Winter Ready 2019 Technical Lab
Level: 300
Contact: omidm

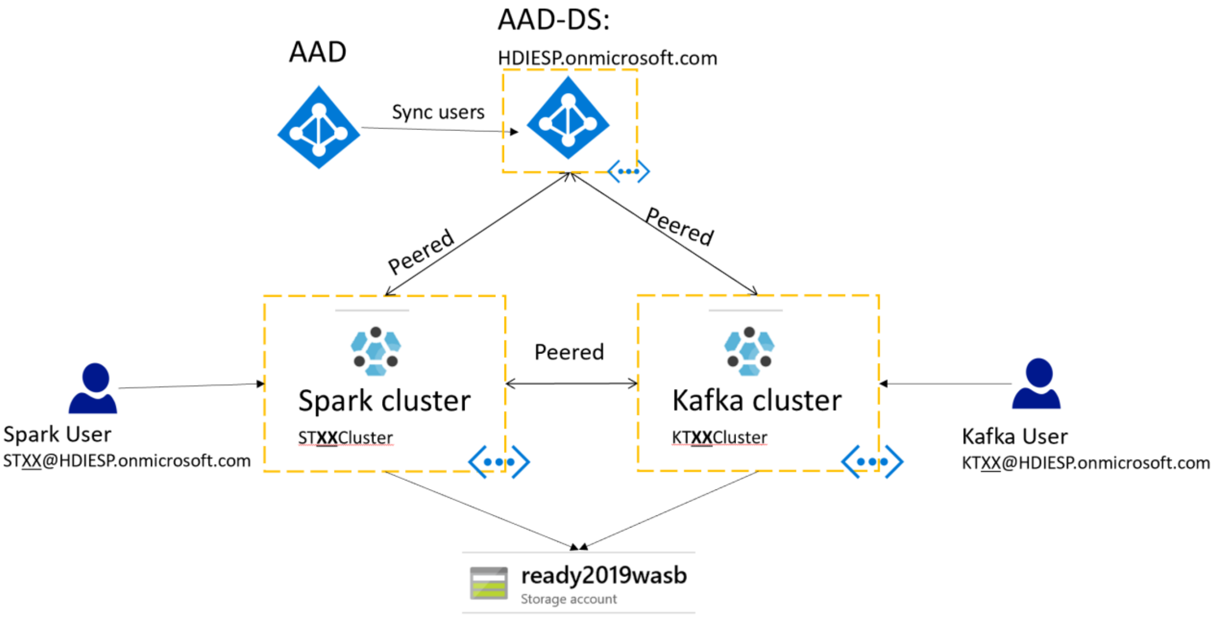
Team XX ==

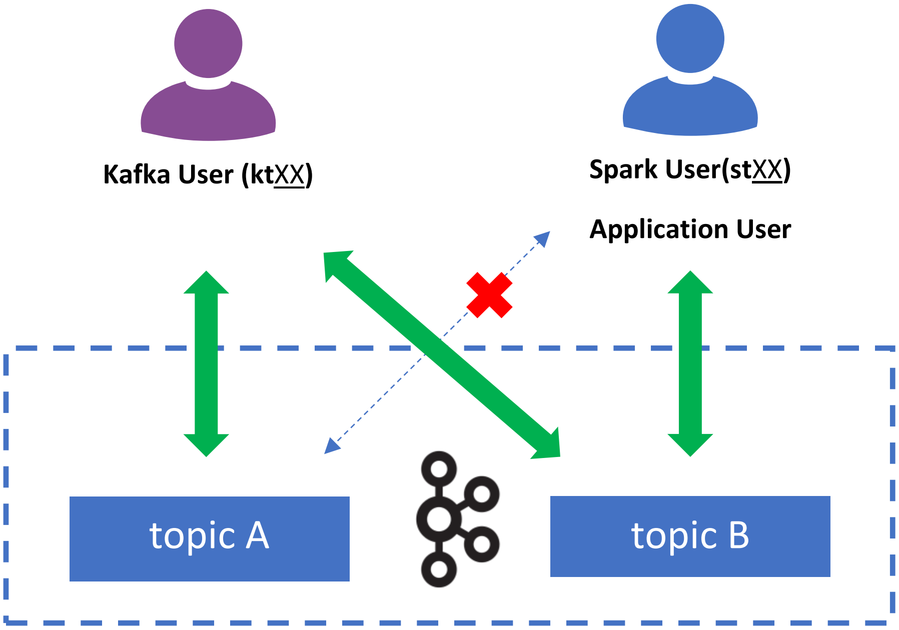
Spark User Instructions

Overview:

This Lab walks through the setup of a typical streaming data pattern in Azure. Data is ingested in Apache Kafka on HDInsight into specific topics. This data in Kafka is then read by a Spark streaming job. What makes this pattern more relevant to enterprises is that both clusters have Enterprise Security Package enabled: hence access to Kafka topics can be gated by Apache Ranger policies.

Imagine a company where …





Winter Ready 2019 Technical Lab
Level: 300
Contact: omidm

Team XX ==

Spark User Instructions

You are the **spark user** in this diagram. The rest of this document covers the necessary steps for creating a secure Spark cluster, executing a spark job that reads a topic from a secure Kafka cluster using domain credentials.

You will go through the following scenarios:

1. Consume data from “topicB” with your domain credentials.
    a. Expected behavior: The spark job would run successfully. The Ranger audit records in Kafka cluster would show that the access is allowed.
2. Consume data from “topicA” with your domain credentials.
    a. Expected behavior: The spark job would fail with “Not authorized to access topics: …….” error message. The Ranger audit records in Kafka cluster shows that the access is Denied.

Pre-requisites:

- AAD-DS is already setup. The lab instructor is the AAD admin and can provide access when/if needed. Think of the instructor as the AD team which is typically different from the big data team in enterprises. The AD team has already created your domain credentials which you will use later in this lab.
- An ESP Kafka cluster deployed in a different VNET: Your teammate in this lab will be creating and preparing this cluster. When needed you can coordinate with him to get related information.

Common info you will need:

- Domain User Credentials: st**XX**@HDIESP.onmicrosoft.com , Pass: Ask Instructors.
- Replace **XX** in the rest of this doc with you team number at the top of this page.

Instructions:

Login with your domain username in the common info above to https://portal.azure.com

We will use ARM templates to deploy resources needed in this Lab.

You can find the required templates on GitHub, use the “Deploy to Azure” button when needed:

https://github.com/tylerfox/HDInsight-ESP-Kafka-Spark

1- Create a VNET & Peer

- Go to GitHub link above and click on “template_vnet.json” Deploy to Azure button OR simply click here: **Deploy to Azure**

Team XX ==

Spark User Instructions

- Resource Group: TeamXXRG
- VNET name: STXXVNET
- Your IP range depends on your team number (XX in top of this doc). Let **Y = [(2 *XX) – 1]**, then your VNET IP range is 10.Y.0.0/16 and Subnet IP range is **10.Y.0.0/24**
- Set Custom DNS server to AAD-DS DNS servers: **10.0.0.5,10.0.0.4**
- Set AAD-DS Resource Group: **AADDS-RG**
- AAD-DS VNET name: **AD-VNET**
- Hit “Purchase” to start the deployment.

This deployment creates a VNET/Subnet with the specified IP range, peer it to the AAD-DS VNET and set custom DNS server settings.

2- Create an HDInsight ESP Spark Cluster

- After the step1 is successfully finished, Go to GitHub link above and click on “template_spark.json” Deploy to Azure button. Deploy to Azure
- Name: STXXCluster
- Cluster_username: **sshuser**
- sshuser Password: Pick a pass and don’t forget it. You will need this pass later.
- WASB account name: **ready2019wasb**
- WASB RG: **Ready2019RG**
- Spark VNET name: from previous section (STXXVNET)
- AAD-DS resource group: **AADDS-RG**
- AAD-DS domain name: **HDIESP.onmicrosoft.com**
- Cluster Admin AAD account: st**XX@HDIESP.onmicrosoft.com**
- Cluster access group name: TeamXXAADGroup
- Managed Identity RG: **Ready2019RG**
- Managed Identity name: **Ready2019MI**

This deployment creates an ESP Spark cluster in your VNET and will take about 20-30 minutes. You can proceed to the next step while the deployment is in progress.

3- Peer to Kafka VNET:

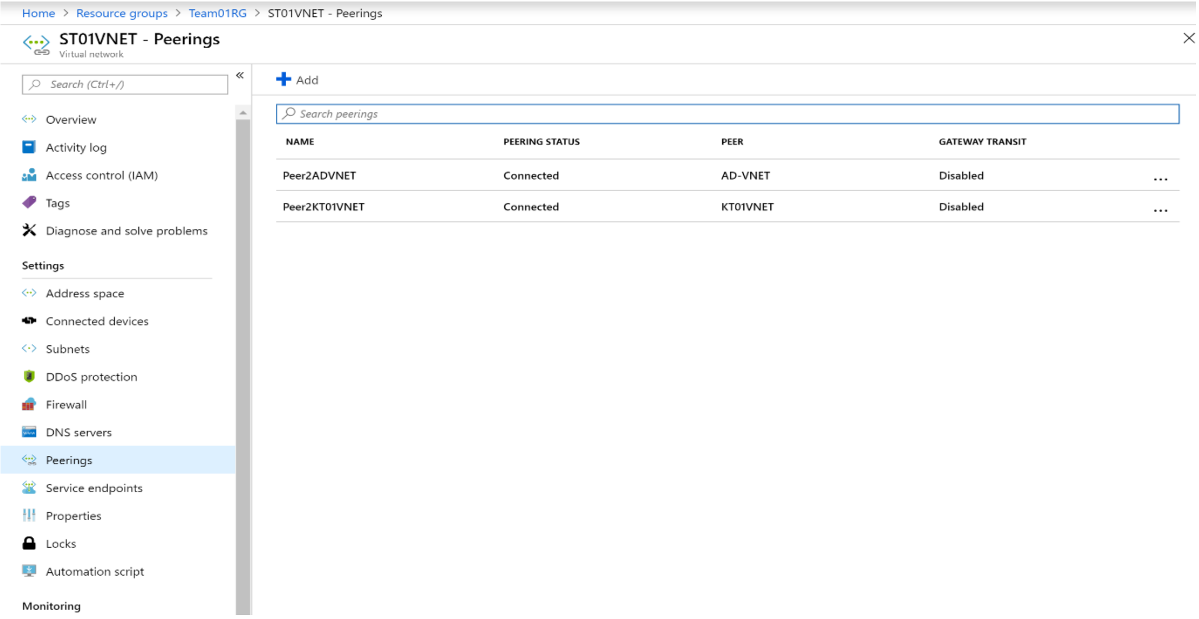
- Before you proceed, check with your teammate or look in to your resource group to make sure that Kafka VNET with the name KTXXVNET is already created.
- Go to GitHub link above and click on “template_peer.json” Deploy to Azure button.
  Deploy to Azure
- My VNET: STXXVNET
- Remote VNET: KTXXVNET

Winter Ready 2019 Technical Lab
Level: 300
Contact: omidm

Team XX ==

Spark User Instructions

This deployment peer your VNET to the Kafka cluster VNET. Your teammate should do the same and then the peering status will change from initiated to “Connected”:



NAME	PEERING STATUS	PEER	GATEWAY TRANSIT
Peer2ADVNET	Connected	AD-VNET	Disabled
Peer2KT01VNET	Connected	KT01VNET	Disabled

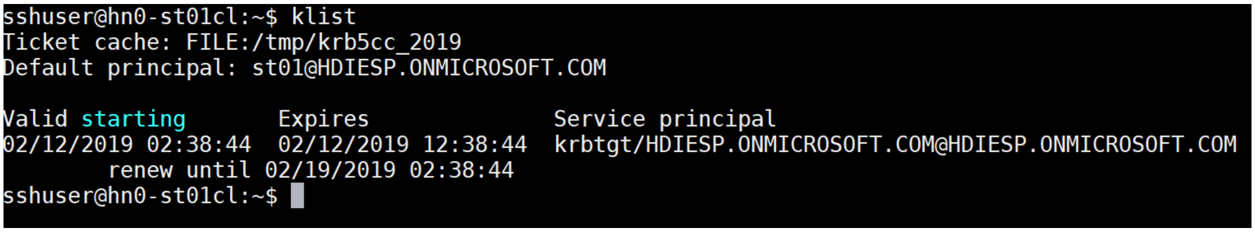
4- Prepare the cluster environment:

While your cluster deploymen is going on (takes 20-30 min), you can use a cluster that we have pre-created for you to complete the rest of this lab.
Your pre-created cluster name is : **STXXACluster (replace XX with your team number)**

- SSH to the cluster using the “sshuser” credentials you picked when creating the cluster. For pre-created clusters ask the instructor for sshuser password.
  - ssh sshuser@<clusterName>-ssh.azurehdinsight.net
- Create a Kerberos keytab for your domain username. You can later use this keytab to authenticate to remote domain joined clusters without entering a password. Note the **UPPERCASE** in the domain name:
  - ktutil
  - ktutil: addent -password -p stXX@HDIESP.ONMICROSOFT.COM -k 1 -e RC4-HMAC
  - Password for st**XX**@HDIESP.ONMICROSOFT.COM:
  - ktutil: wkt st**XX**.keytab
  - ktutil: q
- Create a st**XX**_jaas.conf file with the following content which will be used for authenticating to the Kafka:

```
KafkaClient {
    com.sun.security.auth.module.Krb5LoginModule required
    useKeyTab=true
    storeKey=true
    keyTab="./stXX.keytab"
    useTicketCache=false
    serviceName="kafka"
    principal="stXX@HDIESP.ONMICROSOFT.COM";
 };
```

- Typically, data scientists will have their own logic for consuming the steaming data. In this lab we will follow the example instructions outlined here for reading the Kafka topic.
    - Get the spark-streaming jar ready by building you own. The sample jar used in this lab is located on Github. Please following these steps.
        a. sudo apt install maven
        b. git clone https://github.com/markgrover/spark-secure-kafka-app.git
        c. cd spark-secure-kafka-app
        d. mvn clean package
            a. the jar will be created in the “target” folder
- Test Keytab and Kerberos Authentications:
    i. cd
    ii. Issue a “kdestroy” to remove the Kerberos tickets in Credential Cache by issuing following command: kdestroy
    iii. kinit st**XX**@HDIESP.ONMICROSOFT.COM -t st**XX**.keytab
    iv. klist - to make sure login was successful and domain user is available in the Cache. You should see an output like below:



```
sshuser@hn0-st01cl:~$ klist
Ticket cache: FILE:/tmp/krb5cc_2019
Default principal: st01@HDIESP.ONMICROSOFT.COM

Valid starting       Expires              Service principal
02/12/2019 02:38:44  02/12/2019 12:38:44  krbtgt/HDIESP.ONMICROSOFT.COM@HDIESP.ONMICROSOFT.COM
        renew until 02/19/2019 02:38:44
sshuser@hn0-st01cl:~$
```

Now your Spark cluster is ready to consume data from Kafka topics.

5- Consume data from Kafka topics:

Issue a spark-submit command to read from kafka topic "**topicA**" with st**XX** domain user keytab:

Example:

spark-submit --num-executors 1 --master yarn --deploy-mode cluster --packages org.apache.spark:spark-streaming-kafka-0-10_2.11:2.3.2.3.1.0.4-1 --repositories http://repo.hortonworks.com/content/repositories/releases/ --files st**XX**_jaas.conf#st**XX**_jaas.conf,st**XX**.keytab#st**XX**.keytab --driver-java-options "-Djava.security.auth.login.config=./st**XX**_jaas.conf" --class

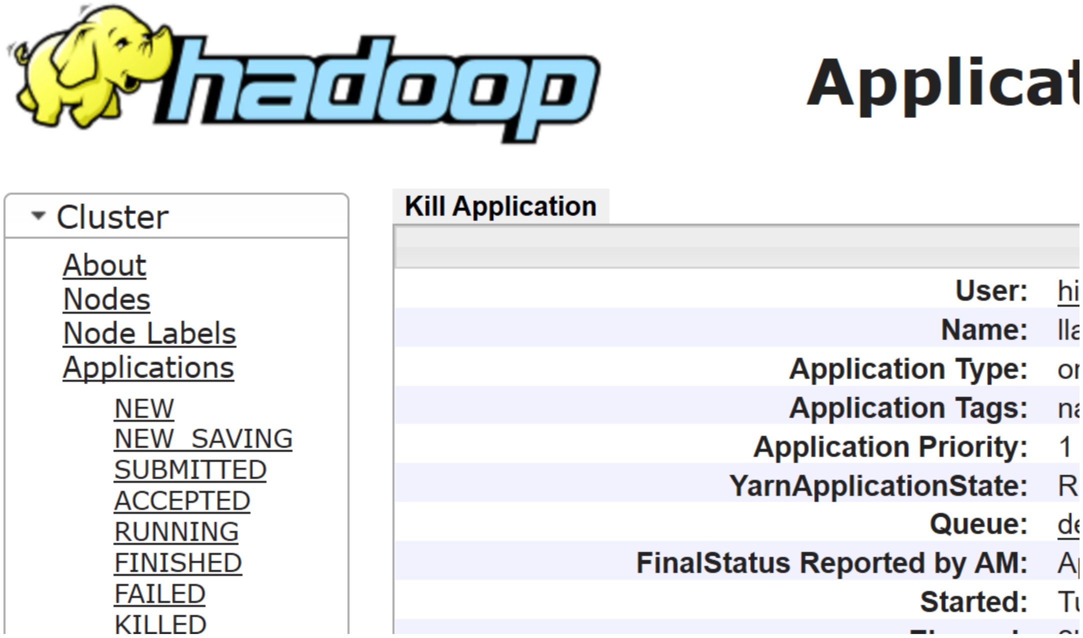
Spark User Instructions

```
com.cloudera.spark.examples.DirectKafkaWordCount --conf
"spark.executor.extraJavaOptions=-Djava.security.auth.login.config=./stXX_jaas.conf"
/home/sshuser/spark-secure-kafka-app/target/spark-secure-kafka-app-1.0-SNAPSHOT.jar
9.Z.0.5:9092 topicA false
```

9.Z.0.5 is the IP address of one of the brokers in the Kafka cluster. You can ask your teammate to provide you with this IP address from /etc/hosts file on the Kafka cluster, look for worker nodes starting with wn0-*. The pre-created Kafka cluster name is KT**XX**ACluster.

Troubleshooting:

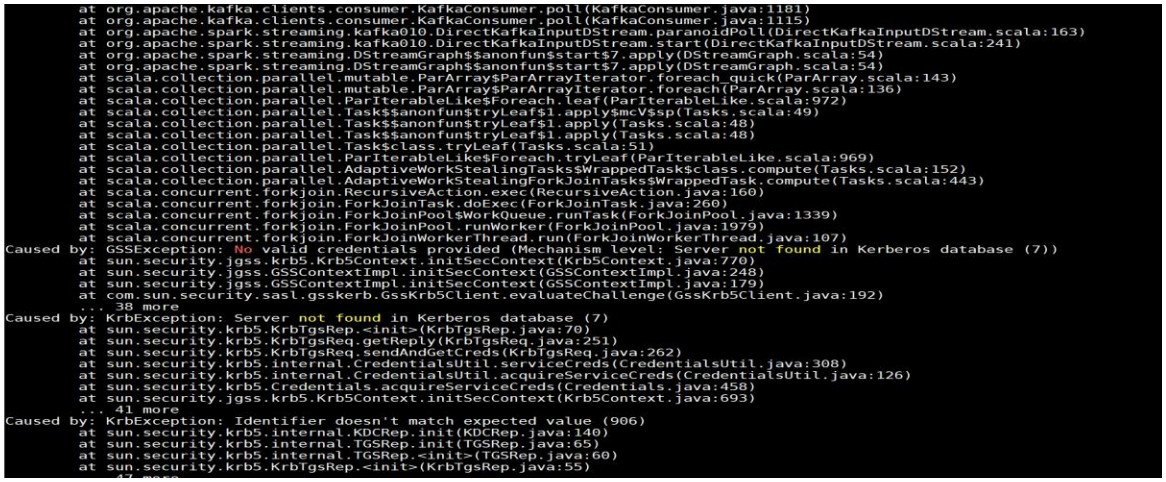
If you make a mistake you can kill your running application: Go to Yarn UI to see your application and if needed "Kill Application": https://st**XX**cluster.azurehdinsight.net/yarnui/



User: hi
Name: lla
Application Type: or
Application Tags: na
Application Priority: 1
YarnApplicationState: R
Queue: de
FinalStatus Reported by AM: A
Started: Tu

If you see the following error message in the output of the spark submit job:
Caused by: GSSException: No valid credentials provided (**Mechanism level: Server not found in Kerberos database (7)**)

Spark User Instructions

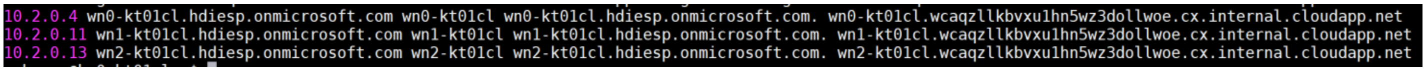


```
        at org.apache.kafka.clients.consumer.KafkaConsumer.poll(KafkaConsumer.java:1181)
        at org.apache.kafka.clients.consumer.KafkaConsumer.poll(KafkaConsumer.java:1115)
        at org.apache.spark.streaming.kafka010.DirectKafkaInputDStream.paranoidPoll(DirectKafkaInputDStream.scala:163)
        at org.apache.spark.streaming.kafka010.DirectKafkaInputDStream.start(DirectKafkaInputDStream.scala:241)
        at org.apache.spark.streaming.DStreamGraph$$anonfun$start$7.apply(DStreamGraph.scala:54)
        at org.apache.spark.streaming.DStreamGraph$$anonfun$start$7.apply(DStreamGraph.scala:54)
        at scala.collection.parallel.mutable.ParArray$ParArrayIterator.foreach_quick(ParArray.scala:143)
        at scala.collection.parallel.mutable.ParArray$ParArrayIterator.foreach(ParArray.scala:136)
        at scala.collection.parallel.ParIterableLike$Foreach.leaf(ParIterableLike.scala:972)
        at scala.collection.parallel.Task$$anonfun$tryLeaf$1.apply$mcV$sp(Tasks.scala:49)
        at scala.collection.parallel.Task$$anonfun$tryLeaf$1.apply(Tasks.scala:48)
        at scala.collection.parallel.Task$$anonfun$tryLeaf$1.apply(Tasks.scala:48)
        at scala.collection.parallel.Task$class.tryLeaf(Tasks.scala:51)
        at scala.collection.parallel.ParIterableLike$Foreach.tryLeaf(ParIterableLike.scala:969)
        at scala.collection.parallel.AdaptiveWorkStealingTasks$WrappedTask$class.compute(Tasks.scala:152)
        at scala.collection.parallel.AdaptiveWorkStealingForkJoinTasks$WrappedTask.compute(Tasks.scala:443)
        at scala.concurrent.forkjoin.RecursiveAction.exec(RecursiveAction.java:160)
        at scala.concurrent.forkjoin.ForkJoinTask.doExec(ForkJoinTask.java:260)
        at scala.concurrent.forkjoin.ForkJoinPool$WorkQueue.runTask(ForkJoinPool.java:1339)
        at scala.concurrent.forkjoin.ForkJoinPool.runWorker(ForkJoinPool.java:1979)
        at scala.concurrent.forkjoin.ForkJoinWorkerThread.run(ForkJoinWorkerThread.java:107)
Caused by: GSSException: No valid credentials provided (Mechanism level: Server not found in Kerberos database (7))
        at sun.security.jgss.krb5.Krb5Context.initSecContext(Krb5Context.java:770)
        at sun.security.jgss.GSSContextImpl.initSecContext(GSSContextImpl.java:248)
        at sun.security.jgss.GSSContextImpl.initSecContext(GSSContextImpl.java:179)
        at com.sun.security.sasl.gsskerb.GssKrb5Client.evaluateChallenge(GssKrb5Client.java:192)
        ... 38 more
Caused by: KrbException: Server not found in Kerberos database (7)
        at sun.security.krb5.KrbTgsRep.<init>(KrbTgsRep.java:70)
        at sun.security.krb5.KrbTgsReq.getReply(KrbTgsReq.java:251)
        at sun.security.krb5.KrbTgsReq.sendAndGetCreds(KrbTgsReq.java:262)
        at sun.security.krb5.internal.CredentialsUtil.serviceCreds(CredentialsUtil.java:308)
        at sun.security.krb5.internal.CredentialsUtil.acquireServiceCreds(CredentialsUtil.java:126)
        at sun.security.krb5.Credentials.acquireServiceCreds(Credentials.java:458)
        at sun.security.jgss.krb5.Krb5Context.initSecContext(Krb5Context.java:693)
        ... 41 more
Caused by: KrbException: Identifier doesn't match expected value (906)
        at sun.security.krb5.internal.KDCRep.init(KDCRep.java:140)
        at sun.security.krb5.internal.TGSRep.init(TGSRep.java:65)
        at sun.security.krb5.internal.TGSRep.<init>(TGSRep.java:60)
        at sun.security.krb5.KrbTgsRep.<init>(KrbTgsRep.java:55)
```

This is due to a known DNS bug that is preventing the Kafka brokers FQDNs to be resolved to the right IP.

The workaround for this issue is to do the following:

- Ask your teammate to send you the list of worker nodes entries from Kafka cluster in "/etc/hosts". This list should look like this:

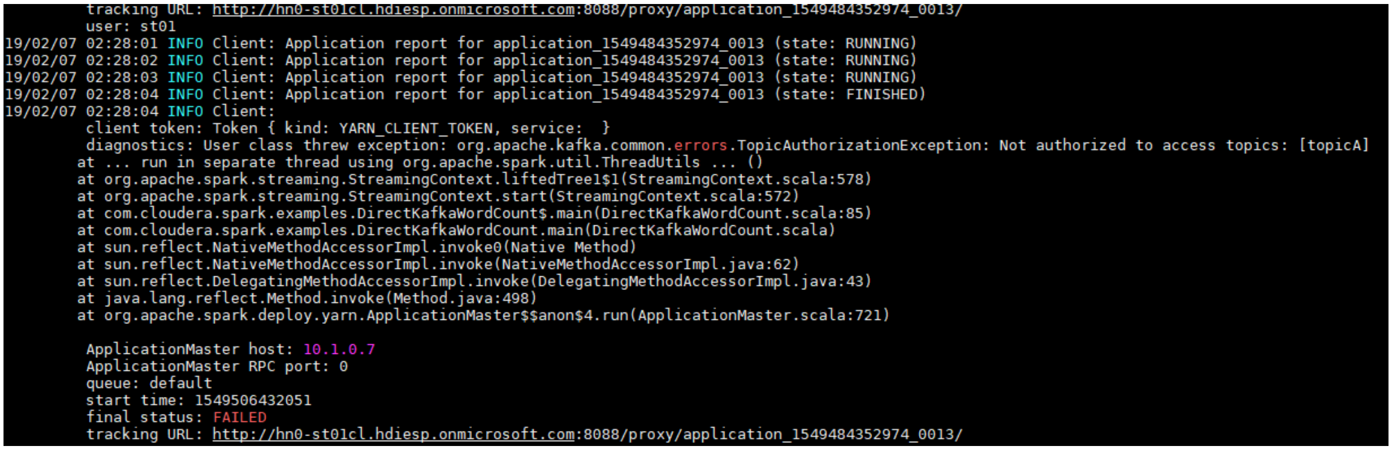


```
10.2.0.4 wn0-kt01cl.hdiesp.onmicrosoft.com wn0-kt01cl wn0-kt01cl.hdiesp.onmicrosoft.com. wn0-kt01cl.wcaqzllkbvxu1hn5wz3dollwoe.cx.internal.cloudapp.net
10.2.0.11 wn1-kt01cl.hdiesp.onmicrosoft.com wn1-kt01cl wn1-kt01cl.hdiesp.onmicrosoft.com. wn1-kt01cl.wcaqzllkbvxu1hn5wz3dollwoe.cx.internal.cloudapp.net
10.2.0.13 wn2-kt01cl.hdiesp.onmicrosoft.com wn2-kt01cl wn2-kt01cl.hdiesp.onmicrosoft.com. wn2-kt01cl.wcaqzllkbvxu1hn5wz3dollwoe.cx.internal.cloudapp.net
```

- Add this list to your "/etc/hosts" on both the head node and the worker node(s) of spark cluster:
  i. Edit /etc/hosts →sudo vim /etc/hosts → add the list at the end and save
  ii. ssh wn0-st**XX**cl (In this example the cluster has only one worker node)
  iii. sudo vim /etc/hosts → add the list at the end and save

Then try the spark-submit command again. This time you should see the "**TopicAuthorizationException**" which is expected and it means the Ranger policies on the Kafka cluster is enforced properly, since this user(st**XX**) is not allowed to read from "**topicA**".

> **spark-submit** --num-executors 1 --master yarn --deploy-mode cluster --packages org.apache.spark:spark-streaming-kafka-0-10_2.11:2.3.2.3.1.0.4-1 --repositories http://repo.hortonworks.com/content/repositories/releases/ --files st**XX**_jaas.conf#st**XX**_jaas.conf,st**XX**.keytab#st**XX**.keytab --driver-java-options "-Djava.security.auth.login.config=./st**XX**_jaas.conf" --class com.cloudera.spark.examples.DirectKafkaWordCount --conf "spark.executor.extraJavaOptions=-Djava.security.auth.login.config=./st**XX**_jaas.conf" /home/sshuser/spark-secure-kafka-app/target/spark-secure-kafka-app-1.0-SNAPSHOT.jar **9.Z.0.5**:9092 **topicA** false



```
         tracking URL: http://hn0-st01cl.hdiesp.onmicrosoft.com:8088/proxy/application_1549484352974_0013/
         user: st01
19/02/07 02:28:01 INFO Client: Application report for application_1549484352974_0013 (state: RUNNING)
19/02/07 02:28:02 INFO Client: Application report for application_1549484352974_0013 (state: RUNNING)
19/02/07 02:28:03 INFO Client: Application report for application_1549484352974_0013 (state: RUNNING)
19/02/07 02:28:04 INFO Client: Application report for application_1549484352974_0013 (state: FINISHED)
19/02/07 02:28:04 INFO Client:
         client token: Token { kind: YARN_CLIENT_TOKEN, service:  }
         diagnostics: User class threw exception: org.apache.kafka.common.errors.TopicAuthorizationException: Not authorized to access topics: [topicA]
        at ... run in separate thread using org.apache.spark.util.ThreadUtils ... ()
        at org.apache.spark.streaming.StreamingContext.liftedTree1$1(StreamingContext.scala:578)
        at org.apache.spark.streaming.StreamingContext.start(StreamingContext.scala:572)
        at com.cloudera.spark.examples.DirectKafkaWordCount$.main(DirectKafkaWordCount.scala:85)
        at com.cloudera.spark.examples.DirectKafkaWordCount.main(DirectKafkaWordCount.scala)
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at org.apache.spark.deploy.yarn.ApplicationMaster$$anon$4.run(ApplicationMaster.scala:721)

         ApplicationMaster host: 10.1.0.7
         ApplicationMaster RPC port: 0
         queue: default
         start time: 1549506432051
         final status: FAILED
         tracking URL: http://hn0-st01cl.hdiesp.onmicrosoft.com:8088/proxy/application_1549484352974_0013/
```

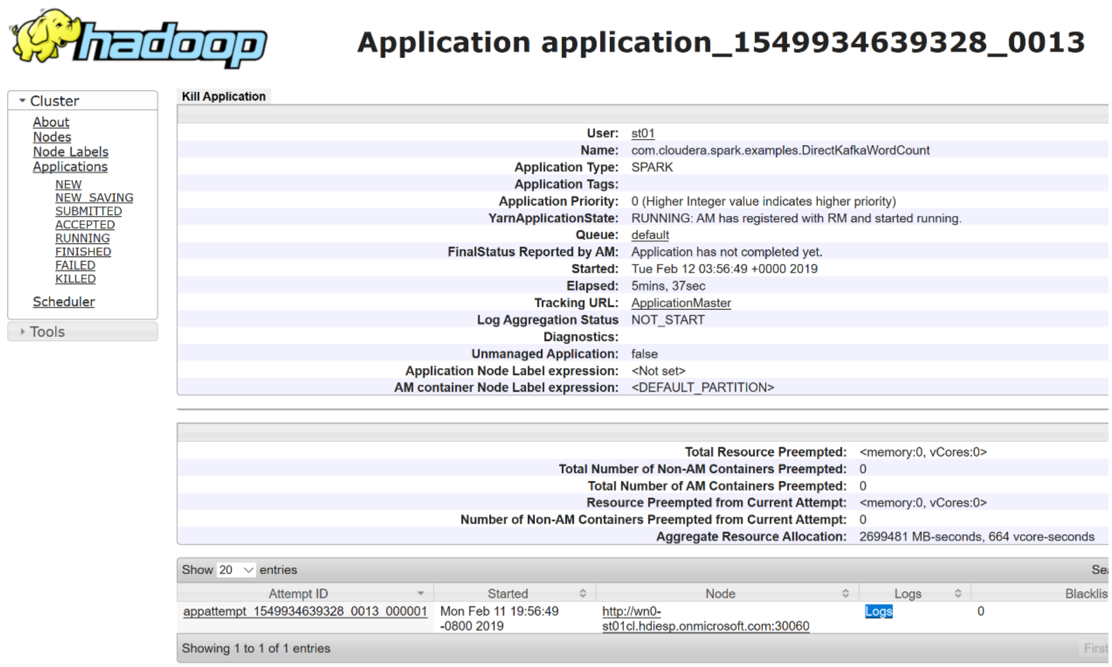
Now if you issue the same spark-submit command to read from "**topicB**":

```
spark-submit --num-executors 1 --master yarn --deploy-mode cluster --packages org.apache.spark:spark-streaming-kafka-0-10_2.11:2.3.2.3.1.0.4-1 --repositories http://repo.hortonworks.com/content/repositories/releases/ --files stXX_jaas.conf#stXX_jaas.conf,stXX.keytab#stXX.keytab --driver-java-options "-Djava.security.auth.login.config=./stXX_jaas.conf" --class com.cloudera.spark.examples.DirectKafkaWordCount --conf "spark.executor.extraJavaOptions=-Djava.security.auth.login.config=./stXX_jaas.conf" /home/sshuser/spark-secure-kafka-app/target/spark-secure-kafka-app-1.0-SNAPSHOT.jar 10.Z.0.5:9092 topicB false
```

This operation is allowed based on the Ranger policies and should result in consuming the data from topicB and showing the word count as per our example logic.

While the spark streaming app is running, go to Yarn UI → Your application → Logs and check the stdout

Spark User Instructions



Application application_1549934639328_0013

Cluster
About
Nodes
Node Labels
Applications
NEW
NEW_SAVING
SUBMITTED
ACCEPTED
RUNNING
FINISHED
FAILED
KILLED
Scheduler
Tools

Kill Application

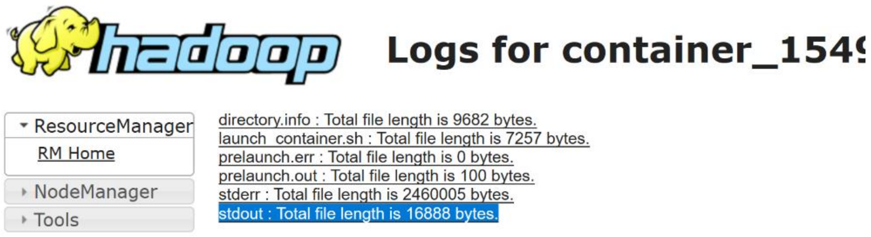
User:	st01
Name:	com.cloudera.spark.examples.DirectKafkaWordCount
Application Type:	SPARK
Application Tags:	
Application Priority:	0 (Higher Integer value indicates higher priority)
YarnApplicationState:	RUNNING: AM has registered with RM and started running.
Queue:	default
FinalStatus Reported by AM:	Application has not completed yet.
Started:	Tue Feb 12 03:56:49 +0000 2019
Elapsed:	5mins, 37sec
Tracking URL:	ApplicationMaster
Log Aggregation Status	NOT_START
Diagnostics:	
Unmanaged Application:	false
Application Node Label expression:	<Not set>
AM container Node Label expression:	<DEFAULT_PARTITION>

Total Resource Preempted:	<memory:0, vCores:0>
Total Number of Non-AM Containers Preempted:	0
Total Number of AM Containers Preempted:	0
Resource Preempted from Current Attempt:	<memory:0, vCores:0>
Number of Non-AM Containers Preempted from Current Attempt:	0
Aggregate Resource Allocation:	2699481 MB-seconds, 664 vcore-seconds

Show 20 entries

Attempt ID	Started	Node	Logs	Blacklis
appattempt_1549934639328_0013_000001	Mon Feb 11 19:56:49 -0800 2019	http://wn0-st01cl.hdiesp.onmicrosoft.com:30060	Logs	0

Showing 1 to 1 of 1 entries

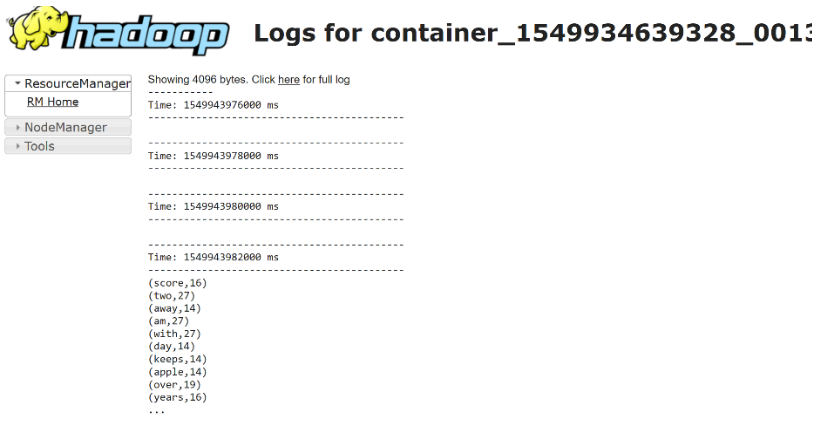


Logs for container_154

ResourceManager
RM Home
NodeManager
Tools

directory.info : Total file length is 9682 bytes.
launch_container.sh : Total file length is 7257 bytes.
prelaunch.err : Total file length is 0 bytes.
prelaunch.out : Total file length is 100 bytes.
stderr : Total file length is 2460005 bytes.
stdout : Total file length is 16888 bytes.

The word count result should look like below:



Logs for container_1549934639328_001

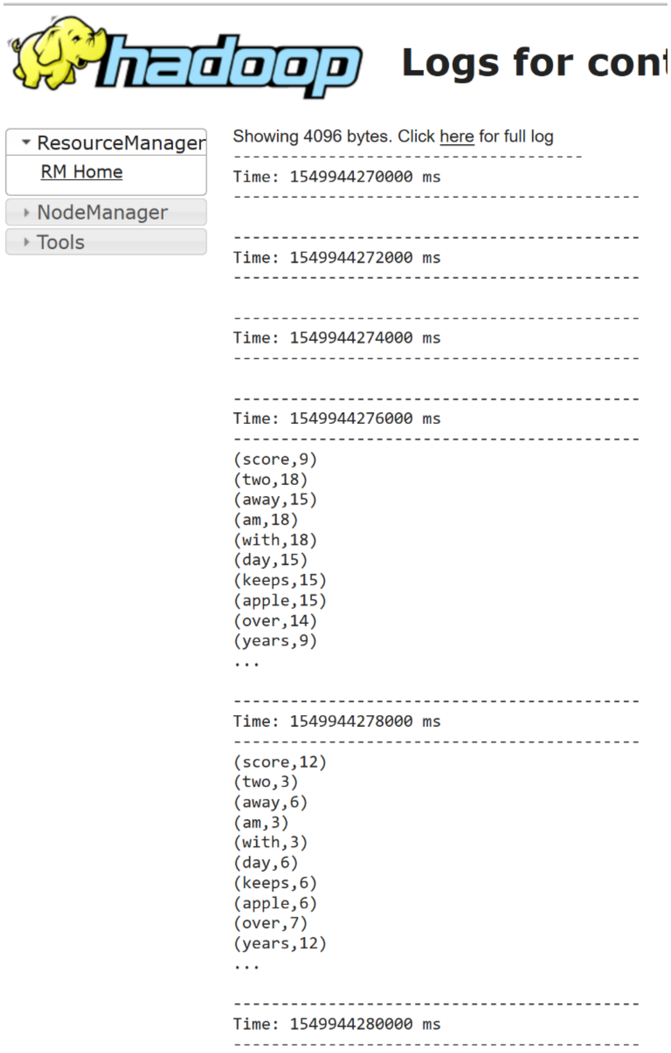
ResourceManager
RM Home
NodeManager
Tools

Showing 4096 bytes. Click here for full log

```
-----------
Time: 1549943976000 ms
-------------------------------------------

-------------------------------------------
Time: 1549943978000 ms
-------------------------------------------

-------------------------------------------
Time: 1549943980000 ms
-------------------------------------------

-------------------------------------------
Time: 1549943982000 ms
-------------------------------------------
(score,16)
(two,27)
(away,14)
(am,27)
(with,27)
(day,14)
(keeps,14)
(apple,14)
(over,19)
(years,16)
...
```

Spark User Instructions

While the app is running, you can ask your team mate to submit more data to topicB using the java command and as the data coming in, refresh the browser to see the results in your logs output.



Showing 4096 bytes. Click here for full log

```
-------------------------------------
Time: 1549944270000 ms
-------------------------------------------

-------------------------------------------
Time: 1549944272000 ms
-------------------------------------------

-------------------------------------------
Time: 1549944274000 ms
-------------------------------------------

-------------------------------------------
Time: 1549944276000 ms
-------------------------------------------
(score,9)
(two,18)
(away,15)
(am,18)
(with,18)
(day,15)
(keeps,15)
(apple,15)
(over,14)
(years,9)
...

-------------------------------------------
Time: 1549944278000 ms
-------------------------------------------
(score,12)
(two,3)
(away,6)
(am,3)
(with,3)
(day,6)
(keeps,6)
(apple,6)
(over,7)
(years,12)
...

-------------------------------------------
Time: 1549944280000 ms
-------------------------------------------
```

Congratulations! You have just created a secure streaming pipeline consisting of two Spark and Kafka clusters, deployed in a virtual network with Ranger policy enforcement for fine grained authorization and AAD-DS integration for authentication. This is the most secure Hadoop you can create in the cloud!