Lab 5. Building Spark Streaming Applications with Kafka

In this lab, we will cover Apache Spark, which is distributed in memory processing engines and then we will walk through Spark Streaming concepts and how we can integrate Apache Kafka with Spark.

In short, we will cover the following topics:

- Introduction to Spark
- Receiver-based approach (Spark-Kafka integration)
- Direct approach (Spark-Kafka integration)
- Use case (Log processing)

Lab Solution

Complete solution for this lab is available in the following directory:

`~/kafka-advanced/labs/Lab05`

Spark Streaming

We have two approaches to integrate Kafka with Spark and we will go into detail on each:

- Receiver-based approach
- Direct approach

The receiver-based approach is the older way of doing integration. Direct API integration provides lots of advantages over the receiver-based approach.

Apache Spark Installation

Make sure you have compatible java installed on your machine. You can verify it by typing command:

```
java -version
```

Apache spark setup has been downloaded on the following path and added to $PATH variable:

```
/headless/Downloads/spark-2.4.7-bin-hadoop2.7/
```

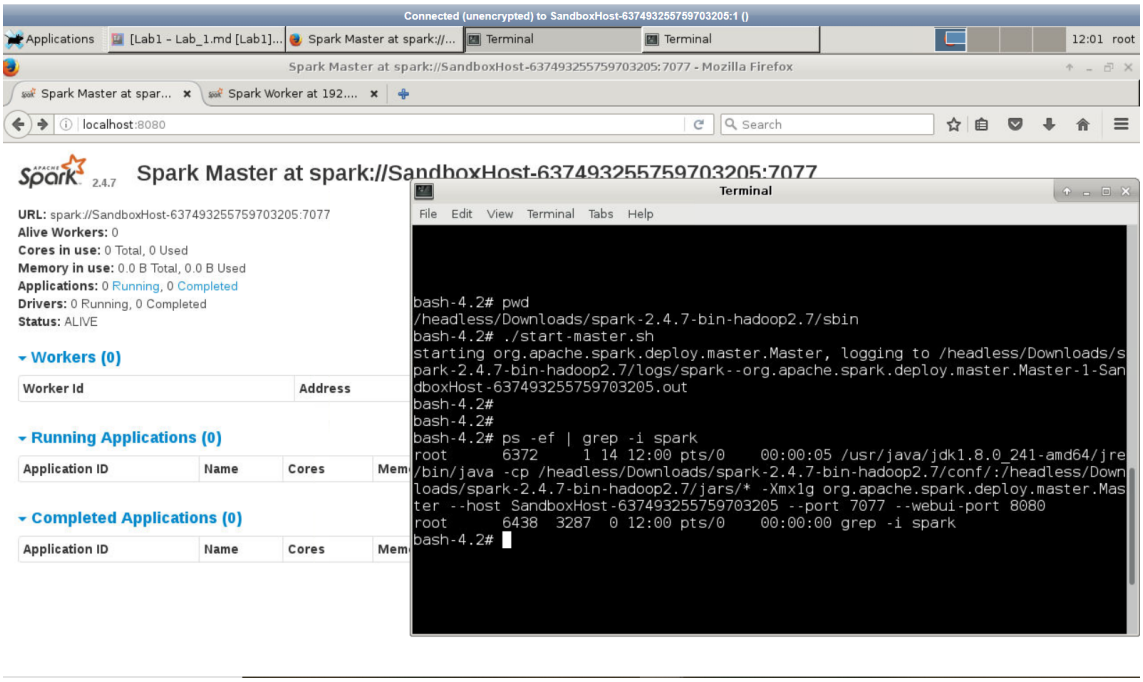
Start Master

```
cd /headless/Downloads/spark-2.4.7-bin-hadoop2.7/

./sbin/start-master.sh
```

Inspect the response:

```
starting org.apache.spark.deploy.master.Master, logging to /headless/Downloads/spark-2.4.7-bin-hadoop2.7/logs/spark--org.apache.spark.deploy.master.Master-1-SandboxHost-637493255759703205.out
```



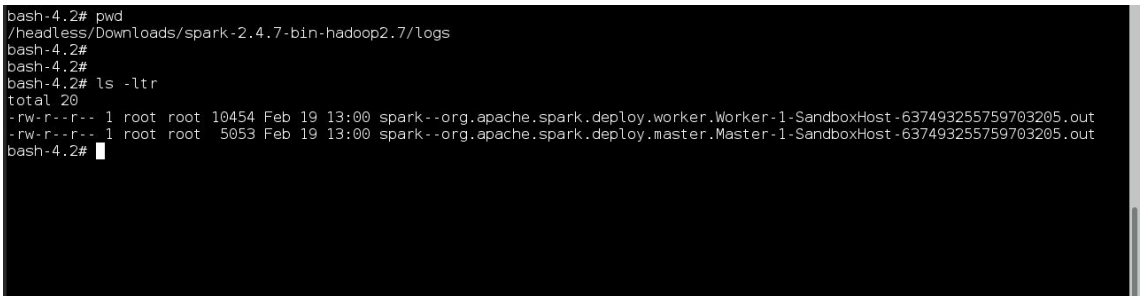
Logs Path

Now inspect the `.out` file

```
cd /headless/Downloads/spark-2.4.7-bin-hadoop2.7/logs/

ls -ltr

cat filename
```



```
bash-4.2# cat spark--org.apache.spark.deploy.master.Master-1-SandboxHost-637493255759703205.out
Spark Command: /usr/java/jdk1.8.0_241-amd64/jre/bin/java -cp /headless/Downloads/spark-2.4.7-bin-hadoop2.7/conf/:/headless/Dow
nloads/spark-2.4.7-bin-hadoop2.7/jars/* -Xmx1g org.apache.spark.deploy.master.Master --host SandboxHost-637493255759703205 --p
ort 7077 --webui-port 8080
========================================
Using Spark's default log4j profile: org/apache/spark/log4j-defaults.properties
21/02/19 12:00:08 INFO Master: Started daemon with process name: 6372@SandboxHost-637493255759703205
21/02/19 12:00:08 INFO SignalUtils: Registered signal handler for TERM
21/02/19 12:00:08 INFO SignalUtils: Registered signal handler for HUP
21/02/19 12:00:08 INFO SignalUtils: Registered signal handler for INT
21/02/19 12:00:08 WARN Utils: Your hostname, SandboxHost-637493255759703205 resolves to a loopback address: 127.0.0.1; using 1
92.168.0.209 instead (on interface eth0)
21/02/19 12:00:08 WARN Utils: Set SPARK_LOCAL_IP if you need to bind to another address
21/02/19 12:00:09 WARN NativeCodeLoader: Unable to load native-hadoop library for your platform... using builtin-java classes
where applicable
21/02/19 12:00:09 INFO SecurityManager: Changing view acls to: root
21/02/19 12:00:09 INFO SecurityManager: Changing modify acls to: root
21/02/19 12:00:09 INFO SecurityManager: Changing view acls groups to:
21/02/19 12:00:09 INFO SecurityManager: Changing modify acls groups to:
21/02/19 12:00:09 INFO SecurityManager: SecurityManager: authentication disabled; ui acls disabled; users  with view permissio
ns: Set(root); groups with view permissions: Set(); users  with modify permissions: Set(root); groups with modify permissions:
 Set()
21/02/19 12:00:09 INFO Utils: Successfully started service 'sparkMaster' on port 7077.
21/02/19 12:00:09 INFO Master: Starting Spark master at spark://SandboxHost-637493255759703205:7077
21/02/19 12:00:09 INFO Master: Running Spark version 2.4.7
21/02/19 12:00:10 INFO Utils: Successfully started service 'MasterUI' on port 8080.
21/02/19 12:00:10 INFO MasterWebUI: Bound MasterWebUI to 0.0.0.0, and started at http://192.168.0.209:8080
21/02/19 12:00:10 INFO Master: I have been elected leader! New state: ALIVE
21/02/19 12:02:51 INFO Master: Registering worker 192.168.0.209:33781 with 3 cores, 6.9 GB RAM
21/02/19 12:06:03 INFO Master: Registering app Spark shell
21/02/19 12:06:03 INFO Master: Registered app Spark shell with ID app-20210219120603-0000
21/02/19 12:06:03 INFO Master: Launching executor app-20210219120603-0000/0 on worker worker-20210219120249-192.168.0.209-3378
1
21/02/19 12:06:44 INFO Master: Received unregister request from application app-20210219120603-0000
21/02/19 12:06:44 INFO Master: Removing app app-20210219120603-0000
21/02/19 12:06:44 INFO Master: 127.0.0.1:58338 got disassociated, removing it.
21/02/19 12:06:44 INFO Master: 192.168.0.209:41351 got disassociated, removing it.
```

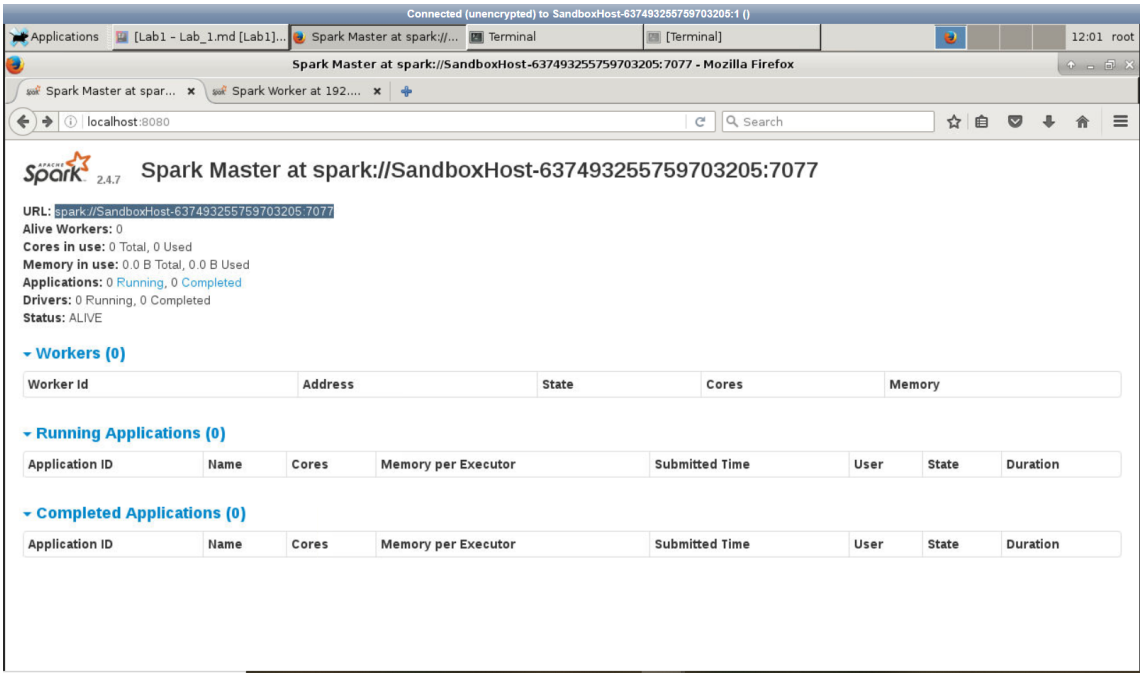
Once started, the master will print out a spark://HOST:PORT URL for itself, which you can use to connect workers to it, or pass as the “master” argument to SparkContext. You can also find this URL on the master’s web UI, which is http://localhost:8080 by default.

Similarly, you can start one or more workers and connect them to the master via:

Start Worker

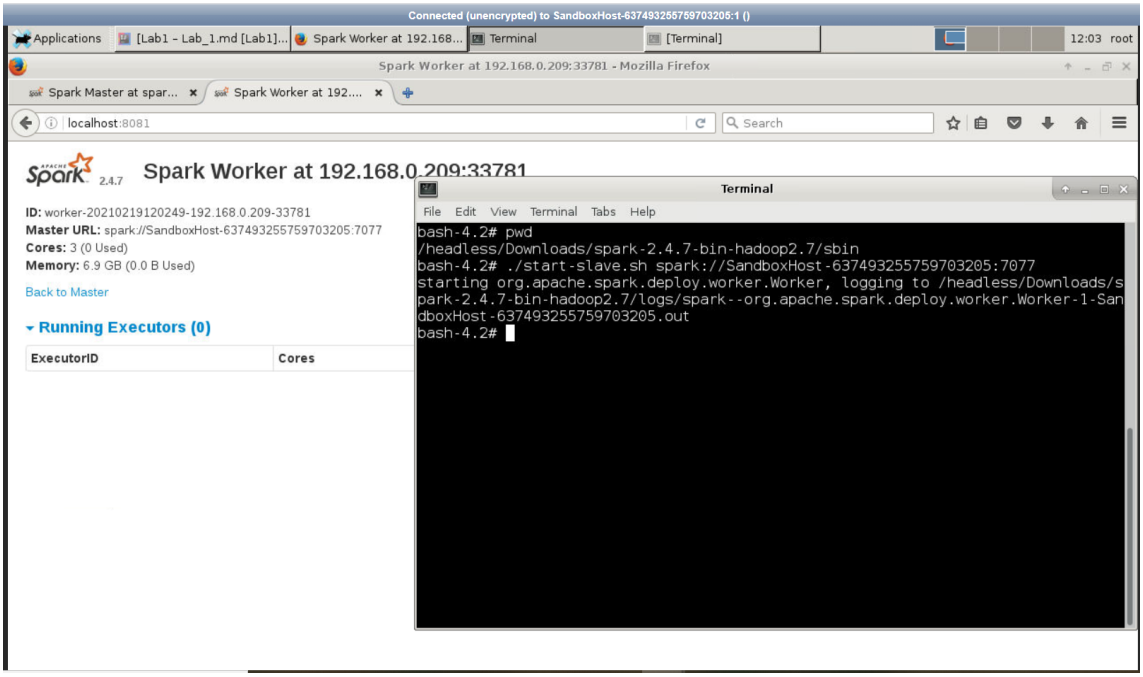
Start Worker and register the worker with master

Open `http://localhost:8080/` in browser and copy the master url

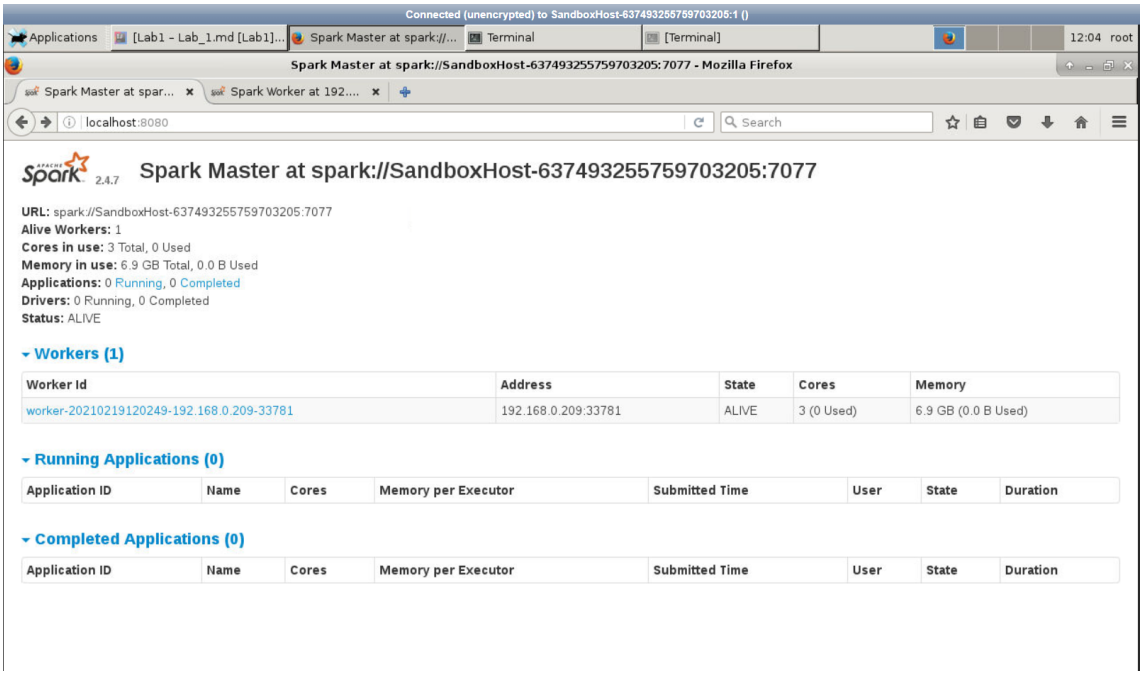


now start the worker and register it with master using following command

```
./sbin/start-slave.sh spark://hostname:7077
```



Worker webUI: `http://localhost:8081`



Once you have started a worker, look at the master's web UI (http://localhost:8080 by default). You should see the new node listed there, along with its number of CPUs and memory (minus one gigabyte left for the OS).

Logs Path

```
cd /headless/Downloads/spark-2.4.7-bin-hadoop2.7/logs/

ls -ltr

cat filename
```

Now inspect the `.out` file, you will see the log like this:

```
2019-09-12 13:41:07 INFO Worker:2612 - Started daemon with process name:
144697@hostname 2019-09-12 13:41:07 INFO SignalUtils:54 - Registered signal handler
for TERM 2019-09-12 13:41:07 INFO SignalUtils:54 - Registered signal handler for HUP
2019-09-12 13:41:07 INFO SignalUtils:54 - Registered signal handler for INT 2019-09-12
13:41:08 WARN NativeCodeLoader:62 - Unable to load native-hadoop library for your
platform... using builtin-java classes where applicable 2019-09-12 13:41:08 INFO
SecurityManager:54 - Changing view acls to: user 2019-09-12 13:41:08 INFO
SecurityManager:54 - Changing modify acls to: user 2019-09-12 13:41:08 INFO
SecurityManager:54 - Changing view acls groups to: 2019-09-12 13:41:08 INFO
SecurityManager:54 - Changing modify acls groups to: 2019-09-12 13:41:08 INFO
SecurityManager:54 - SecurityManager: authentication disabled; ui acls disabled; users
with view permissions: Set(user); groups with view permissions: Set(); users with
modify permissions: Set(user); groups with modify permissions: Set() 2019-09-12
13:41:08 INFO Utils:54 - Successfully started service 'sparkWorker' on port 35633.
2019-09-12 13:41:08 INFO Worker:54 - Starting Spark worker 100.2.101.101:35633 with 32
cores, 124.6 GB RAM 2019-09-12 13:41:08 INFO Worker:54 - Running Spark version 2.3.4
2019-09-12 13:41:08 INFO Worker:54 - Spark home: /headless/Downloads/spark-2.4.7-bin-
hadoop2.7 2019-09-12 13:41:08 INFO log:192 - Logging initialized @1510ms 2019-09-12
13:41:08 INFO Server:351 - jetty-9.3.z-SNAPSHOT, build timestamp: unknown, git hash:
unknown 2019-09-12 13:41:08 INFO Server:419 - Started @1576ms 2019-09-12 13:41:08 INFO
AbstractConnector:278 - Started ServerConnector@3f9e3902{HTTP/1.1,[http/1.1]}
{0.0.0.0:8081} 2019-09-12 13:41:08 INFO Utils:54 - Successfully started service
'WorkerUI' on port 8081. 2019-09-12 13:41:08 INFO ContextHandler:781 - Started
o.s.j.s.ServletContextHandler@1dc21140{/logPage,null,AVAILABLE,@Spark} 2019-09-12
13:41:08 INFO ContextHandler:781 - Started
o.s.j.s.ServletContextHandler@5896ed4f{/logPage/json,null,AVAILABLE,@Spark} 2019-09-12
13:41:08 INFO ContextHandler:781 - Started
o.s.j.s.ServletContextHandler@1d9a25f0{/,null,AVAILABLE,@Spark} 2019-09-12 13:41:08
INFO ContextHandler:781 - Started
o.s.j.s.ServletContextHandler@1ad57f24{/json,null,AVAILABLE,@Spark} 2019-09-12
13:41:08 INFO ContextHandler:781 - Started
o.s.j.s.ServletContextHandler@754605a4{/static,null,AVAILABLE,@Spark} 2019-09-12
13:41:08 INFO ContextHandler:781 - Started
o.s.j.s.ServletContextHandler@c5e9251{/log,null,AVAILABLE,@Spark} 2019-09-12 13:41:08
INFO WorkerWebUI:54 - Bound WorkerWebUI to 0.0.0.0, and started
athttp://hostname.com:8081 2019-09-12 13:41:08 INFO Worker:54 - Connecting to master
hostname.com:7077... 2019-09-12 13:41:08 INFO ContextHandler:781 - Started
o.s.j.s.ServletContextHandler@4ac9255f{/metrics/json,null,AVAILABLE,@Spark} 2019-09-12
13:41:08 INFO TransportClientFactory:267 - Successfully created connection to
hostname.com/199.6.212.152:7077 after 40 ms (0 ms spent in bootstraps) 2019-09-12
13:41:09 INFO Worker:54 - Successfully registered with master
spark://hostname.com:7077
```

Note that above scripts must be executed on the machine you want to run the Spark master on, not your local machine.

You can optionally configure the cluster further by setting environment variables in conf/spark-env.sh. Create this file by starting with the conf/spark-env.sh.template, and copy it to on your worker machine for the settings to take effect. The following settings are available:

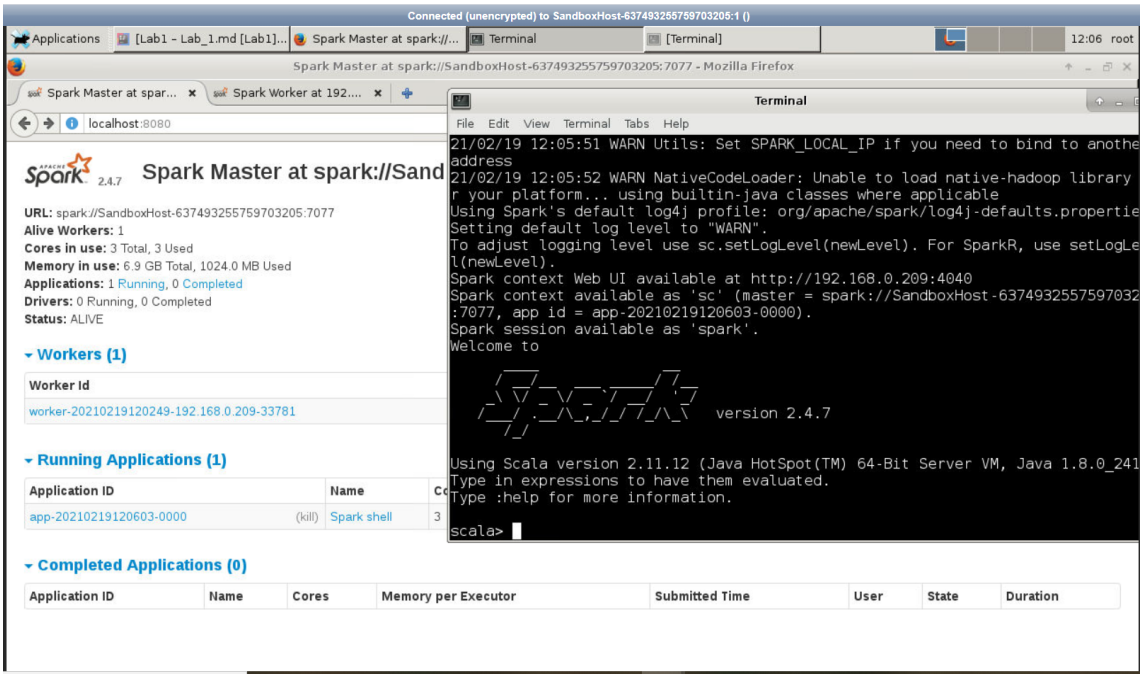
Environment Variable	Meaning
`SPARK_MASTER_HOST`	Bind the master to a specific hostname or IP address, for example a public one.
`SPARK_MASTER_PORT`	Start the master on a different port (default: 7077).
`SPARK_MASTER_WEBUI_PORT`	Port for the master web UI (default: 8080).
`SPARK_MASTER_OPTS`	Configuration properties that apply only to the master in the form "-Dx=y" (default: none). See below for a list of possible options.
`SPARK_LOCAL_DIRS`	Directory to use for "scratch" space in Spark, including map output files and RDDs that get stored on disk. This should be on a fast, local disk in your system. It can also be a comma-separated list of multiple directories on different disks.
`SPARK_WORKER_CORES`	Total number of cores to allow Spark applications to use on the machine (default: all available cores).
`SPARK_WORKER_MEMORY`	Total amount of memory to allow Spark applications to use on the machine, e.g. `1000m`, `2g` (default: total memory minus 1 GiB); note that each application's *individual* memory is configured using its `spark.executor.memory` property.
`SPARK_WORKER_PORT`	Start the Spark worker on a specific port (default: random).
`SPARK_WORKER_WEBUI_PORT`	Port for the worker web UI (default: 8081).
`SPARK_WORKER_DIR`	Directory to run applications in, which will include both logs and scratch space (default: SPARK_HOME/work).
`SPARK_WORKER_OPTS`	Configuration properties that apply only to the worker in the form "-Dx=y" (default: none). See below for a list of possible options.
`SPARK_DAEMON_MEMORY`	Memory to allocate to the Spark master and worker daemons themselves (default: 1g).
`SPARK_DAEMON_JAVA_OPTS`	JVM options for the Spark master and worker daemons themselves in the form "-Dx=y" (default: none).
`SPARK_DAEMON_CLASSPATH`	Classpath for the Spark master and worker daemons themselves (default: none).
`SPARK_PUBLIC_DNS`	The public DNS name of the Spark master and workers (default: none).

Spark Shell

Your cluster on single node is ready now, you can test it using running command **spark-shell**

```
[user@hostname ~]$ spark-shell --master spark://hostname:7077
```

Reload the master webui. You will get one running application:



You can exit the spark shell using typing `:q` then enter

Java example for receiver-based integration

Let us take an example to be sure:

```
import org.apache.Spark.SparkConf;
import org.apache.Spark.api.java.function.FlatMapFunction;
import org.apache.Spark.api.java.function.Function;
import org.apache.Spark.api.java.function.Function2;
import org.apache.Spark.api.java.function.PairFunction;
import org.apache.Spark.streaming.Duration;
import org.apache.Spark.streaming.api.java.JavaDStream;
import org.apache.Spark.streaming.api.java.JavaPairDStream;
import org.apache.Spark.streaming.api.java.JavaPairReceiverInputDStream;
import org.apache.Spark.streaming.api.java.JavaStreamingContext;
import org.apache.Spark.streaming.kafka.KafkaUtils;
import scala.Tuple2;

import java.util.Arrays;
import java.util.HashMap;
import java.util.Iterator;
import java.util.Map;
import java.util.regex.Pattern;


public class KafkaWordCountJava {
    private static final Pattern WORD_DELIMETER = Pattern.compile(" ");

    public static void main(String[] args) throws Exception {
        String zkQuorum = "localhost:2181";
```

```
        String groupName = "stream";
        int numThreads = 3;
        String topicsName = "test";
        SparkConf SparkConf = new
SparkConf().setAppName("WordCountKafkaStream").setMaster("local[2]");

        JavaStreamingContext javaStreamingContext = new
JavaStreamingContext(SparkConf, new Duration(5000));

        Map<String, Integer> topicToBeUsedBySpark = new HashMap<>();
        String[] topics = topicsName.split(",");
        for (String topic : topics) {
            topicToBeUsedBySpark.put(topic, numThreads);
        }

        JavaPairReceiverInputDStream<String, String> streamMessages =
                KafkaUtils.createStream(javaStreamingContext, zkQuorum, groupName,
topicToBeUsedBySpark);

        JavaDStream<String> lines = streamMessages.map(new Function<Tuple2<String,
String>, String>() {
            @Override
            public String call(Tuple2<String, String> tuple2) {
                return tuple2._2();
            }
        });

        JavaDStream<String> words = lines.flatMap(new FlatMapFunction<String, String>
() {
            @Override
            public Iterator<String> call(String x) {
                return Arrays.asList(WORD_DELIMETER.split(x)).iterator();
            }
        });

        JavaPairDStream<String, Integer> wordCounts = words.mapToPair(
                new PairFunction<String, String, Integer>() {
                    @Override
                    public Tuple2<String, Integer> call(String s) {
                        return new Tuple2<>(s, 1);
                    }
                }).reduceByKey(new Function2<Integer, Integer, Integer>() {
            @Override
            public Integer call(Integer i1, Integer i2) {
                return i1 + i2;
            }
        });

        wordCounts.print();
        javaStreamingContext.start();
        javaStreamingContext.awaitTermination();
```

```
    }
}
```

Direct approach

In receiver-based approach, we saw issues of data loss, costing less throughput using write-ahead logs and difficulty in achieving exactly one semantic of data processing. To overcome all these problems, Spark introduced the direct stream approach of integrating Spark with Kafka.

Java example for direct approach

Again, let us take a Java example:

```
import java.util.HashMap;
import java.util.HashSet;
import java.util.Arrays;
import java.util.Map;
import java.util.Set;
import java.util.regex.Pattern;

import scala.Tuple2;

import kafka.serializer.StringDecoder;

import org.apache.Spark.SparkConf;
import org.apache.Spark.streaming.api.java.*;
import org.apache.Spark.streaming.kafka.KafkaUtils;
import org.apache.Spark.streaming.Durations;

public class JavaDirectKafkaWordCount {
    private static final Pattern SPACE = Pattern.compile(" ");

    public static void main(String[] args) throws Exception {

        String brokers = "localhost:9092";
        String topics = "test";

        SparkConf SparkConf = new
SparkConf().setAppName("DirectKafkaWordCount").setMaster("local[2]");
        JavaStreamingContext javaStreamingContext = new
JavaStreamingContext(SparkConf, Durations.seconds(2));

        Set<String> topicsSet = new HashSet<>(Arrays.asList(topics.split(",")));
        Map<String, String> kafkaConfiguration = new HashMap<>();
        kafkaConfiguration.put("metadata.broker.list", brokers);

        JavaPairInputDStream<String, String> messages = KafkaUtils.createDirectStream(
                javaStreamingContext,
                String.class,
                String.class,
                StringDecoder.class,
                StringDecoder.class,
                kafkaConfiguration,
```

```
                topicsSet
        );

        JavaDStream<String> lines = messages.map(Tuple2::_2);

        JavaDStream<String> words = lines.flatMap(x ->
Arrays.asList(SPACE.split(x)).iterator());

        JavaPairDStream<String, Integer> wordCounts = words.mapToPair(s -> new
Tuple2<>(s, 1))
                .reduceByKey((i1, i2) -> i1 + i2);

        wordCounts.print();

        javaStreamingContext.start();
        javaStreamingContext.awaitTermination();
    }
}
```

Use case log processing - fraud IP detection

This section will cover a small use case which uses Kafka and Spark Streaming to detect a fraud IP, and the number of times the IP tried to hit the server. We will cover the use case in the following:

- [**Producer**]: We will use Kafka Producer API, which will read a log file and publish records to Kafka topic. However, in a real case, we may use Flume or producer application, which directly takes a log record on a real-time basis and publish to Kafka topic.
- [**Fraud IPs list**]: We will maintain a list of predefined fraud IP range which can be used to identify fraud IPs. For this application we are using in memory IP list which can be replaced by fast key based lookup, such as HBase.
- [**Spark Streaming**]: Spark Streaming application will read records from Kafka topic and will detect IPs and domains which are suspicious.

Maven

[**Maven**] is a build and project management tool and we will be building this project using Maven. I recommend using Eclipse or IntelliJ for creating projects. Add the following dependencies and plugins to your `pom.xml` :

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://Maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://Maven.apache.org/POM/4.0.0
http://Maven.apache.org/xsd/Maven-4.0.0.xsd">
    <modelVersion>4.0.0</modelVersion>

    <groupId>com.fenago</groupId>
    <artifactId>ip-fraud-detetion</artifactId>
    <version>1.0-SNAPSHOT</version>
    <packaging>jar</packaging>

    <name>kafka-producer</name>

    <properties>
```

```
        <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
    </properties>


    <dependencies>
        <!-- https://mvnrepository.com/artifact/org.apache.Spark/Spark-streaming-
kafka_2.10 -->
        <dependency>
            <groupId>org.apache.Spark</groupId>
            <artifactId>Spark-streaming-kafka_2.10</artifactId>
            <version>1.6.3</version>
        </dependency>


        <!-- https://mvnrepository.com/artifact/org.apache.hadoop/hadoop-common -->
        <dependency>
            <groupId>org.apache.hadoop</groupId>
            <artifactId>hadoop-common</artifactId>
            <version>2.7.2</version>
        </dependency>

        <!-- https://mvnrepository.com/artifact/org.apache.Spark/Spark-core_2.10 -->
        <dependency>
            <groupId>org.apache.Spark</groupId>
            <artifactId>Spark-core_2.10</artifactId>
            <version>2.0.0</version>
            <scope>provided</scope>

        </dependency>
        <!-- https://mvnrepository.com/artifact/org.apache.Spark/Spark-streaming_2.10
-->
        <dependency>
            <groupId>org.apache.Spark</groupId>
            <artifactId>Spark-streaming_2.10</artifactId>
            <version>2.0.0</version>
            <scope>provided</scope>

        </dependency>


        <dependency>
            <groupId>org.apache.kafka</groupId>
            <artifactId>kafka_2.11</artifactId>
            <version>0.10.0.0</version>
        </dependency>
    </dependencies>

    <build>
        <plugins>
            <plugin>
                <groupId>org.apache.Maven.plugins</groupId>
                <artifactId>Maven-shade-plugin</artifactId>
```

```
                <version>2.4.2</version>
                <executions>
                    <execution>
                        <phase>package</phase>
                        <goals>
                            <goal>shade</goal>
                        </goals>
                        <configuration>
                            <filters>
                                <filter>
                                    <artifact>junit:junit</artifact>
                                    <includes>
                                        <include>junit/framework/**</include>
                                        <include>org/junit/**</include>
                                    </includes>
                                    <excludes>
                                        <exclude>org/junit/experimental/**</exclude>
                                        <exclude>org/junit/runners/**</exclude>
                                    </excludes>
                                </filter>
                                <filter>
                                    <artifact>*:*</artifact>
                                    <excludes>
                                        <exclude>META-INF/*.SF</exclude>
                                        <exclude>META-INF/*.DSA</exclude>
                                        <exclude>META-INF/*.RSA</exclude>
                                    </excludes>
                                </filter>
                            </filters>
                            <transformers>
                                <transformer

implementation="org.apache.Maven.plugins.shade.resource.ServicesResourceTransformer"/>

                                <transformer

implementation="org.apache.Maven.plugins.shade.resource.ManifestResourceTransformer">

<mainClass>com.fenago.streaming.FraudDetectionApp</mainClass>
                                </transformer>
                            </transformers>
                        </configuration>
                    </execution>
                </executions>
            </plugin>
            <plugin>
                <groupId>org.codehaus.mojo</groupId>
                <artifactId>exec-Maven-plugin</artifactId>
                <version>1.2.1</version>
                <executions>
                    <execution>
                        <goals>
```

```
                            <goal>exec</goal>
                        </goals>
                    </execution>
                </executions>
                <configuration>
                    <includeProjectDependencies>true</includeProjectDependencies>
                    <includePluginDependencies>false</includePluginDependencies>
                    <executable>java</executable>
                    <classpathScope>compile</classpathScope>
                    <mainClass>com.fenago.streaming.FraudDetectionApp</mainClass>
                </configuration>
            </plugin>


            <plugin>
                <groupId>org.apache.Maven.plugins</groupId>
                <artifactId>Maven-compiler-plugin</artifactId>
                <configuration>
                    <source>1.8</source>
                    <target>1.8</target>
                </configuration>
            </plugin>
        </plugins>
    </build>
</project>
```

Producer

You can use IntelliJ or Eclipse to build a producer application. This producer reads a log file taken from an Apache project which contains detailed records like:

```
64.242.88.10 - - [08/Mar/2004:07:54:30 -0800] "GET
/twiki/bin/edit/Main/Unknown_local_recipient_reject_code?
topicparent=Main.ConfigurationVariables HTTP/1.1" 401 12846
```

You can have just one record in the test file and the producer will produce records by generating random IPs and replace it with existing. So, we will have millions of distinct records with unique IP addresses.

Record columns are separated by space delimiters, which we change to commas in producer. The first column represents the IP address or the domain name which will be used to detect whether the request was from a fraud client. The following is the Java Kafka producer which remembers logs.

Property reader

We preferred to use a property file for some important values such as topic, Kafka broker URL, and so on. If you want to read more values from the property file, then feel free to change it in the code. `streaming.properties` file:

```
topic=ipTest2
broker.list=localhost:9092
appname=IpFraud
group.id=Stream
```

The following is an example of the property reader:

```
import java.io.FileNotFoundException;
import java.io.IOException;
import java.io.InputStream;
import java.util.Properties;

public class PropertyReader {

    private Properties prop = null;

    public PropertyReader() {

        InputStream is = null;
        try {
            this.prop = new Properties();
            is = this.getClass().getResourceAsStream("/streaming.properties");
            prop.load(is);
        } catch (FileNotFoundException e) {
            e.printStackTrace();
        } catch (IOException e) {
            e.printStackTrace();
        }
    }

    public String getPropertyValue(String key) {
        return this.prop.getProperty(key);
    }
}
```

Producer code

A producer application is designed to be like a real-time log producer where the producer runs every three seconds and produces a new record with random IP addresses. You can add a few records in the `IP_LOG.log` file and then the producer will take care of producing millions of unique records from those three records.

We have also enabled auto creation of topics so you need not create topic before running your producer application. You can change the topic name in the `streaming.properties` file mentioned before:

```
import com.fenago.reader.PropertyReader;
import org.apache.kafka.clients.producer.KafkaProducer;
import org.apache.kafka.clients.producer.ProducerRecord;
import org.apache.kafka.clients.producer.RecordMetadata;

import java.io.BufferedReader;
import java.io.File;
import java.io.IOException;
import java.io.InputStreamReader;
import java.util.*;
import java.util.concurrent.Future;


public class IPLogProducer extends TimerTask {
    static String path = "";
```

```
    public BufferedReader readFile() {
        BufferedReader BufferedReader = new BufferedReader(new InputStreamReader(
                this.getClass().getResourceAsStream("/IP_LOG.log")));
        return BufferedReader;

    }

    public static void main(final String[] args) {
        Timer timer = new Timer();
        timer.schedule(new IPLogProducer(), 3000, 3000);
    }

    private String getNewRecordWithRandomIP(String line) {
        Random r = new Random();
        String ip = r.nextInt(256) + "." + r.nextInt(256) + "." + r.nextInt(256) + "."
+ r.nextInt(256);
        String[] columns = line.split(" ");
        columns[0] = ip;
        return Arrays.toString(columns);
    }

    @Override
    public void run() {
        PropertyReader propertyReader = new PropertyReader();

        Properties producerProps = new Properties();
        producerProps.put("bootstrap.servers",
propertyReader.getPropertyValue("broker.list"));
        producerProps.put("key.serializer",
"org.apache.kafka.common.serialization.StringSerializer");
        producerProps.put("value.serializer",
"org.apache.kafka.common.serialization.StringSerializer");
        producerProps.put("auto.create.topics.enable", "true");

        KafkaProducer<String, String> ipProducer = new KafkaProducer<String, String>
(producerProps);

        BufferedReader br = readFile();
        String oldLine = "";
        try {
            while ((oldLine = br.readLine()) != null) {
                String line = getNewRecordWithRandomIP(oldLine).replace("[",
"").replace("]", "");
                ProducerRecord ipData = new ProducerRecord<String, String>
(propertyReader.getPropertyValue("topic"), line);
                Future<RecordMetadata> recordMetadata = ipProducer.send(ipData);
            }
        } catch (IOException e) {
            e.printStackTrace();
        }
        ipProducer.close();
```

```
    }
}
```

Fraud IP lookup

The following classes will help us as a lookup service which will help us to identify if request is coming from a fraud IP. We have used interface before implementing the class so that we can add more NoSQL databases or any fast lookup service. You can implement this service and add a lookup service by using HBase or any other fast key lookup service. We are using in-memory lookup and just added the fraud IP range in the cache. Add the following code to your project:

```
public interface IIPScanner {

    boolean isFraudIP(String ipAddresses);

}
```

`CacheIPLookup` is the implementation for the `IIPSCanner` interface which does in memory lookup:

```
import java.io.Serializable;
import java.util.HashSet;
import java.util.Set;


public class CacheIPLookup implements IIPScanner, Serializable {

    private Set<String> fraudIPList = new HashSet<>();

    public CacheIPLookup() {
        fraudIPList.add("212");
        fraudIPList.add("163");
        fraudIPList.add("15");
        fraudIPList.add("224");
        fraudIPList.add("126");
        fraudIPList.add("92");
        fraudIPList.add("91");
        fraudIPList.add("10");
        fraudIPList.add("112");
        fraudIPList.add("194");
        fraudIPList.add("198");
        fraudIPList.add("11");
        fraudIPList.add("12");
        fraudIPList.add("13");
        fraudIPList.add("14");
        fraudIPList.add("15");
        fraudIPList.add("16");
    }


    @Override
    public boolean isFraudIP(String ipAddresses) {

        return fraudIPList.contains(ipAddresses);
```

```
    }
}
```

Streaming code

We haven't focused much on modularization in our code. The IP fraud detection application scans each record and filters those records which qualify as a the fraud record based on fraud IP lookup service. The lookup service can be changed to use any fast lookup database. We are using in memory lookup service for this application:

```
import com.fenago.reader.PropertyReader;
import org.apache.Spark.SparkConf;
import org.apache.Spark.api.java.function.Function;
import org.apache.Spark.streaming.api.java.JavaStreamingContext;
import java.util.Set;
import java.util.regex.Pattern;
import java.util.HashMap;
import java.util.HashSet;
import java.util.Arrays;
import java.util.Map;
import scala.Tuple2;
import kafka.serializer.StringDecoder;
import org.apache.Spark.streaming.api.java.*;
import org.apache.Spark.streaming.kafka.KafkaUtils;
import org.apache.Spark.streaming.Durations;

public class FraudDetectionApp {
    private static final Pattern SPACE = Pattern.compile(" ");

    private static void main(String[] args) throws Exception {
        PropertyReader propertyReader = new PropertyReader();
        CacheIPLookup cacheIPLookup = new CacheIPLookup();
        SparkConf SparkConf = new
SparkConf().setAppName("IP_FRAUD").setMaster("local[2]");
        JavaStreamingContext javaStreamingContext = new
JavaStreamingContext(SparkConf, Durations.seconds(3));

        Set<String> topicsSet = new HashSet<>
(Arrays.asList(propertyReader.getPropertyValue("topic").split(",")));
        Map<String, String> kafkaConfiguration = new HashMap<>();
        kafkaConfiguration.put("metadata.broker.list",
propertyReader.getPropertyValue("broker.list"));
        kafkaConfiguration.put("group.id",
propertyReader.getPropertyValue("group.id"));

        JavaPairInputDStream<String, String> messages = KafkaUtils.createDirectStream(
                javaStreamingContext,
                String.class,
                String.class,
                StringDecoder.class,
                StringDecoder.class,
                kafkaConfiguration,
                topicsSet
        );
```

```
        JavaDStream<String> ipRecords = messages.map(Tuple2::_2);

        JavaDStream<String> fraudIPs = ipRecords.filter(new Function<String, Boolean>
() {
            @Override
            public Boolean call(String s) throws Exception {
                String IP = s.split(",")[0];
                String[] ranges = IP.split("\\.");
                String range = null;
                try {
                    range = ranges[0];
                } catch (ArrayIndexOutOfBoundsException ex) {

                }
                return cacheIPLookup.isFraudIP(range);

            }
        });

        DStream<String> fraudDstream = fraudIPs.dstream();
        fraudDstream.saveAsTextFiles("FraudRecord", "");

        javaStreamingContext.start();
        javaStreamingContext.awaitTermination();
    }
}
```

Once the Spark Streaming application starts, run Kafka producer and check the records.

Summary

In this lab, we learned about Apache Spark. Our focus was on covering different ways we can integrate Kafka with Spark and their advantages and disadvantages. We also covered APIs for the receiver-based approach and direct approach. Finally, we covered a small use case about IP fraud detection through the log file and lookup service. You can now create your own Spark streaming application.