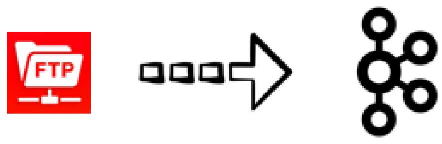
> An **FTP server**, together with a pair of credentials is a common pattern, on how data providers expose data as a service.

In this article we are going to implement custom file transformers to efficiently load files over FTP and using **Kafka Connect** convert them to meaningful events in Avro format.



Depending on data subscriptions we might get access to FTP locations with files updated `daily` , `weekly` or `monthly`. File structures might be **positional**, **csv**, **json** , **xml** or even binary.

On IoT use cases we might need to flatten multiple events arriving in a single line; or apply other transformations before allowing the data to enter into the **kafka highway** as a stream of meaningful messages.

Kafka Connect distributed workers can provide a reliable and straight forward way of ingesting data over FTP. Let's now look at some **real IoT cases** with data delivered on FTP and how to load them into Kafka:

XML : Iradiance Solar data

The first data set is available through FTP and multiple XML files, contain data per day for numerous geo-locations in the world:

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
  <SOAP-ENV:Header>
    <wsse:Security xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd" xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-utility-1.0.xsd" SOAP-ENV:mustUnderstand="1">
      <wsu:Timestamp wsu:Id="AB-1234">
        <wsu:Created>2016-12-02T00:13:11.807Z</wsu:Created>
        <wsu:Expires>2016-12-02T00:18:11.807Z</wsu:Expires>
      </wsu:Timestamp>
      <wsse11:SignatureConfirmation xmlns:wsse11="http://docs.oasis-open.org/wss/oasis-wss-wssecurity-secext-1.1.xsd" wsu:Id="SC-2947"/>
    </wsse:Security>
  </SOAP-ENV:Header>
  <SOAP-ENV:Body>
    <ns2:dataDeliveryResponse xmlns:ns2="http://geomodel.eu/schema/ws/data" xmlns:ns3="http://geomodel.eu/schema/common/geo">
      <ns2:site id="site-ID-1234" lat="56.3491" lng="-2.41118">
```

Note in the above block the last line. The `siteID`, `lat` and `lng` are metadata about this time-series

The XML file continues with the entries:

```
        <ns2:row dateTime="2016-12-01T00:18:00.000Z" values="1.2"/>
        <ns2:row dateTime="2016-12-01T00:33:00.000Z" values="12.5"/>
        ...
```

All we need to do is to define a case class, and provide a class implementing `SourceRecordConverter` and encapsulating the logic of flattening XML packed data into messages:

```
package com.landoop

import com.datamountaineer.streamreactor.connect.ftp.source.SourceRecordConverter

import scala.collection.JavaConverters._
import java.util

import org.apache.kafka.connect.source.SourceRecord

class IradianceXML extends SourceRecordConverter {

  override def configure(props: util.Map[String, _]): Unit = {}

  override def convert(in: SourceRecord): util.List[SourceRecord] = {
    val line = new String(in.value.asInstanceOf[Array[Byte]])
    val data = scala.xml.XML.loadString(line)

    val siteID = (data \\ "site" \ "@id").toString
    val lat = (data \\ "site" \ "@lat").toString.toDouble
    val lng = (data \\ "site" \ "@lng").toString.toDouble

    val rows = (data \\ "row").map { rowData =>
      val dateTime = (rowData \ "@dateTime").toString
      val value = (rowData \ "@values").toString.toDouble
      val message = IradianceData(siteID, lat, lng, dateTime, value)
      new SourceRecord(in.sourcePartition, in.sourceOffset, in.topic, 0, message.connectSchema, message.getStructure)
    }
    rows.toList.asJava
  }

}
```

That's it no more than 30 lines of code, we have encapsulated the entire parsing logic into a RecordConverter. The data contract is inside a case class, that provides access to the schema and a converter to an **Avro** structure.

```
case class IradianceData(siteID: String,
                         lat: Double,
                         lng: Double,
                         datetime: String,
                         value: Double) {

  val connectSchema: Schema = SchemaBuilder.struct()
    .doc("Iradiance Solar Data")
    .name("com.landoop.IradianceData")
    .field("siteID", Schema.STRING_SCHEMA)
    .field("lat", Schema.FLOAT64_SCHEMA)
    .field("lng", Schema.FLOAT64_SCHEMA)
    .field("datetime", Schema.STRING_SCHEMA)
    .field("value", Schema.FLOAT64_SCHEMA)
    .build()

  def getStructure: Struct = new Struct(connectSchema)
    .put("siteID", siteID)
    .put("lat", lat)
    .put("lng", lng)
    .put("datetime", datetime)
    .put("value", value)
}
```

Get the code from github (https://github.com/Landoop/ftp-kafka-converters), build the JAR file with `sbt assembly` and add it into the classpath of Kafka Connect.

Next we can instruct the connector to use it via setting the property `sourcerecordconverter` to `com.landoop.IradianceXML` :

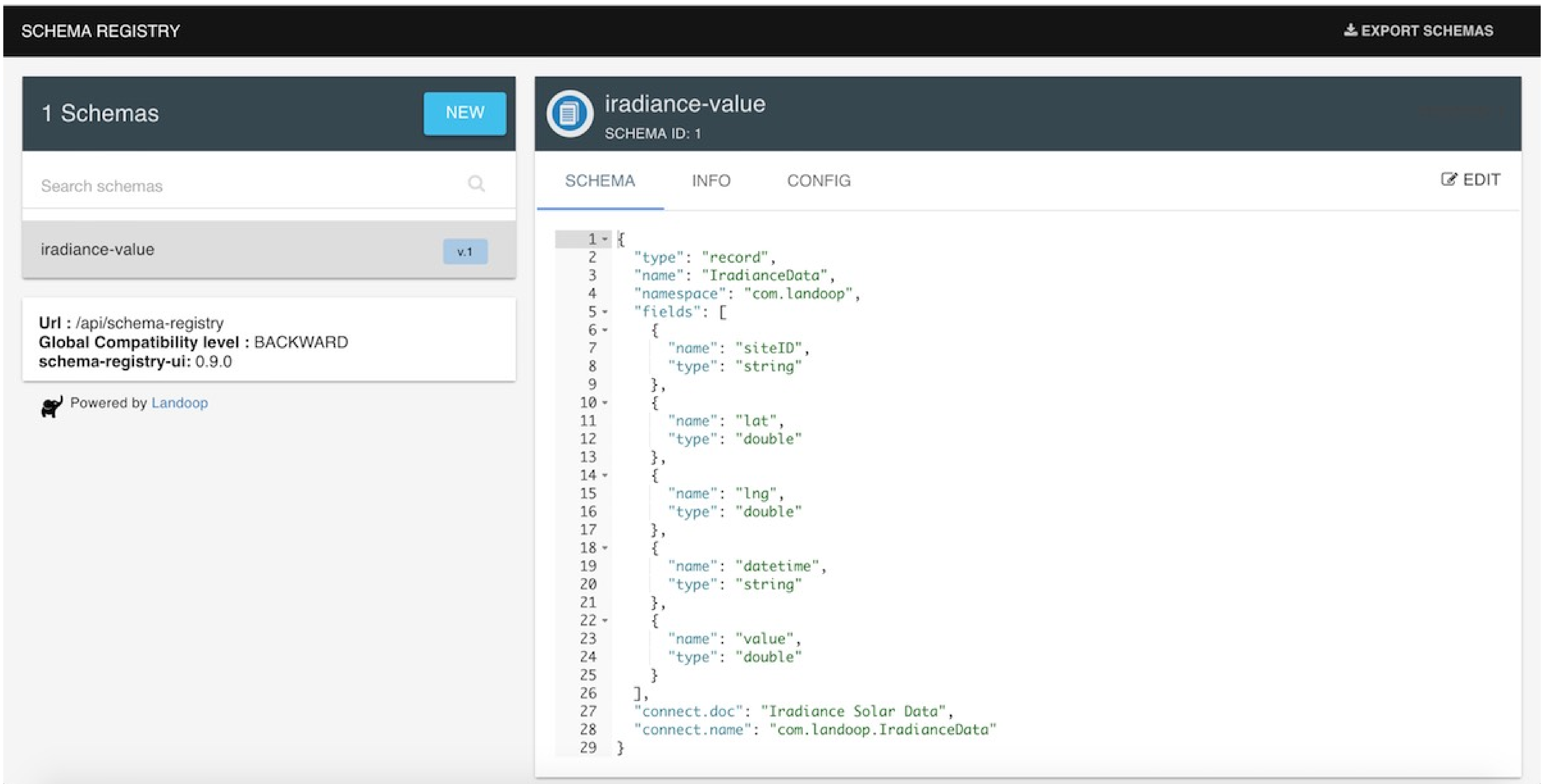
```
cat << EOF > iradiance-ftp-source-connector.json
{
  "name": "iradiance-ftp",
  "config": {
    "tasks.max": "1",
    "connector.class": "com.datamountaineer.streamreactor.connect.ftp.source.FtpSourceConnector",
    "connect.ftp.address": "192.168.0.15:21",
    "connect.ftp.user": "Antwnis",
    "connect.ftp.password": "********",
    "connect.ftp.refresh": "PT1M",
    "connect.ftp.file.maxage": "P14D",
    "connect.ftp.keystyle": "struct",
    "connect.ftp.monitor.tail": "iradiance/*.xml:iradiance",
    "connect.ftp.sourcerecordconverter": "com.landoop.IradianceXML"
  }
}
EOF

curl -X POST -H "Content-Type: application/json" -H "Accept: application/json" -d @iradiance-ftp-source-connector.json \
  http://192.168.99.100:8083/connectors
```

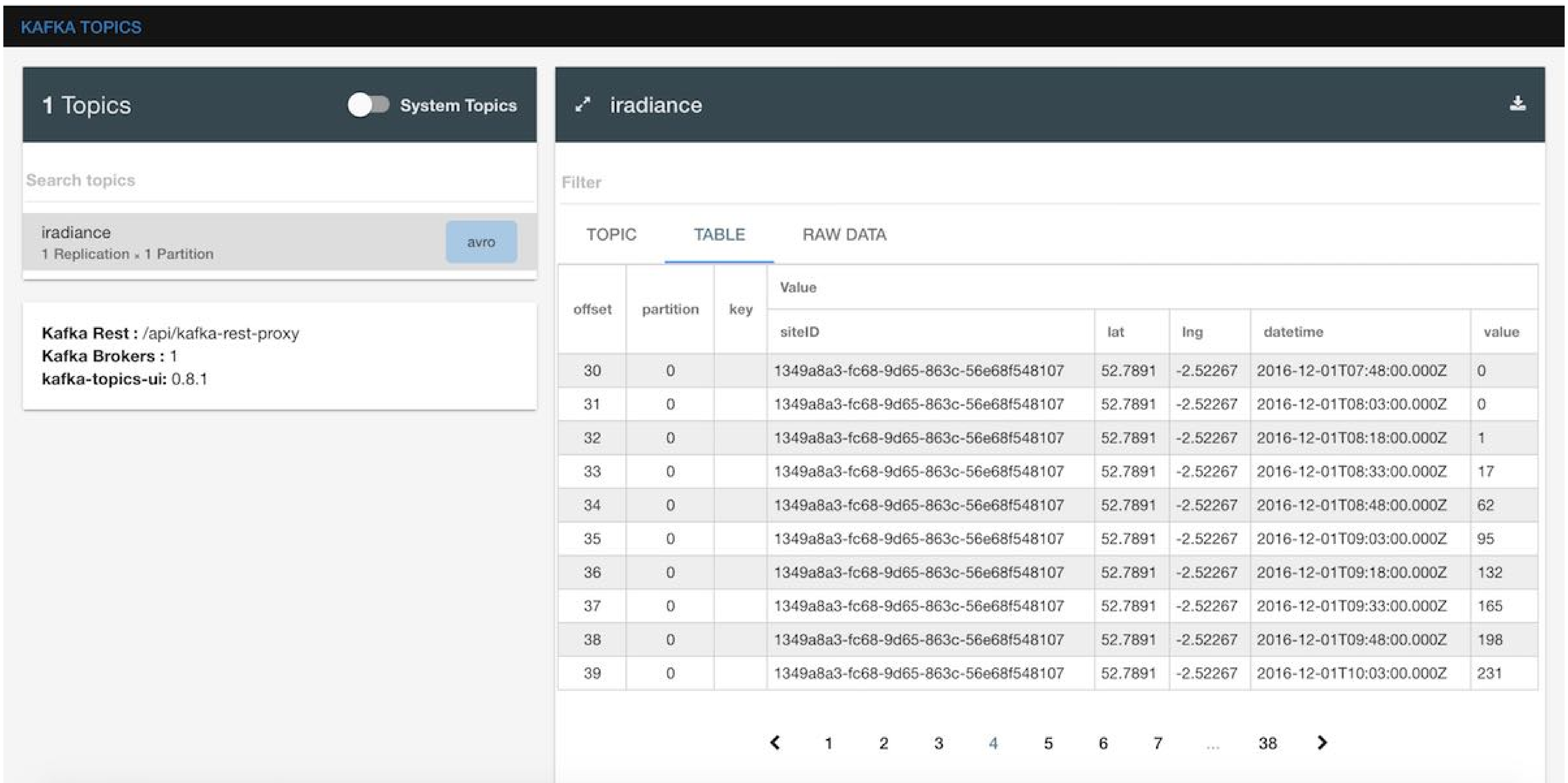
What we have achieved, is setting up and posting to Kafka Connect distributed, a connector that **tails** all files newer than 14 days `P14D` in a remote FTP at the location `iradiance/*.xml` and refreshes the tailing every (1 minute) `PT1M`.

> Timings are provided in the `iso8601 duration` format.

When the first XML file is consumed, and a number of events are generated in Avro format. The first message is checked against the schema-registry, and as no such avro subject is yet register it will register it automatically:



By using the kafka-topics-ui we can also see the data landing into the topic:



offset	partition	key	Value				
			siteID	lat	lng	datetime	value
30	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T07:48:00.000Z	0
31	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T08:03:00.000Z	0
32	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T08:18:00.000Z	1
33	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T08:33:00.000Z	17
34	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T08:48:00.000Z	62
35	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T09:03:00.000Z	95
36	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T09:18:00.000Z	132
37	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T09:33:00.000Z	165
38	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T09:48:00.000Z	198
39	0		1349a8a3-fc68-9d65-863c-56e68f548107	52.7891	-2.52267	2016-12-01T10:03:00.000Z	231

As instructed a single XML file, is parsed into multiple messages, that each one makes sense in isolation, thus are converted to streaming-events. The solar iradiance seems to be picking up in the morning hours.

Every time an XML file is consumed and multiple new Avro messages are generated into Kafka, a record is automatically added in the `connect-offsets` topic:


```
{
  "key": "[\"iradiance-ftp\",{\"path\":\"iradiance/2017-02-13-iradiance.xml\"}]",
  "value": "{\"lastmodified\":1486640864308,\"timestamp\":1486631400000,\"size\":8671,\"firstfetched\":1486640864264,\"hash\":\"3bb2154287499b4a57444906b2dfbe3c371a7b255b8aeeae676a885f1c16903a\",\"lastinspected\":1486640864308}",
  "partition": 0,
  "offset": 17
}
```


The above record acts as the `high watermark` , so that on the next poll of the connector, only **new** files and files that increased **in size** will be consumed. So, similarly to `Camel` and other FTP pollers, the FTP connector is a state-less micro service that preserves state and data in Kafka.

Horizontal CSV files (monthly)

Let's look at some CSV files delivered over FTP. Horizontal files, come in with some metadata columns, followed by a date column and then by 24 or 48 comma separated set of numbers that indicate a reading every 60 minute or 30 minute time interval in that day.

```
DeviceID_1234_foo,21/01/2017,1.5,1.6 … 10.2,10.4,10.2,12.6,11.2,9.5,8.8
```

A compacted time-series in plain sight, requires a simple transformation to break it down to simple events and then send them to Kafka in records, ready to be consumed by downstream apps.

```
package com.landoop

import java.util

import com.datamountaineer.streamreactor.connect.ftp.source.SourceRecordConverter
import com.typesafe.scalalogging.slf4j.StrictLogging
import org.joda.time.format.{DateTimeFormat, DateTimeFormatter}
import org.apache.kafka.connect.source.SourceRecord

import scala.collection.JavaConverters._
import org.joda.time.DateTime

class HorizontalMonthlyCSV extends SourceRecordConverter with StrictLogging {

  override def configure(props: util.Map[String, _]): Unit = {}

  val dateFormat: DateTimeFormatter = DateTimeFormat.forPattern("dd/mm/yy")

  override def convert(in: SourceRecord): util.List[SourceRecord] = {
    val line = new String(in.value.asInstanceOf[Array[Byte]])
    val tokens = Parser.fromLine(line)
    val id = tokens.head
    val day = DateTime.parse(tokens(1), dateFormat)
    val readings = tokens.drop(2)

    val minutes = 1440 / readings.length
    logger.debug(s"Monthly CSV parser with 1 entry every $minutes minutes")
    val eventsList = readings.indices.flatMap { index =>
      val value: String = readings(index)
      val parsedDouble = parseDouble(value)
      if (parsedDouble.isDefined) {
        val newTime = day.plusMinutes(index * minutes).getMillis / 1000
        val event = DeviceEvent(id, newTime, parsedDouble.get)
        Option(new SourceRecord(in.sourcePartition, in.sourceOffset, in.topic, 0, event.connectSchema, event.getStructure))
      }
      else None
    }.toList
    eventsList.asJava
  }

  def parseDouble(s: String): Option[Double] = try { Some(s.toDouble) } catch { case _ : Throwable => None }

}
```

The above code will cater for entries coming with missing values. We have defined the specifications of the connectors as scala spec tests:

```
"allow missing reading" in {
  val line =
    """ABCDEFG_214669932_Import,21/01/2017,1.4,1.3,1.7,1.3,1.5,,,,,,,,12.5,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,"""
  val inputLineRecord = new SourceRecord(sourcePartition, sourceOffset, "topic", 0, null, line.getBytes)
  val convertedRecords = new HorizontalMonthlyCSV().convert(inputLineRecord)
  convertedRecords.size shouldBe 6
}
```

All we need to do is send a request for a new CSV (horizontal) files with:

```
cat << EOF > horizontal-csv-ftp-source-connector.json
{
  "name": "horizontal-ftp",
  "config": {
    "tasks.max": "1",
    "connector.class": "com.datamountaineer.streamreactor.connect.ftp.source.FtpSourceConnector",
    "connect.ftp.address": "192.168.0.15:21",
    "connect.ftp.user": "Antwnis",
    "connect.ftp.password": "********",
    "connect.ftp.refresh": "PT1M",
    "connect.ftp.file.maxage": "P14D",
    "connect.ftp.keystyle": "struct",
    "connect.ftp.monitor.tail": "horizontal/*.csv:horizontalCSV",
    "connect.ftp.sourcerecordconverter": "com.landoop.HorizontalMonthlyCSV"
  }
}
EOF

curl -X POST -H "Content-Type: application/json" -H "Accept: application/json" -d @horizontal-csv-ftp-source-connector.json \
  http://192.168.99.100:8083/connectors
```

CSV : Multi channel files

We will now look at another use case where an embedded device captures multiple data points and interpolates them into discrete channels. For example when having Channel A and Channel B a CSV file could have the following columns:

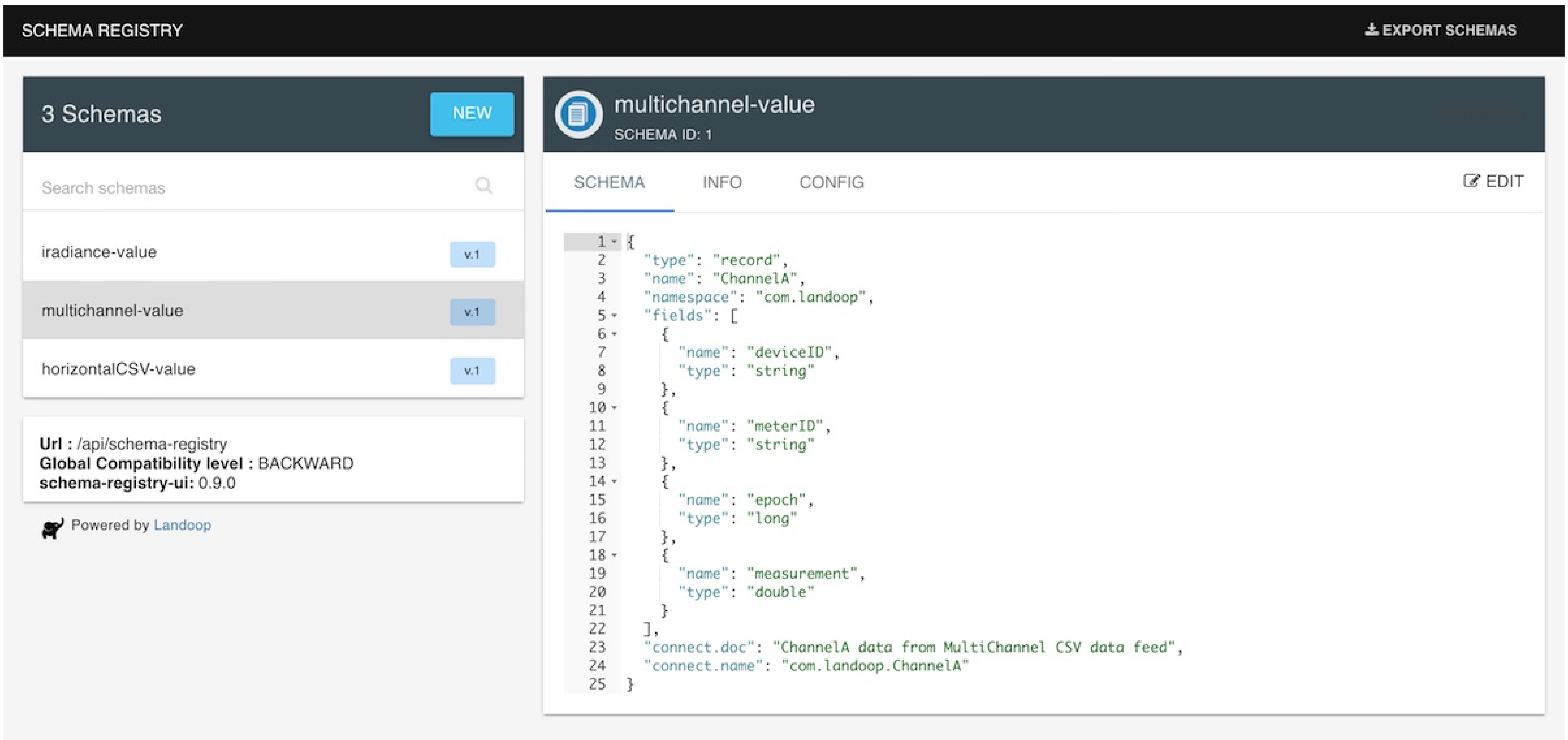
```
Column 1: Device ID
Column 2: Meter ID
Column 3: Date
Column 4: Channel A snapshot
Column 5: Channel B snapshot
Column 6,8,10,..,100: Channel A delta
Column 7,9,11,...,101: Channel B delta
```

The implementation, available on github, ignores completely the **Channel B** data and for every line it emits 1 record with (Column 4) data to topic `` ... and 1 record for each measurement.

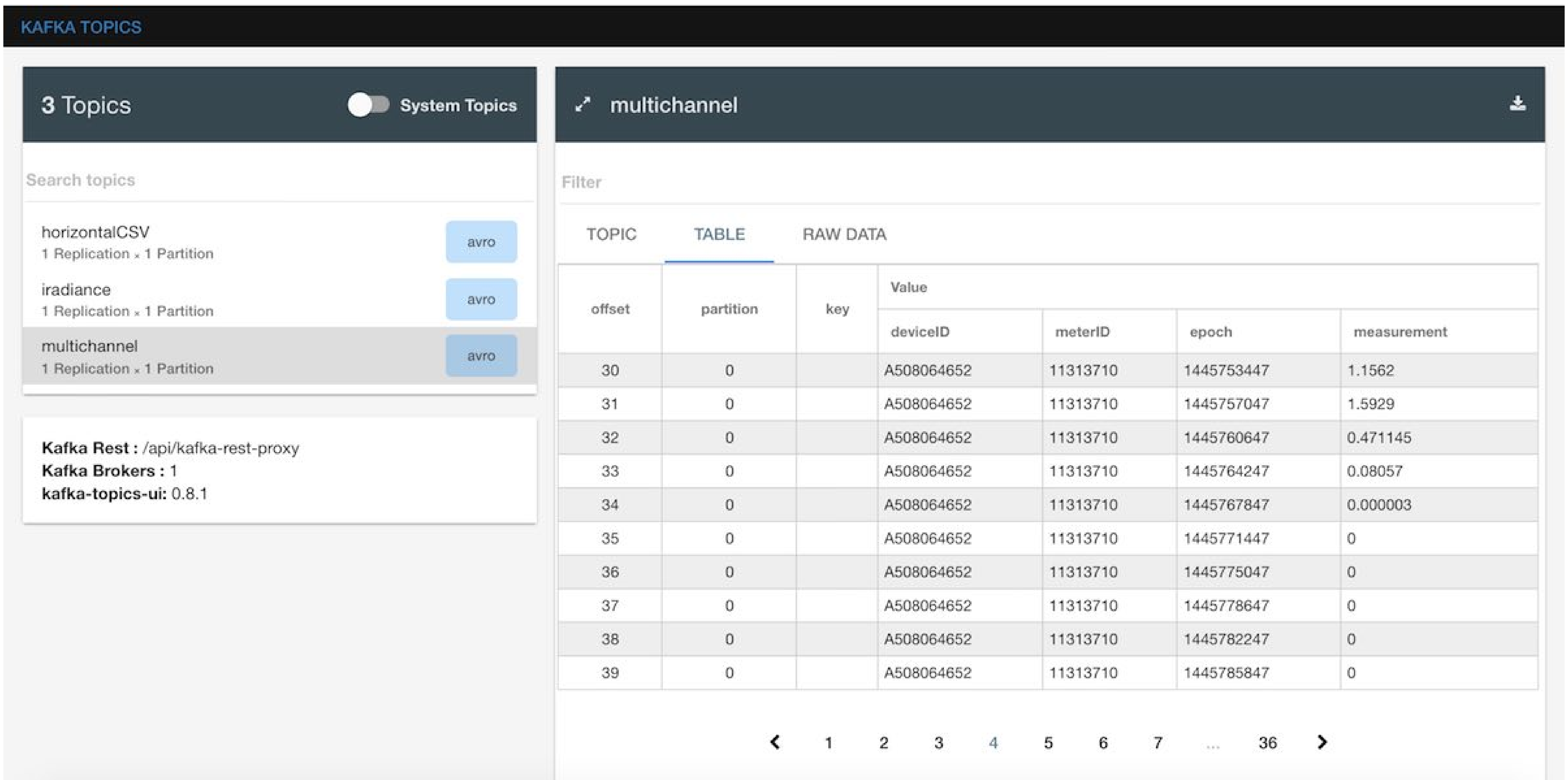
```
cat << EOF > multichannel-csv-ftp-source-connector.json
{
  "name": "multichannel-ftp",
  "config": {
    "tasks.max": "1",
    "connector.class": "com.datamountaineer.streamreactor.connect.ftp.source.FtpSourceConnector",
    "connect.ftp.address": "192.168.0.15:21",
    "connect.ftp.user": "Antwnis",
    "connect.ftp.password": "********",
    "connect.ftp.refresh": "PT1M",
    "connect.ftp.file.maxage": "P14D",
    "connect.ftp.keystyle": "struct",
    "connect.ftp.monitor.tail": "multichannel/*.csv:multichannel",
    "connect.ftp.sourcerecordconverter": "com.landoop.MultiChannelCSV"
  }
}
EOF

curl -X POST -H "Content-Type: application/json" -H "Accept: application/json" -d @multichannel-csv-ftp-source-connector.json \
  http://192.168.99.100:8083/connectors
```

We can inspect our schemas:



And using the kafka-topics-ui we can also see the data landing into the topic:



offset	partition	key	Value			
			deviceID	meterID	epoch	measurement
30	0		A508064652	11313710	1445753447	1.1562
31	0		A508064652	11313710	1445757047	1.5929
32	0		A508064652	11313710	1445760647	0.471145
33	0		A508064652	11313710	1445764247	0.08057
34	0		A508064652	11313710	1445767847	0.000003
35	0		A508064652	11313710	1445771447	0
36	0		A508064652	11313710	1445775047	0
37	0		A508064652	11313710	1445778647	0
38	0		A508064652	11313710	1445782247	0
39	0		A508064652	11313710	1445785847	0

You will have noticed, that currently all topics have 1 partition and 1 replication factor.

Binary compressed files

Setting up a connector to fetch Binary files, is supported by default, by using the In the above configuration we have selected the `ftp.monitor.update` capability of the connector.

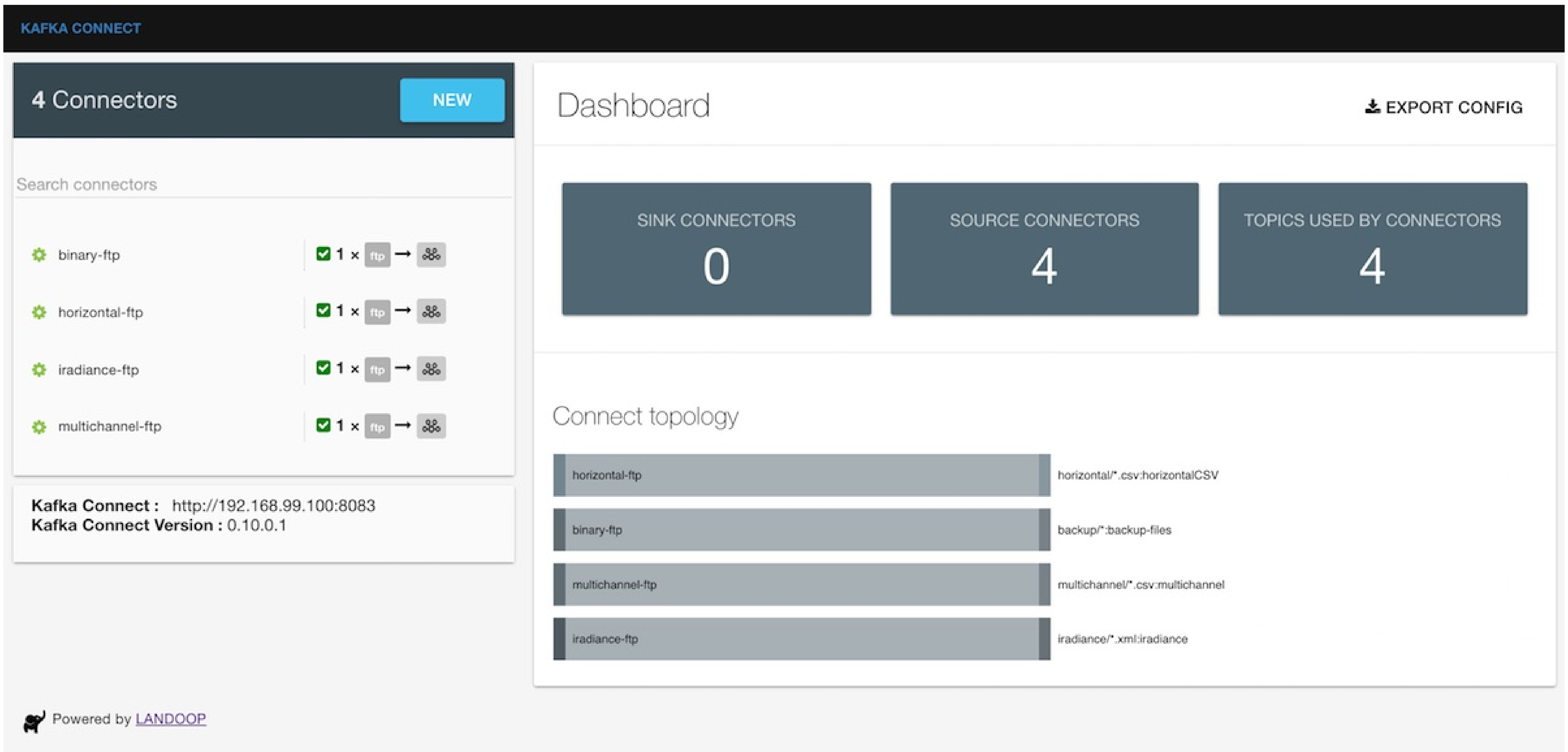
No development is required, and all we need to do is post a connector with the appropriate configuration.

```
cat << EOF > binary-ftp-source-connector.json
{
  "name": "binary-ftp",
  "config": {
    "tasks.max": "1",
    "connector.class": "com.datamountaineer.streamreactor.connect.ftp.source.FtpSourceConnector",
    "connect.ftp.address": "192.168.0.15:21",
    "connect.ftp.user": "Antwnis",
    "connect.ftp.password": "********",
    "connect.ftp.refresh": "PT1M",
    "connect.ftp.file.maxage": "P14D",
    "connect.ftp.keystyle": "struct",
    "connect.ftp.monitor.update": "backup/*:backup-files"
  }
}
EOF

 curl -X POST -H "Content-Type: application/json" -H "Accept: application/json" -d @binary-ftp-source-connector.json \
   http://192.168.99.100:8083/connectors
```

Connect Topology

We can now have a unified view of our Connect topology using the kafka-connect-ui tool:



Conclusions

In this article we've presented how to use **Kafka Connect** to set up connectors to poll remote FTP locations, pick up new data (in a variety of file-formats) and transform them into **Avro** messages and transmit them to Apache Kafka.

In the second part of this Blog we will present how to run a setup such as the above operationally, will associated metrics, monitoring and alerting.

Happy coding - Landoop team

References

Documentation and Download page of open source FTP -> Kafka Connector (http://lenses.stream/connectors/source/ftp.html)
GitHub repository with example implementation of custom FTP plugins (https://github.com/Landoop/ftp-kafka-converters)
