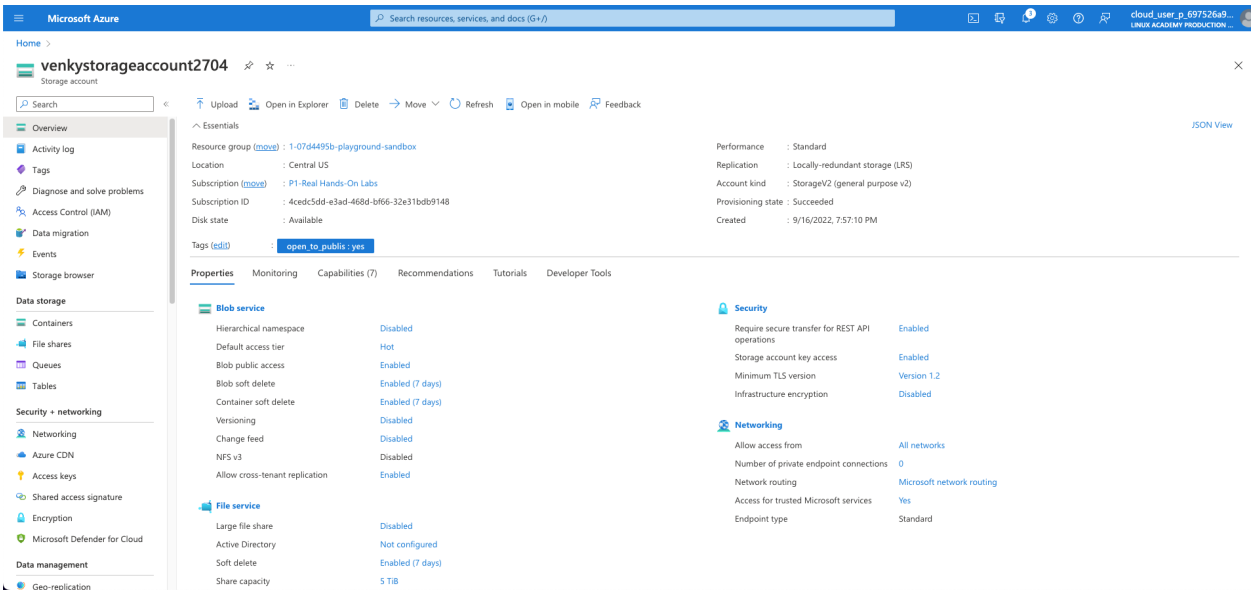
Azure Blob Storage & Azure Data Lake Storage Experiments

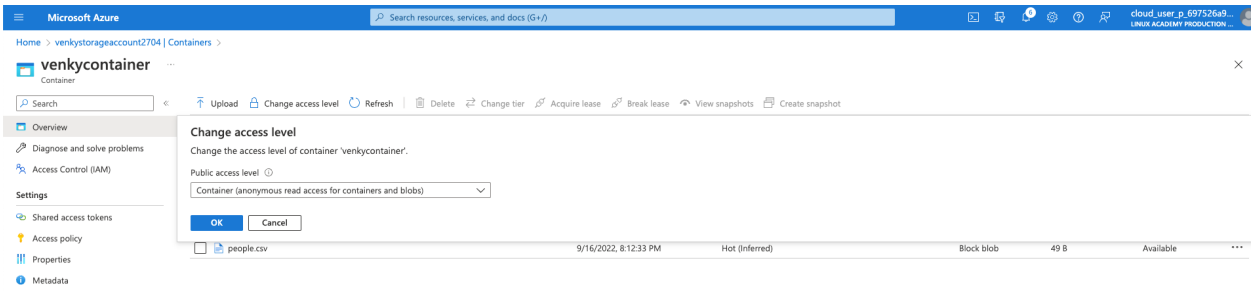
The idea of this document is to play with Azure storage and see whether we can access the data in there from a local spark/Hadoop cluster.

1: Install Azure CLI on MacOS via Homebrew.
brew install azure-cli

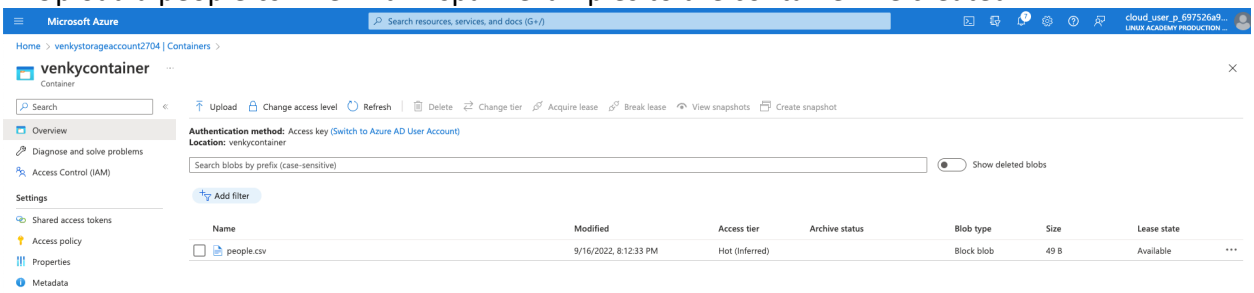
2. Login to the azure account and create a storage account with no hierarchical namespace enabled (regular blob storage). Public access is enabled.



3. Create a container under the storage account with access level set at container anonymous access enabled.



4. Upload a people.csv we find in spark examples to the container we created.



5. Install Hadoop on mac via homebrew.
brew install hadoop.

Make sure we add the ADLS access jars to the classpath.

```
export HADOOP_OPTIONAL_TOOLS=hadoop-azure

hadoop fs -ls
wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/
```

```
vkjagan@MU-C02G9694MD6R 3.3.4 % hadoop fs -ls wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/
2022-09-16 20:29:09,941 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
2022-09-16 20:29:10,228 INFO impl.MetricsConfig: Loaded properties from hadoop-metrics2.properties
2022-09-16 20:29:10,292 INFO impl.MetricsSystemImpl: Scheduled Metric snapshot period at 10 second(s).
2022-09-16 20:29:10,292 INFO impl.MetricsSystemImpl: azure-file-system metrics system started
Found 1 items
-rwxrwxrwx   1         49 2022-09-16 20:12 wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/people.csv
2022-09-16 20:29:10,936 INFO impl.MetricsSystemImpl: Stopping azure-file-system metrics system...
2022-09-16 20:29:10,936 INFO impl.MetricsSystemImpl: azure-file-system metrics system stopped.
2022-09-16 20:29:10,936 INFO impl.MetricsSystemImpl: azure-file-system metrics system shutdown complete.
vkjagan@MU-C02G9694MD6R 3.3.4 %
```

As we can see, with container level anonymous access granted, we can use the Hadoop ls command to get to the data stored in the container.

Change access level to disallow anonymous access.

As we can see below, the list call now fails.

```
vkjagan@MU-C02G9694MD6R 3.3.4 % hadoop fs -ls wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/
2022-09-16 20:33:02,930 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
2022-09-16 20:33:03,224 INFO impl.MetricsConfig: Loaded properties from hadoop-metrics2.properties
2022-09-16 20:33:03,294 INFO impl.MetricsSystemImpl: Scheduled Metric snapshot period at 10 second(s).
2022-09-16 20:33:03,294 INFO impl.MetricsSystemImpl: azure-file-system metrics system started
2022-09-16 20:33:03,809 WARN fs.FileSystem: Failed to initialize fileystem wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/: org.apache.hadoop.fs.azure
.AzureException: org.apache.hadoop.fs.azure.AzureException: No credentials found for account venkystorageaccount2704.blob.core.windows.net in the configuration, and its con
tainer venkycontainer is not accessible using anonymous credentials. Please check if the container exists first. If it is not publicly available, you have to provide accoun
t credentials.
2022-09-16 20:33:03,810 INFO impl.MetricsSystemImpl: Stopping azure-file-system metrics system...
2022-09-16 20:33:03,810 INFO impl.MetricsSystemImpl: azure-file-system metrics system stopped.
2022-09-16 20:33:03,810 INFO impl.MetricsSystemImpl: azure-file-system metrics system shutdown complete.
ls: org.apache.hadoop.fs.azure.AzureException: No credentials found for account venkystorageaccount2704.blob.core.windows.net in the configuration, and its container venkyc
ontainer is not accessible using anonymous credentials. Please check if the container exists first. If it is not publicly available, you have to provide account credentials
.
vkjagan@MU-C02G9694MD6R 3.3.4 %
```

To set credentials when we make the call, we need to follow the documentation presented here.
https://hadoop.apache.org/docs/stable/hadoop-azure/index.html

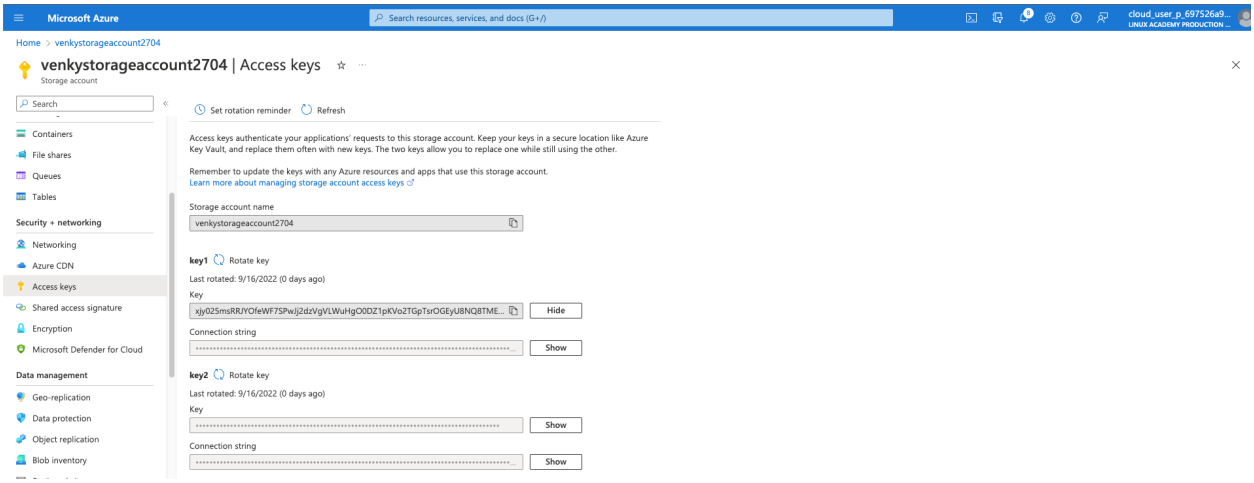
We must create a core-site.xml in the directory where brew installed Hadoop.
Change directory to the correct directory eg.
`/usr/local/Cellar/hadoop/3.3.4/libexec/etc/hadoop`

REPLACE the file with the following contents:

```
<?xml version="1.0"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>

<!-- Put site-specific property overrides in this file. -->

<configuration>

<property>
  <name>fs.azure.account.key.venkystorageaccount2704.blob.core.windows.net</name>
  <value>xjy025msRRJYOfeWF7SPwJj2dzVgVLWuHgO0DZ1pKVo2TGpTsrOGEyU8NQ8TMEDNb9VDim9gKQi9+AStI0YUsg==</value>
</property>

</configuration>
~
```

The value of the access keys can be got from either the Azure portal, or we can get it from the command line.

```
vkjagan@MU-C02G9694MD6R 3.3.4 % az storage account show-connection-string --name
venkystorageaccount2704
{
  "connectionString":
"DefaultEndpointsProtocol=https;EndpointSuffix=core.windows.net;AccountName=venkystorageaccount27
04;AccountKey=xjy025msRRJYOfeWF7SPwJj2dzVgVLWuHgO0DZ1pKVo2TGpTsrOGEyU8NQ8TMEDNb9VDim9gKQi9+AStI0Y
Usg==;BlobEndpoint=https://venkystorageaccount2704.blob.core.windows.net/;FileEndpoint=https://ve
nkystorageaccount2704.file.core.windows.net/;QueueEndpoint=https://venkystorageaccount2704.queue.
core.windows.net/;TableEndpoint=https://venkystorageaccount2704.table.core.windows.net/"
}
```

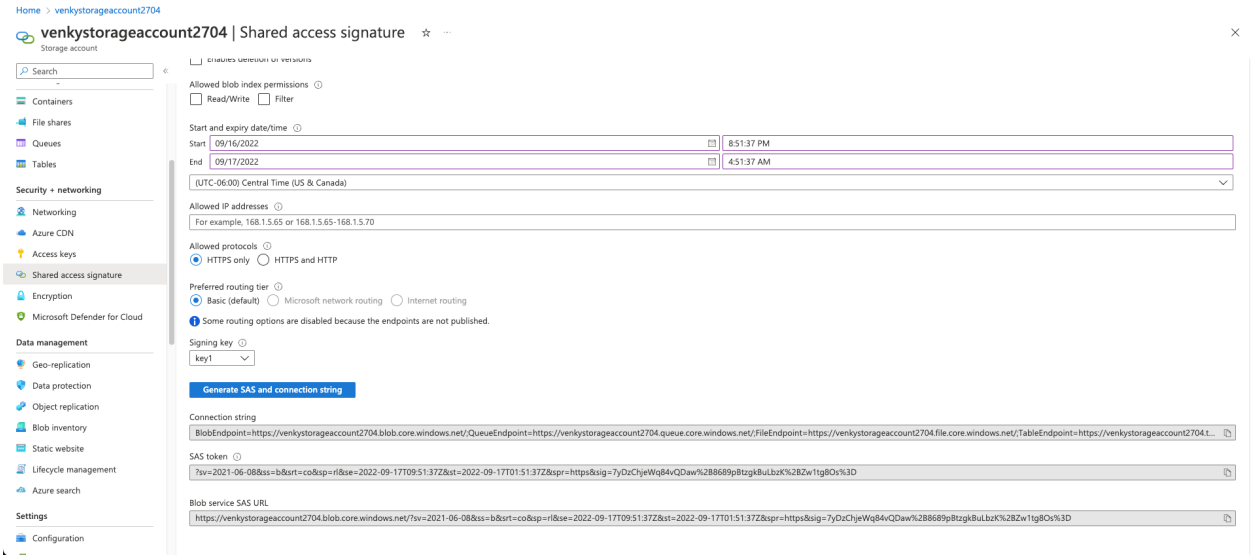


Once we make sure the put the access keys into the core-site.xml and save it in the correct location specified above, the Hadoop list command just works perfect!

```
vkjagan@MU-C02G9694MD6R 3.3.4 % ls
INSTALL_RECEIPT.json    LICENSE.txt             README.txt              core-site.xml           libexec
LICENSE-binary          NOTICE.txt              bin                     hadoop-env.sh           sbin
vkjagan@MU-C02G9694MD6R 3.3.4 % mv core-site.xml libexec/etc/hadoop
vkjagan@MU-C02G9694MD6R 3.3.4 % hadoop fs -ls wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/
2022-09-16 20:48:39,235 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
2022-09-16 20:48:39,521 INFO impl.MetricsConfig: Loaded properties from hadoop-metrics2.properties
2022-09-16 20:48:39,589 INFO impl.MetricsSystemImpl: Scheduled Metric snapshot period at 10 second(s).
2022-09-16 20:48:39,589 INFO impl.MetricsSystemImpl: azure-file-system metrics system started
Found 1 items
-rwxrwxrwx   1         49 2022-09-16 20:12 wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/people.csv
2022-09-16 20:48:40,204 INFO impl.MetricsSystemImpl: Stopping azure-file-system metrics system...
2022-09-16 20:48:40,205 INFO impl.MetricsSystemImpl: azure-file-system metrics system stopped.
2022-09-16 20:48:40,205 INFO impl.MetricsSystemImpl: azure-file-system metrics system shutdown complete.
vkjagan@MU-C02G9694MD6R 3.3.4 %
```

Note that the core-site.xml has the ACCESS KEY in plain text! This is a serious violation of security principles.

Once way we can adjust this is to create a SAS string on the portal giving it exactly the access we want to give.



As we can see the SAS token is generated and the access is time-bound now.

```
<?xml version="1.0"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>

<!-- Put site-specific property overrides in this file. -->

<configuration>

<property>

  <!-- <name>fs.azure.account.key.venkystorageaccount2704.blob.core.windows.net</name> -->
  <name>fs.azure.sas.venkycontainer.venkystorageaccount2704.blob.core.windows.net</name>

  <!-- <value>xjy025msRRJYOfeWF7SPwJj2dzVgVLWuHgO0DZ1pKVo2TGpTsrOGEyU8NQ8TMEDNb9VDim9gKQi9+AStI0YUsg==</value> -->
  <value>sv=2021-06-08&amp;ss=b&amp;srt=co&amp;sp=rl&amp;se=2022-09-17T09:51:37Z&amp;st=2022-09-17T01:51:37Z&amp;spr=https&amp;sig=7yDzChjeWq84vQDaw%2B8689pBtzgkBuLbzK%2BZw
1tg8Os%3D</value>
</property>

</configuration>
~
```

Note how the core-site.xml has changed. It has now used a new key for the <name> and the sas token value from the azure portal.

This should work right? NO!!!

```
vkjagan@MU-C02G9694MD6R hadoop % hadoop fs -ls wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/
Exception in thread "main" [com.ctc.wstx.exc.WstxLazyException] com.ctc.wstx.exc.WstxUnexpectedCharException: Unexpected character '=' (code 61); expected a semi-colon afte
r the reference for entity 'ss'
 at [row,col,system-id]: [14,26,"file:/usr/local/Cellar/hadoop/3.3.4/libexec/etc/hadoop/core-site.xml"]
        at com.ctc.wstx.exc.WstxLazyException.throwLazily(WstxLazyException.java:40)
        at com.ctc.wstx.sr.StreamScanner.throwLazyError(StreamScanner.java:737)
        at com.ctc.wstx.sr.BasicStreamReader.safeFinishToken(BasicStreamReader.java:3745)
        at com.ctc.wstx.sr.BasicStreamReader.getTextCharacters(BasicStreamReader.java:914)
        at org.apache.hadoop.conf.Configuration$Parser.parseNext(Configuration.java:3403)
        at org.apache.hadoop.conf.Configuration$Parser.parse(Configuration.java:3182)
        at org.apache.hadoop.conf.Configuration.loadResource(Configuration.java:3075)
        at org.apache.hadoop.conf.Configuration.loadResources(Configuration.java:3036)
        at org.apache.hadoop.conf.Configuration.loadProps(Configuration.java:2914)
        at org.apache.hadoop.conf.Configuration.getProps(Configuration.java:2896)
        at org.apache.hadoop.conf.Configuration.set(Configuration.java:1412)
        at org.apache.hadoop.conf.Configuration.set(Configuration.java:1384)
        at org.apache.hadoop.conf.Configuration.setBoolean(Configuration.java:1726)
        at org.apache.hadoop.util.GenericOptionsParser.processGeneralOptions(GenericOptionsParser.java:340)
        at org.apache.hadoop.util.GenericOptionsParser.parseGeneralOptions(GenericOptionsParser.java:573)
        at org.apache.hadoop.util.GenericOptionsParser.<init>(GenericOptionsParser.java:175)
        at org.apache.hadoop.util.GenericOptionsParser.<init>(GenericOptionsParser.java:157)
        at org.apache.hadoop.util.ToolRunner.run(ToolRunner.java:75)
        at org.apache.hadoop.util.ToolRunner.run(ToolRunner.java:95)
        at org.apache.hadoop.fs.FsShell.main(FsShell.java:390)
Caused by: com.ctc.wstx.exc.WstxUnexpectedCharException: Unexpected character '=' (code 61); expected a semi-colon after the reference for entity 'ss'
 at [row,col,system-id]: [14,26,"file:/usr/local/Cellar/hadoop/3.3.4/libexec/etc/hadoop/core-site.xml"]
        at com.ctc.wstx.sr.StreamScanner.throwUnexpectedChar(StreamScanner.java:666)
        at com.ctc.wstx.sr.StreamScanner.parseEntityName(StreamScanner.java:2080)
        at com.ctc.wstx.sr.StreamScanner.fullyResolveEntity(StreamScanner.java:1538)
        at com.ctc.wstx.sr.BasicStreamReader.readTextSecondary(BasicStreamReader.java:4765)
        at com.ctc.wstx.sr.BasicStreamReader.finishToken(BasicStreamReader.java:3789)
        at com.ctc.wstx.sr.BasicStreamReader.safeFinishToken(BasicStreamReader.java:3743)
        ... 17 more
vkjagan@MU-C02G9694MD6R hadoop %
```

The characters we get from the portal are not compatible with XML format. So we need to go to this site https://www.freeformatter.com/xml-escape.html#before-output and fix the characters.

```
<?xml version="1.0"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>

<!-- Put site-specific property overrides in this file. -->

<configuration>

<property>

  <!-- <name>fs.azure.account.key.venkystorageaccount2704.blob.core.windows.net</name> -->
  <name>fs.azure.sas.venkycontainer.venkystorageaccount2704.blob.core.windows.net</name>

  <!-- <value>xjy025msRRJYOfeWF7SPwJj2dzVgVLWuHgO0DZ1pKVo2TGpTsrOGEyU8NQ8TMEDNb9VDim9gKQi9+AStI0YUsg==</value> -->
  <value>sv=2021-06-08&amp;ss=b&amp;srt=co&amp;sp=rl&amp;se=2022-09-17T09:51:37Z&amp;st=2022-09-17T01:51:37Z&amp;spr=https&amp;sig=7yDzChjeWq84vQDaw%2B8689pBtzgkBuLbzK%2BZw
1tg8Os%3D</value>
</property>

</configuration>
~
```

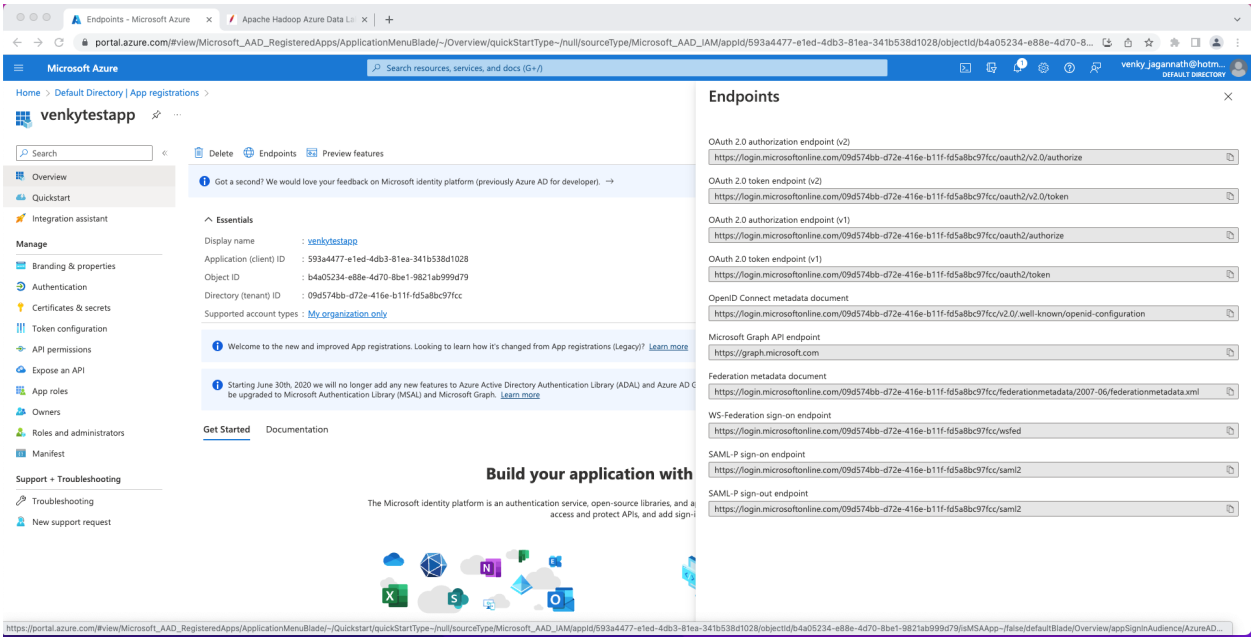
With this escaping in place, we are able to access the data.

```
vkjagan@MU-C02G9694MD6R hadoop % hadoop fs -ls wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/
2022-09-16 21:18:09,276 WARN util.NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes where applicable
2022-09-16 21:18:09,617 INFO impl.MetricsConfig: Loaded properties from hadoop-metrics2.properties
2022-09-16 21:18:09,718 INFO impl.MetricsSystemImpl: Scheduled Metric snapshot period at 10 second(s).
2022-09-16 21:18:09,718 INFO impl.MetricsSystemImpl: azure-file-system metrics system started
Found 1 items
-rwxrwxrwx   1         49 2022-09-16 20:12 wasbs://venkycontainer@venkystorageaccount2704.blob.core.windows.net/people.csv
2022-09-16 21:18:10,339 INFO impl.MetricsSystemImpl: Stopping azure-file-system metrics system...
2022-09-16 21:18:10,340 INFO impl.MetricsSystemImpl: azure-file-system metrics system stopped.
2022-09-16 21:18:10,340 INFO impl.MetricsSystemImpl: azure-file-system metrics system shutdown complete.
vkjagan@MU-C02G9694MD6R hadoop %
```

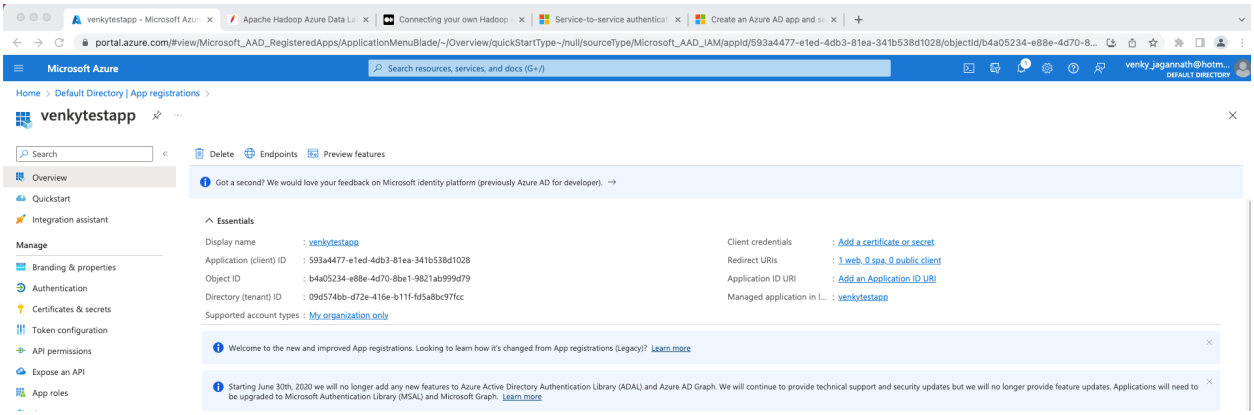
Next if we do not want to access these using oAuth, we need to follow this: https://hadoop.apache.org/docs/stable/hadoop-azure-datalake/index.html#Configuring_Credentials_and_FileSystem

We need to create an application registration into AAD.

Linuxacademy does not allow me to create a registration. I had to use my personal account to test this part out.

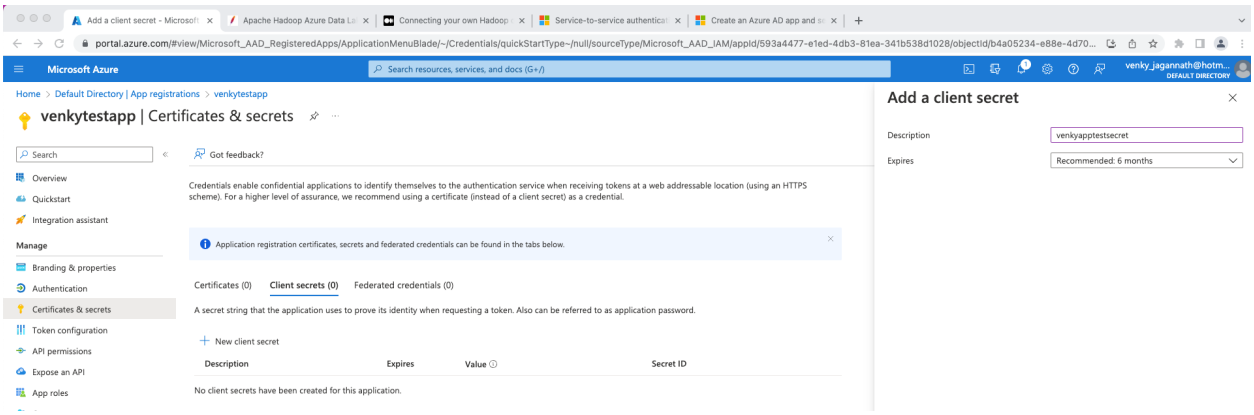


Note that I created a fake webapp for fun, and registered it. The end-points for that app are displayed here.



Copy the Directory (tenant) ID. 09d574bb-d72e-416e-b11f-fd5a8bc97fcc
Copy the application ID = 593a4477-e1ed-4db3-81ea-341b538d1028

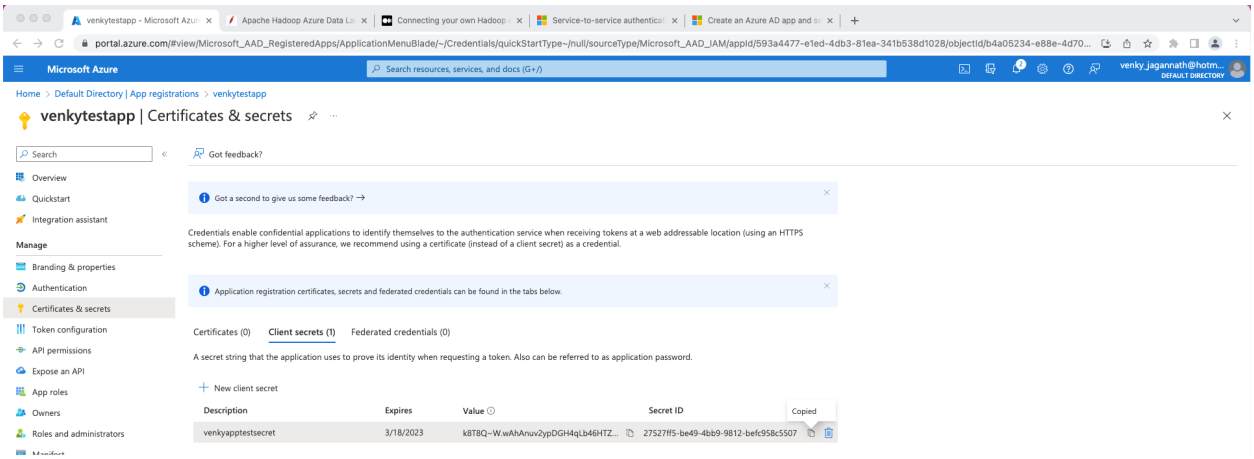
More details about how to setup the app secrets are here
https://learn.microsoft.com/en-us/azure/active-directory/develop/howto-create-service-principal-portal#get-tenant-and-app-id-values-for-signing-in



Copy secret value and Secret ID

Secret value.
k8T8Q~W.wAhAnuv2ypDGH4qLb46HTZxa75ZYya4~

Secret ID
27527ff5-be49-4bb9-9812-befc958c5507



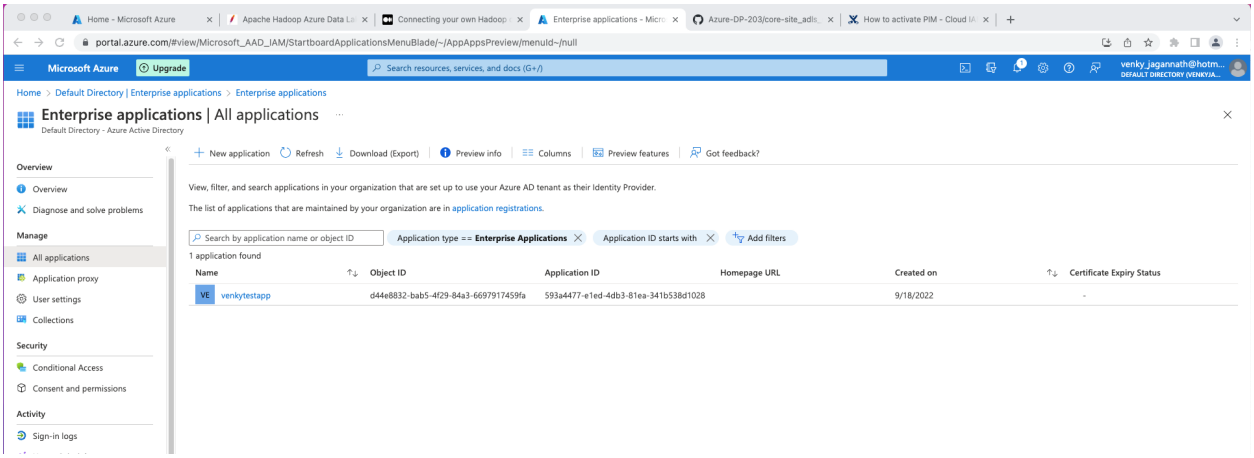
Next we need to let this webapp access to ADLS

https://learn.microsoft.com/en-us/azure/data-lake-store/data-lake-store-service-to-service-authenticate-using-active-directory#create-an-active-directory-application

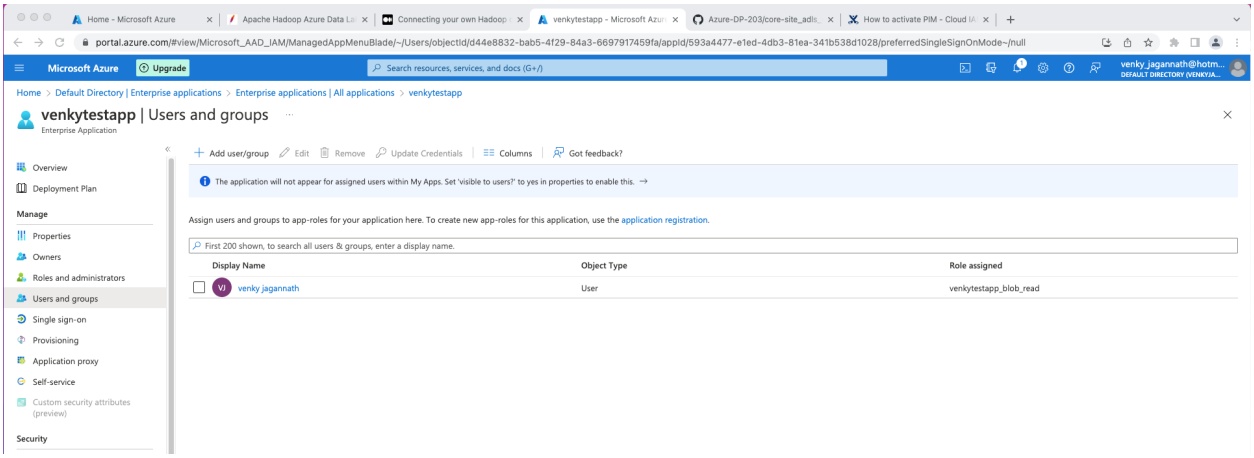
Copy the OAuth 2.0 token endpoint from the screen. (under endpoints).
https://login.microsoftonline.com/09d574bb-d72e-416e-b11f-fd5a8bc97fcc/oauth2/v2.0/token

Once this app registration is done, we need to give it roles to allow us to use it and connect to the storage system.

Next click on Enterprise applications on the left nav and add the users/groups to the application role we have.

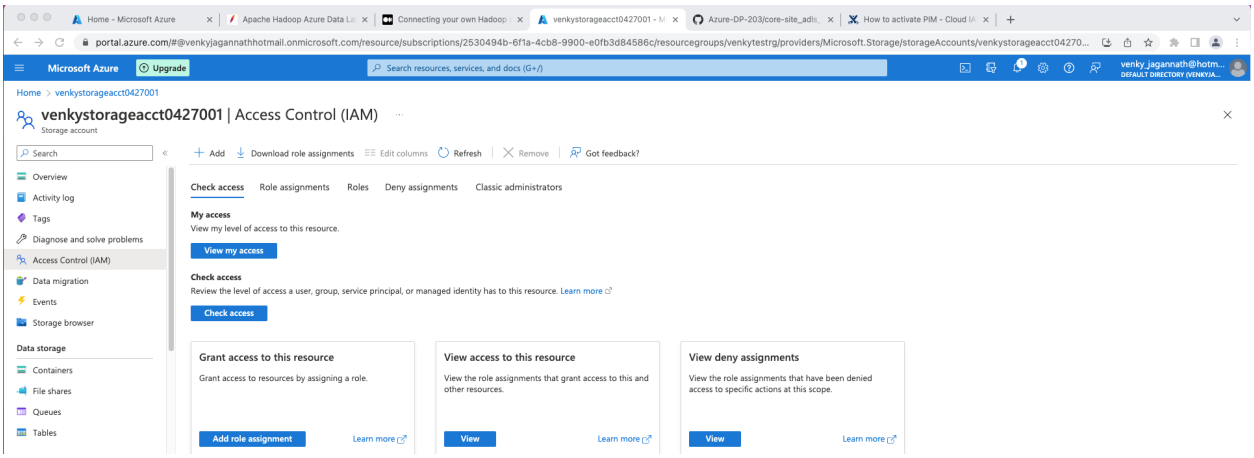


Click on the app, open the screen, click on assign users and groups.

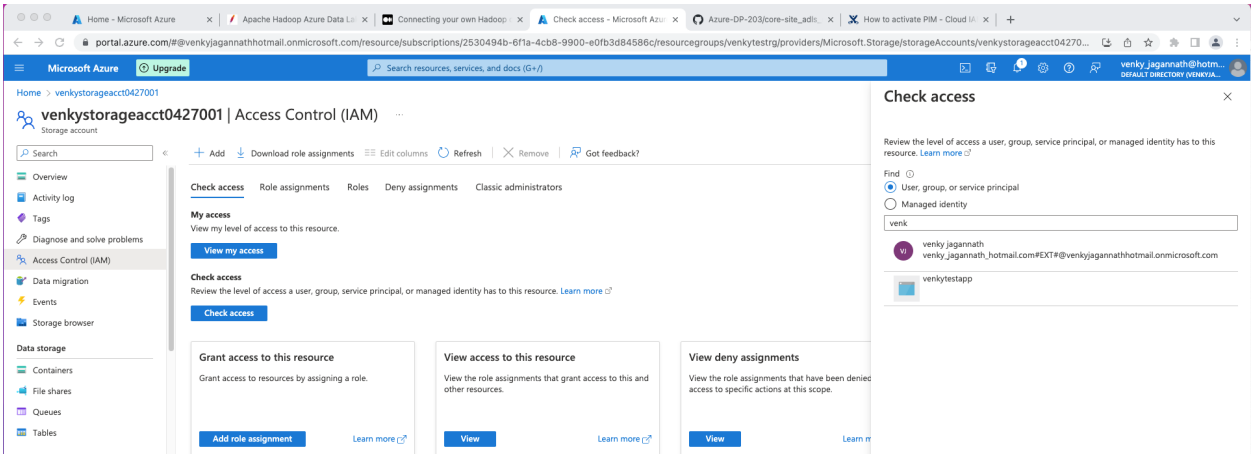


As we can see, I have added me to this app.

Now we need to assign the IAM permissions to the storage account we have created, so that the app can get to the storage.

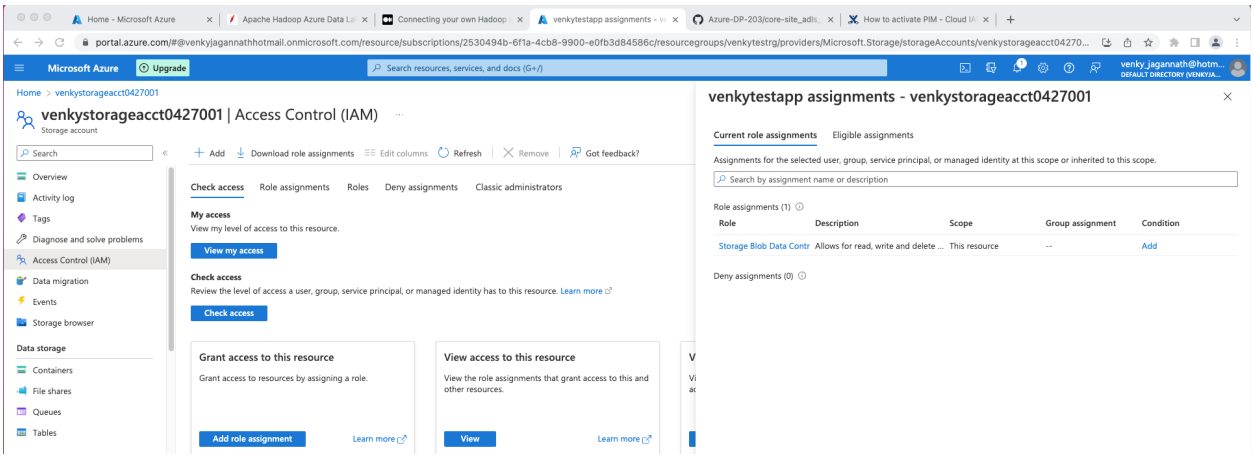


Click on Check Access, Search for the app name venky in the search box, with the User, Group or Service Principal and select the app we provisioned.



Pick the app that shows.

We need to make sure that the Storage Blob Data Contributor is assigned to the service principal we had created.



If we do not see that assignment, we need to Add Role Assignment button, select the “Storage Blob Contributor” and then assign it to the correct service principal.

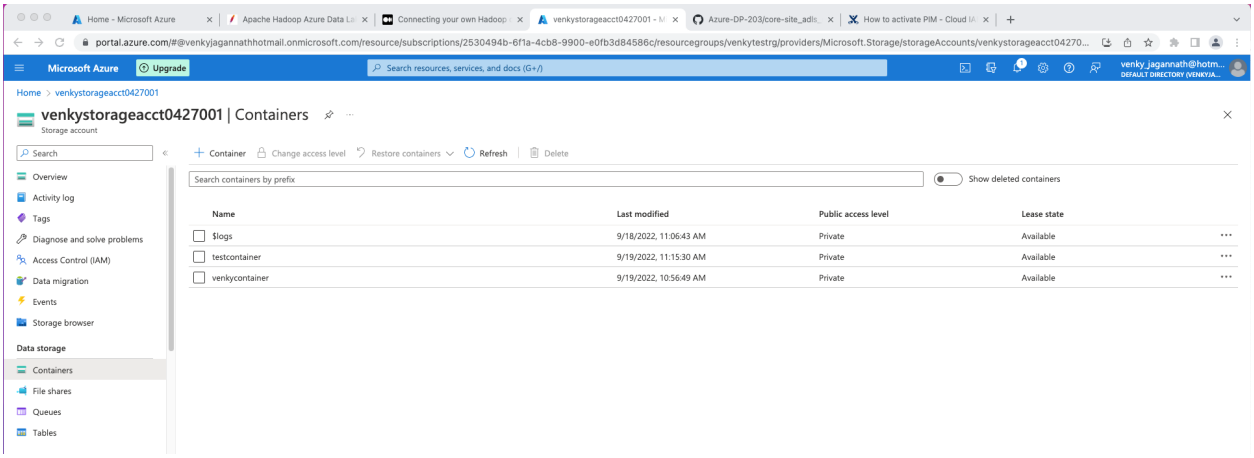
Make sure NO OTHER permissions are assigned, like contributor, owner etc. That will cause problems.

After this assignment is done, we need to wait for 5 mins to make sure the assignment goes through.

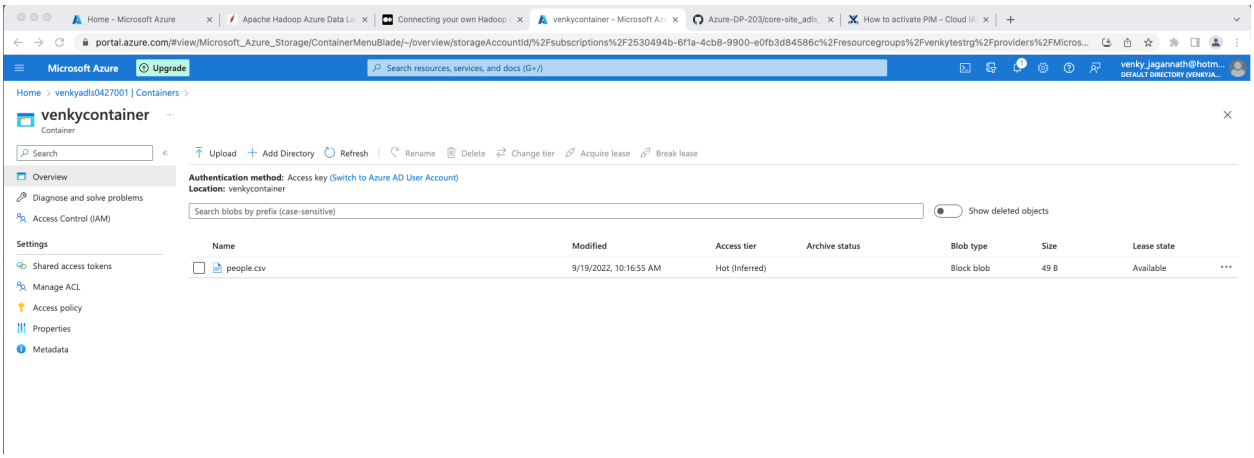
Once we do this, we can check to see what we get when we do the Hadoop fs -ls.

We need to have the abfss:// for the settings to take effect.

I have created 2 containers under the blob storage account and added people.csv in there.



I have also created another ADLS account and added the same file there too. See top breadcrumb. Venkyadls0427001 is the name of the storage account. This has hierarchical namespaces enabled.



This is the final core-site.xml that worked for me.

https://github.com/SowmyaVenky/Azure-DP-203/blob/main/hadoop_adls_experiments/core-site_adls_example.xml

I will go ahead and delete all the keys, resource groups etc. to make sure I do not get billed.

```
37
38  ## Copy the people.csv in the temp folder to the container we created.
39
40
41  hadoop fs -ls wasbs://venkycontainer@venkystorageacct0427001.blob.core.windows.net/
42
43  SET HADOOP_CLASSPATH=%HADOOP_CLASSPATH%;%HADOOP_HOME%\share\hadoop\tools\lib\*
44  C:\Venky\DP-203\Azure-DP-203\hadoop_adls_experiments>hadoop fs -ls wasbs://venkycontainer@venkystorageaccount0427.blob.core.windows.net/
45  2022-09-17 20:39:37,438 INFO impl.MetricsConfig: Loaded properties from hadoop-metrics2.properties
46  2022-09-17 20:39:37,582 INFO impl.MetricsSystemImpl: Scheduled Metric snapshot period at 10 second(s).
47  2022-09-17 20:39:37,582 INFO impl.MetricsSystemImpl: azure-file-system metrics system started
48  Found 1 items
49  -rwxrwxrwx   1         49 2022-09-17 20:22 wasbs://venkycontainer@venkystorageaccount0427.blob.core.windows.net/people.csv
50  2022-09-17 20:39:38,745 INFO impl.MetricsSystemImpl: Stopping azure-file-system metrics system...
51  2022-09-17 20:39:38,745 INFO impl.MetricsSystemImpl: azure-file-system metrics system stopped.
52  2022-09-17 20:39:38,745 INFO impl.MetricsSystemImpl: azure-file-system metrics system shutdown complete.
53
54  We need to do a lot of setup, app registration, permissions, and adding the role to the storage account as blob contributor.
55
56  C:\Venky\DP-203\Azure-DP-203>hadoop fs -ls abfss://venkycontainer@venkystorageacct0427001.blob.core.windows.net/people.csv
57  -rwxrwxrwx   1 VenkyJagannath docker-users         49 2022-09-19 09:33 abfss://venkycontainer@venkystorageacct0427001.blob.core.windows.net/people.csv
58
59  C:\Venky\DP-203\Azure-DP-203>hadoop fs -ls abfss://test@venkystorageacct0427001.blob.core.windows.net/people.csv
60  ls: `abfss://test@venkystorageacct0427001.blob.core.windows.net/people.csv': No such file or directory
61
62  C:\Venky\DP-203\Azure-DP-203>hadoop fs -ls abfss://venkycontainer@venkyadls0427001.dfs.core.windows.net/
63  Found 1 items
64  -rwxrwx---+  1 VenkyJagannath docker-users         49 2022-09-19 10:16 abfss://venkycontainer@venkyadls0427001.dfs.core.windows.net/people.csv
```

This proves that we can hit the oAuth token using the client id and token, get authenticated, and then authorized to list the contents of ADLS from our local.