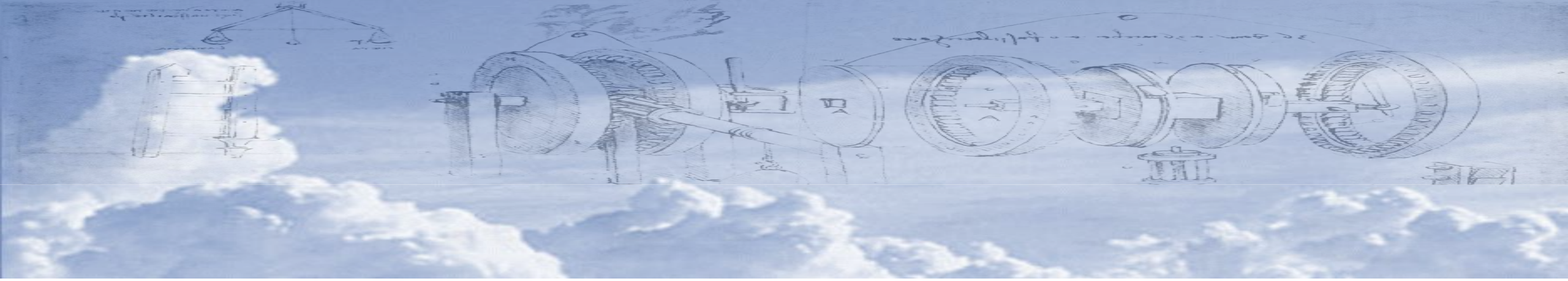


Cloud Computing for Science

Part 1. Managing Data in the Cloud

Dennis Gannon

Motivating Examples

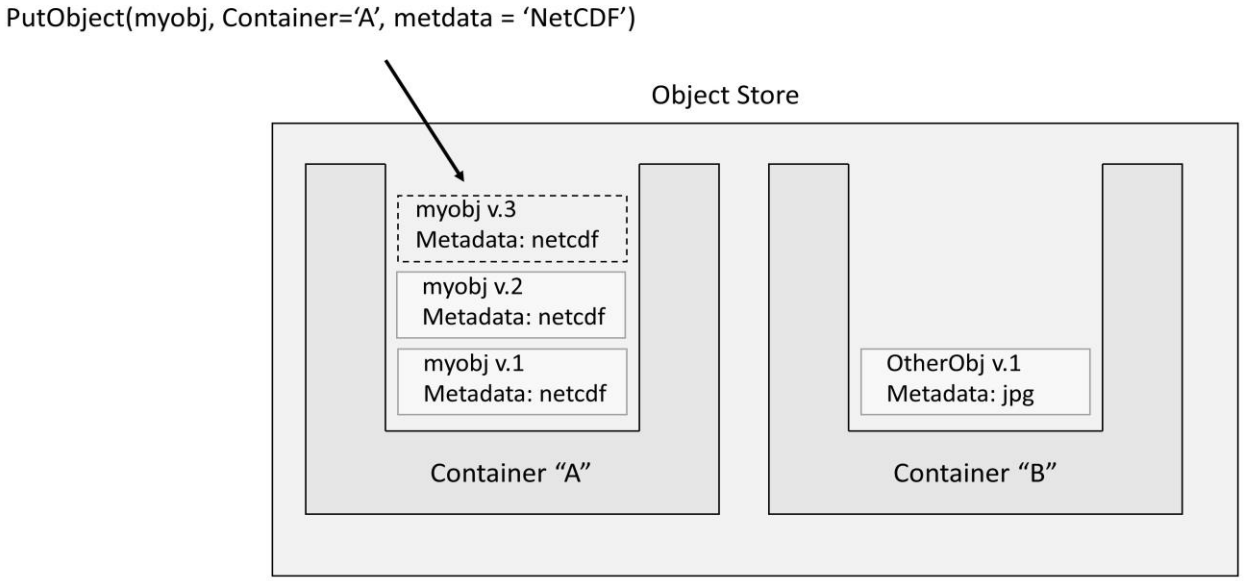
- BIG objects
  - Climate scientists with big simulation output files in NetCDF.
    - Assume 10 TB in big objects
- Many small CVS files
  - Environmental Engineers with 1 Million records of observations each in CSV format
    - May be 100 TB total
- Streams
  - Scientists with a distributed collection of several thousand instruments.
    - Each generates a stream of records that must be collected and analyzed every few hours or continuously

Types of Cloud Data Storage Systems

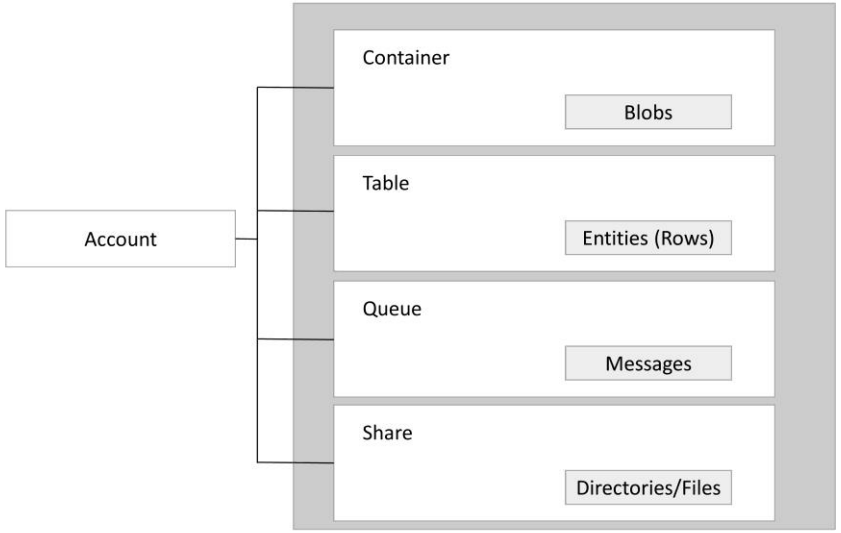
- Basic Blob Object store
  - Buckets of immutable objects
  - Highly scalable & reliable
- Databases
  - SQL Style relational databases
  - NoSQL storage
  - Data warehouses
- Attached File stores
- Graph databases
- Streaming systems

Object stores

- Amazon AWS
  - S3- buckets of immutable objects
    - Organized in a 2-level folder system
    - Each object has associated metadata
- Microsoft Azure
  - Storage accounts contain blob storage along with tables, queues and file shares.
  - Blob containers are similar to S3
- Google Cloud Storage
  - Different models based on availably and cost
- OpenStack does not have a standard but semi-standards exist and various ones are used in various deployment



Azure storage account structure



Relational Databases

- Amazon AWS
  - Relational Data Services (RDS)
  - Aurora
- Microsoft Azure
  - Azure SQL
    - 3 service tiers
    - Premium tier up to 1TB
    - Up to 30000 concurrent sessions
  - Azure Data Lake
- Google Cloud Storage
  - Cloud Spanner (beta)
    - Full relational
    - Strongly consistent
    - Scalable to thousands of servers

- Aurora is distributed
  - Scalable from 2 vCPUs to 32 vCPUs
  - Data up to 64TB
  - MySQL compatible
  - Fully geo-replicated

- Data Lake is a platform
  - Structured & unstructured data
  - Scalable to petabytes
  - Distributed and designed to support analytics

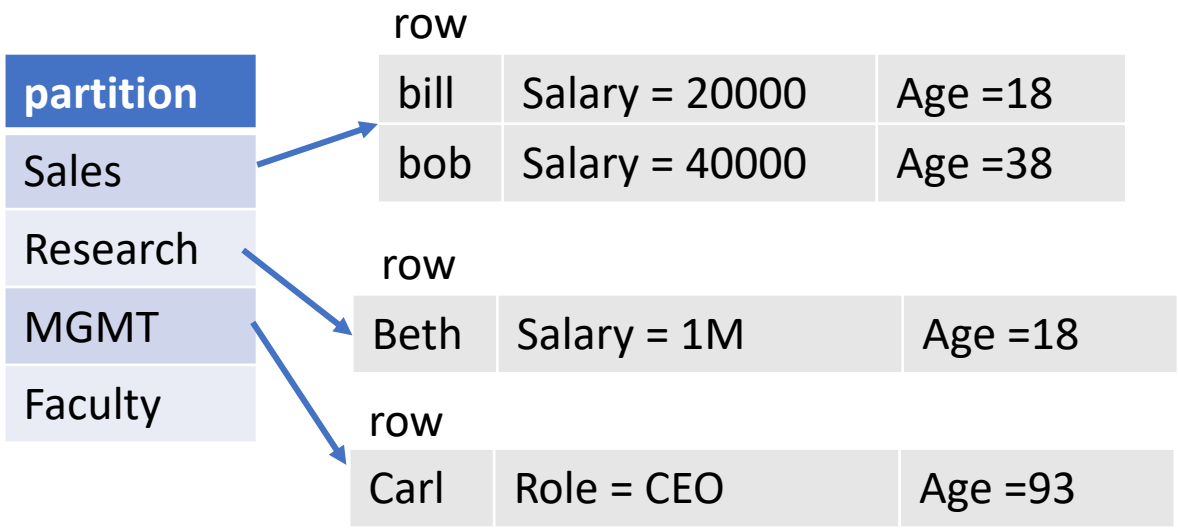
NoSQL Storage Systems

- Main Concepts
  - Designed for massive scale
    - Distributed over many storage nodes
  - Support some SQL operations (not joins)
  - May be only eventually consistent
  - Different types
    - Key-value
    - Column oriented
    - Document style
    - Graph

Relational table

Name	Job	Salary	age
Bill	Sales	$20000	18
Beth	Research	$1m	35
Carl	CEO	0	93
Jill	Prof	$100000	24

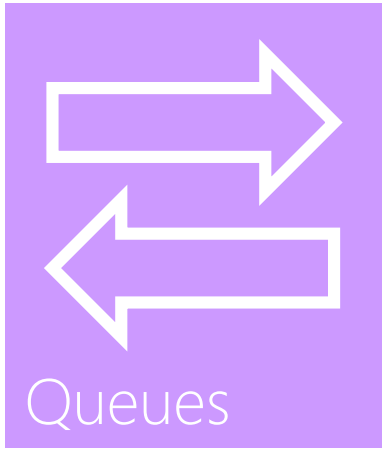
NoSQL Key-value system



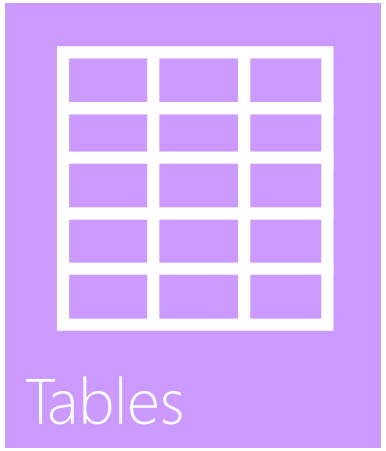
Key-value NoSQL examples *similar* to
Amazon AWS DynamoDB
Azure Tables
Google BigTable and Cloud DataStore

Azure Storage

Storage for any type of data, analogous to files in a file system, with individual blobs storing up to 4.75 TB of data



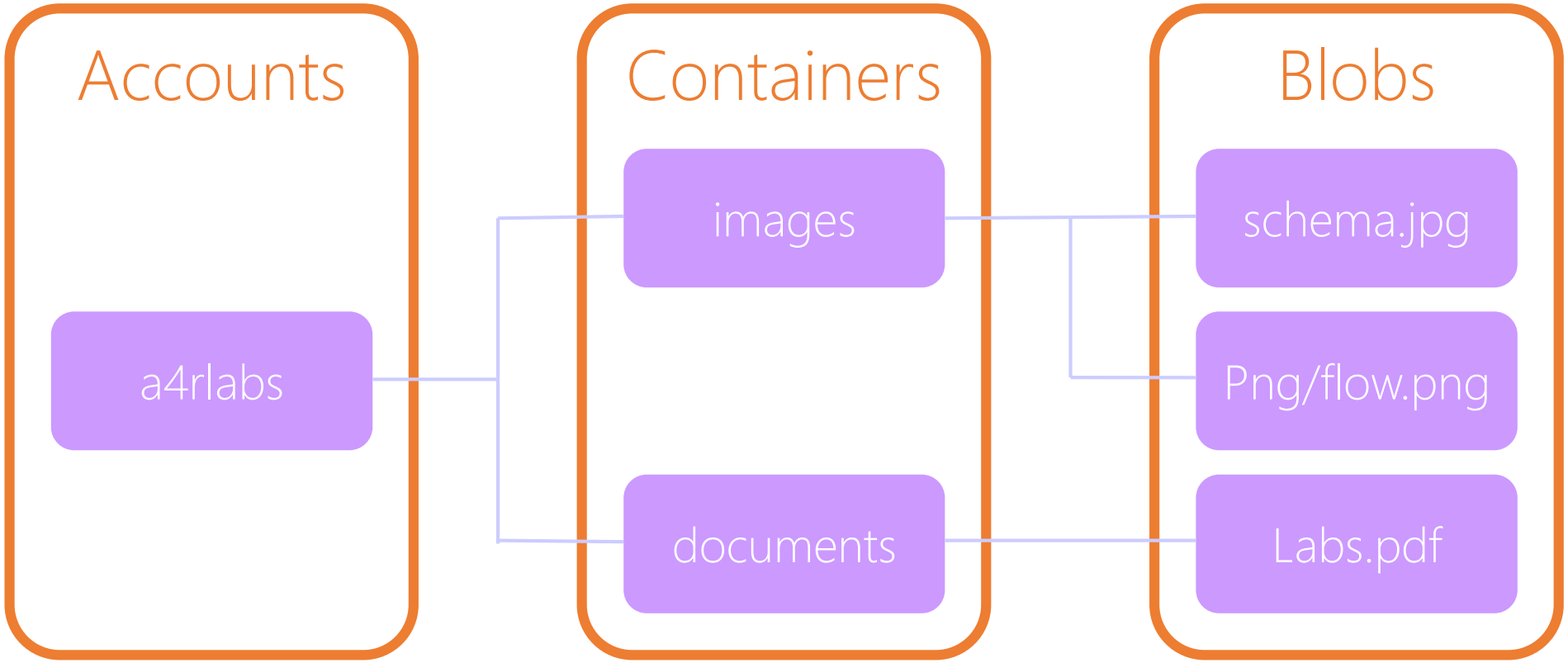
Reliable messaging for workflow processing and for communication between applications or application components



NoSQL storage of semi-structured data for rapid development and fast access to large quantities of data

File sharing using Server Message Block (SMB) protocol

Blob Storage

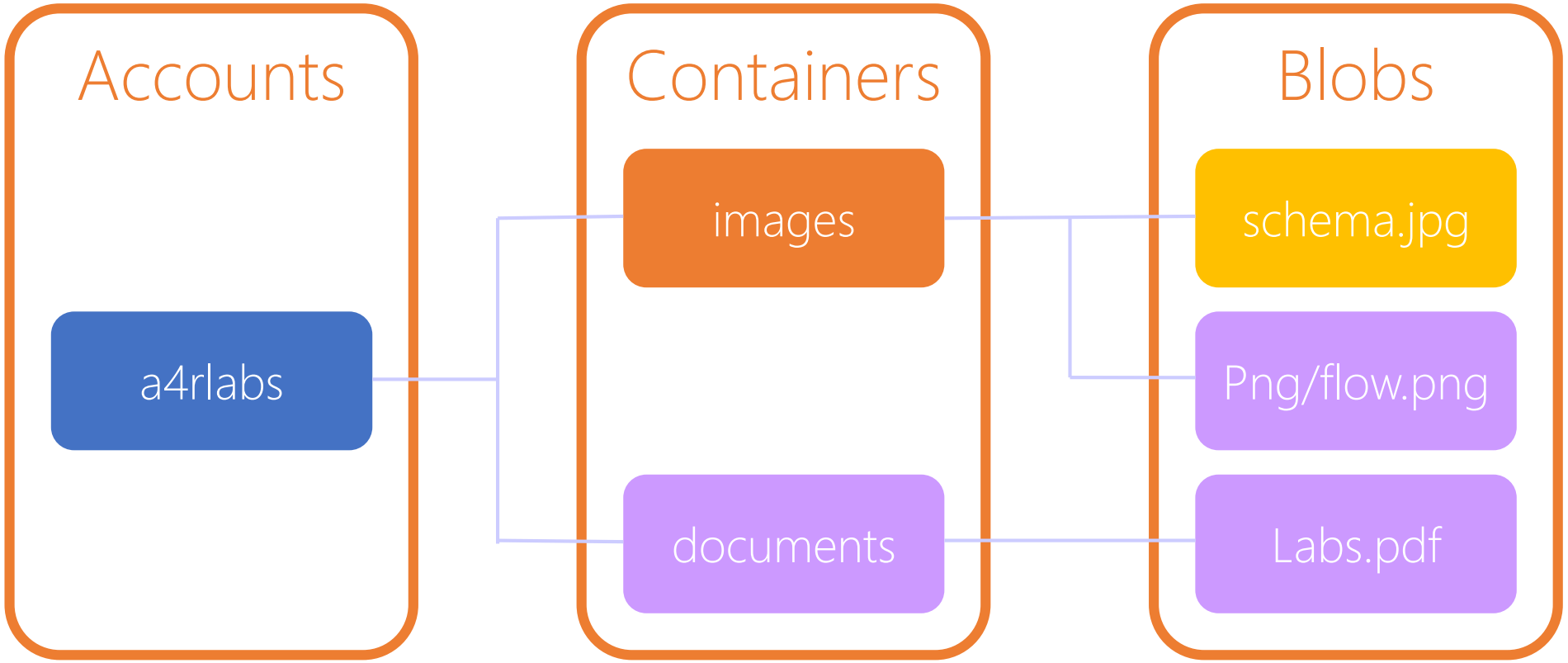


3 to 24 characters
0-9 and a-z
Unique within Azure

3 to 63 characters
0-9, a-z, and dashes

1 to 1,024 characters
Any characters (including slashes)
URL characters must be escaped
Max. 254 path segments

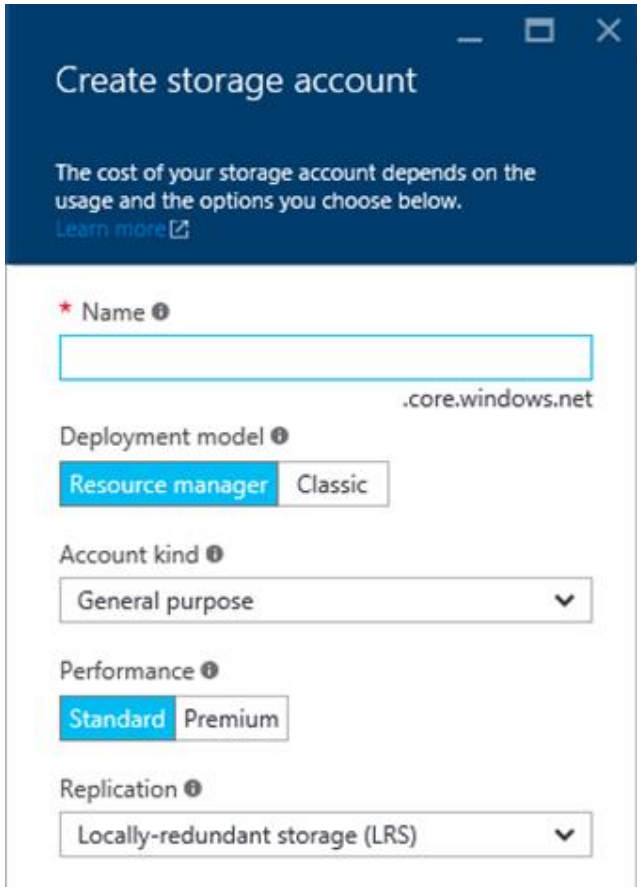
Blob URLs



https://a4rlabs.blob.core.windows.net/images/schema.jpg

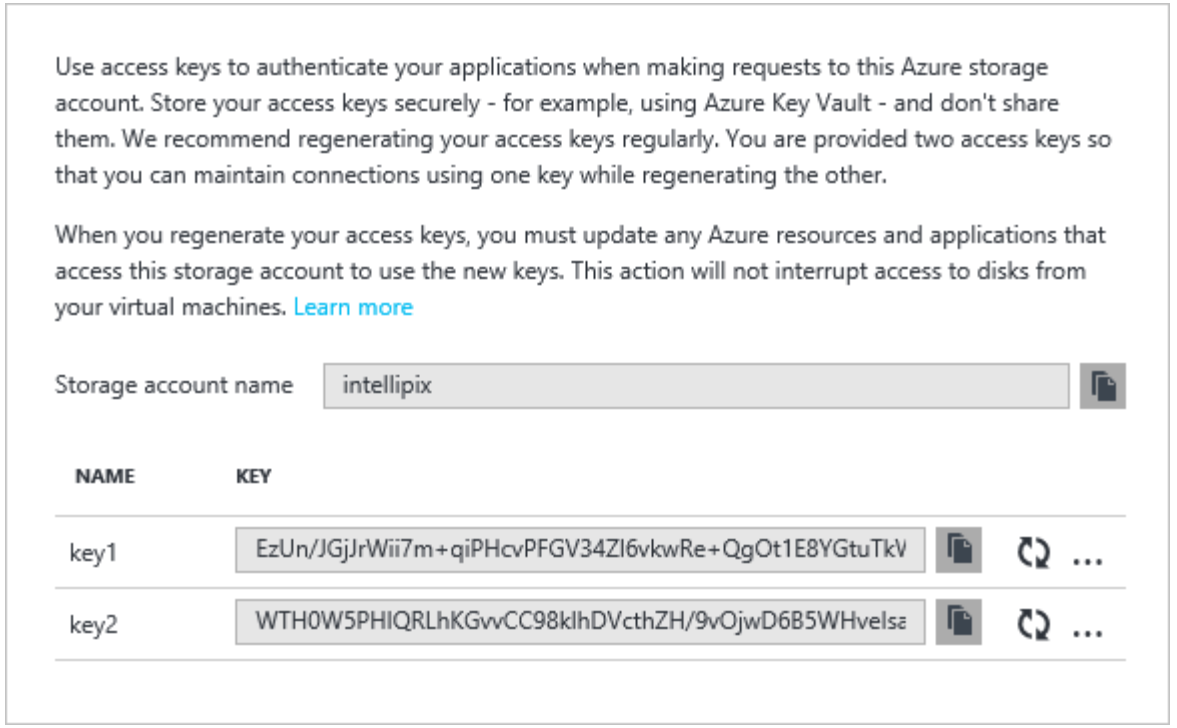
Storage Accounts

- Up to 500 TB of data per account
- Maximum of 200 storage accounts per subscription
- Two types of accounts
  - "General purpose" and "Blob storage"
- Four types of replication
- Support optional 256-bit AES encryption for "data at rest"



Access Keys

- Access to storage by non-account-owners relies on access keys
- Keys should be "rolled" periodically for security
- Keys can be used to generate shared-access signatures (SAS) for secure and restricted access



Get the container for the demo

- Make sure you have docker installed on your machine
- Download Docker for your pc or mac
  - https://docs.docker.com/engine/installation/
- Then do

  docker run -i -t -p 8888:8888 dbgannon/tutorial
- This will take a while
- When it is up go to https://localhost:8888
  - You will need to add security exceptions in the browser. It is safe.
  - Password is “tutorial”
  - Open azure.ipynb in Jupyter
- Or, if using a different jupyter, download https://SciengCloud.github.io/azure.ipynb
- Using the azure portal create a storage account and have the key ready

Azure Solution – now create table and blob container

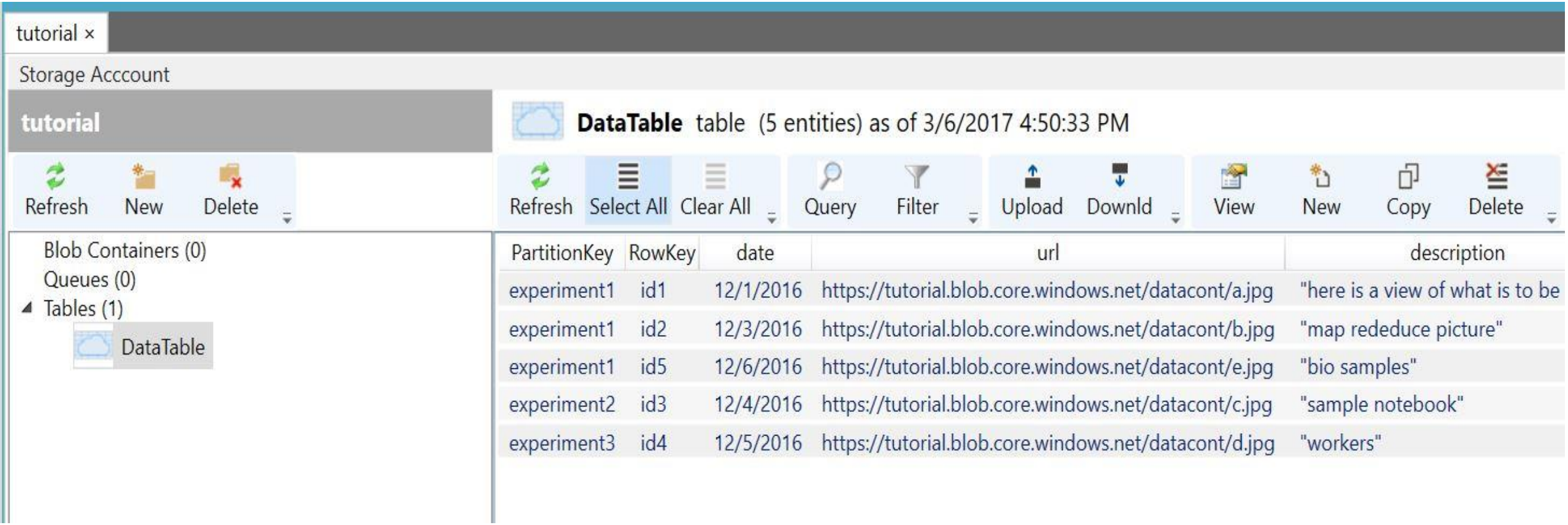
```
import csv
import sys
import azure.storage
from azure.storage.table import TableService, Entity
from azure.storage.blob import BlockBlobService
from azure.storage.blob import PublicAccess

block_blob_service = BlockBlobService(account_name='tutorial',
      account_key='biglongaccesskey')

block_blob_service.create_container('datacont',
            public_access=PublicAccess.Container)

table_service = TableService(account_name='tutorial',
      account_key='samebiglongkey')


if table_service.create_table('DataTable'):
    print "table created"
else:
    print "table already there"
```

Azure Solution

- Assume data objects are stored in files in /home/me/ and there is a CSV file “thedata” with rows
  - Experiment name, item id, date, filename, comment string

```
with open('/datadir/experiments.csv', 'rb') as csvfile:
    csvf = csv.reader(csvfile, delimiter=',', quotechar='|')
    for item in csvf:
            print item
            block_blob_service.create_blob_from_path(
                    'datacont', item[3],
                   "/datadir/"+item[3]
             )
        url = "https://"+account+".blob.core.windows.net/datacont/"+item[3]
        metadata_item = {'PartitionKey': item[0], 'RowKey': item[1],
                         'description' : item[4], 'date' : item[2], 'url':url}
        table_service.insert_entity('DataTable', metadata_item)
```

Use Azure Storage Explorer to inspect the table



Time for Exercise 1.

- Look for the file Excercise1.pdf and go through it. It will introduce you to the azure portal and the simple task of creating a storage account and uploading a file and viewing it with the azure storage explorer.

- If you are done with that and you are familiar with Docker, Jupyter and Python then move on to Exercise1b.pdf. That will show you how you can manage storage of blobs and tables directly from a python program without using the portal. If you don't have docker installed it may take more time than you have right now.

Next VMs and Containers