SpringOne Platform

Spring and Big Data

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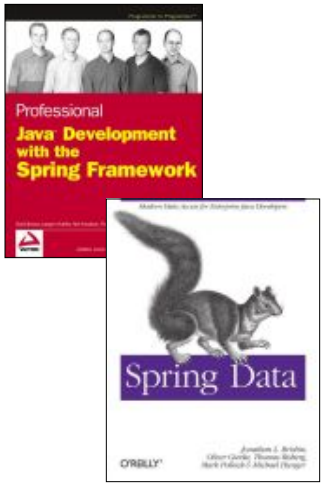
About me

Thomas Risberg

- Member of the Spring Cloud Data Flow engineering team at Pivotal
- Lead for the Spring for Apache Hadoop project
- Joined the Spring Framework open source project in 2003 working on JDBC support
- co-author of “Professional Java Development with Spring Framework” from Wrox 2005 and “Spring Data” book from O'Reilly 2012



Agenda

- Introduction
  - Big Data
  - Microservices with Spring Boot and Spring Cloud Stream
- Spring projects for “Big Data”
  - Spring Integration, Spring Batch, Spring Data etc.
- Data Ingestion
- Data Analysis
- Cloud
  - Local laptop, Cloud Foundry, Google Cloud etc.

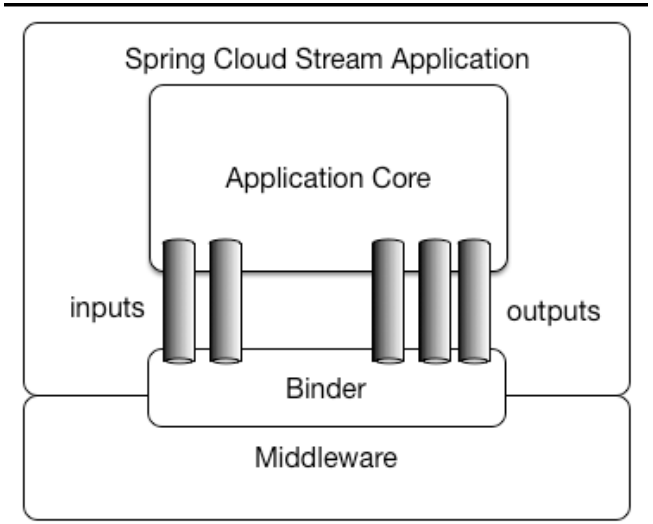
Introduction

What is “Big Data”

- Existing definitions are very vague:
  - Wikipedia” “Big data is a term for data sets that are so large or complex that traditional data processing applications are inadequate.“
- We can look at it in terms of new technologies used to process data:
  - Kafka
  - Hadoop
  - HBase
  - Cassandra
- What these technologies have in common:
  - Open Source projects usually started at “big” web companies
  - Ability to scale
  - Support structured and un-structured data

Boot Apps for Big Data

- Cloud Native
- Spring Cloud Stream
  - Rabbit / Kafka binder
- Spring Data
  - Spring for Apache Hadoop
  - Spring Data Cassandra



Spring Projects for Big Data

Spring Projects for Big Data

- Spring Projects for “Big Data”
  - Spring for Apache Kafka [1]
  - Spring Data
    - Spring for Apache Hadoop - HDFS, YARN, Hive, Spark, HBase
    - Spring Data Cassandra [2]
    - Spring Data GemFire (GemFire and Apache Geode) [3]
  - Spring Cloud
    - Spring Cloud Stream/Task - writing cloud native data microservices
    - Spring Cloud Data Flow - orchestrating data microservices

[1] Spring For Apache Kafka - Wed Aug 3rd 11:30am
[2] Sneak Peek at Spring Data Cassandra - Wed Aug 3rd 3:20pm
[3] Spring Data and In-Memory Data Management in Action - Thu Aug 4th 9:00am

Spring for Apache Hadoop

> *Spring for Apache Hadoop provides extensions to Spring, Spring Boot, Spring Batch, and Spring Integration to build manageable and robust pipeline solutions around Hadoop.*

Consistent Programming Model

- Configure, and parameterize Hadoop connectivity and all job types
- Support for running MapReduce jobs, streaming, tool, jars
- Configure Hadoop's distributed cache
- Support for working with Hive, Pig, HBase, Sqoop2, Spark and MapReduce
- Writing to HDFS – partitioning, many data formats
- Support for YARN programming
- Relies on standard Spring Framework features
  - Configuration and property files
  - Environment profiles – easily move application from dev to qa to prod

Developer Productivity

- Create well-formed applications, not spaghetti script applications
- Simplify HDFS access:
  - `FsShell` API with support for JVM scripting
  - Powerful and flexible `DataStoreWriter` implementations
- Helper “Template” classes for Hive/Pig/HBase
- Runner classes for Hive/Pig/MapReduce for small workflows
- Tasklet implementations for larger Spring Batch flows
  - Hive, Pig, Spark, Sqoop2, MapReduce

Common Use Cases

- Apply across a wide range of use cases
  - Ingestion: Events/JDBC/NoSQL/Files to HDFS
  - Orchestrate: Hadoop Jobs
  - Export: HDFS to JDBC/NoSQL
- Spring Integration and Spring Batch make this possible
- Spring Boot simplifies it
- Spring XD/Spring Cloud Data Flow makes it even easier

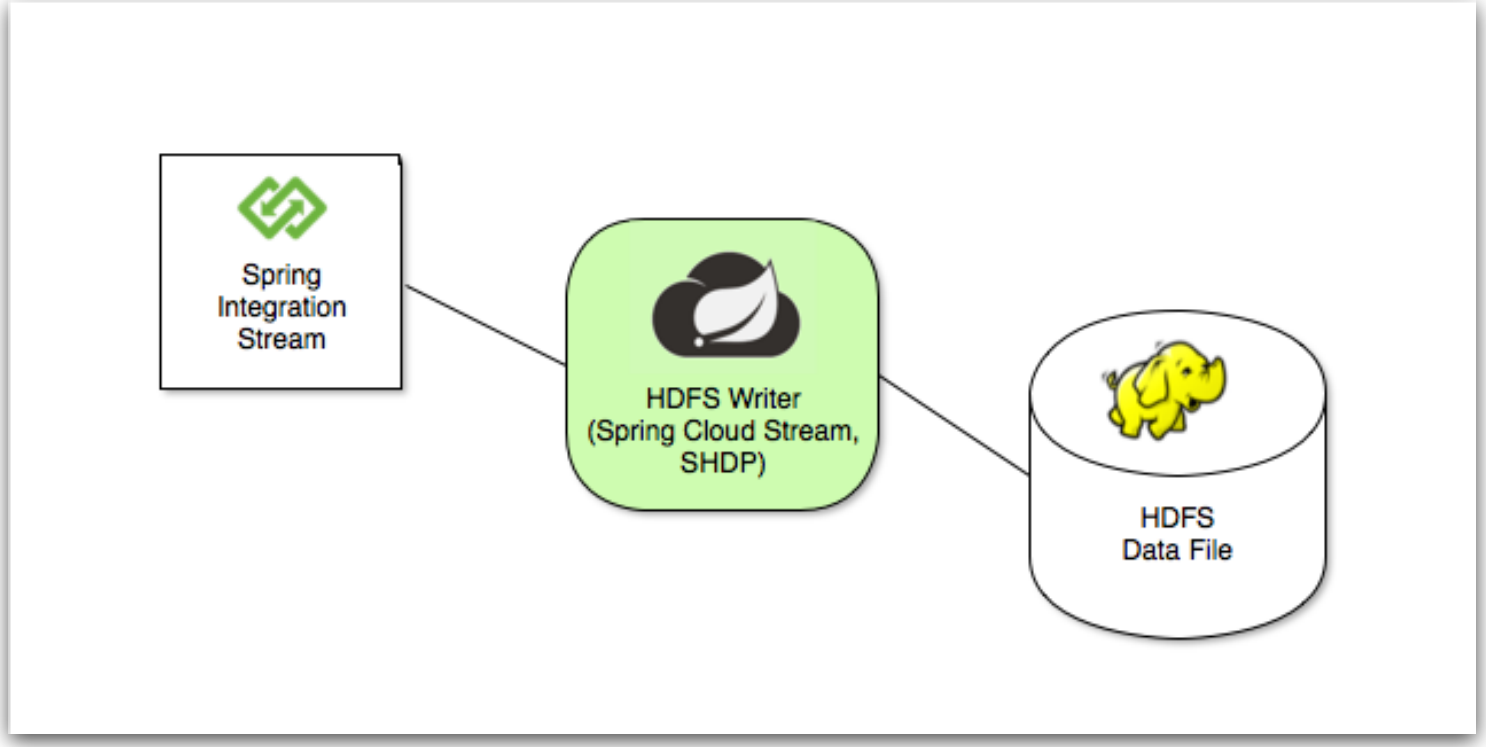
A unified model for different Hadoop distros

- Spring for Apache Hadoop provides several “flavors” to match dependencies with Hadoop distributions from:
  - Apache Hadoop
  - Cloudera CDH
  - Hortonworks HDP
  - Pivotal HD

- See Wiki page for details:
  - ➡ https://github.com/spring-projects/spring-hadoop/wiki#supported-distributions
  - ➡ https://github.com/spring-projects/spring-hadoop/wiki#building-using-supported-distributions

Data Ingestion

Demo #1 - Ingestion



The sink implementation

```
1  package com.springdeveloper.demo;
2
3  import java.io.IOException;
4
5  import org.springframework.beans.factory.annotation.Autowired;
6  import org.springframework.cloud.stream.annotation.EnableBinding;
7  import org.springframework.cloud.stream.messaging.Sink;
8  import org.springframework.data.hadoop.store.DataStoreWriter;
9  import org.springframework.integration.annotation.ServiceActivator;
10
11 @EnableBinding(Sink.class)
12 public class IngestSink {
13
14    @Autowired
15    private DataStoreWriter<String> writer;
16
17    private long counter = 0;
18
19    @ServiceActivator(inputChannel=Sink.INPUT)
20    public void writeData(String payload) {
21       System.out.println("*** PROCESSING ... " + ++counter);
22       try {
23          writer.write(payload);
24       } catch (IOException e) {
25          e.printStackTrace();
26          throw new IllegalStateException("Unable to write to HDFS", e);
27       }
28    }
29
30 }
```

The configuration

```
32  @Configuration
33  public class IngestConfiguration {
34
35      @Value("${app.basePath:/tmp/demo}")
36      private String basePath;
37
38      @Value("${app.fileName:data}")
39      private String fileName;
40
41      @Value("${app.fileExtension:dat}")
42      private String fileExtension;
43
44      @Bean
45      DataStoreWriter<String> dataStoreWriter(org.apache.hadoop.conf.Configuration hadoopConfiguration) {
46          TextFileWriter writer = new TextFileWriter(hadoopConfiguration, new Path(basePath), null);
47          ChainedFileNamingStrategy namingStrategy = new ChainedFileNamingStrategy(
48                  Arrays.asList(new FileNamingStrategy[] {
49                          new StaticFileNamingStrategy(fileName),
50                          new UuidFileNamingStrategy(),
51                          new StaticFileNamingStrategy(fileExtension, ".")}));
52          writer.setFileNamingStrategy(namingStrategy);
53          return writer;
54      }
55  }
```

The POM

```xml
<parent>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-parent</artifactId>
    <version>1.3.6.RELEASE</version>
    <relativePath/> <!-- lookup parent from repository -->
</parent>

<properties>
    <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
    <project.reporting.outputEncoding>UTF-8</project.reporting.outputEn
    <java.version>1.8</java.version>
    <spring-data-hadoop.version>2.4.0.RELEASE</spring-data-hadoop.versi
    <stream-binder>kafka</stream-binder>
</properties>

<profiles>
    <profile>
        <id>rabbit</id>
        <properties>
            <stream-binder>rabbit</stream-binder>
        </properties>
    </profile>
</profiles>
```

```xml
<dependencies>
    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-starter-stream-${stream-binder}</artifactId>
    </dependency>

    <dependency>
        <groupId>org.springframework.data</groupId>
        <artifactId>spring-data-hadoop-boot</artifactId>
        <version>${spring-data-hadoop.version}</version>
    </dependency>
    <dependency>
        <groupId>org.springframework.data</groupId>
        <artifactId>spring-data-hadoop-store</artifactId>
        <version>${spring-data-hadoop.version}</version>
    </dependency>

    <dependency>
        <groupId>org.springframework.cloud</groupId>
        <artifactId>spring-cloud-stream-test-support</artifactId>
        <scope>test</scope>
    </dependency>
</dependencies>

<dependencyManagement>
    <dependencies>
        <dependency>
            <groupId>org.springframework.cloud</groupId>
            <artifactId>spring-cloud-dependencies</artifactId>
            <version>Brixton.SR3</version>
            <type>pom</type>
            <scope>import</scope>
        </dependency>
    </dependencies>
</dependencyManagement>
```

The Integration Tests

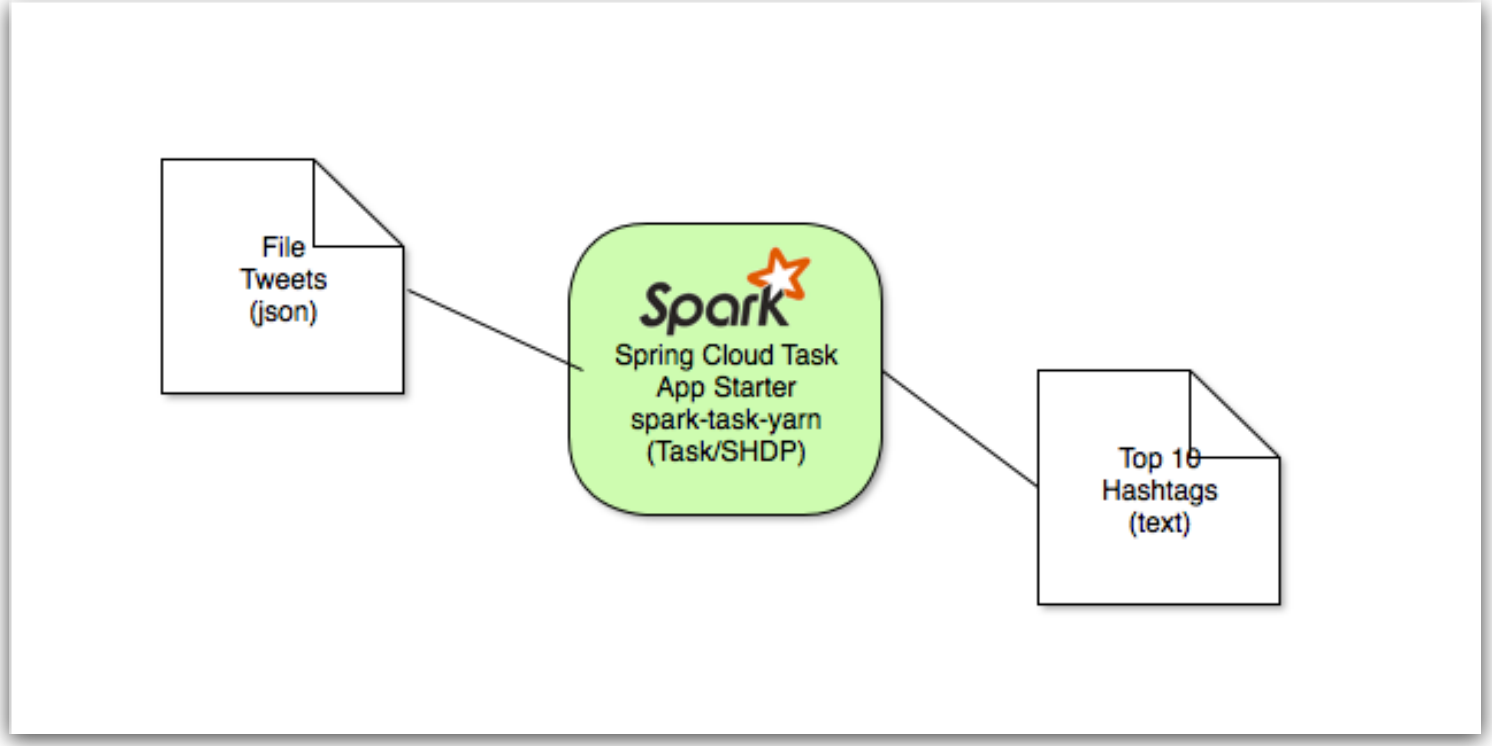
```
47  @RunWith(SpringJUnit4ClassRunner.class)
48  @SpringApplicationConfiguration(classes = IngestSinkIntegrationTests.IngestApplication.class)
49  @IntegrationTest({"spring.hadoop.fsUri=file:///",
50      "app.basePath=${java.io.tmpdir}/test"})
51  public class IngestSinkIntegrationTests {
52
53      @Autowired
54      ConfigurableApplicationContext applicationContext;
55
56      @Value("${app.basePath}")
57      private String testDir;
58
59      @Autowired
60      private FsShell fsShell;
61
62      @Autowired
63      @Bindings(IngestSink.class)
64      private Sink sink;
65
66      @Before
67      public void setup() {
68          if (fsShell.test(testDir)) {
69              fsShell.rmr(testDir);
70          }
71          fsShell.mkdir(testDir);
72      }
73
74      @Test
75      public void testWritingSomething() throws IOException {
76          sink.input().send(new GenericMessage<>("Foo"));
77          sink.input().send(new GenericMessage<>("Bar"));
78          sink.input().send(new GenericMessage<>("Baz"));
79      }
```

```
81      @After
82      public void checkFilesClosedOK() throws IOException {
83          applicationContext.close();
84          File testOutput = new File(testDir);
85          assertTrue(testOutput.exists());
86          File[] files = testOutput.listFiles((dir, name) -> name.endsWith(".dat"));
87          assertTrue(files.length > 0);
88          File dataFile = files[0];
89          assertNotNull(dataFile);
90          Assert.assertThat(readFile(dataFile.getPath(),
91                  Charset.forName("UTF-8")), equalTo("Foo\nBar\nBaz\n"));
92      }
93
94      private String readFile(String path, Charset encoding) throws IOException {
95          byte[] encoded = Files.readAllBytes(Paths.get(path));
96          return new String(encoded, encoding);
97      }
```

```
98      @SpringBootApplication
99      static class IngestApplication {
100         public static void main(String[] args) {
101             SpringApplication.run(IngestApplication.class, args);
102         }
103     }
104 }
```

Data Analysis

Demo #2 - Spark Task



The task implementation

```
17  package com.springdeveloper.demo;
18
19  import org.springframework.boot.SpringApplication;
20  import org.springframework.boot.autoconfigure.SpringBootApplication;
21  import org.springframework.cloud.task.app.spark.yarn.SparkYarnTaskConfiguration;
22  import org.springframework.context.annotation.Import;
23
24  @SpringBootApplication
25  @Import(SparkYarnTaskConfiguration.class)
26  public class SparkTaskApplication {
27
28      public static void main(String[] args) {
29          SpringApplication.run(SparkTaskApplication.class, args);
30      }
31  }
```

The task application properties

```
# Hadoop config
spring.hadoop.fs-uri=hdfs://localhost:8020
spring.hadoop.resource-manager-host=localhost
spring.hadoop.resource-manager-port=8032
spring.hadoop.job-history-address=localhost:10020

# Spring application configuration
# (override spark.app-args if needed)
spark.app-name=hashtags
spark.app-class=Hashtags
spark.app-jar=hdfs:///app/spark/spark-hashtags_2.10-0.1.0.jar
spark.assembly-jar=hdfs:///app/spark/spark-assembly-1.6.2-hadoop2.6.0.jar
spark.app-args=/demo/input,/demo/testout

```

The POM

```
<properties>
    <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
    <project.reporting.outputEncoding>UTF-8</project.reporting.outputEncoding>
    <java.version>1.8</java.version>
    <start-class>com.springdeveloper.demo.SparkTaskApplication</start-class>
</properties>

<dependencies>
    <dependency>
        <groupId>org.springframework.cloud.task.app</groupId>
        <artifactId>spring-cloud-starter-task-spark-yarn</artifactId>
    </dependency>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-test</artifactId>
        <scope>test</scope>
    </dependency>
</dependencies>

<dependencyManagement>
    <dependencies>
        <dependency>
            <groupId>org.springframework.cloud.task.app</groupId>
            <artifactId>spring-cloud-task-app-dependencies</artifactId>
            <version>1.0.1.RELEASE</version>
            <type>pom</type>
            <scope>import</scope>
        </dependency>
    </dependencies>
</dependencyManagement>
```

The Starter

```
53      private class SparkAppYarnRunner implements CommandLineRunner {
54
55          private final Log logger = LogFactory.getLog(SparkAppYarnRunner.class);
56
57          @Autowired
58          private Configuration hadoopConfiguration;
59
60          @Autowired
61          private SparkYarnTaskProperties config;
62
63          @Override
64          public void run(String... args) throws Exception {
65              SparkConf sparkConf = new SparkConf();
66              sparkConf.set("spark.yarn.jar", config.getAssemblyJar());
67
68              List<String> submitArgs = new ArrayList<String>();
69              if (StringUtils.hasText(config.getAppName())) {
70                  submitArgs.add("--name");
71                  submitArgs.add(config.getAppName());
72              }
73              submitArgs.add("--jar");
74              submitArgs.add(config.getAppJar());
75              submitArgs.add("--class");
76              submitArgs.add(config.getAppClass());
77              if (StringUtils.hasText(config.getResourceFiles())) {
78                  submitArgs.add("--files");
79                  submitArgs.add(config.getResourceFiles());
80              }
81              if (StringUtils.hasText(config.getResourceArchives())) {
82                  submitArgs.add("--archives");
83                  submitArgs.add(config.getResourceArchives());
84              }
85              submitArgs.add("--executor-memory");
86              submitArgs.add(config.getExecutorMemory());
87              submitArgs.add("--num-executors");
88              submitArgs.add("" + config.getNumExecutors());
89              for (String arg : config.getAppArgs()) {
90                  submitArgs.add("--arg");
91                  submitArgs.add(arg);
92              }
93              logger.info("Submit App with args: " + Arrays.asList(submitArgs));
94              ClientArguments clientArguments =
95                      new ClientArguments(submitArgs.toArray(new String[submitArgs.size()]), sparkConf);
96              clientArguments.isClusterMode();
97              Client client = new Client(clientArguments, hadoopConfiguration, sparkConf);
98              System.setProperty("SPARK_YARN_MODE", "true");
99              try {
100                 client.run();
101             } catch (Throwable t) {
102                 logger.error("Spark Application failed: " + t.getMessage(), t);
103                 throw new RuntimeException("Spark Application failed", t);
104             }
105         }
106     }
107
```

Improve the Spark Starters

- Provide for better extensibility
- protected methods for
  - creating the `SparkContext`
  - adding Spark properties and client submit args
  - configuring the Spark `Client`

See: https://github.com/spring-cloud/spring-cloud-task-app-starters/issues/57

Cloud

Using Hadoop in the Cloud

- Amazon Elastic MapReduce
- Microsoft Azure HDInsight
- Google Cloud - Dataproc
- IBM BigInsights
- Hortonworks/SequenceIQ Cloudbreak
- Cloudera on AWS / Cloudera Live
- Your own Docker image
- Your own AWS installation

Common issues with Hadoop Cloud Clusters

- Hadoop has a cluster centric view
  - easier to run apps from inside the cluster
  - you should have core-site.xml, yarn-site.xml etc accessible
  - some insights into internal configs might be necessary
- Spring for Apache Hadoop tries to work around this
  - creating its own Hadoop Configuration
  - pulling from environment and config properties
- Cloud clusters usually configured for internal network
  - hard/impossible to reach from outside - have to use proxies/tunnels
  - easiest to run your apps on the same network as the Hadoop cluster

Use Hadoop with Pivotal Cloud Foundry

- Deploy Hadoop separately on the same network as PCF
- Use a user-provided service:

```
cf create-user-provided-service hadoop -p \
     '{“fs":{"defaultFS":"hdfs://node1.af.pivotal.io:8020"},
       “yarn":{"resourcemanager":{"host":"node2.af.pivotal.io","port":"8050"}}}'
```

- Refer to the VCAP_SERVICES env var values in Boot config file:

```
---
 spring:
   profiles: cloud
   hadoop:
     fsUri: ${vcap.services.hadoop.credentials.fs.defaultFS}
     resourceManagerHost: ${vcap.services.hadoop.credentials.yarn.resourcemanager.host}
     resourceManagerPort: ${vcap.services.hadoop.credentials.yarn.resourcemanager.port}
```

Use Hadoop with Google Cloud Platform

- Create a Hadoop cluster on Dataproc:

```
gcloud dataproc clusters create hadoop-demo --master-boot-disk-size-gb 100 \
    –worker-boot-disk-size-gb 100 --zone us-central1-b
```

- Provide the setting in env var using SPRING_APPLICATION_JSON:

```
env:
  - name: SPRING_APPLICATION_JSON
    value: '{"spring.hadoop.fs-uri":"hdfs://hadoop-demo-m:8020",
             "spring.hadoop.resource-manager-host": "hadoop-demo-m",
             "spring.hadoop.resource-manager-port": 8032,
             "spring.hadoop. job-history-address": "hadoop-demo-m:10020"}'
```

Spring Cloud Data Flow

- Supports what we have done so far to deploy apps from a GUI/ Shell environment
- Allows you to register apps you need - from a curated list and also your own custom apps
- Supports multiple runtime environments CF, YARN, Kubernetes and Mesos plus “local” for testing/demos
- See the following presentations
  - Data Microservices in the Cloud - Tue Aug 2nd 11:30am (watch replay)
  - Task Madness - Modern On Demand Processing - Tue Aug 2nd 2:40pm (watch replay)
  - Orchestrate All the Things! with Spring Cloud Data Flow - Thu Aug 4th 11:10am

Spring Cloud Stream/Task - Some Big Data Apps

Source	Processor	Sink	Task
gemfire	bridge	cassandra	spark-client
jdbc	filter	counter	spark-yarn
jms	httpclient	gemfire	
mongodb	pmml	gpfdist	
s3	splitter	hdfs	
tcp	tcp-client	hdfs-dataset	
twitterstream	transform	jdbc	*(more coming)*

Take aways

- Run “Big Data” apps as cloud native microservices
  - locally with `java -jar` or using Docker
  - in the “cloud”
    - Kubernetes on Google Cloud
    - Cloud Foundry with PCF
- Same app can move un-changed from one environment to another
- We used Spring/Spring Boot passing of config override settings using `--spring.xxx`
- We also used Spring Cloud Stream for communication between apps
- In addition we utilized Spring Cloud Data Flow for orchestrating the source app for our ingest pipeline
- We used Spark for analysis running as a task with Spring Cloud Task

SpringOne Platform

Learn More. Stay Connected.

Demo Source & Slides: https://github.com/trisberg/springone-2016
Hadoop Install: https://github.com/trisberg/hadoop-install
Spring for Apache Hadoop Project: http://projects.spring.io/spring-hadoop/
Spring Cloud Data Flow Project: http://cloud.spring.io/spring-cloud-dataflow/
Questions: http://stackoverflow.com/questions/tagged/spring-data-hadoop
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