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DEEP DIVE ON OBJECT STORAGE: AMAZON S3 AND AMAZON GLACIER

Adrian Hornsby, Technical Evangelist @ AWS

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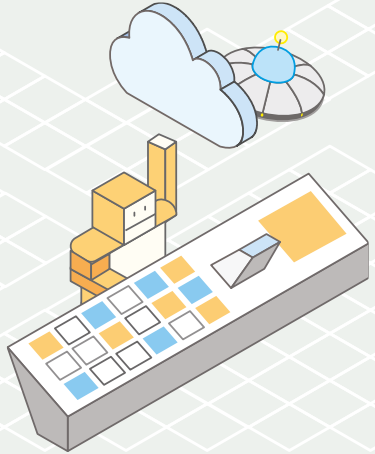
Email: adhorn@amazon.com



- Technical Evangelist, Developer Advocate,
  … Software Engineer
- Own bed in Finland
- Previously:
  - Solutions Architect @AWS
  - Lead Cloud Architect @Dreambroker
  - Director of Engineering, Software Engineer, DevOps, Manager, ... @Hdm
  - Researcher @Nokia Research Center
  - and a bunch of other stuff.
- Climber, like Ginger shots.

What to Expect from the Session

- What you need to know about S3 on AWS.
- Architectural design patterns with S3.
- Best practices & tips.
- Tools to help you.

Amazon S3 in 2006

Announcing Amazon S3 - Simple Storage Service

Posted On: Mar 13, 2006

Amazon S3 is storage for the Internet. It is designed to make web-scale computing easier for developers. Amazon S3 provides a simple web services interface that can be used to store and retrieve any amount of data, at any time, from anywhere on the web. It gives any developer access to the same highly scalable, reliable, fast, inexpensive data storage infrastructure that Amazon uses to run its own global network of web sites.

Amazon S3 today

Amazon S3 holds trillions of objects and regularly peaks at millions of requests per second.

(1,000,000,000,000; one million million; 10^{12}; SI prefix: tera-), ..American and British English
(1,000,000,000,000,000,000; one million million million; 10^{18}; SI prefix: exa-), ..non-English-speaking countries

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

Netflix delivers billions of hours of content from Amazon S3.

SmugMug stores billions of photos and images on Amazon S3.

Airbnb handles over 10PB of user images on Amazon S3.

Soundcloud currently stores 2.5 PB of data on Amazon Glacier.

Nasdaq uses Amazon S3 to support years of historical tick data down to the millisecond.

We currently log 20 terabytes of new data each day, and have around 10 petabytes of data in S3. (2014)

FINRA stores over 700 TB of data on Amazon S3 for low cost, durable, scalable storage and uses Amazon EMR for scalable compute workloads using Hive, Presto, and Spark.

Sony moved over 1M hours of video from magnetic tape to Glacier for digital preservation.

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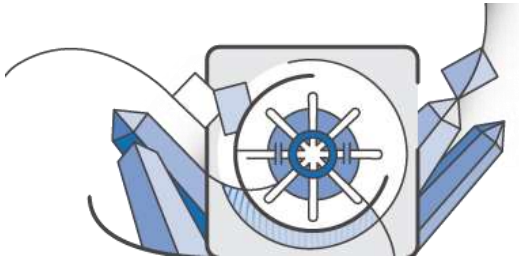
Choice of storage classes on S3

Standard

Standard - Infrequent Access



Amazon Glacier

Choice of storage classes on S3

S3 Standard

- Big data analysis
- Content distribution
- Static website hosting

Standard - IA

- Backup & archive
- Disaster recovery
- File sync & share
- Long-retained data

Amazon Glacier

- Long term archives
- Digital preservation
- Magnetic tape replacement

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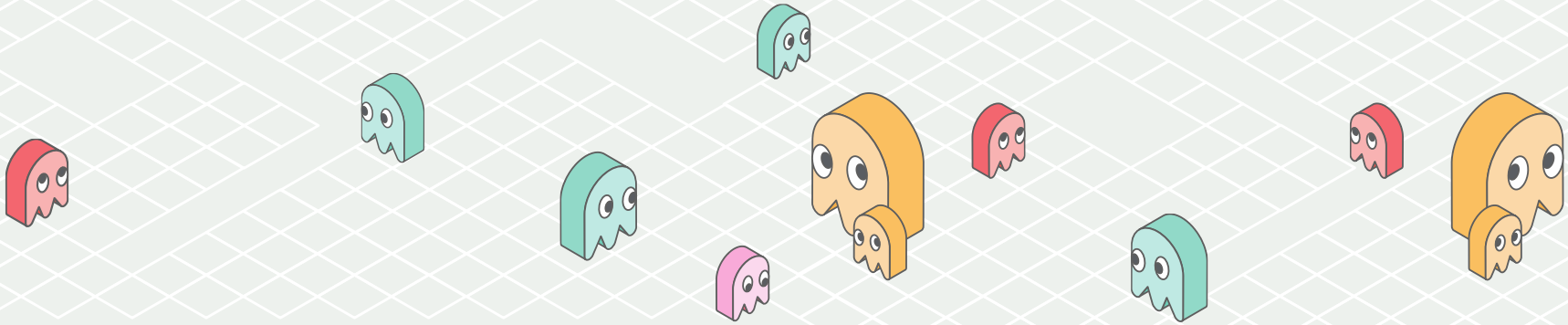
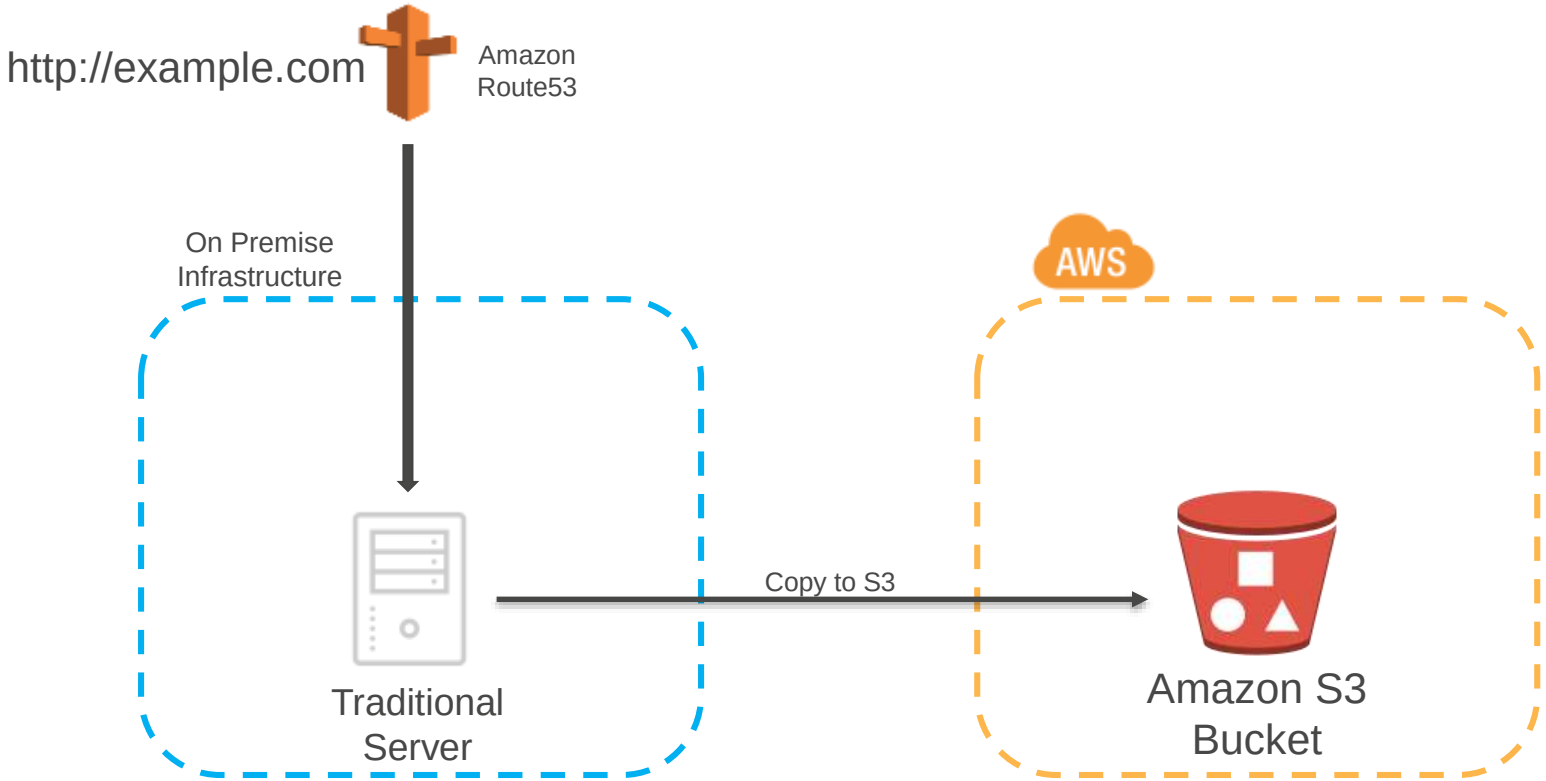
Disaster Recovery & Backups



Back up data to Amazon S3



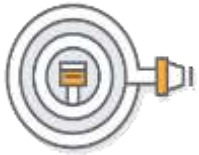
Data collection into Amazon S3

AWS Direct Connect

AWS Snowball

ISV Connectors

AWS Snowball Edge



Amazon Kinesis Firehose

S3 Transfer Acceleration

AWS Storage Gateway

AWS Snowmobile

Fun fact

Since October 2015, AWS Snowball has moved over

5 billion objects into Amazon S3, and AWS Snowball appliances have traveled a distance equal to circling the world more than 100 times.

Exabyte-scale data transfer

up to 100PB per Snowmobile

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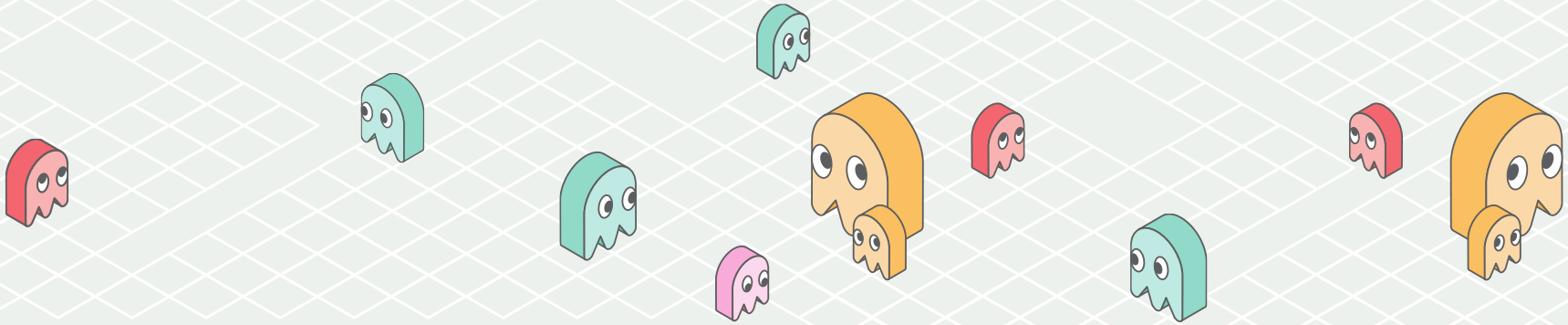
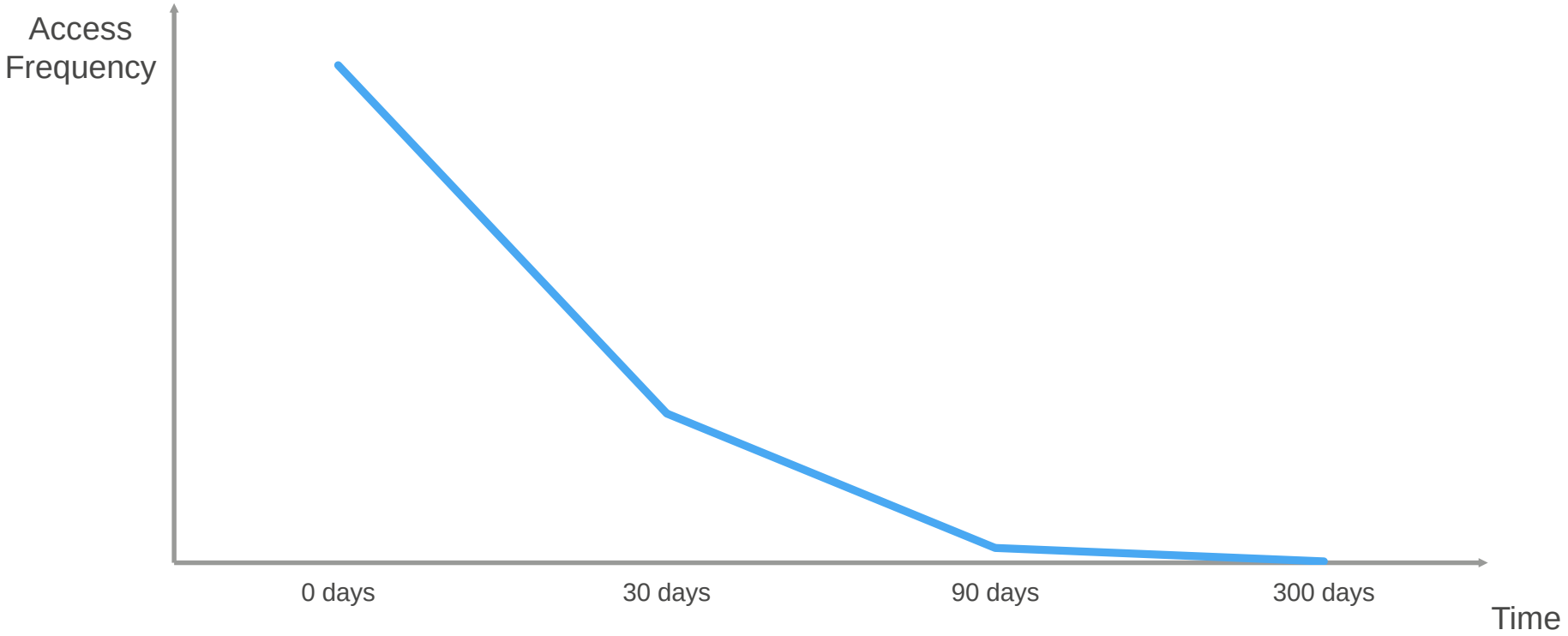
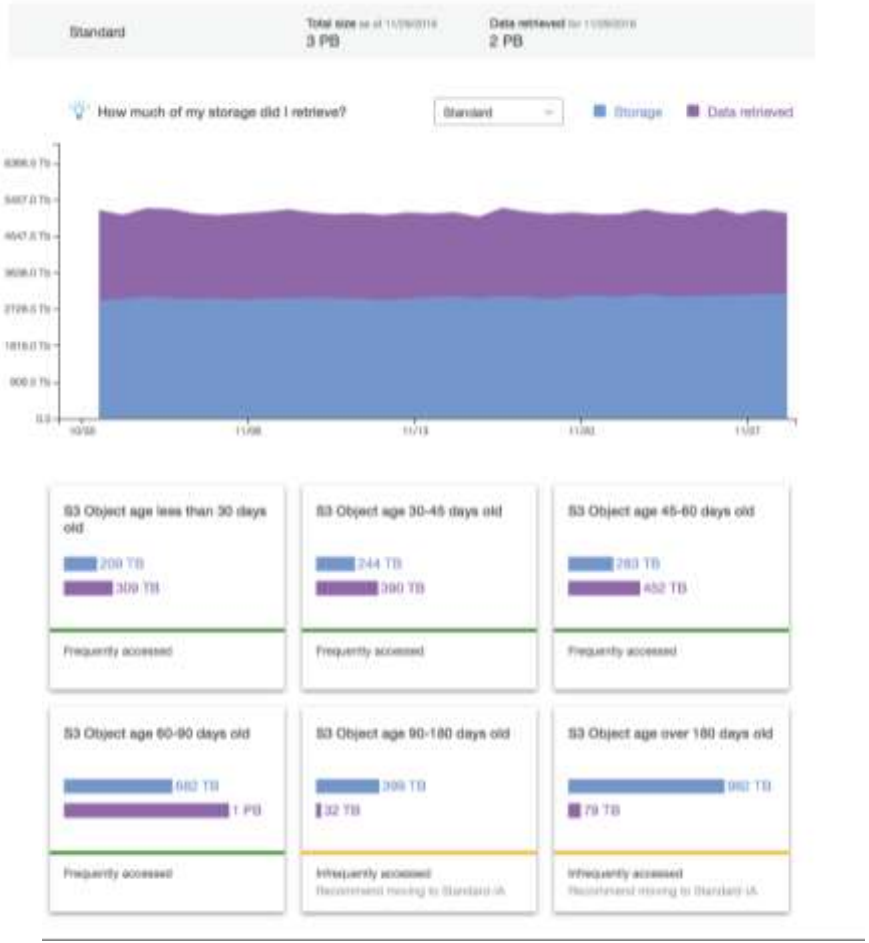
Archiving



Data access pattern.

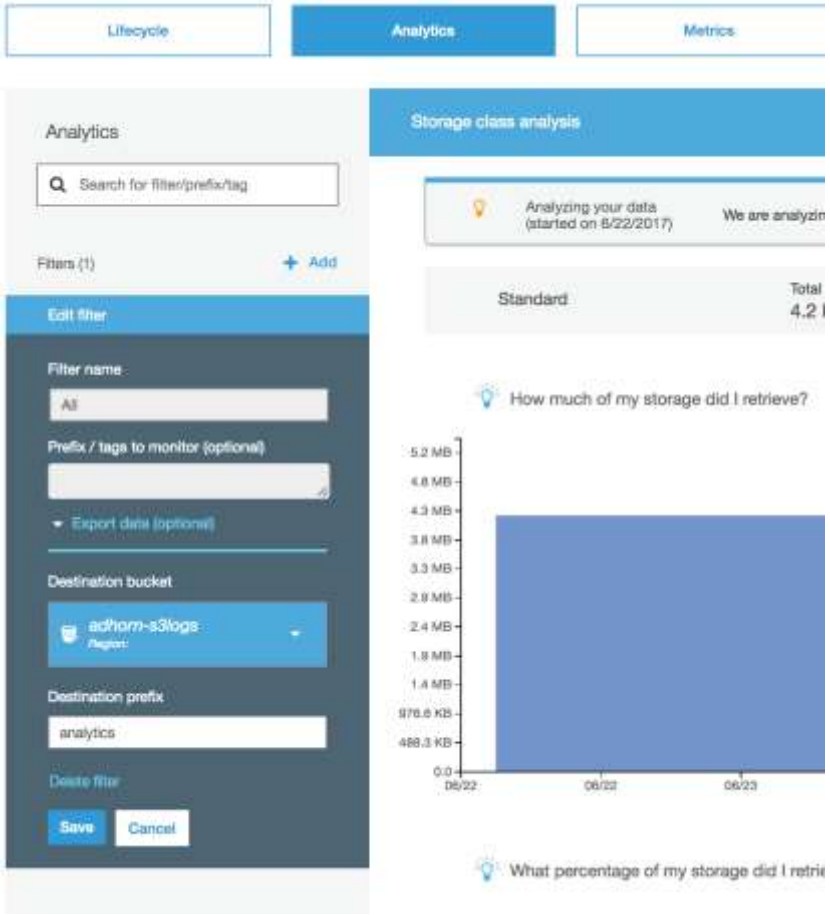


S3 Analytics



- Visualize the access pattern.
- Measure the object age.
- By bucket, prefixes or tag.
- Analysis based lifecycle policy.

Export S3 Analytics



TIBCO™

MicroStrategy

Amazon Storage Partner Solutions

Primary Storage

Solutions that leverage file, block, object, and streamed data formats as an extension to on-premises storage

AVERE
ctera
NetApp
panzura
SoftNAS
ZADARA STORAGE

Backup and Recovery

Solutions that leverage Amazon S3 for durable data backup

COMMVAULT
Cloudberry
druva
DELL EMC
IBM
NetApp
VERITAS

Archive

Solutions that leverage Amazon Glacier for durable and cost-effective long-term data backup

COMMVAULT
NetApp
sonian
VERITAS

aws.amazon.com/backup-recovery/partner-solutions/
Note: Represents a sample of storage partners

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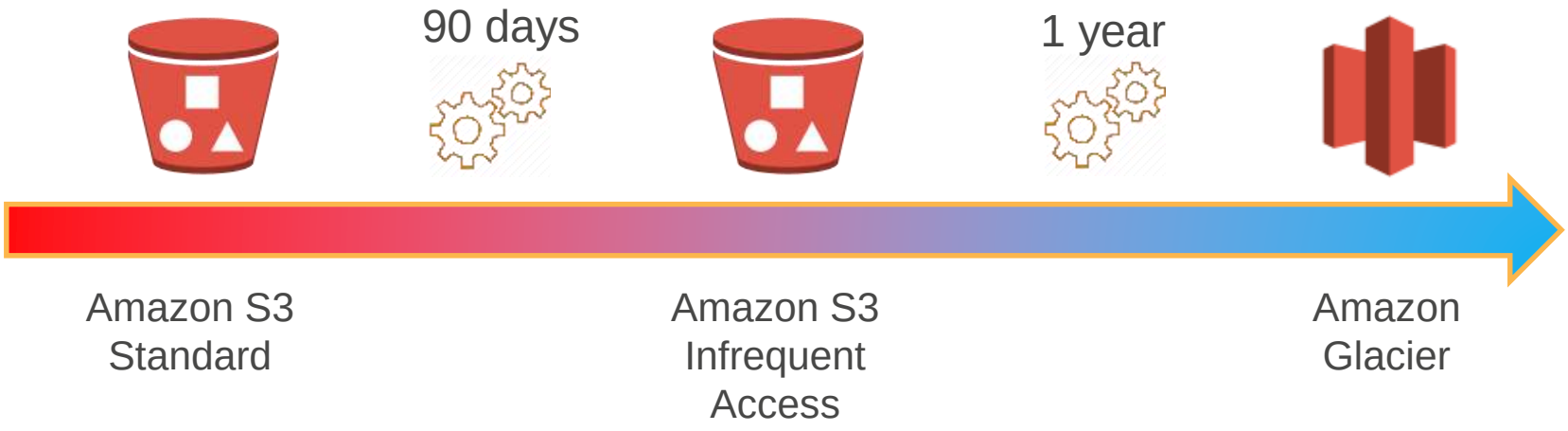
Automate Lifecycle policies

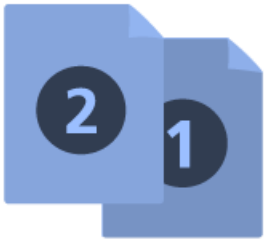
Transition



Automate Lifecycle policies

Deletion

Protect your data from the “oups”



**default

** versioning-enabled

** suspended

Versioning

- Protects from:
  - unintended user deletes
  - application failures
- New version with every upload
- Easy retrieval
- Roll back to previous versions

MFA

Protection on delete

(multi-factor authentication)

- Requires additional authentication to:
  - Change the versioning state of your bucket
  - Permanently delete an object version

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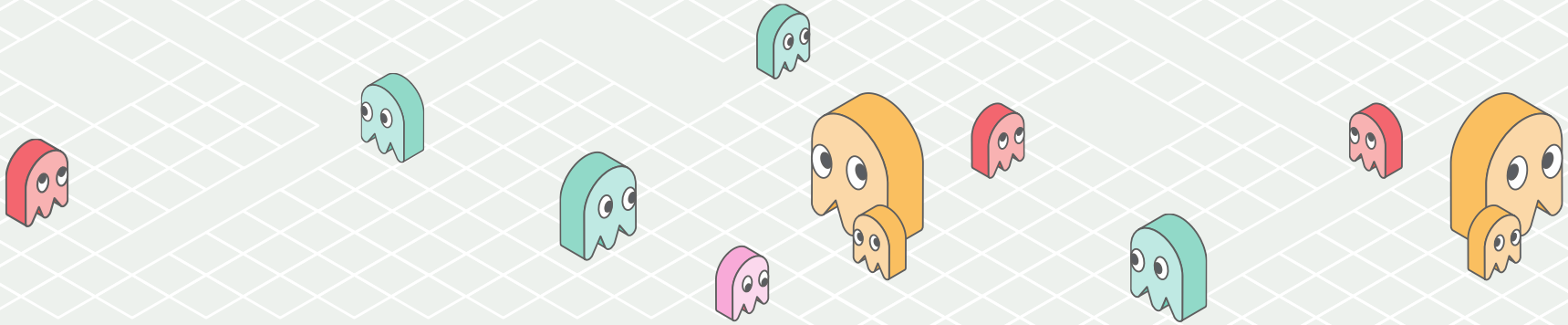
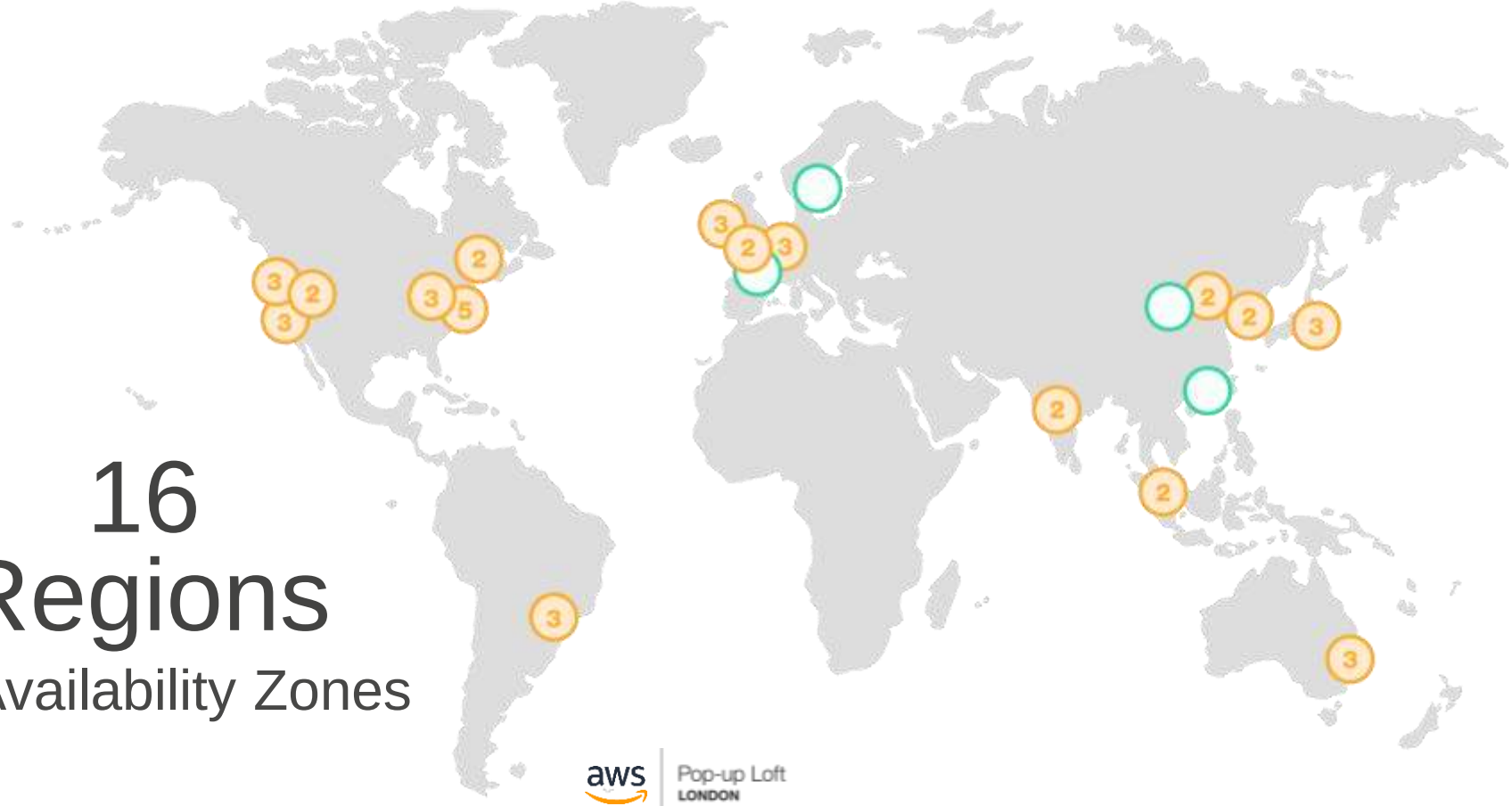
Content Storage & Distribution



AWS Global Infrastructure

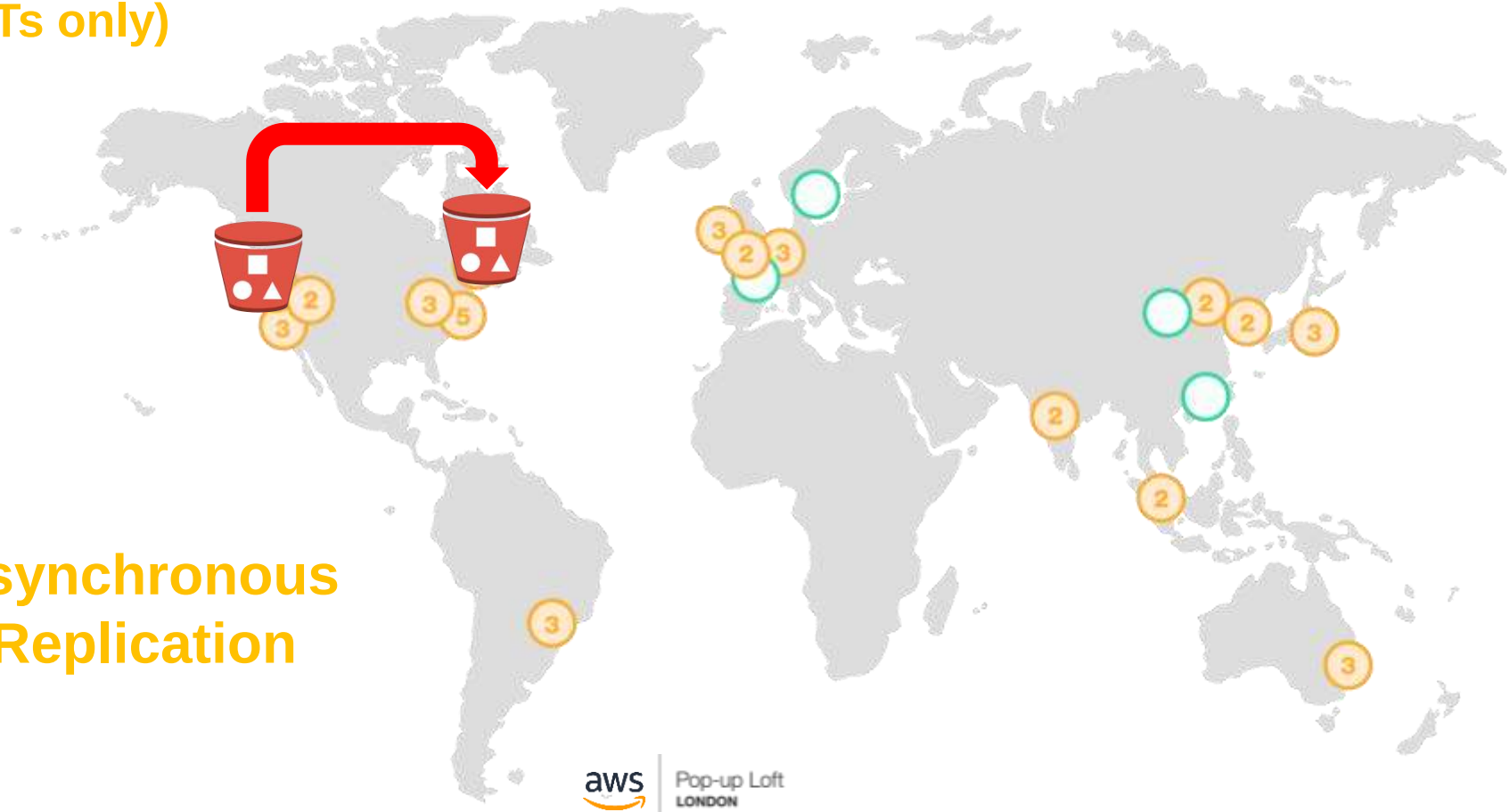


16
Regions

44 Availability Zones

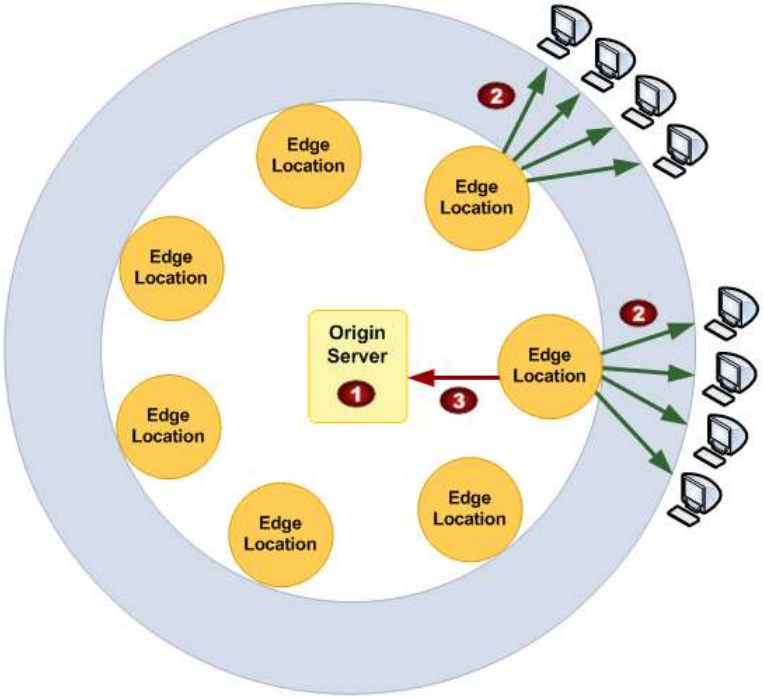
Cross region replication

(PUTs only)



Asynchronous Replication

Amazon CloudFront (CDN)

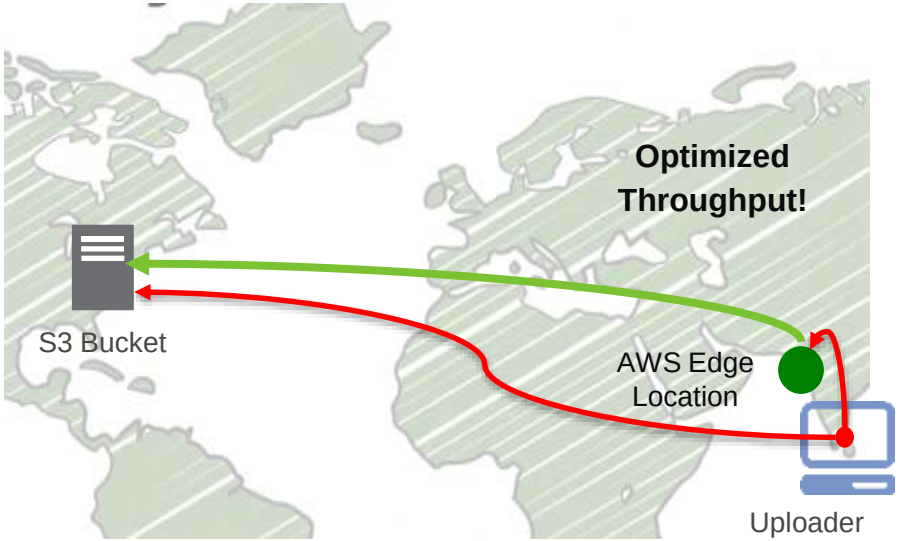


- Cache content at the edge.
- Lower load on origin.
- Dynamic and static content.
- Custom SSL certificates
- Low TTLs

Faster upload over long distances

S3 Transfer Acceleration

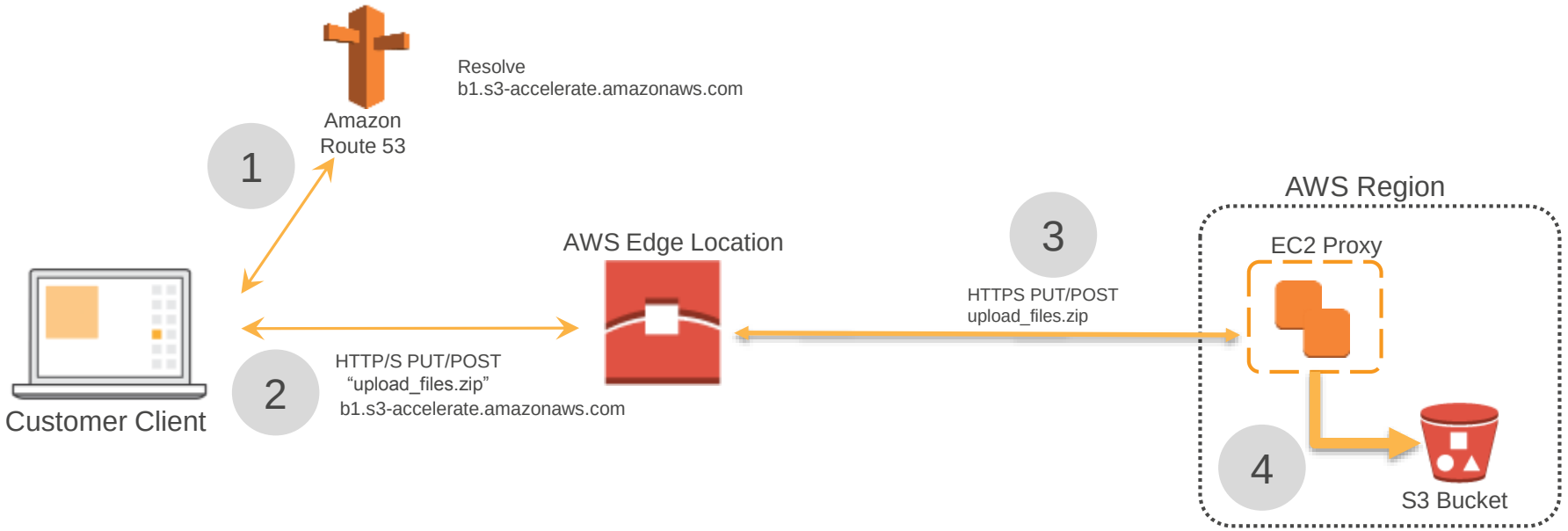
- Change your endpoint, not your code
- No firewall changes or client software
- Longer distance, larger files, more benefit
- Faster or free
- 82 global edge locations



Try it at S3speedtest.com

Service traffic flow

Client to S3 Bucket example



Upload speed comparison in the selected region

Virginia
(US-EAST-1) 21% faster

S3 Direct Upload Speed

Upload complete

S3 Accelerated Transfer Upload Speed

Upload complete

This speed checker uses multipart uploads to transfer a file from your browser to various Amazon S3 regions with and without Amazon S3 Transfer Acceleration. It compares the speed results and shows the percentage difference for every region.

Note: In general, the farther away you are from an Amazon S3 region, the higher the speed improvement you can expect from using Amazon S3 Transfer Acceleration. If you see similar speed results with and without the acceleration, your upload bandwidth or a system constraint might be limiting your speed.

Upload speed comparison in other regions

San Francisco
(US-WEST-1) 33% faster

S3 Direct Upload Speed

Upload complete

S3 Accelerated Transfer Upload Speed

Upload complete

Oregon
(US-WEST-2) 40% faster

S3 Direct Upload Speed

Upload complete

S3 Accelerated Transfer Upload Speed

Upload complete

Dublin
(EU-WEST-1) 0% faster

S3 Direct Upload Speed

Upload complete

S3 Accelerated Transfer Upload Speed

Upload complete

Frankfurt
(EU-CENTRAL-1) 3% faster

S3 Direct Upload Speed

Upload complete

S3 Accelerated Transfer Upload Speed

Upload complete

Tokyo
(AP-NORTHEAST-1) 104% faster

S3 Direct Upload Speed

Upload complete

S3 Accelerated Transfer Upload Speed

Upload complete

Seoul
(AP-NORTHEAST-2) 173% faster

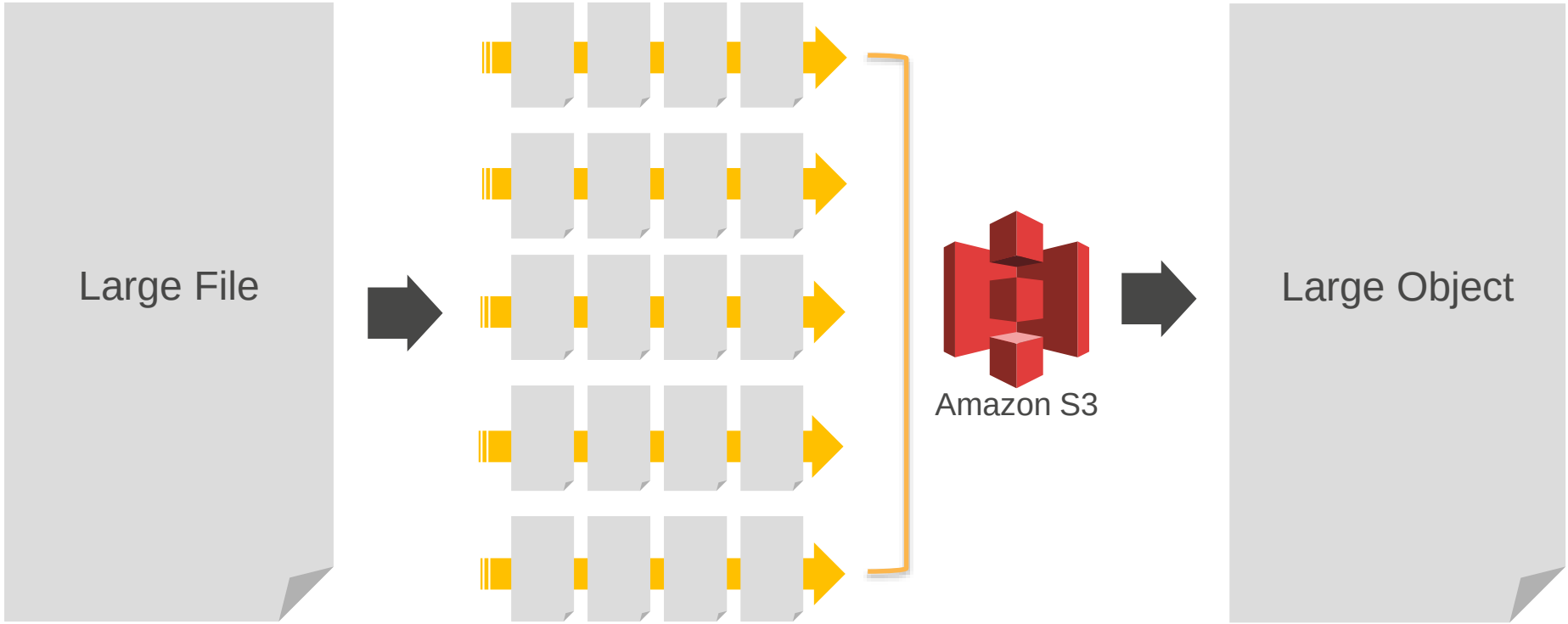
S3 Direct Upload Speed

Upload complete

S3 Accelerated Transfer Upload Speed

Upload complete

Multipart uploads/download for large objects



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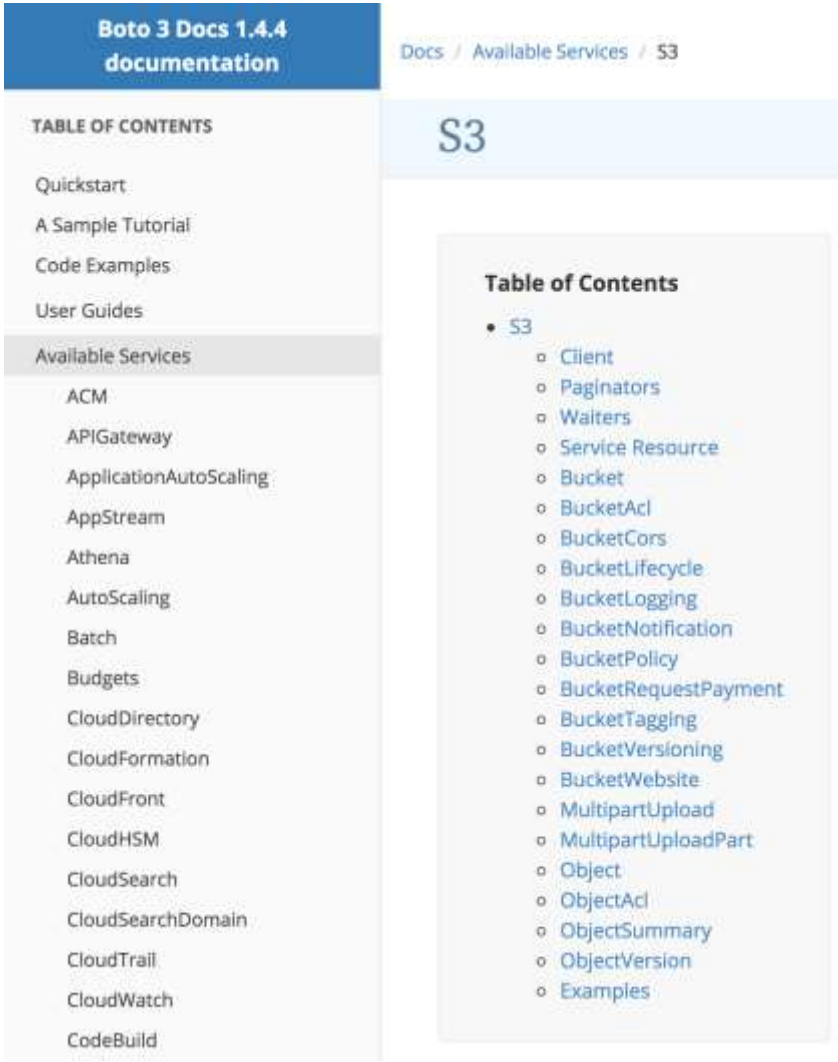
AWS SDKs

- *Automatically switching to multipart transfers when a file is over a specific size threshold*
- *Uploading/downloading a file in parallel*
- *Progress callbacks to monitor transfers*
- *Retries.*



Higher TPS by distributing key names

If you regularly exceed 100 TPS on a bucket

- Avoid starting with a date or monotonically increasing numbers

Don’t do this…

```
<my_bucket>/2013_11_13-164533125.jpg
<my_bucket>/2013_11_13-164533126.jpg
<my_bucket>/2013_11_13-164533127.jpg
<my_bucket>/2013_11_13-164533128.jpg
<my_bucket>/2013_11_12-164533129.jpg
<my_bucket>/2013_11_12-164533130.jpg
<my_bucket>/2013_11_12-164533131.jpg
<my_bucket>/2013_11_12-164533132.jpg
<my_bucket>/2013_11_11-164533133.jpg
<my_bucket>/2013_11_11-164533134.jpg
<my_bucket>/2013_11_11-164533135.jpg
<my_bucket>/2013_11_11-164533136.jpg
```

Distributing key names

Add randomness to the beginning of the key name

- E.g. with a hash or reversed timestamp (ssmmhhddmmyy)

```
<my_bucket>/521335461-2013_11_13.jpg
<my_bucket>/465330151-2013_11_13.jpg
<my_bucket>/987331160-2013_11_13.jpg
<my_bucket>/465765461-2013_11_13.jpg
<my_bucket>/125631151-2013_11_13.jpg
<my_bucket>/934563160-2013_11_13.jpg
<my_bucket>/532132341-2013_11_13.jpg
<my_bucket>/565437681-2013_11_13.jpg
<my_bucket>/234567460-2013_11_13.jpg
<my_bucket>/456767561-2013_11_13.jpg
<my_bucket>/345565651-2013_11_13.jpg
<my_bucket>/431345660-2013_11_13.jpg
```

Organize your data with object tags

Manage data based on what it is as opposed to where its located

Tags

Up to 10 tags per object

- Tag your objects with key-value pairs
- Write policies once based on the type of data
- Put object with tag or add tag to existing objects

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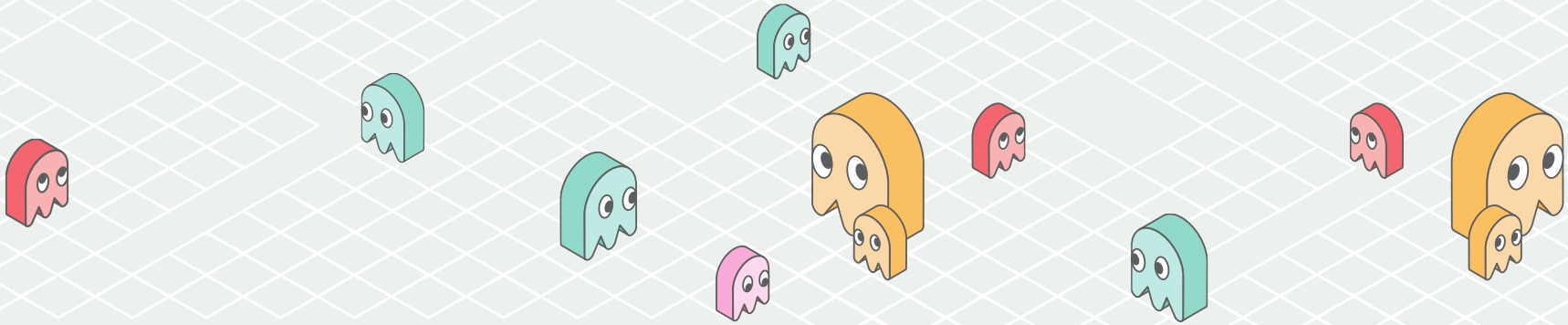
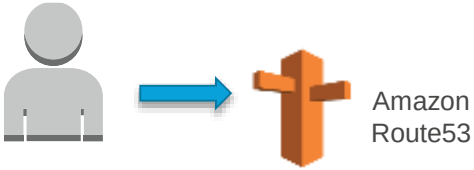
Website hosting



App 0.1

Simple Static Website



http://poliko.adhorn.me

http://poliko.adhorn.me.s3-website-eu-west-1.amazonaws.com

```
cat << EOF >  /tmp/website.json
{
    "IndexDocument": {
        "Suffix": "index.html"
    },
    "ErrorDocument": {
        "Key": "error.html"
    }
}
EOF

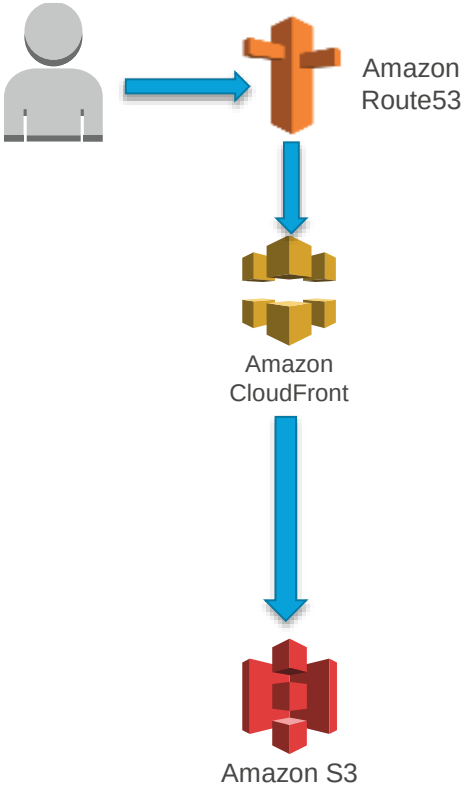

cat << EOF >  /tmp/bucket_policy.json
{
  "Version":"2012-10-17",
  "Statement":[{
  "Sid":"PublicReadForGetBucketObjects",
        "Effect":"Allow",
    "Principal": "*",
      "Action":["s3:GetObject"],
      "Resource":["arn:aws:s3:::$BUCKET_NAME/*"
      ]
    }
  ]
}
EOF


create_website() {
  aws s3api create-bucket --bucket $BUCKET_NAME --region $REGION
  aws s3api put-bucket-policy --bucket $BUCKET_NAME --policy file:///tmp/bucket_policy.json
  aws s3api put-bucket-website --bucket $BUCKET_NAME --website-configuration file:///tmp/website.json
}

sync_files() {
aws s3 sync . s3://$BUCKET_NAME --exclude "*.sh" --exclude ".git/*" --exclude "README" --region $REGION
}
```

App 0.2

Simple Static Website



http://example.com

Announcing Regional Edge Caches for Amazon CloudFront

Posted On: Nov 30, 2016

Today, we are pleased to announce that Amazon CloudFront has added a new type of edge location called Regional Edge Cache that further improves performance for your viewers. Regional Edge Caches, in addition to improving performance, also help reduce the load on your origin resources, minimizing operational burden associated with scaling your origin and reducing your origin costs. Regional Edge Caches are turned on by default for your CloudFront distributions; you do not need to make any changes to your distributions to take advantage of this feature. There are also no additional charges to use this feature.

The nine new Regional Edge Cache locations are in Northern Virginia, Oregon, São Paulo, Frankfurt, Singapore, Seoul, Tokyo, Mumbai, and Sydney. These locations sit between your origin webserver and the 68 global edge locations that serve traffic directly to your viewers. As the popularity of your objects reduce, individual edge locations may evict those objects to make room for more popular content. Regional Edge Caches have larger cache-width than any individual edge location, so your objects remain in cache longer at these locations. This helps keep more of your content closer to your viewers, reducing the need for CloudFront to go back to your origin webserver, and improving overall performance for viewers. For instance, our edge locations in Europe now go to the regional edge cache in Frankfurt to fetch an object before going back to your origin webserver.

To see a list of Amazon CloudFront global edge network locations, please see our edge network locations list here. To learn more about Amazon CloudFront, see the Amazon CloudFront product page.


Edge
Locations
Regional
Edge Caches

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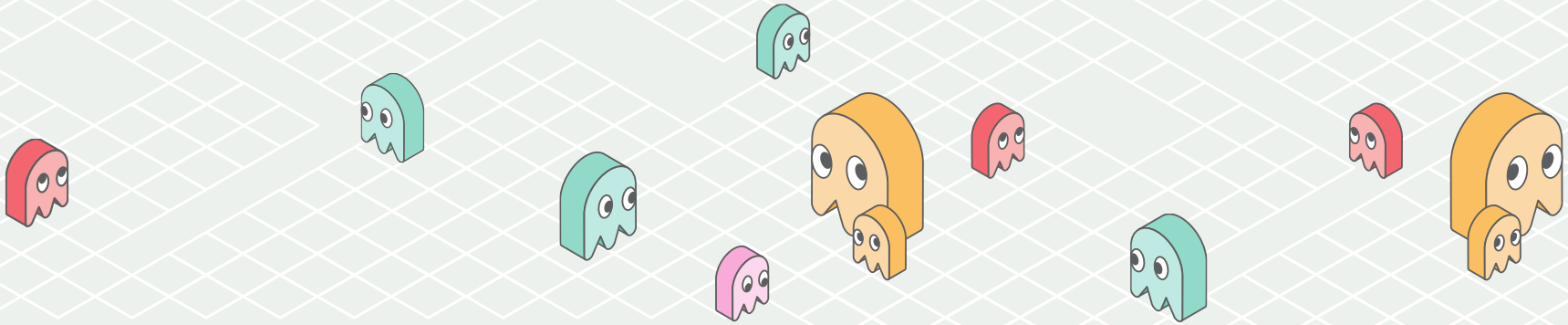
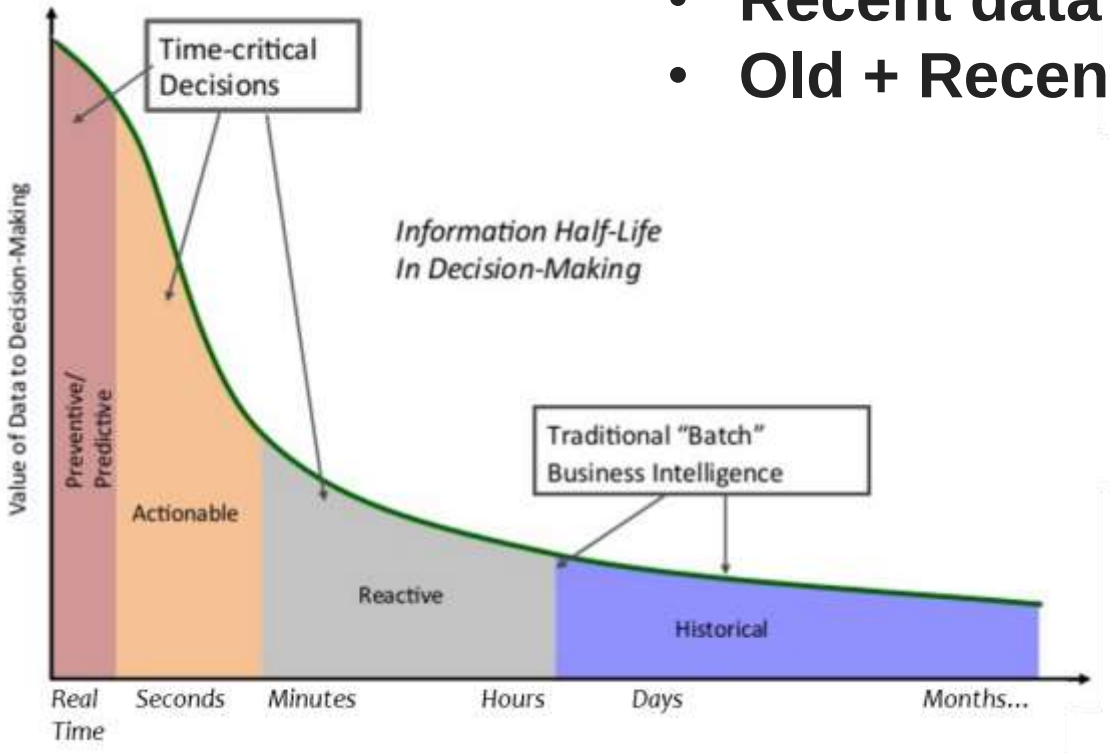
Big Data Analytics

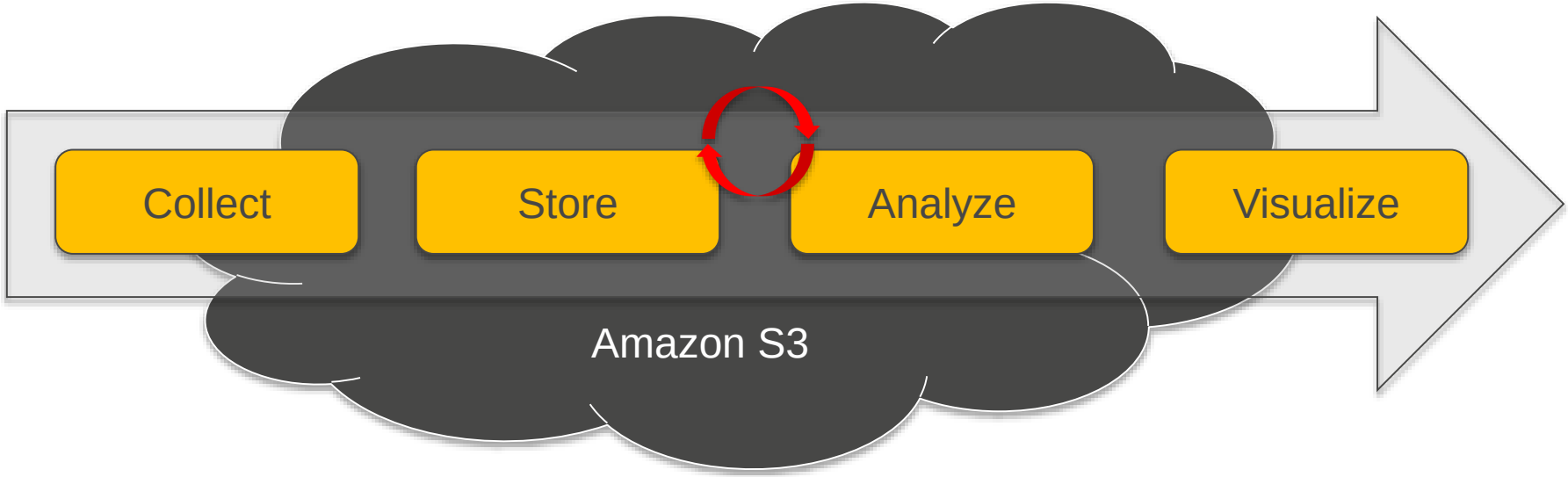


The diminishing value of data

- **Recent data** is highly valuable
- **Old + Recent** data is more valuable



Amazon S3 usage pattern



Amazon Athena: SQL Query on S3

- No loading of data
- Serverless
- Support text, CSV, TSV, JSON, AVRO
- Columnar formats Apache ORC & Parquet
- Access via Console or JDBC driver
- $5 per TB scanned from S3

Athena **Query Editor** Saved Queries History Catalog Manager

DATABASE

default

TABLES

Filter Tables...

Add table...

example_summit

sensehat_iot_full

```
CREATE EXTERNAL TABLE example_summit (
    datetime timestamp,
    device_id string,
    yaw double,
    pitch double,
    roll double,
    pressure double,
    temperature double,
    humidity double
  )
ROW FORMAT  serde 'org.apache.hive.hcatalog.data.JsonSerDe'
with serdeproperties( 'ignore.malformed.json' = 'true' )
LOCATION 's3://adhorn-rasp-sensehat/'
```

Run Query **Save As** **Format Query** **New Query** (Run time: 0.62 seconds, Data scanned: 0KB)

Results

Query successful.

query_datetime Query datetime > particular da

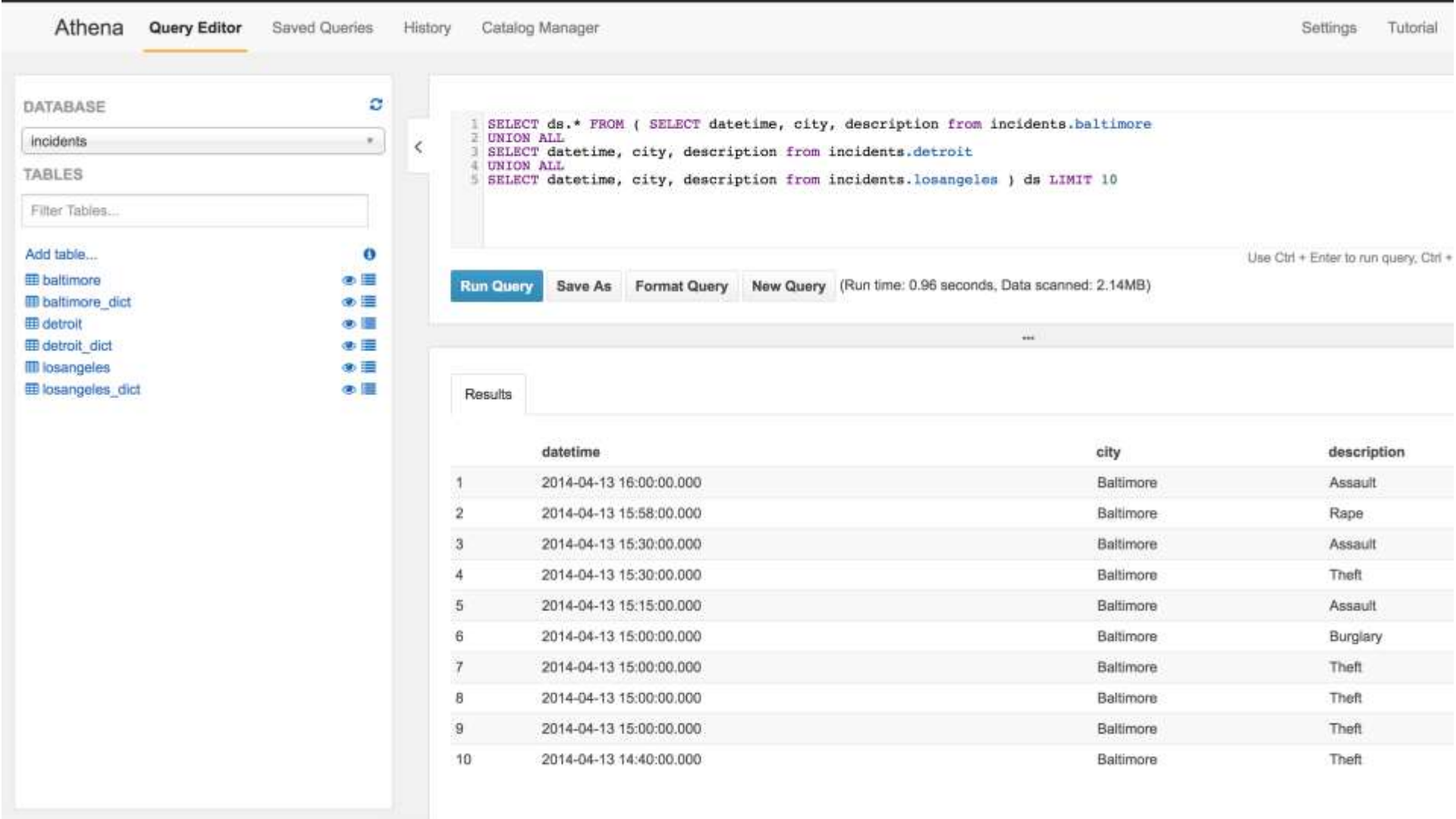
```
1 SELECT * FROM sensehat_iot_full WHERE datetime > date '2017-03-26';
```

Use Ctrl + Enter to run query, Ctrl + Space to autocomplete

Run Query | Save As | Format Query | New Query (Run time: 6.05 seconds, Data scanned: 4.22MB)

Results

	datetime	device_id	yaw	pitch	roll	pressure	temperature	humidity
1	2017-03-27 12:06:25.000	00000000b93dd96a	359.99835128273514	358.3057949484319	269.148505132453	1007.681396484375	22.24460792541504	27.49226760
2	2017-03-27 12:06:30.000	00000000b93dd96a	359.9983485585177	358.3039377773079	269.14501490578715	1007.65869140625	22.151809692382812	27.55992126
3	2017-03-27 12:06:35.000	00000000b93dd96a	359.9983502089522	358.29874651337354	269.1458003775417	1007.62255859375	22.263166427612305	27.04123687
4	2017-03-27 12:06:41.000	00000000b93dd96a	359.9983511181711	358.30062214735267	269.1445777736803	1007.64599609375	22.133249282836914	27.28930282
5	2017-03-27 12:06:46.000	00000000b93dd96a	359.9983536287367	358.30246544465496	269.1414495470404	1007.6669921875	22.24460792541504	27.07989692
6	2017-03-27 12:06:51.000	00000000b93dd96a	359.99833707353207	358.2953429447328	269.13601954665023	1007.64599609375	22.24460792541504	27.02835083
7	2017-03-27 12:06:56.000	00000000b93dd96a	359.99832868712366	358.2895604425484	269.13260445206527	1007.6943359375	22.337406158447266	27.23131370
8	2017-03-27 12:07:01.000	00000000b93dd96a	359.99832484097345	358.2867126805514	269.1295376971279	1007.68701171875	22.318845748901367	27.39239692
9	2017-03-27 12:07:06.000	00000000b93dd96a	359.99832809890364	358.2883956818515	269.1251663760591	1007.665283203125	22.430204391479492	27.16043853
10	2017-03-27 12:07:12.000	00000000b93dd96a	359.99832030186167	358.28512295402203	269.1195246398047	1007.6416015625	22.430204391479492	26.87048912
11	2017-03-27 12:07:17.000	00000000b93dd96a	359.99831795200396	358.2840529621999	269.1143883375488	1007.59375	22.448762893676758	27.15077209


Athena
Query Editor
Saved Queries
History
Catalog Manager
Settings
Tutorial
DATABASE
incidents
TABLES
Filter Tables...
Add table...
baltimore
baltimore_dict
detroit
detroit_dict
losangeles
losangeles_dict
1 SELECT ds.* FROM (SELECT datetime, city, description from incidents.baltimore
2 UNION ALL
3 SELECT datetime, city, description from incidents.detroit
4 UNION ALL
5 SELECT datetime, city, description from incidents.losangeles) ds LIMIT 10
Use Ctrl + Enter to run query, Ctrl +
Run Query
Save As
Format Query
New Query
(Run time: 0.96 seconds, Data scanned: 2.14MB)
Results
datetime
city
description
1 2014-04-13 16:00:00.000 Baltimore Assault
2 2014-04-13 15:58:00.000 Baltimore Rape
3 2014-04-13 15:30:00.000 Baltimore Assault
4 2014-04-13 15:30:00.000 Baltimore Theft
5 2014-04-13 15:15:00.000 Baltimore Assault
6 2014-04-13 15:00:00.000 Baltimore Burglary
7 2014-04-13 15:00:00.000 Baltimore Theft
8 2014-04-13 15:00:00.000 Baltimore Theft
9 2014-04-13 15:00:00.000 Baltimore Theft
10 2014-04-13 14:40:00.000 Baltimore Theft

AWS Blog

Amazon Redshift Spectrum – Exabyte-Scale In-Place Queries of S3 Data

by Jeff Barr | on 19 APR 2017 | in Amazon Redshift, Amazon S3 | Permalink | Comments | Share

Now that we can launch cloud-based compute and storage resources with a couple of clicks, the challenge is to use these resources to go from raw data to actionable results as quickly and efficiently as possible.

Amazon Redshift allows AWS customers to build petabyte-scale data warehouses that unify data from a variety of internal and external sources. Because Redshift is optimized for complex queries (often involving multiple joins) across large tables, it can handle large volumes of retail, inventory, and financial data without breaking a sweat. Once the data is loaded, our customers can make use of a plethora of enterprise reporting and business intelligence tools provided by the Redshift Partners.

One of the most challenging aspects of running a data warehouse involves loading data that is continuously changing and/or arriving at a rapid pace. In order to provide great query performance, loading data into a data warehouse includes compression, normalization, and optimization steps. While these steps can be automated and scaled, the loading process introduces overhead and complexity, and also gets in the way of those all-important actionable results.

Data formats present another interesting challenge. Some applications will process the data in its original form, outside of the data warehouse. Others will issue queries to the data warehouse. This model leads to storage inefficiencies because the data must be stored twice, and can also mean that results from one form of processing may not align with those from another due to delays introduced by the loading process.

Amazon Redshift Spectrum

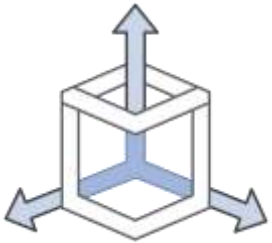
In order to allow you to process your data as-is, where-is, while taking advantage of the power and flexibility of Amazon Redshift, we are launching Amazon Redshift Spectrum. You can use Spectrum to run complex queries on data stored in Amazon Simple Storage Service (S3), with no need for loading or other data prep.

You simply create a data source and issue your queries to your Redshift cluster as usual. Behind the scenes, Spectrum scales to thousands of instances on a per-query basis, ensuring that you get fast, consistent performance even as your data set grows up to an beyond an exabyte! Being able to query data stored in S3 means that you can scale your compute and your storage independently, with the full power of the Redshift query model and all of the reporting and business intelligence tools at your disposal. Your queries can

Amazon Redshift Spectrum

Run SQL queries directly against data in S3 using thousands of nodes

Fast @ exabyte scale



Elastic & highly available

On-demand, pay-per-query

High concurrency: Multiple clusters access same data

No ETL: Query data in-place using open file formats

Full Amazon Redshift SQL support

S3 Inventory

Save time

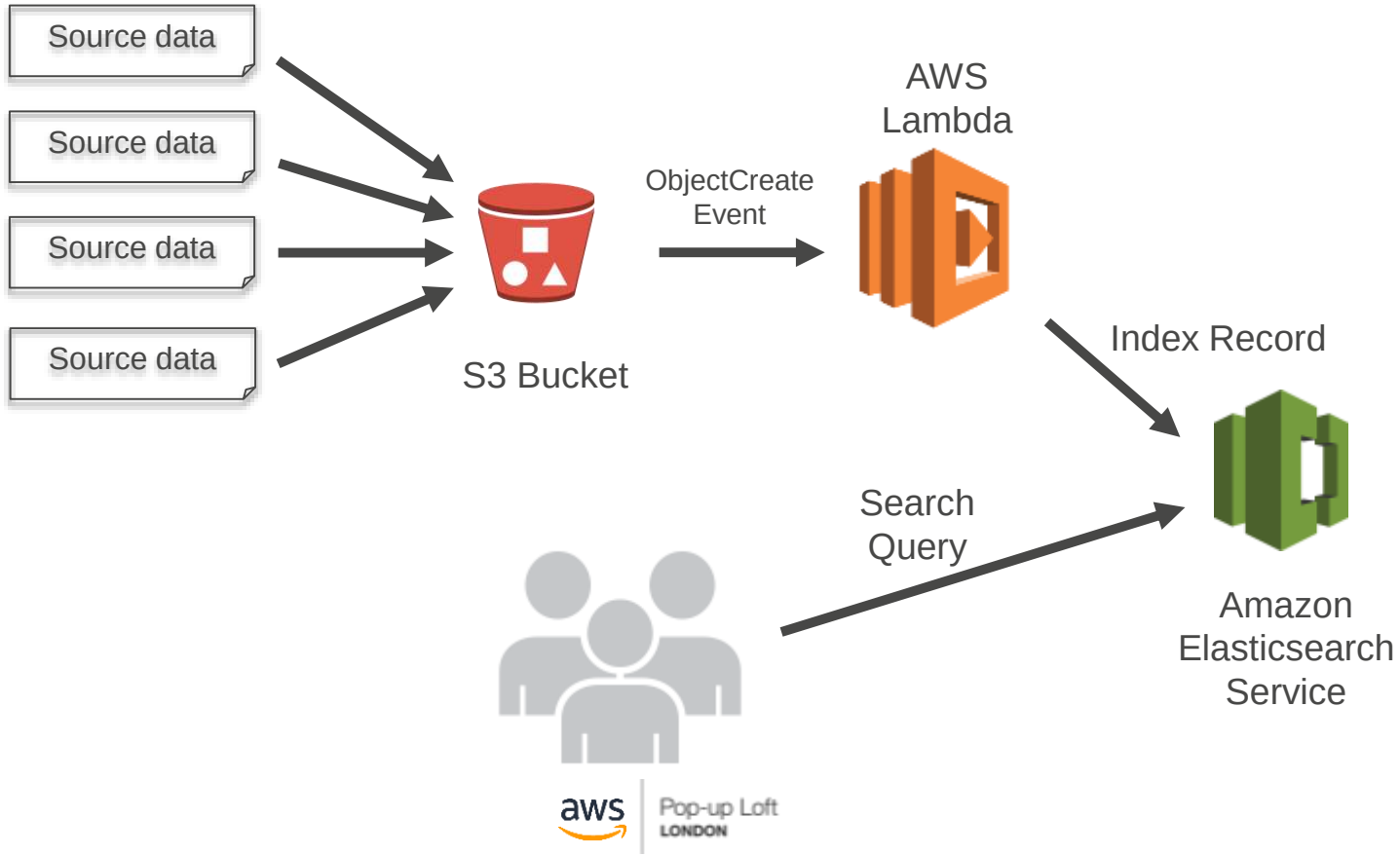
Daily or Weekly delivery

Delivery to S3 bucket

CSV File Output

Bucket
Key
Version Id
Is Latest
Delete Marker
Size
Last Modified
ETag
StorageClass
Multipart Uploaded
Replication Status

Indexing S3 content using Elasticsearch



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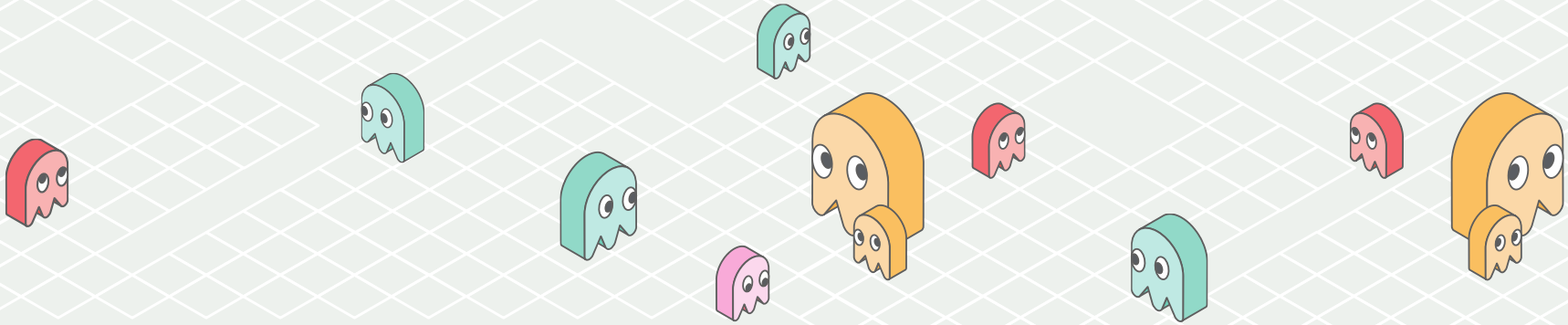
LONDON

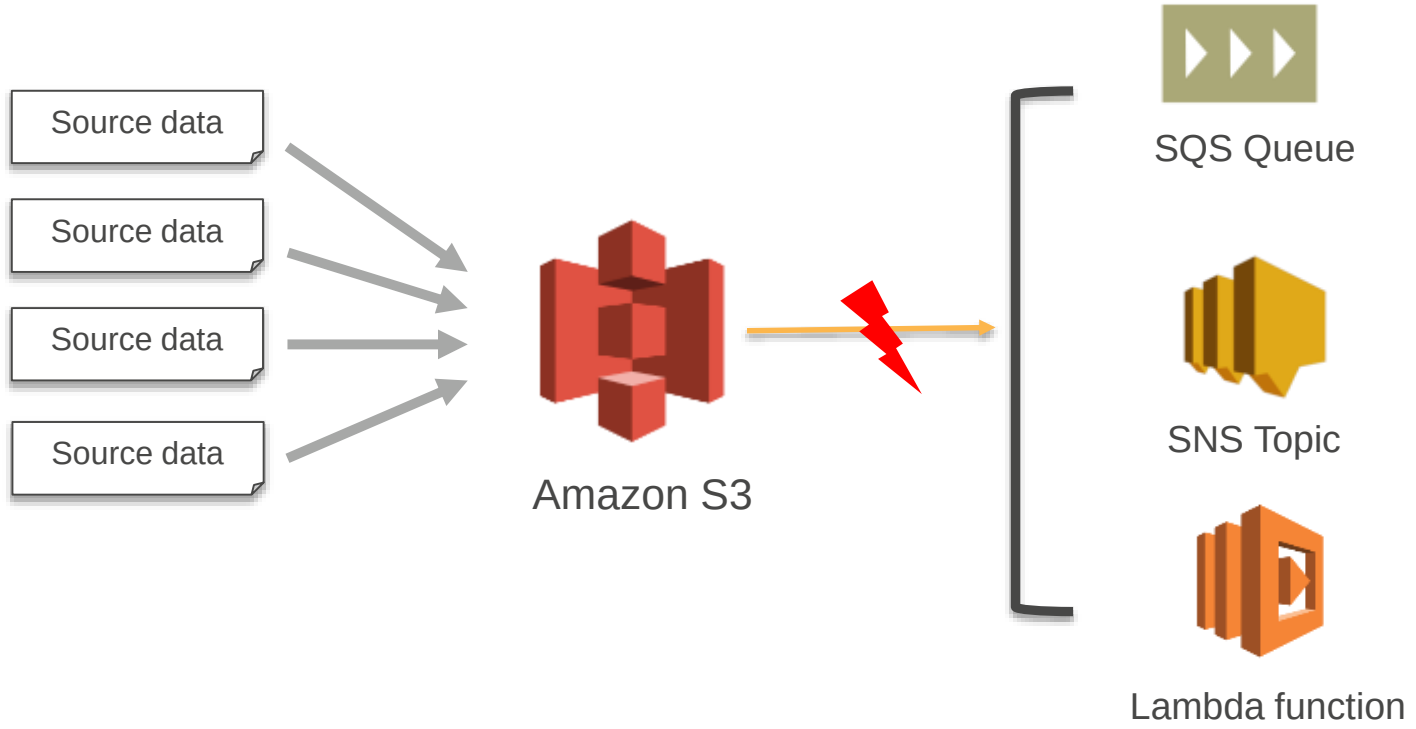
Event Driven Architecture



Event driven

Event on B by A triggers C

Amazon S3 with event-driven workflow



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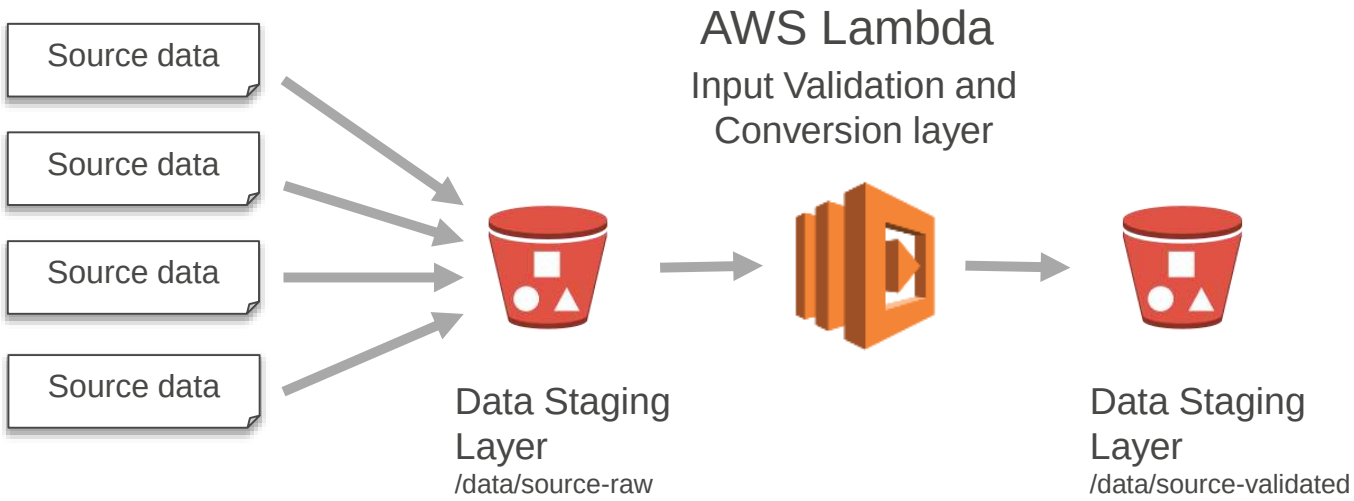
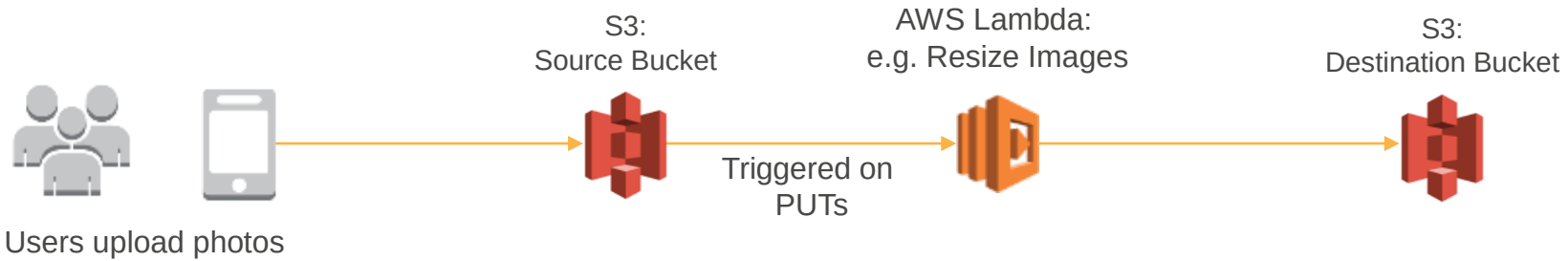
Invoked in response to events

Event-Driven validation layer on Amazon S3

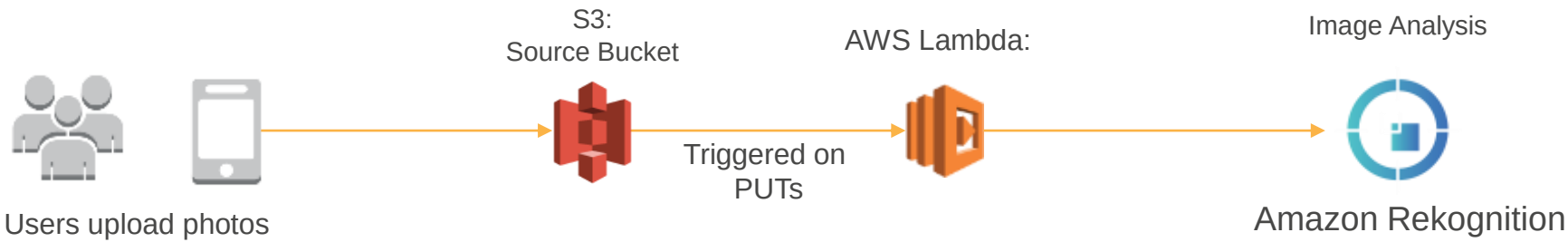


Event-driven photo manipulation with Lambda



THOMSON REUTERS™ CMP.LY The Seattle Times NETFLIX FireEye

Event-driven photo analysis with Lambda & Rekognition



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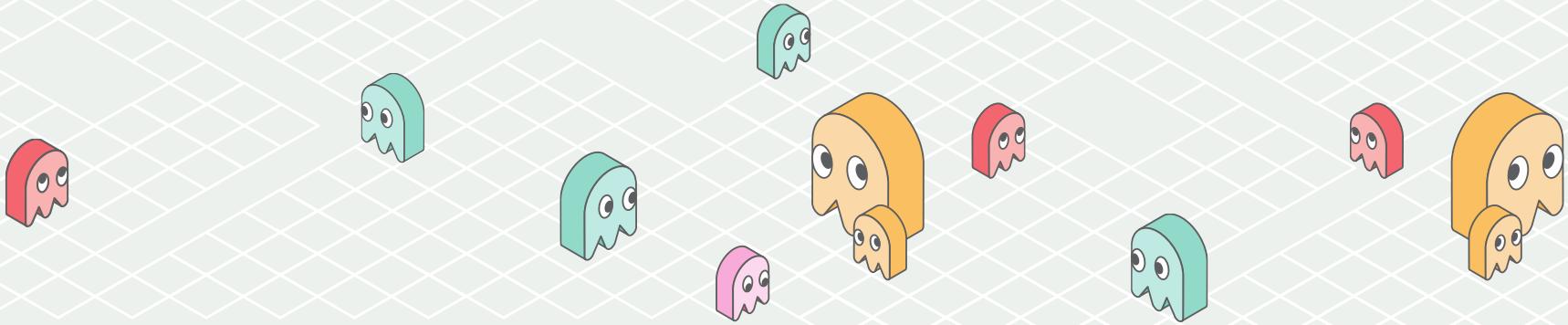
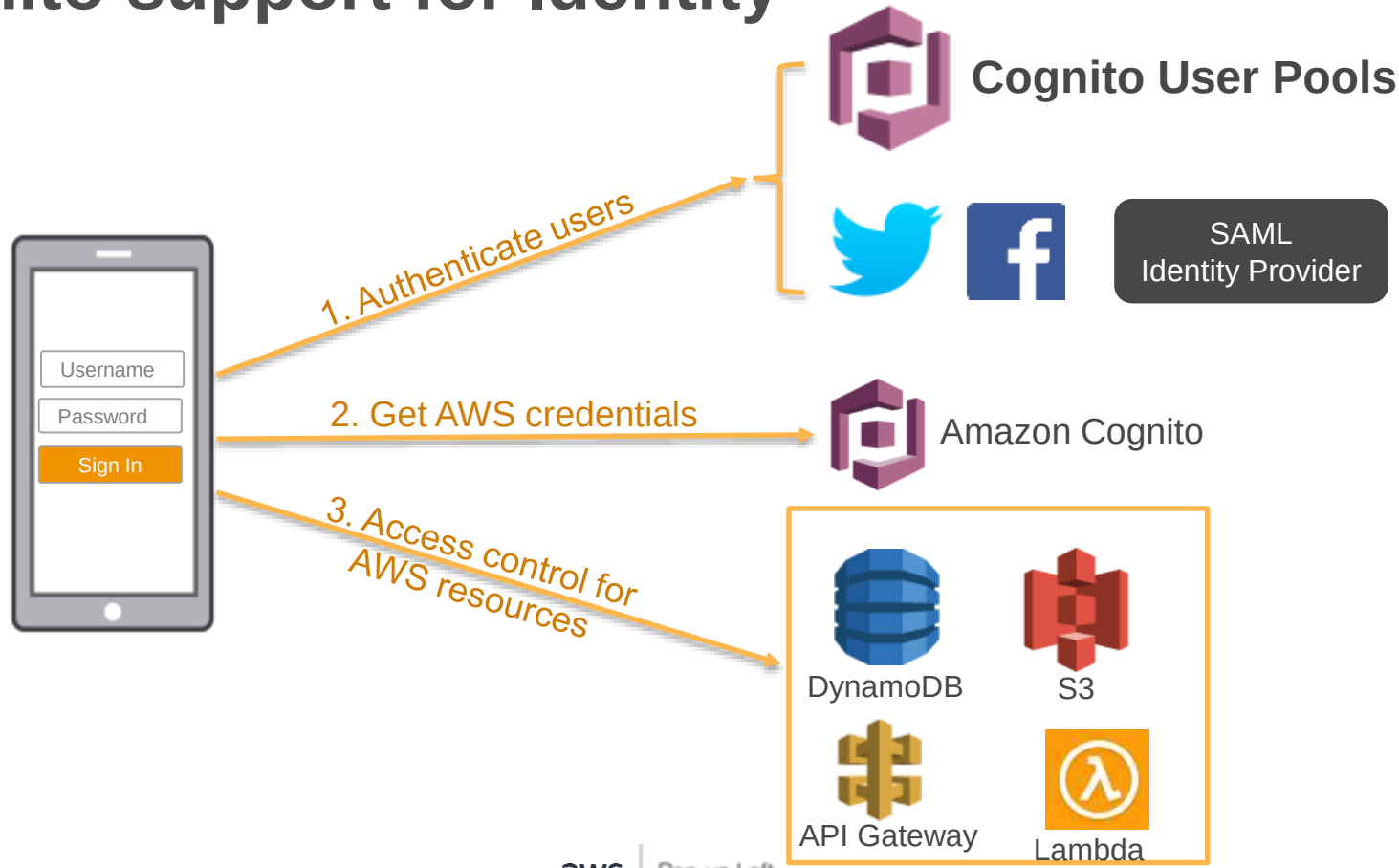
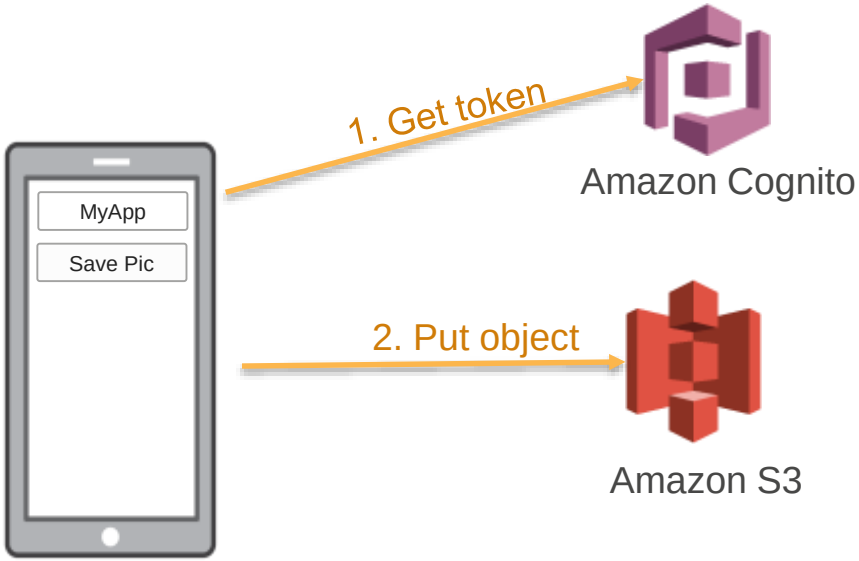
Cloud Native Applications



Cognito support for Identity



Leverage Amazon S3 directly from the app.

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      ],
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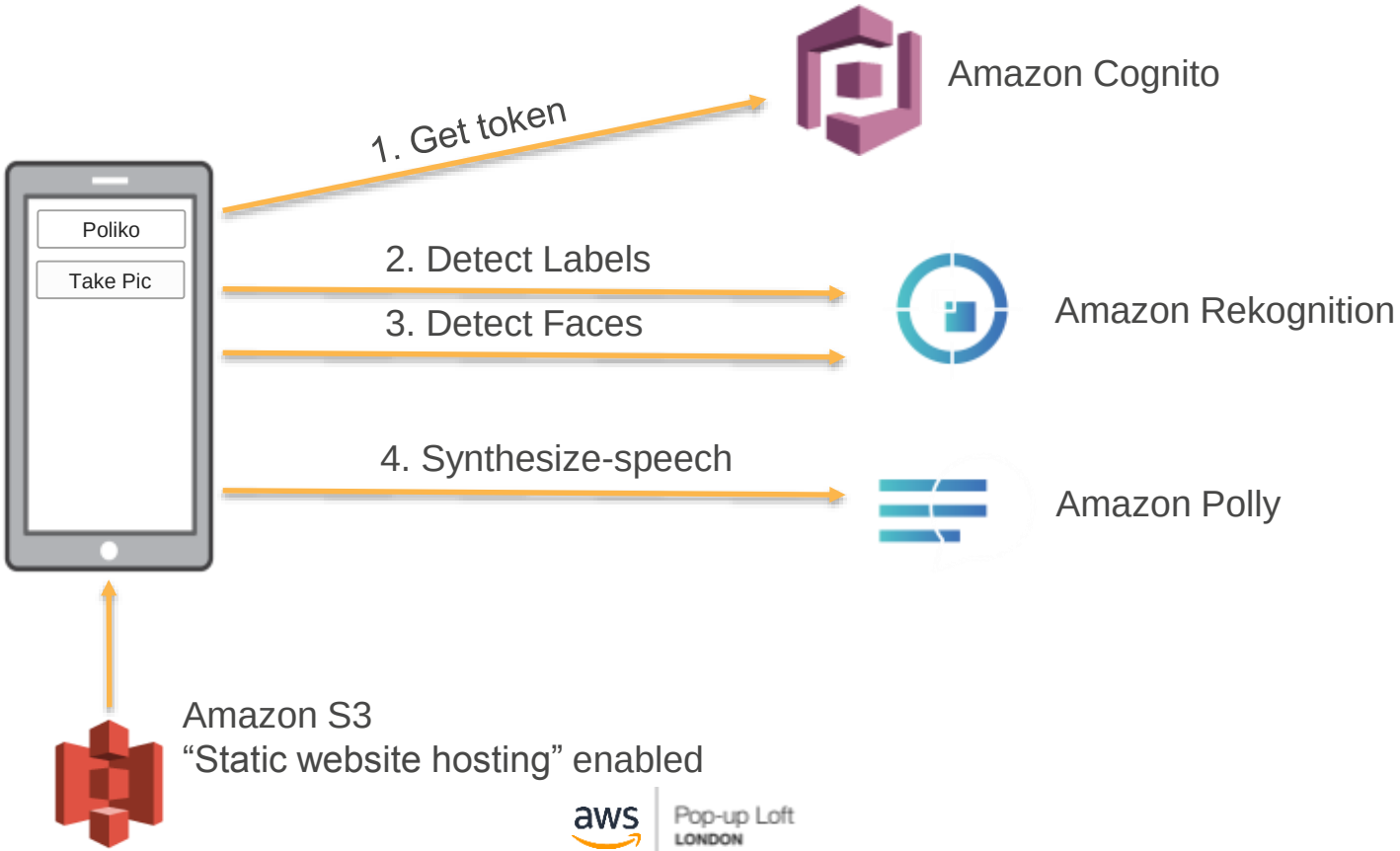
  }]
}
```

http://poliko.adhorn.me



http://poliko.adhorn.me

https://github.com/adhorn/poliko

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Questions?

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@adhorn

adhorn@amazon.com