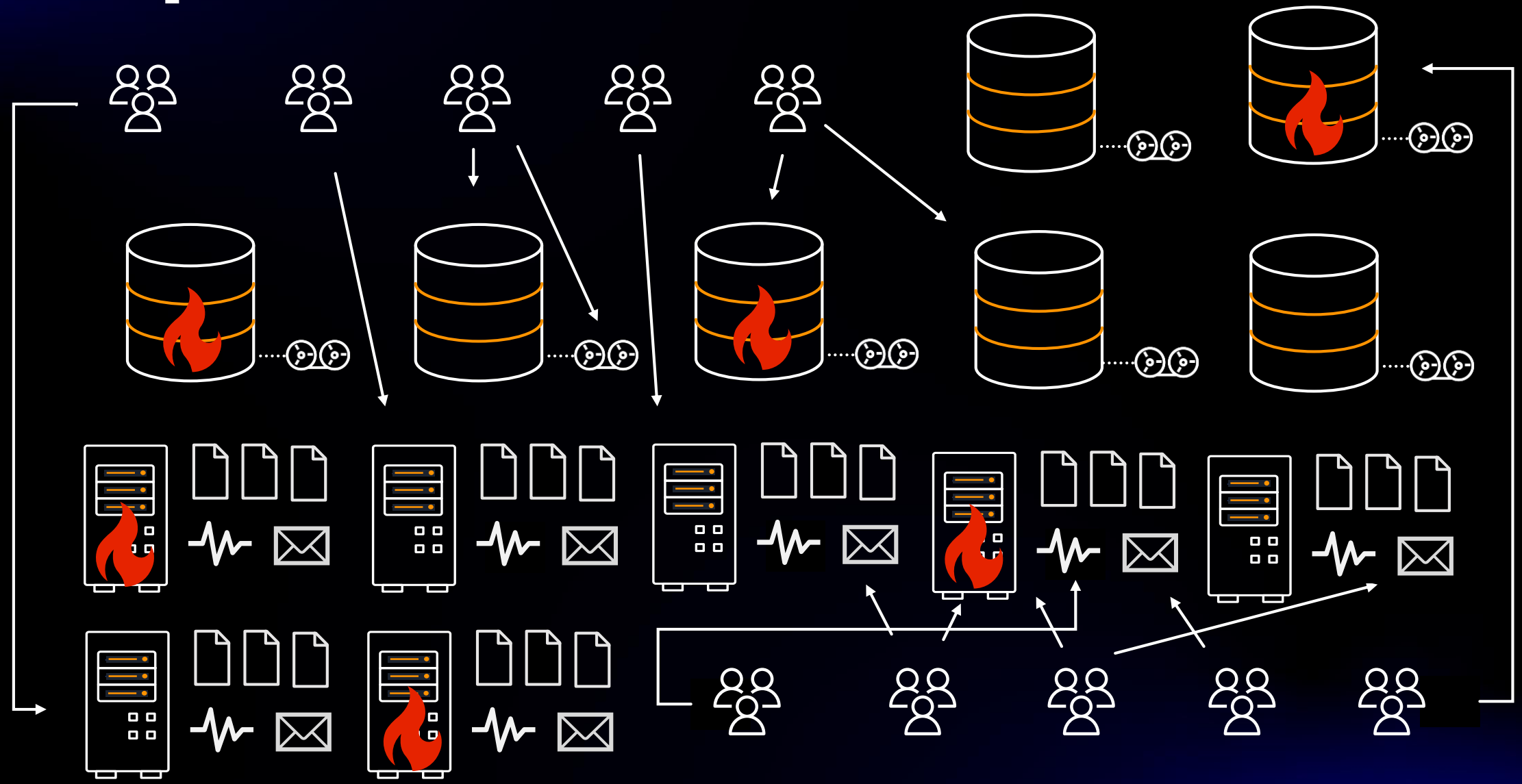
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Data “puddle”



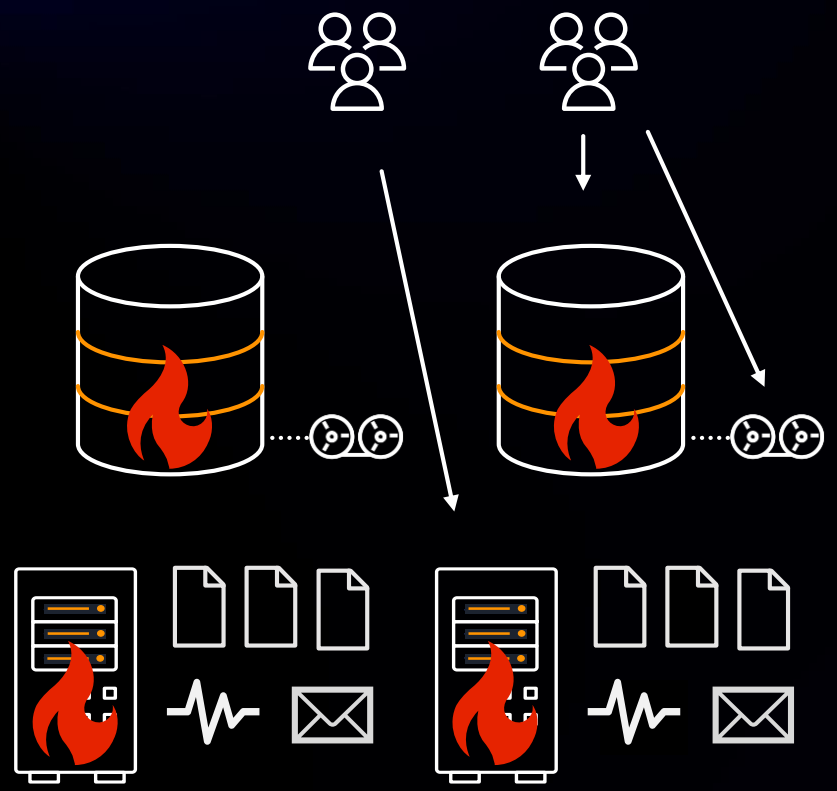
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Data “puddle”



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Data “puddle”



Insights scorecard	
Scale	
Quality	
Complexity	
Performance	
Cost	
Durability	

Customers are impacted

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What now?

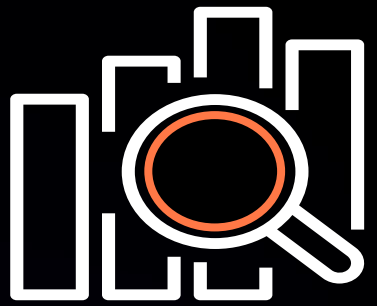
Let’s rethink everything

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What now? Let’s rethink everything



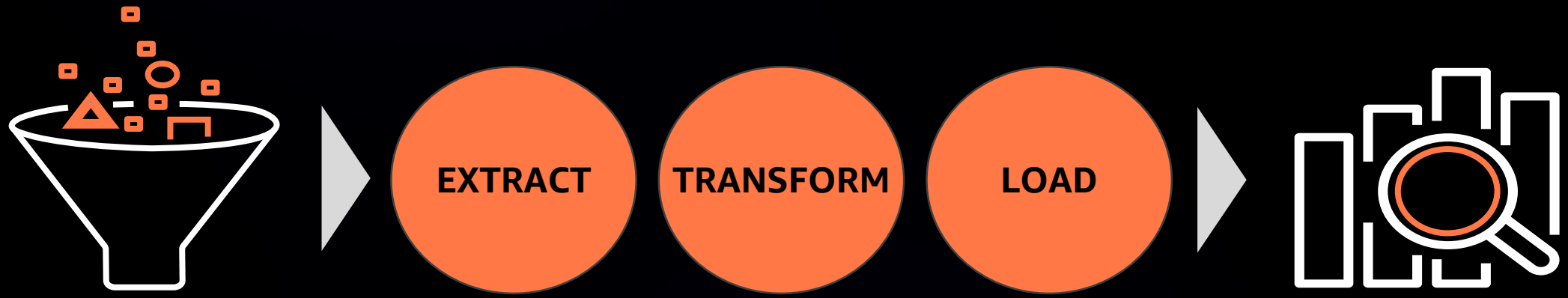
Raw data



Insights

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What now? Let’s rethink everything

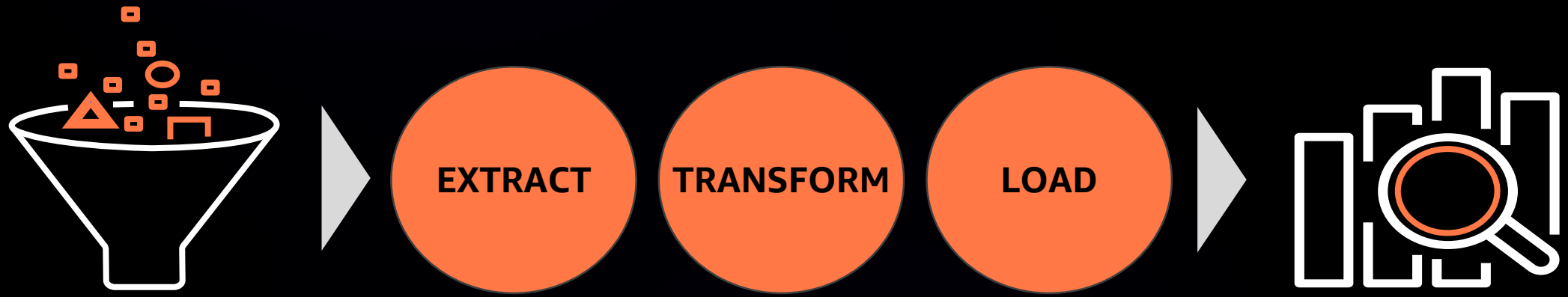


Raw data

Insights

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Enter: ETL

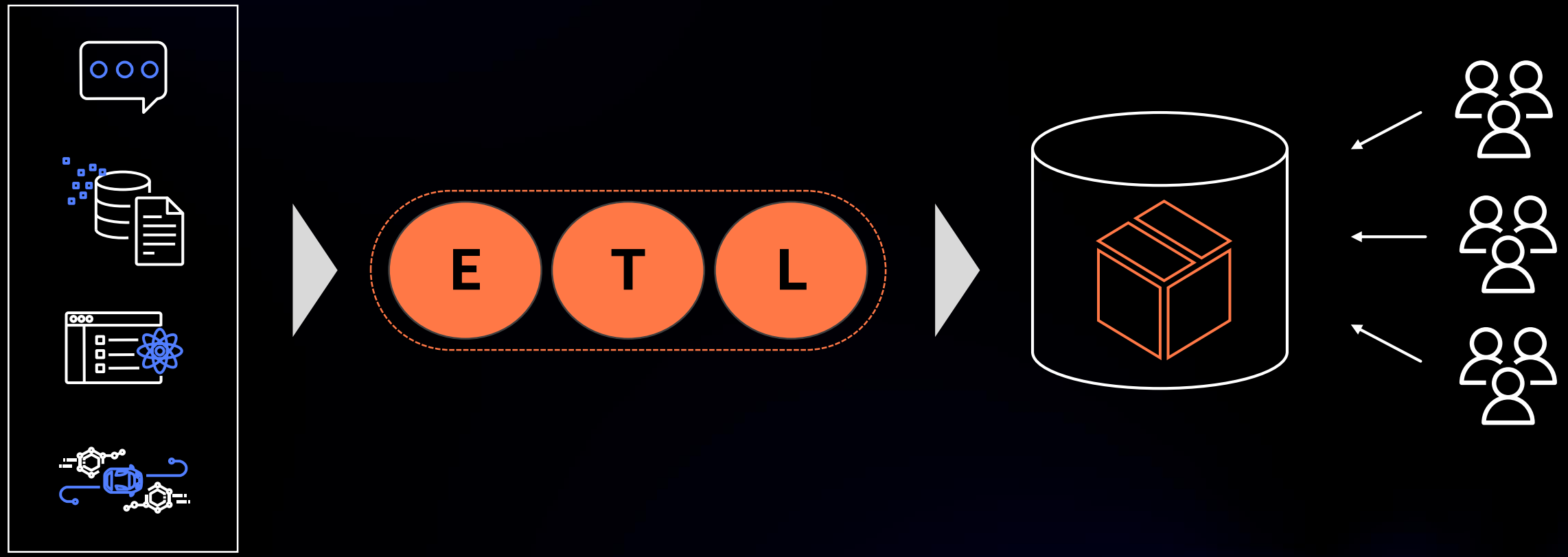


Raw data

Insights

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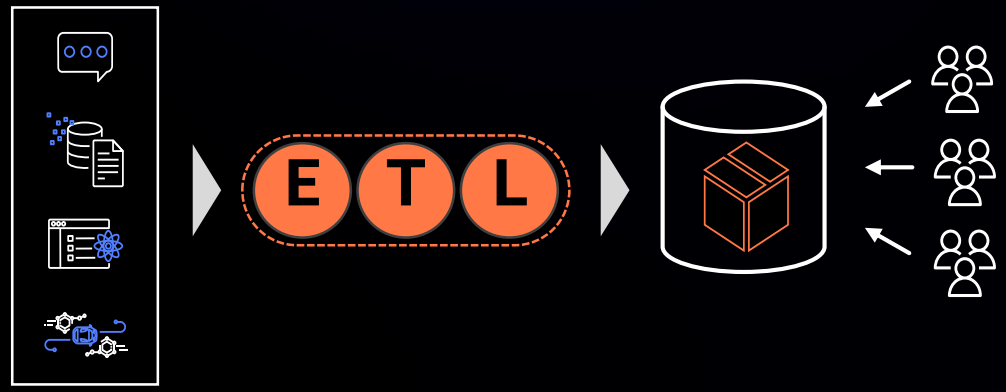
Data “pool”



Data sources

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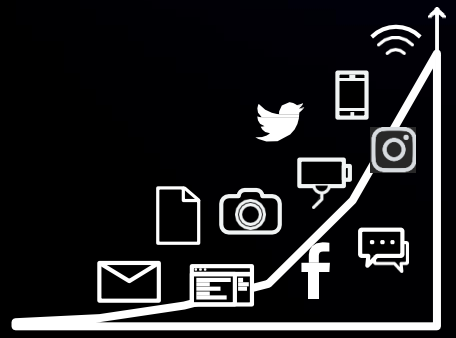
Data “pool”



Insights scorecard	
Scale	✓
Quality	✓
Complexity	✓
Performance	✓
Cost	✓
Durability	✓

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But remember . . .



Explosion of data



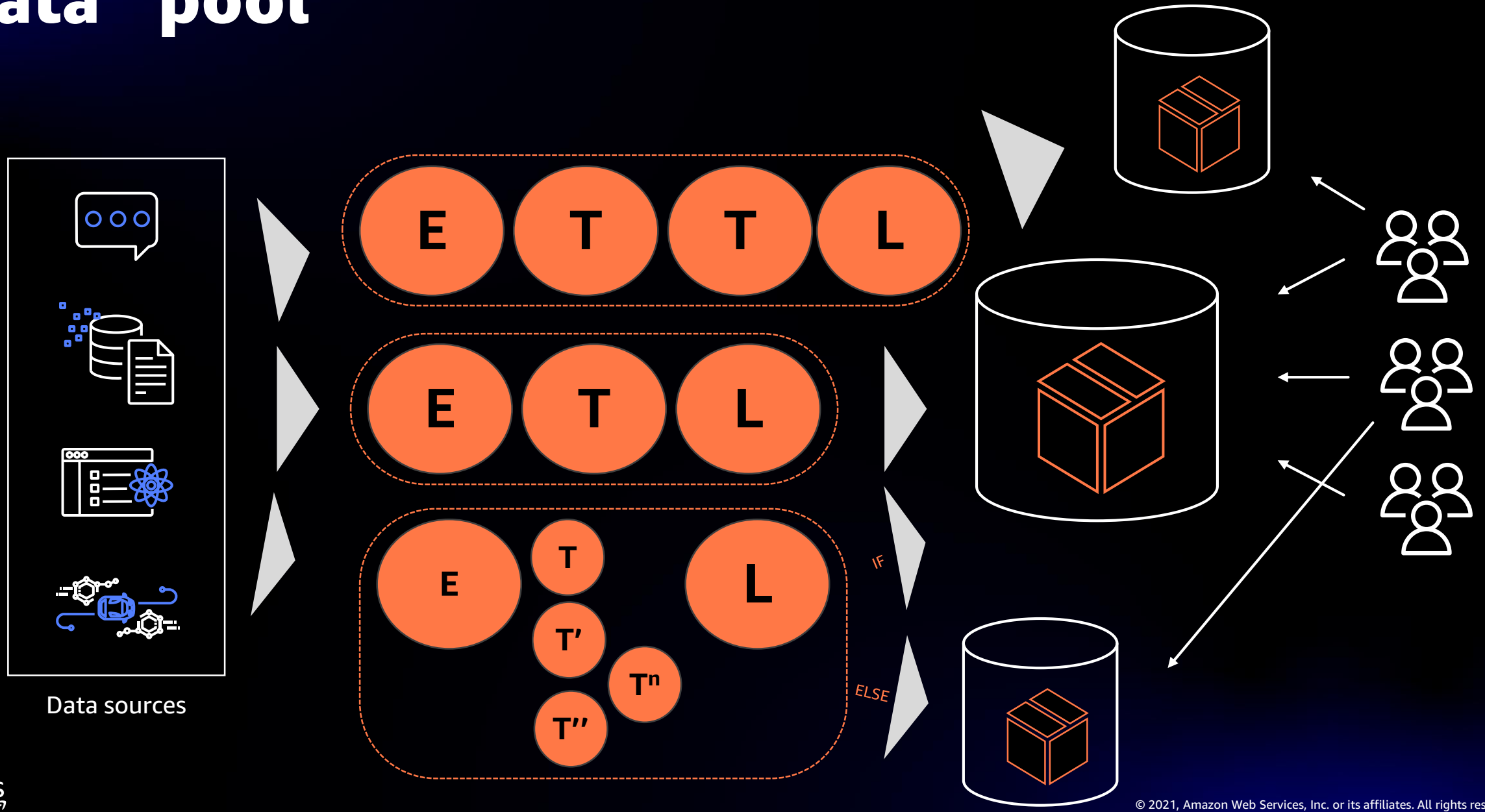
Explosion of personas



Business is accelerating

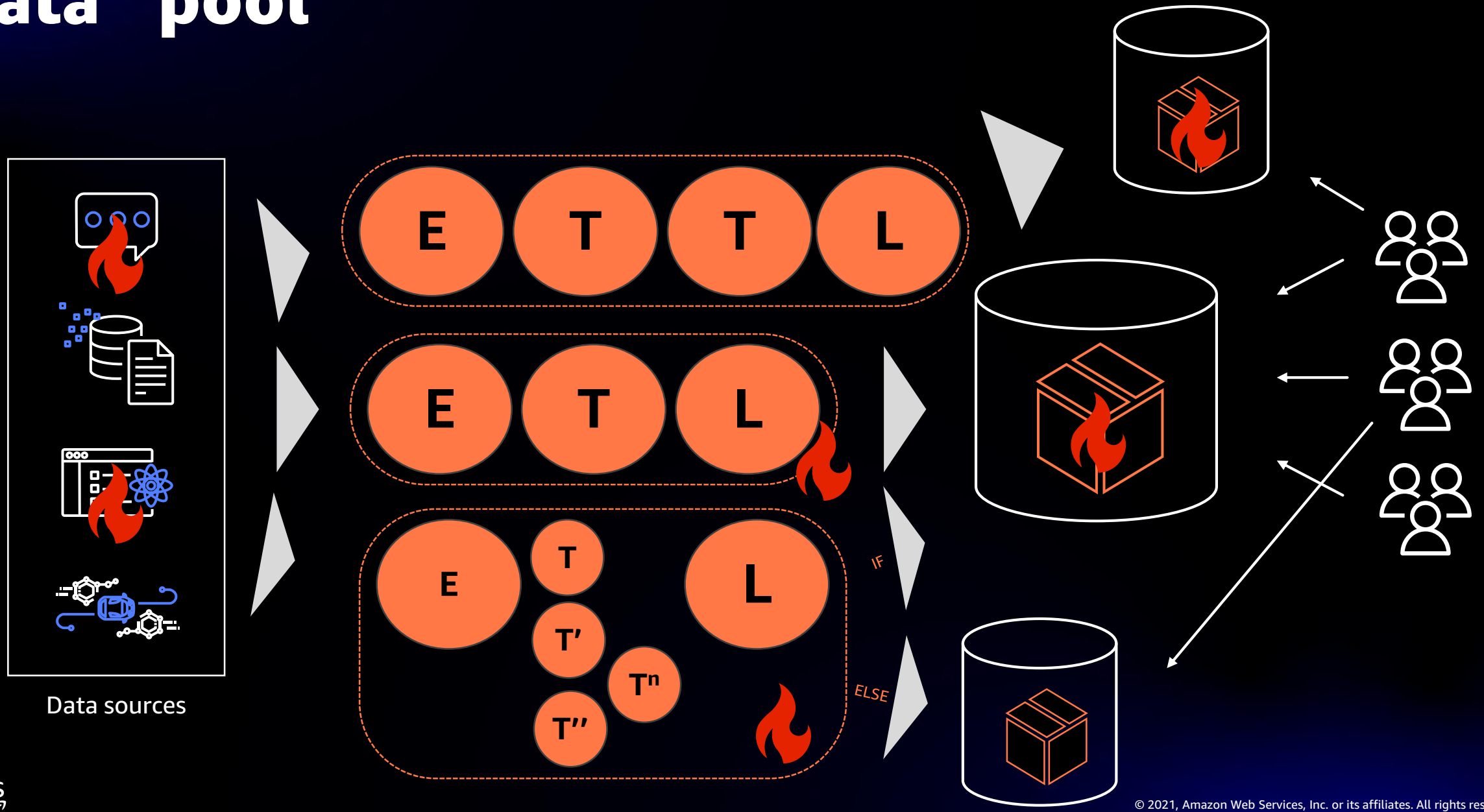
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Data “pool”



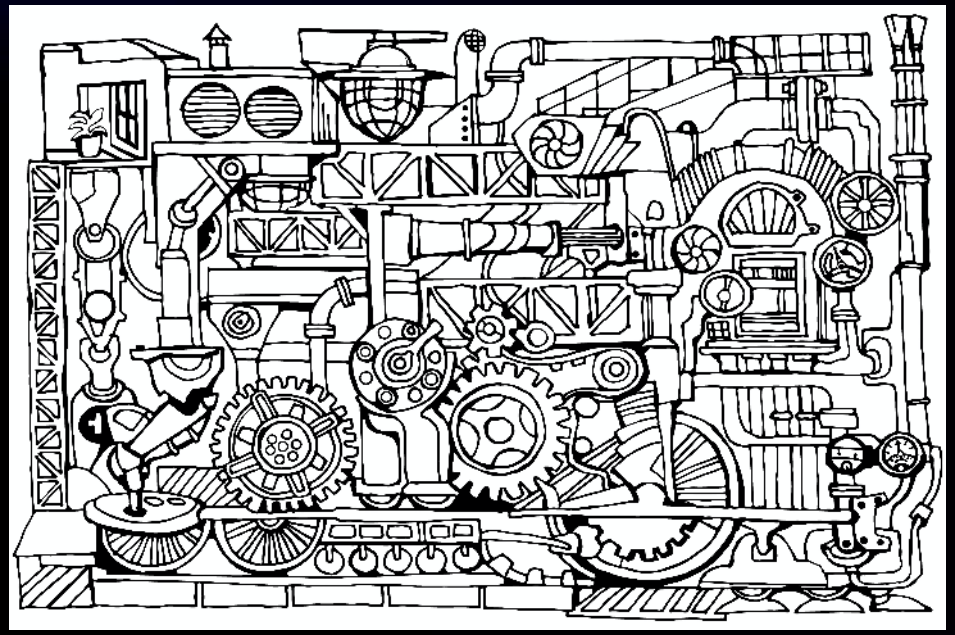
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Data “pool”



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Data “pool”



Insights scorecard	
Scale	
Quality	
Complexity	
Performance	
Cost	
Durability	

Customers are impacted

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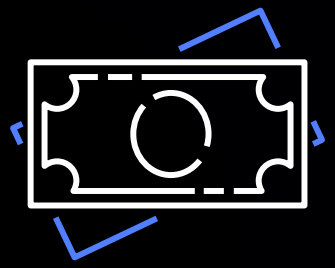
What now?

Let’s rethink everything

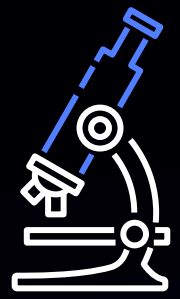
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What now? Let’s rethink everything.

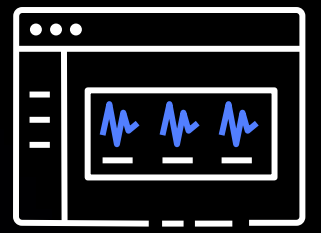
Vertical scaling



COST



PHYSICS

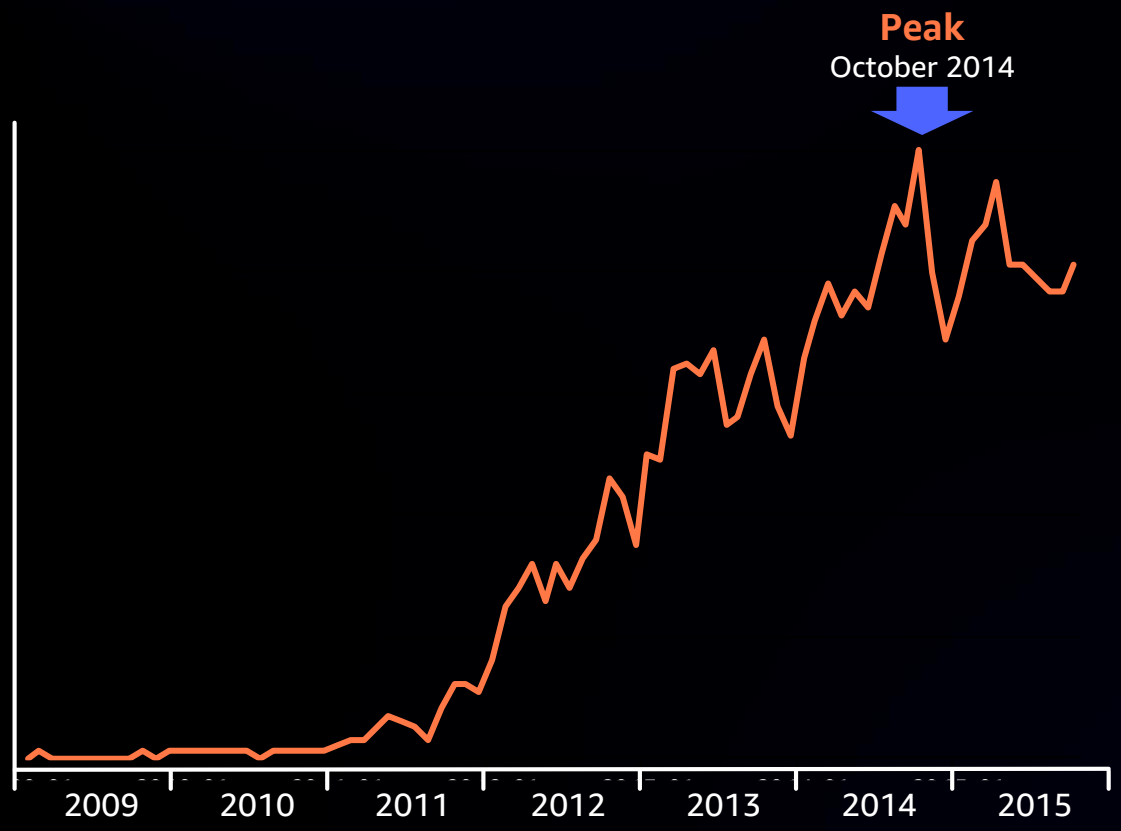


RELIABILITY

aws

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Enter: Distributed systems

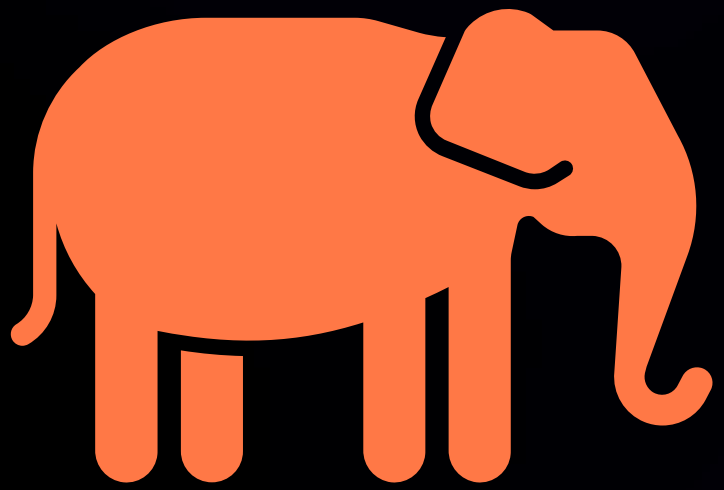


Popularity of the search term “Big Data”

- **Horizontal scaling** at the core
- **Commodity** hardware
- Built-in **fault tolerance**

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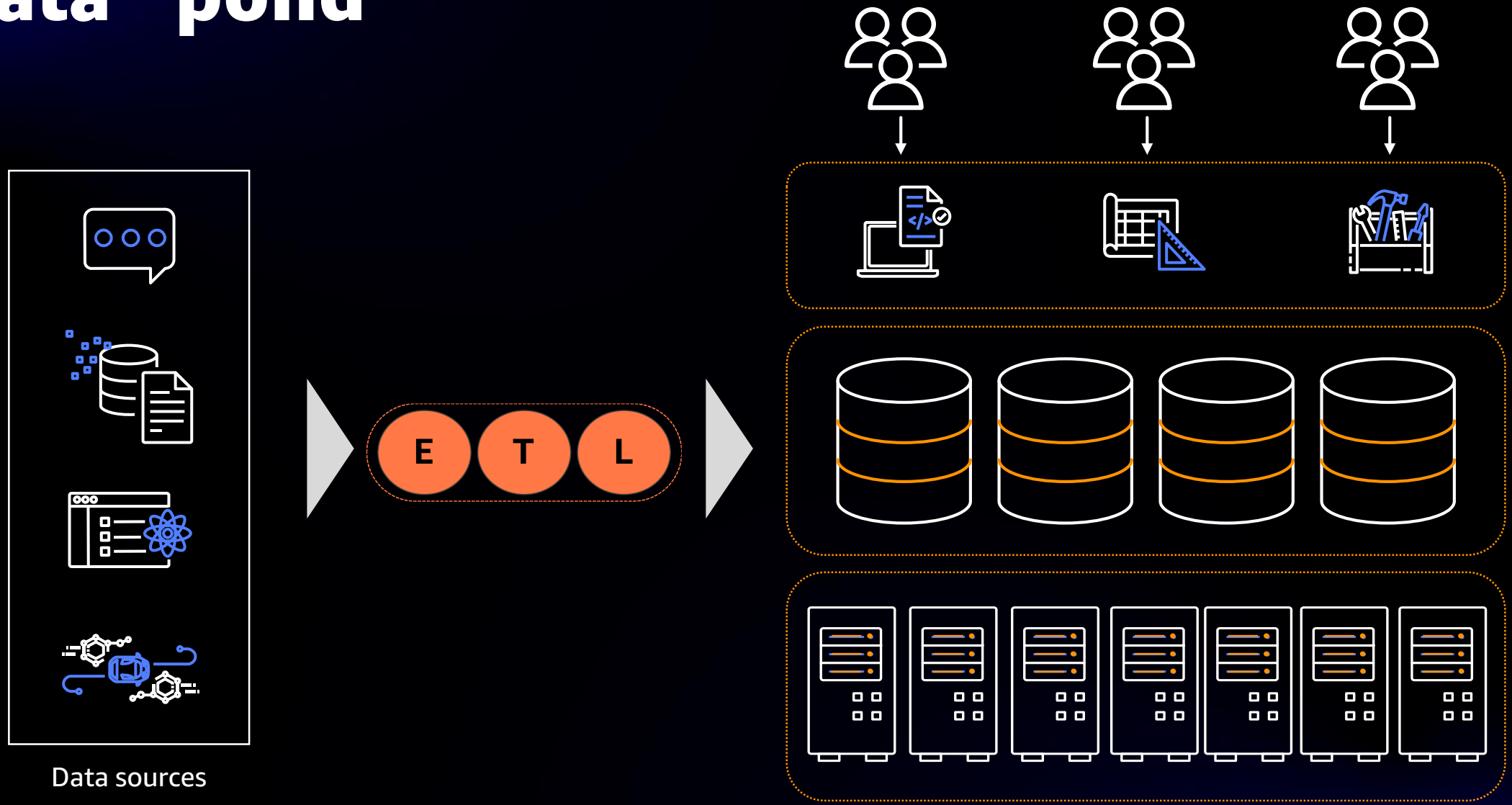
“Big data”



- **HDFS** for storage
- **MapReduce** for compute
- And most importantly . . .
- **An ecosystem**

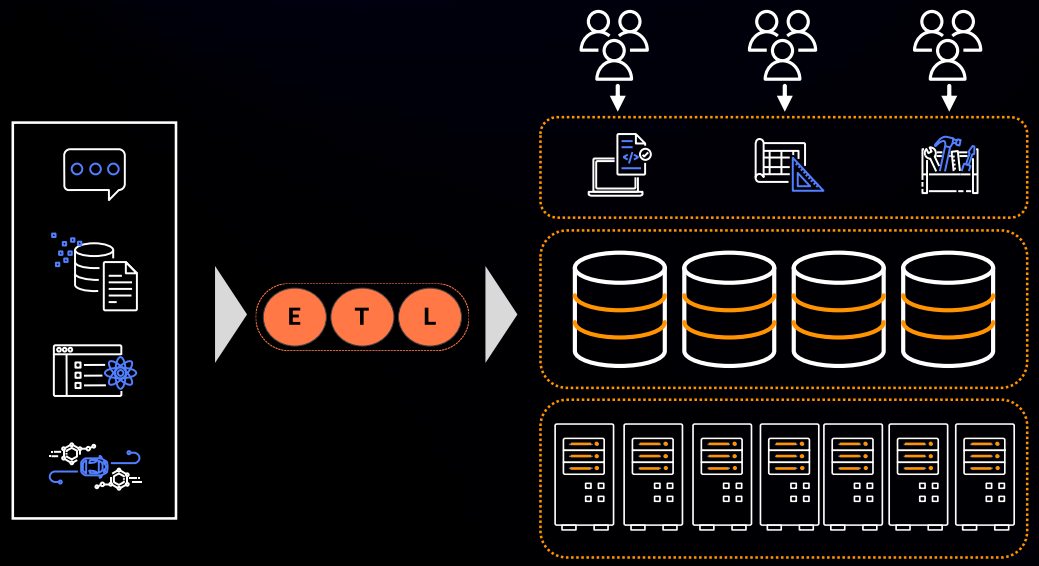
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Data “pond”



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Data “pond”



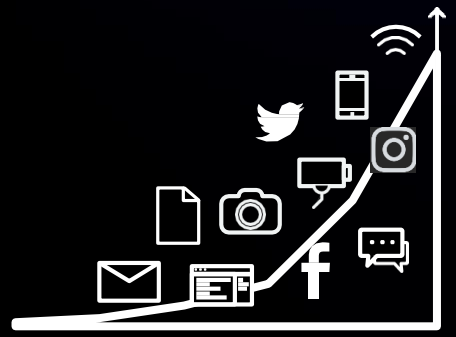
Insights scorecard	
Scale	✓
Quality	✓
Complexity	✓
Performance	✓
Cost	✓
Durability	✓
Ecosystem	✓

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Surely this is enough

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Yes, this again



Explosion of data



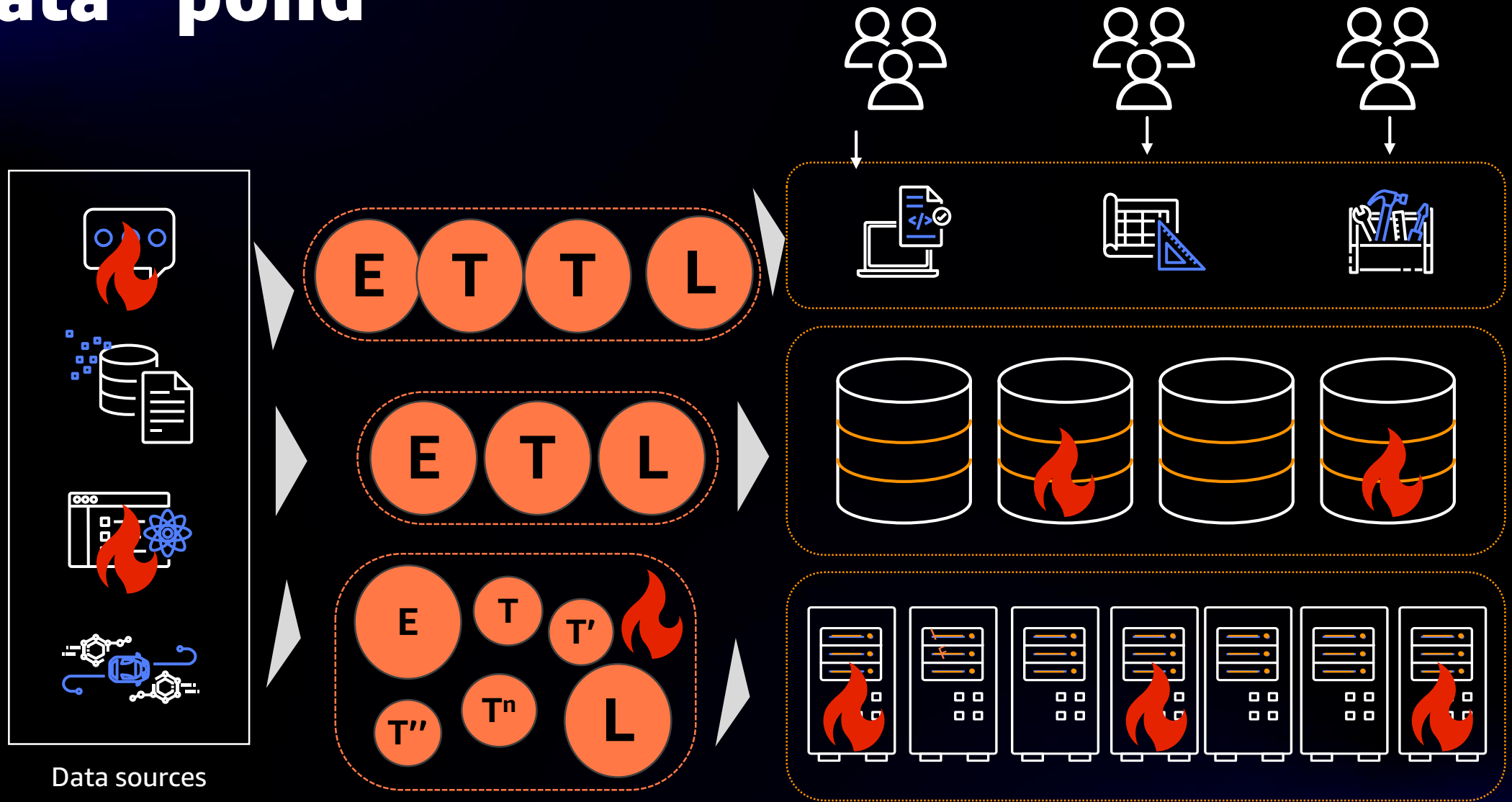
Explosion of personas



Business is accelerating

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Data “pond”



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Data “swamp”



You can’t find anything,

and you keep putting out fires

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Data “swamp”



Insights scorecard	
Scale	
Quality	
Complexity	
Performance	
Cost	
Durability	
Ecosystem	
Discoverability	
Security	
Compliance	

Customers are impacted

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What do we need?

A centralized repository that allows you to store all your structured and unstructured data at **any scale**

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Why is this so hard?



Business needs

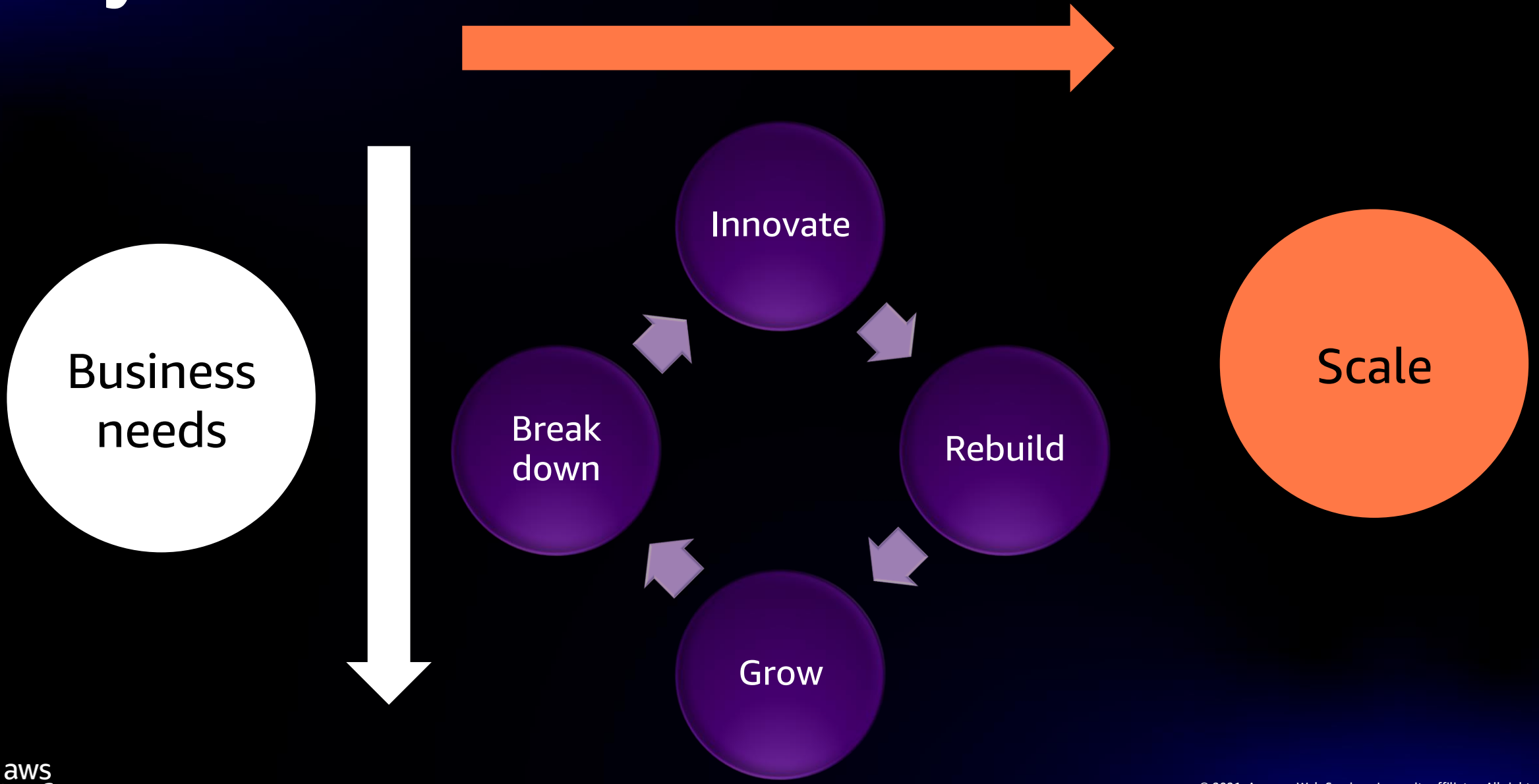


Scale
Quality
Complexity
Performance
Cost
Durability
Ecosystem
Discoverability
Security
Compliance

Scale

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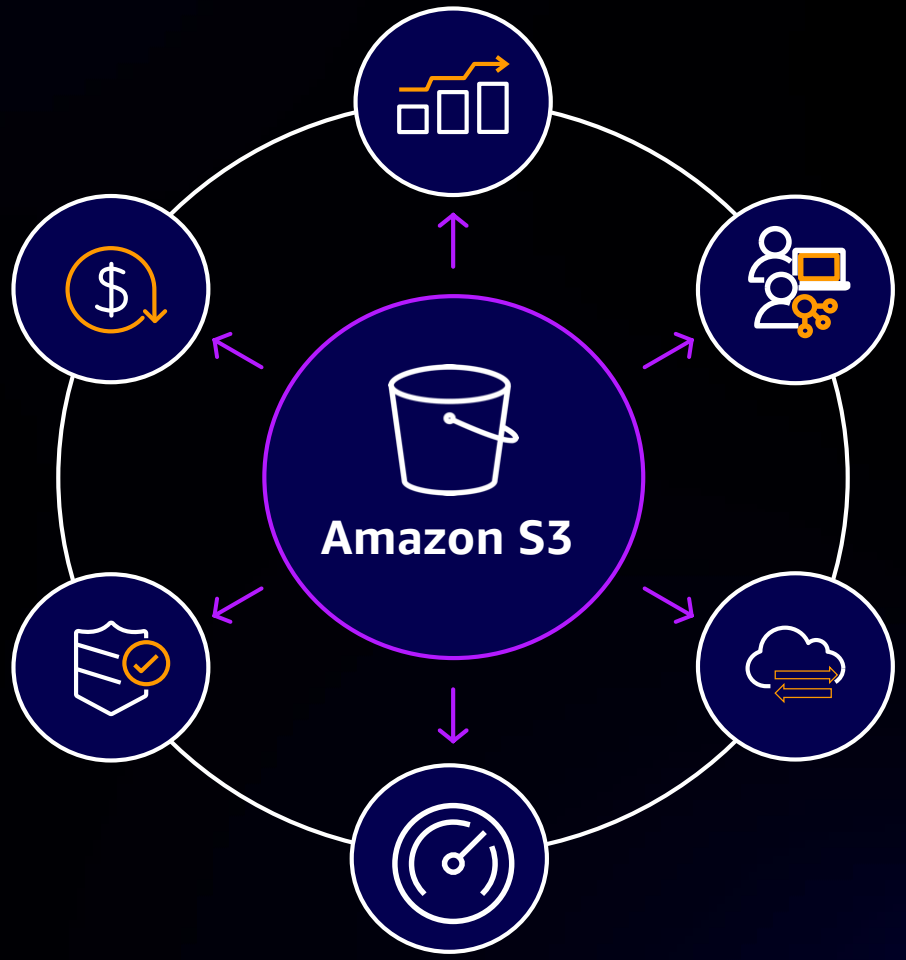
Why is this so hard?



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Amazon S3: So you can focus on your business

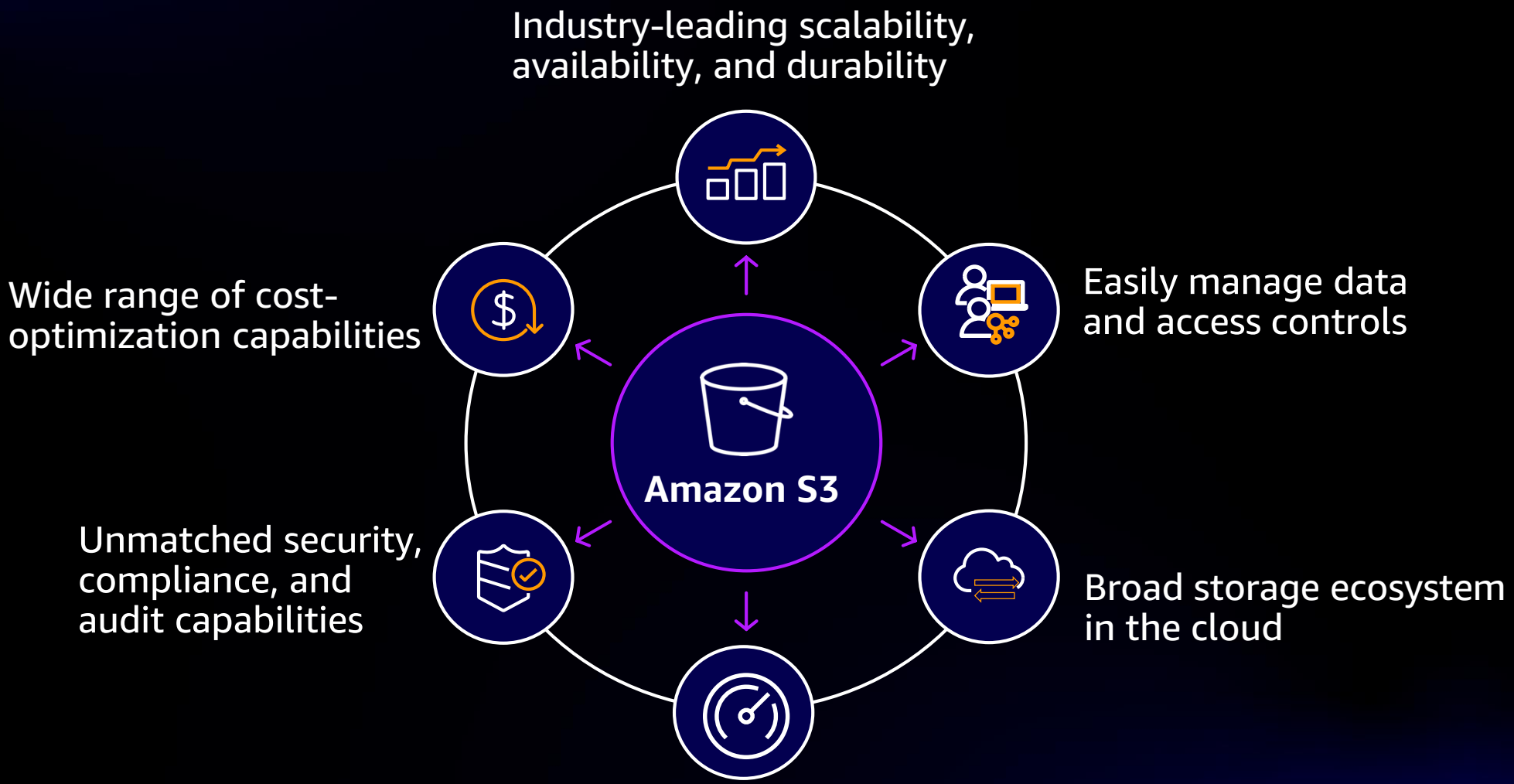
Business needs



Scale

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Amazon S3: So you can focus on your business



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Practical data lake design

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Practical data lake design



"Lift and shift" is **not always** the best approach

Consider **current** and **future** business needs

Decisions you make upfront **matter**

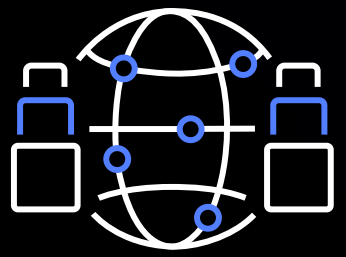
Placement, format, ingestion, access and more

Consider **ecosystem** integration

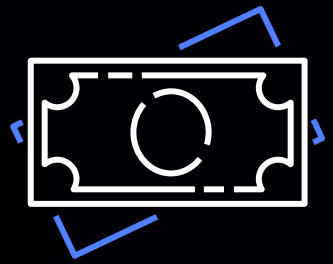
Design for security and compliance

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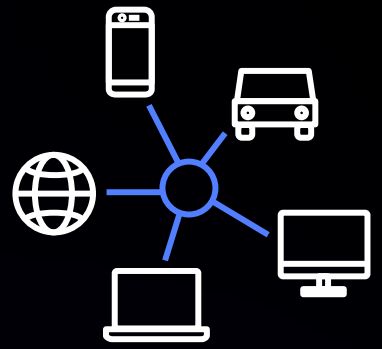
Practical data lake design



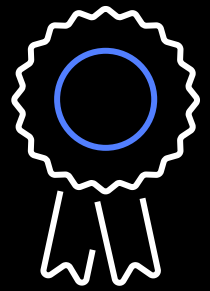
Scale



Cost



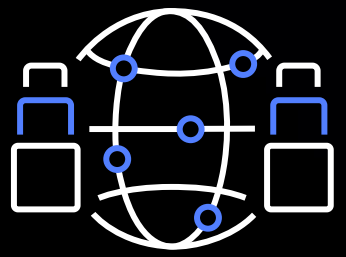
Ecosystem



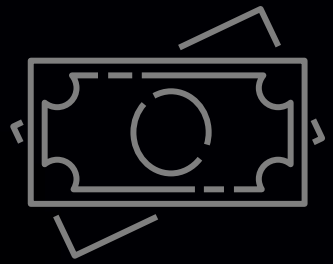
Security

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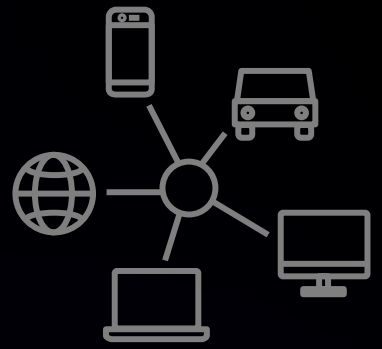
Practical data lake design



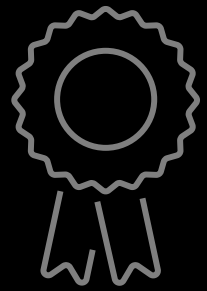
Scale



Cost



Ecosystem



Security

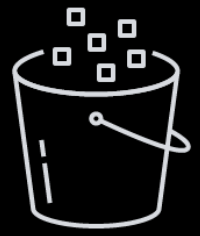
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Organize your data at scale

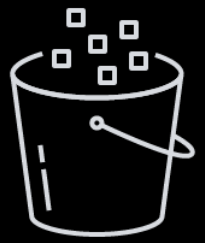


Account

Buckets



Bucket1



Bucket2

Prefixes

Bucket1/internal/usage/
Bucket1/internal2/billing
Bucket1/internal3/free/usage

Bucket2/model1/inference
Bucket2/model2/inference
Bucket2/predictions/prod

Object Tags

Department = Finance
Team = Business Reporting
Classification = Confidential

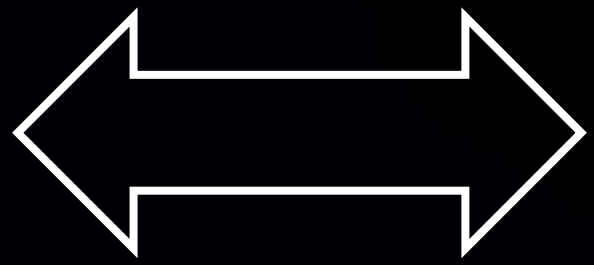
Department = Marketing
Team = Data Science
Classification = Confidential

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Prefix design for scale

3,500

PUT/COPY/POST/DELETE



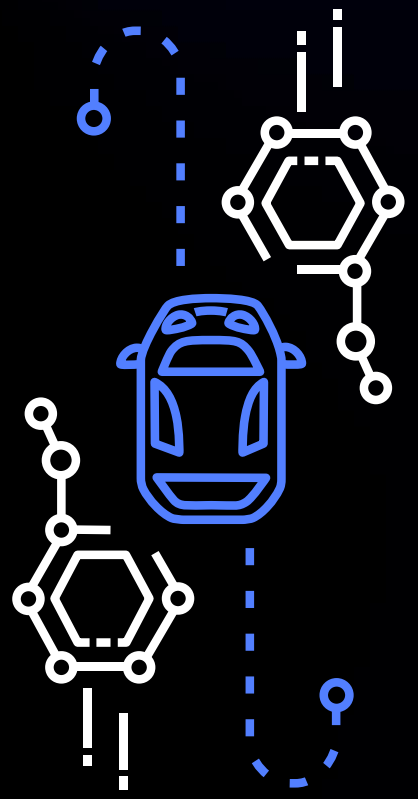
5,500

GET/HEAD

Per prefix

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Example: Autonomous vehicles



1. A bunch of instrumented cars are sitting at a central location
2. Every day they embark, drive around, and collect a bunch of data
3. Return home (at about the same time) and upload all of the data that they collected into the data lake

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Example: Autonomous vehicles



/daily-uploads/<date>/<car>/drive-data

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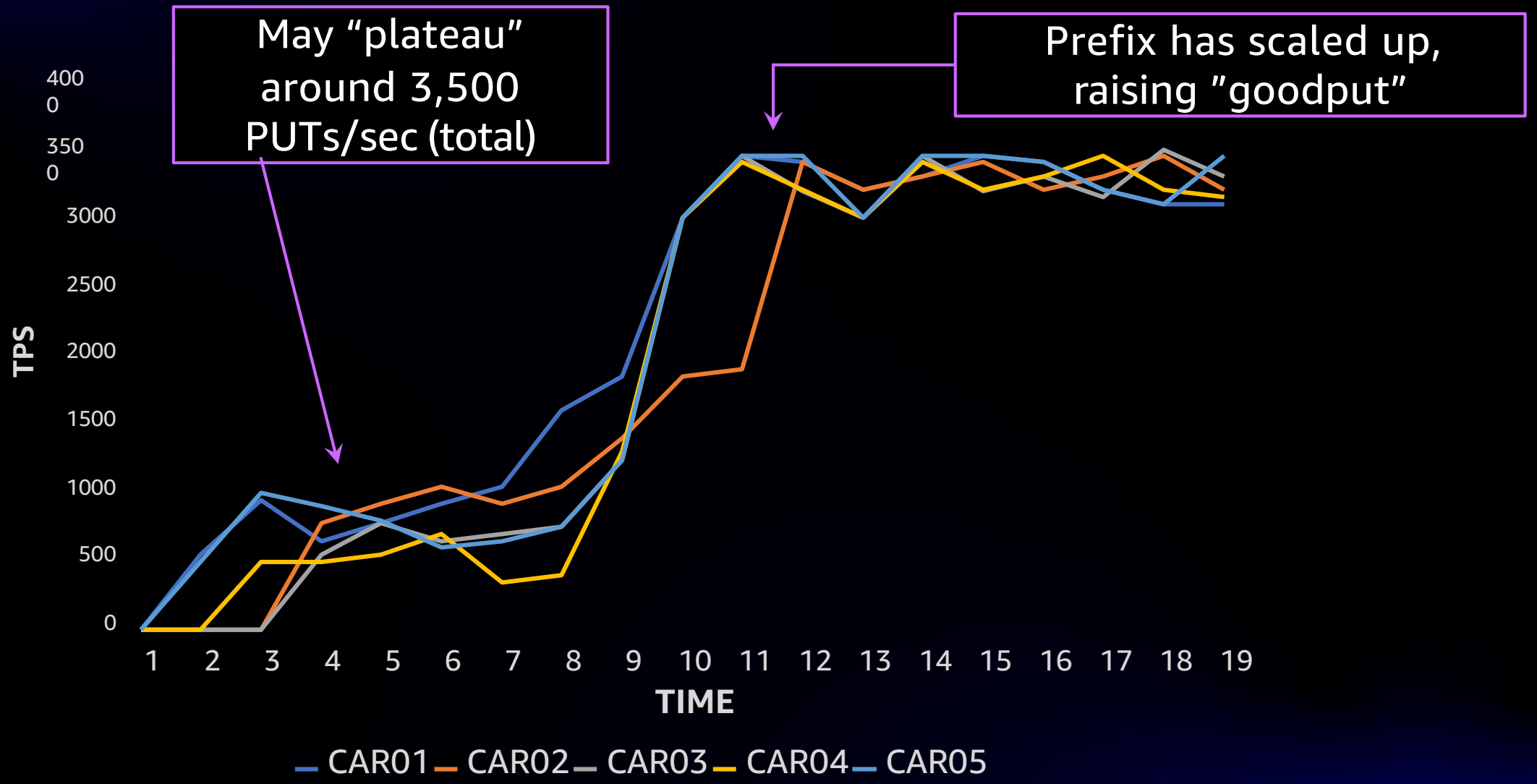
Example: Autonomous vehicles



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Example: Autonomous vehicles



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Example: Autonomous vehicles



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Example: Autonomous vehicles



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/daily-uploads/dd/20211006/CAR07/drive-data
/daily-uploads/ca/20211006/CAR05/drive-data
/daily-uploads/25/20211006/CAR01/drive-data
/daily-uploads/11/20211006/CAR02/drive-data
/daily-uploads/27/20211006/CAR07/drive-data
/daily-uploads/ef/20211006/CAR05/drive-data
/daily-uploads/fd/20211006/CAR01/drive-data
/daily-uploads/10/20211006/CAR02/drive-data
/daily-uploads/01/20211006/CAR07/drive-data

Entropy added to the start of the prefix

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Prefix design for scale



- Avoid bursty workloads **on the same prefix**
- For date-based prefixes under high TPS **consider**
  - Injecting “entropy” at the start
  - Changing the naming pattern
- Consider using product features that make this easier, such as **EXTERNAL TABLE/PARTITION**
- **Consider** using manifest-based formats

Design your **prefixes** and **workloads** intentionally

aws

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Object design: Size and formats matter

SIZE

Aim for large objects that are 2–16 MB+

- Reduces TPS on your prefixes
- Lowers cost on requests and storage management features
- Reduces data roundtrips

FORMAT

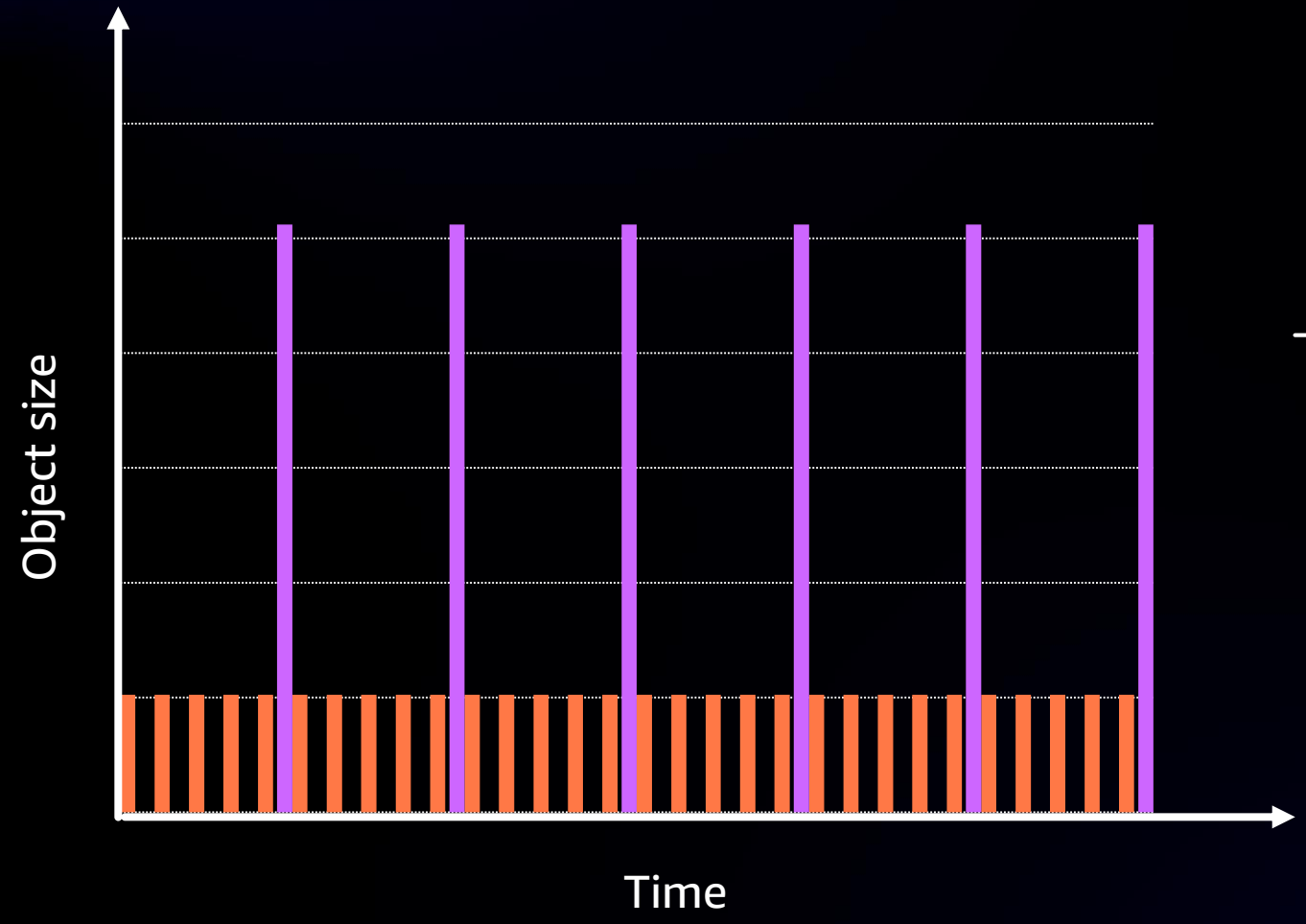
Carefully choose your formats

- Widely adopted formats tend to have a wider ecosystem
- Columnar formats: compact sizes, better performance, predicate pushdowns
- **Amazon S3 Select** natively supports a range of formats

aws

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Object design: Size vs. “freshness”



Consider the tradeoff:

One 5 MB object every **5** seconds

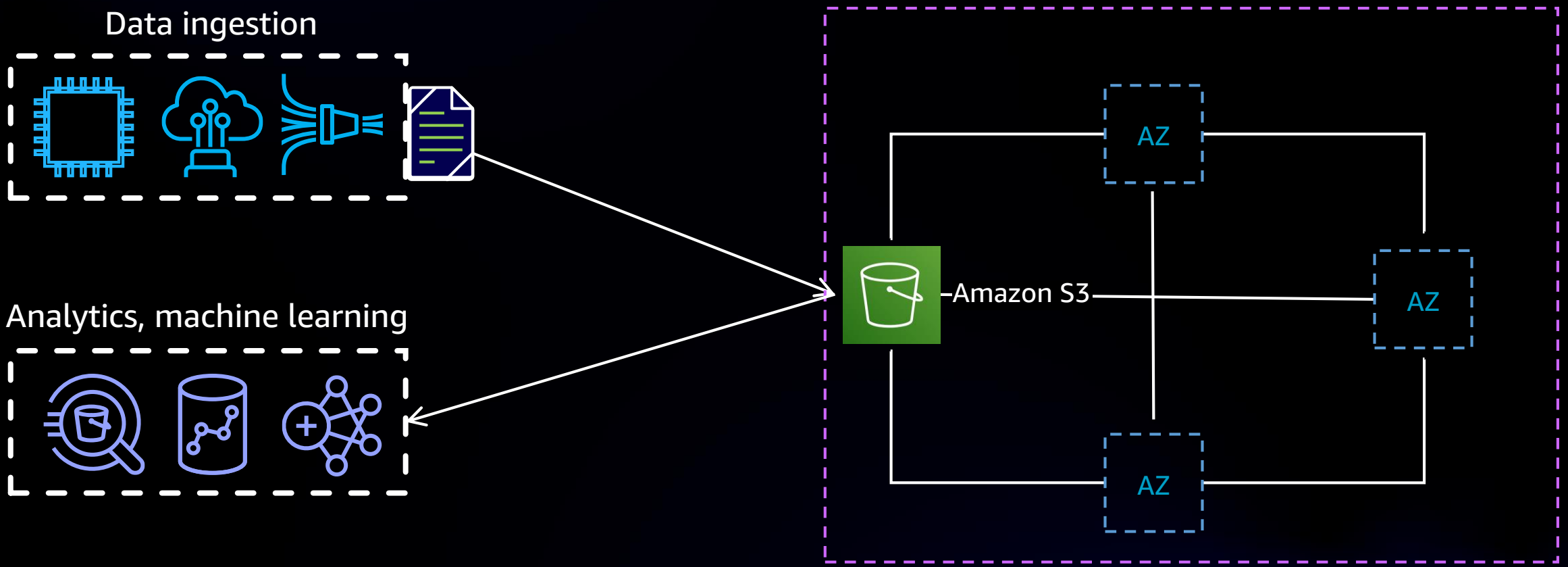
vs.

One 1 MB object every **1** second

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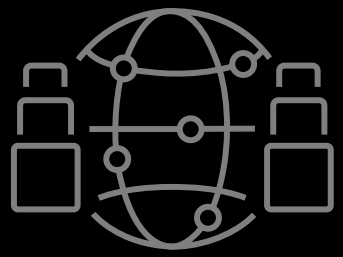
Amazon S3 strong consistency

Launched November 2020

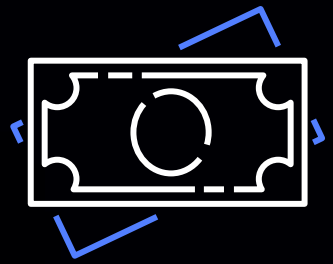


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Practical data lake design



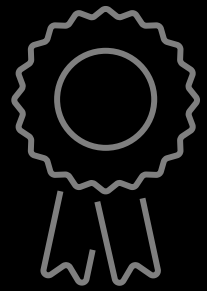
Scale



Cost



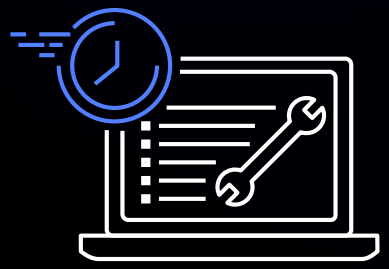
Ecosystem



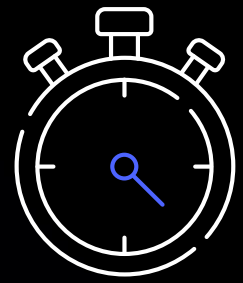
Security

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Choose a storage class for your data



Access pattern



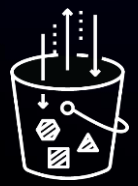
Duration of storage

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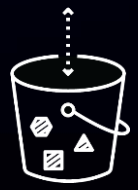
Choose a storage class for your data



S3 Intelligent-Tiering



S3 Standard



S3 Standard-IA

New



S3 Glacier Instant Retrieval



S3 Glacier Flexible Retrieval (formerly S3 Glacier)



S3 Glacier Deep Archive



S3 One Zone-IA



S3 Outposts

AWS Region ≥ 3 Availability Zones

Changing access patterns

- Milliseconds access
- No retrieval charge
- **Archive Instant Access tier** New

Frequently accessed data

- Milliseconds access
- No retrieval charge

Infrequently accessed data

- Milliseconds access
- Per-GB retrieval charge

Rarely accessed data

- Milliseconds access
- Per-GB retrieval charge

Archive data

- Retrieval options from minutes to hours
- **Free bulk retrievals** New

Long-term archive data

- Retrieval in hours

AWS AZ

Re-creatable, infrequently accessed data

- Milliseconds access
- Per-GB retrieval charge

AWS Outposts

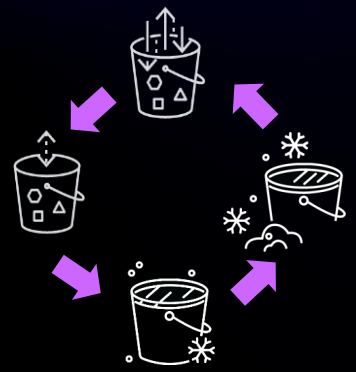
On-premises data

- Milliseconds access

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Choose the option that works best for you



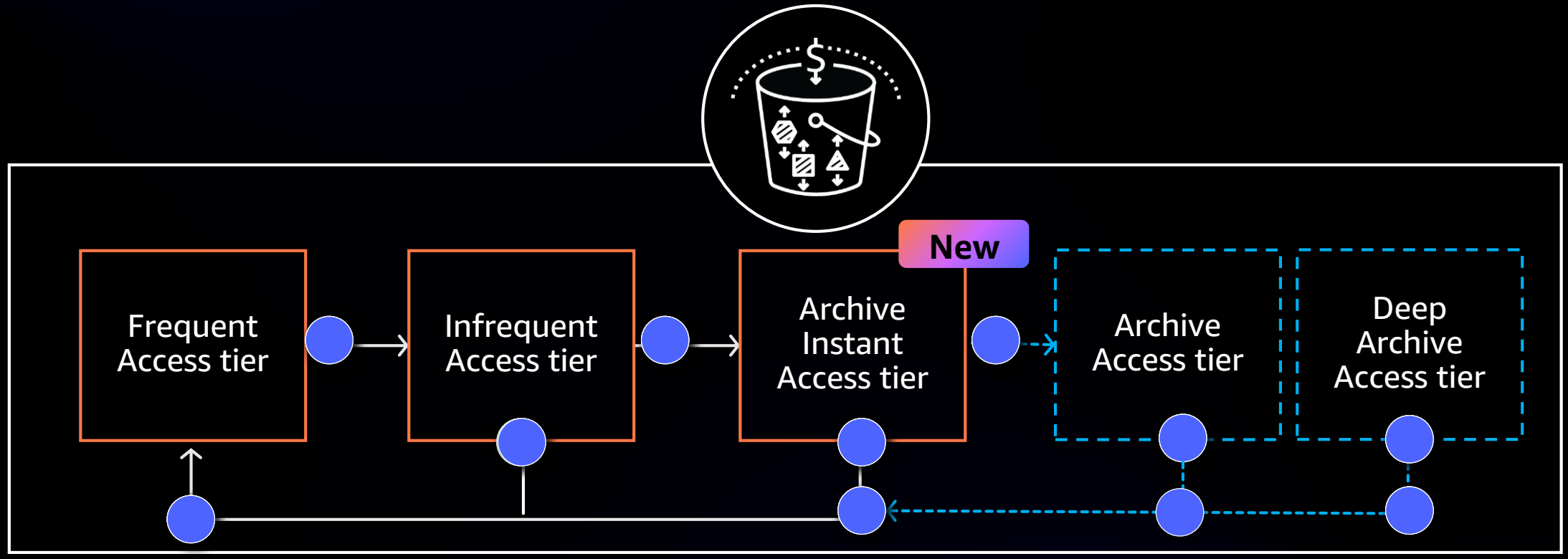
S3 Lifecycle to transition to different storage classes



S3 Intelligent-Tiering with Frequent, Infrequent, Archive, Deep Archive, and now Archive Instant access tiers

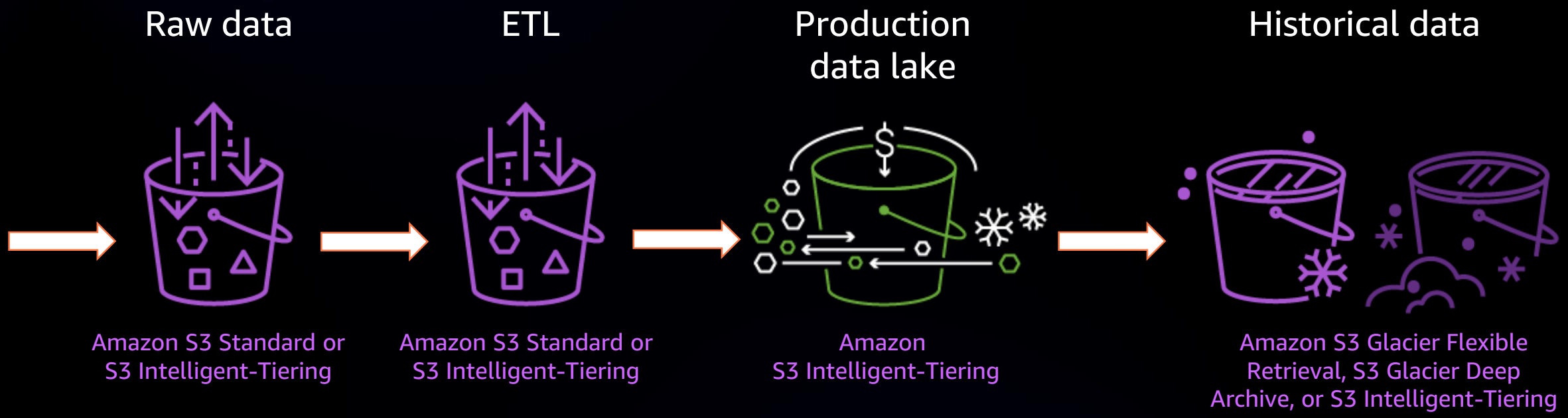
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Use S3 Intelligent-Tiering for data with unknown or changing access patterns



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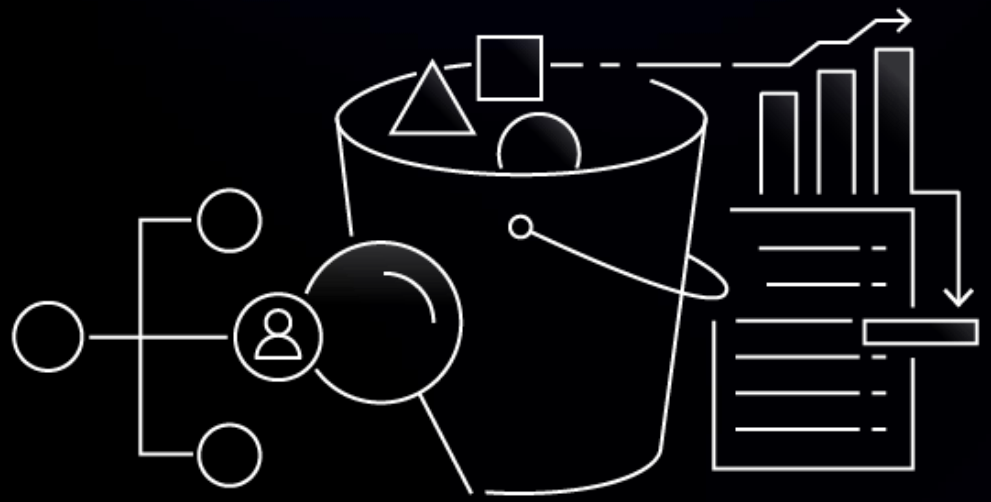
Choose a storage class for your data



Optimize storage cost and performance for all stages of a data lake workflow

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Amazon S3 Storage Lens

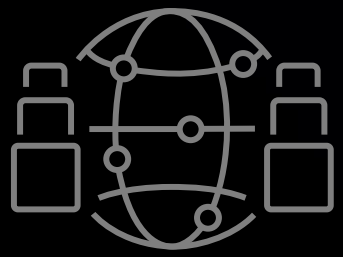


Launched November 2020

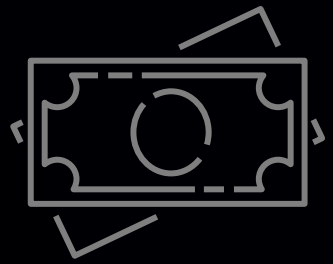
- Organization-wide visibility
- 29+ storage usage & activity metrics
- Drill down by Region, storage class, bucket, and prefix
- Recommendations for cost efficiency & data protection best practices
- Integrated S3 console experience
- **Amazon CloudWatch Publishing** New

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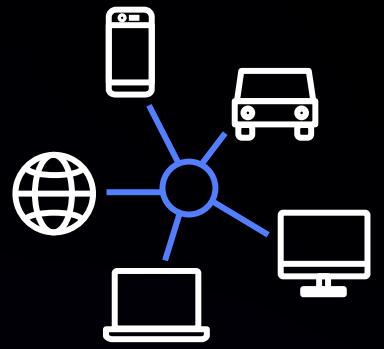
Practical data lake design



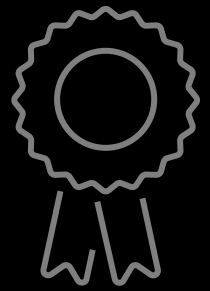
Scale



Cost



Ecosystem



Security

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Ingest
Prepare
Analyze

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AWS services: Ingest



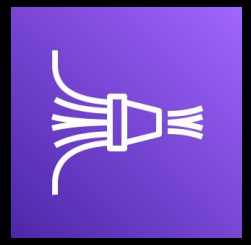
Amazon S3

- Direct PUTs or multi-part uploads



AWS Lambda

- Transformation on PUT



Amazon Kinesis

- Streaming into S3
- Flexible buffering

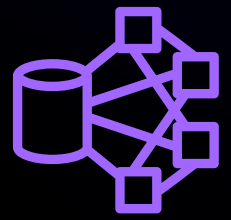


AWS DataSync

- Online data transfer
- Wide range of sources
- Scales to terabytes

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AWS services: ETL and catalog



Amazon EMR

- Batch or stream ETL



AWS Lambda

- Transformation on Amazon S3 PUT
- Serverless



AWS Glue

- Managed ETL
- AWS Glue Studio
- Serverless

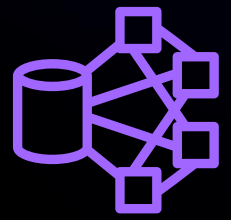


AWS Glue Catalog

- Catalog services
- Crawling support
- Serverless

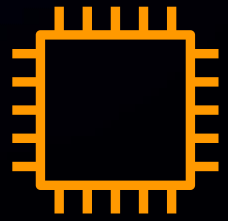
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AWS services: Analyze



Amazon EMR

- Hadoop-style workloads
- **Optimized for Amazon S3**
- **Supports Amazon S3 Select**



Third-party analytics on Amazon EC2

Consider S3A-optimized committers



Amazon Athena

- Interactive query
- Based on Presto
- Serverless



Amazon Redshift

- Data warehousing

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AWS services: even more!



Amazon FSx for Lustre

- File system view
- Integrates with S3
- HPC workloads



Amazon S3 File Gateway

- File system view
- SMB, NFS
- HPS workloads



Amazon SageMaker

- Machine Learning



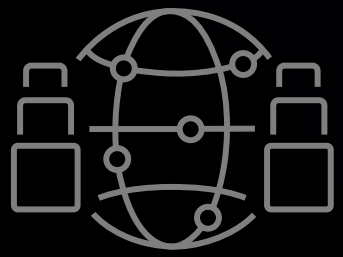
Amazon OpenSearch Service

- Search, visualize
- Amazon Lambda to index your data

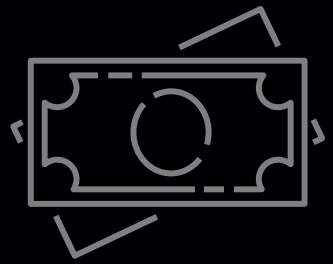
aws

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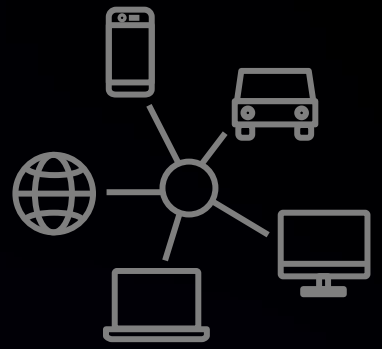
Practical data lake design



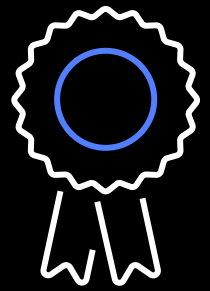
Scale



Cost



Ecosystem

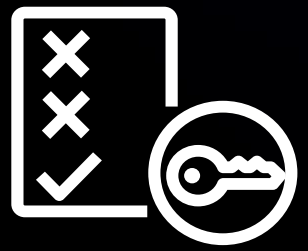


Security

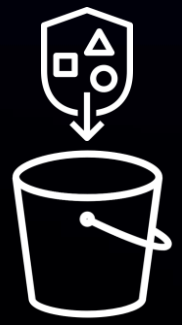
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Secure your data lake

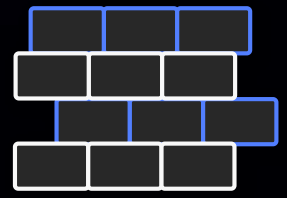
DATA STORED IN AMAZON S3 IS SECURE BY DEFAULT



Access control with IAM and bucket policy

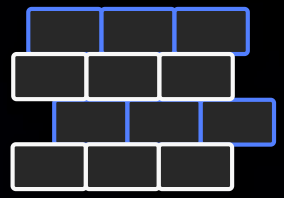


Amazon S3 Access Points



Amazon S3 Block Public Access

New



Amazon S3 Object Ownership



Amazon S3 Access Analyzer

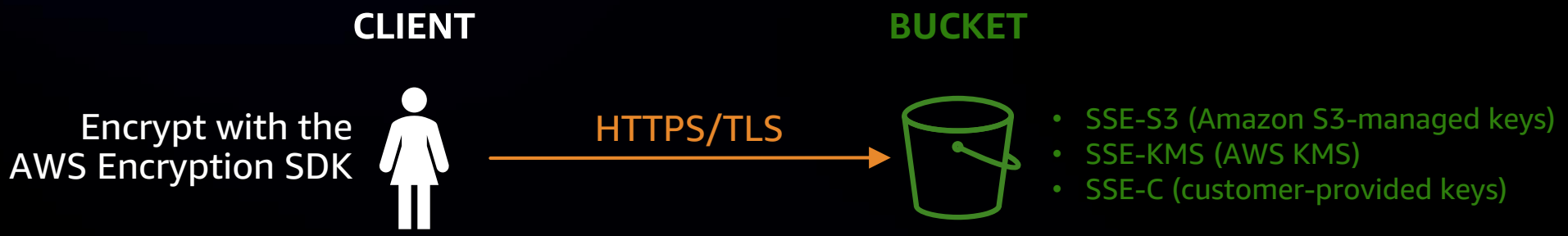


Amazon S3 Object Lock

aws

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Amazon S3 encryption support



1 Client-side

2 In transit

3 At rest

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Secure infrastructure: Certifications

CSA
Cloud Security Alliance Controls

ISO 9001
Global Quality Standard

ISO 27001
Security Management Controls

ISO 27017
Cloud Specific Controls

ISO 27018
Personal Data Protection

PCI DSS Level 1
Payment Card Standards

SOC 1
Audit Controls Report

SOC 2
Security, Availability & Confidentiality Report

SOC 3
General Controls Report

Financial Industry Information Systems

IRAP [Australia]
Australian Security Standards

K-ISMS [Korea]
Korean Information Security

MTCS Tier 3 [Singapore]
Multi-Tier Cloud Security Standard

My Number Act [Japan]
Personal Information Protection

United States

CJIS
Criminal Justice Information Services

DoD SRG
DoD Data Processing

FedRAMP
Government Data Standards

FERPA
Educational Privacy Act

ISO FFIEC
Financial Institutions Regulation

FIPS
Government Security Standards

FISMA
Federal Information Security Management

GxP
Quality Guidelines and Regulations

HIPAA
Protected Health Information

ITAR
International Arms Regulations

MPAA
Protected Media Content

NIST
National Institute of Standards and Technology

SEC Rule 17a-4(f)
Financial Data Standards

VPAT/Section 508
Accountability Standards

Europe

C5 [Germany]
Operational Security Attestation

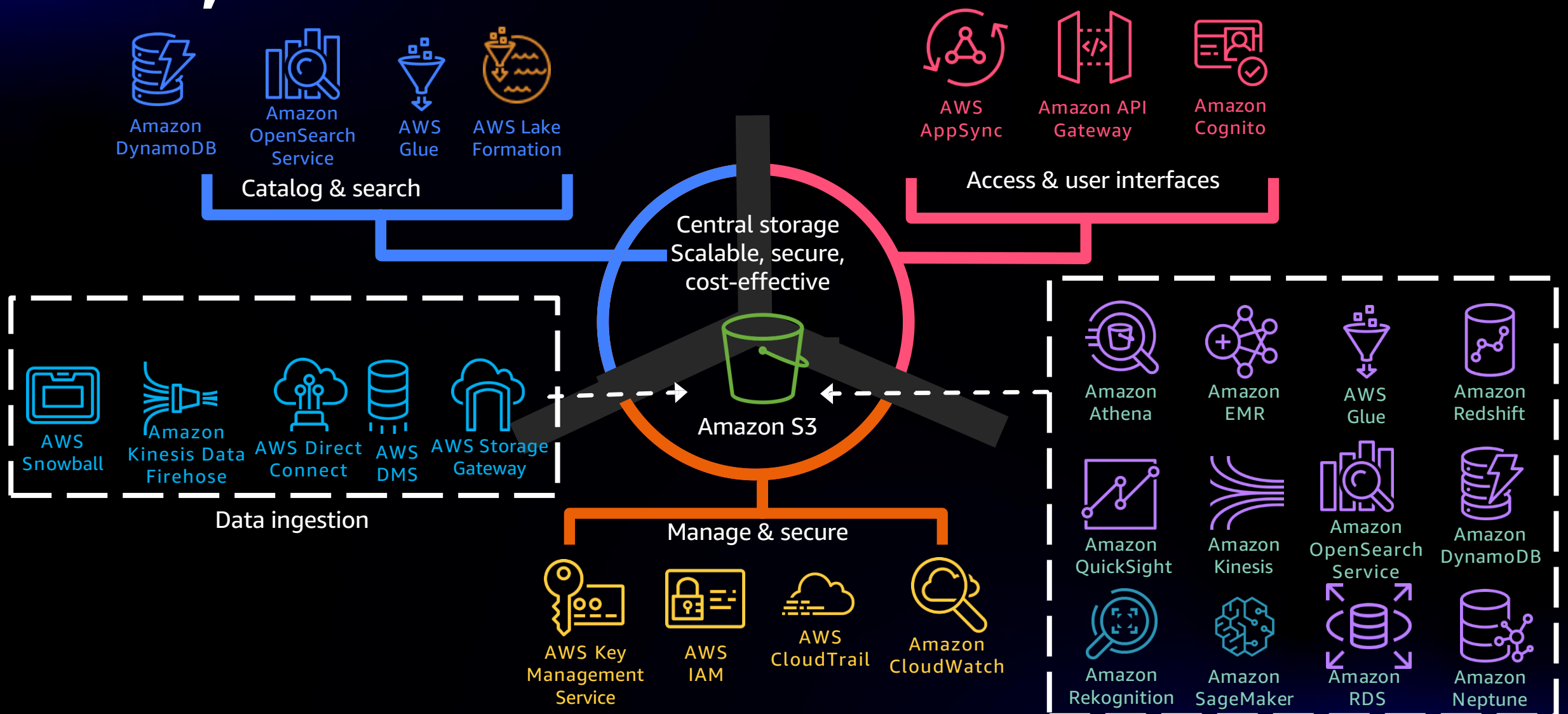
Cyber Essentials Plus [UK]
Cyber Threat Protection

G-Cloud [UK]
UK Government Standards

IT-Grundschutz [Germany]
Baseline Protection Methodology

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Much, much more



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Practical data lake design



"Lift and shift" is **not always** the best approach

Consider **current** and **future** business needs

Decisions you make upfront **matter**

Placement, format, ingestion, access and more

Consider **ecosystem** integration

Design for security and compliance

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Thank you!

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