Query Real-Time Kafka Streams with Oracle SQL

developer.oracle.com

Melli Annamalai
Senior Principal Product Manager
Oracle
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melliyal.Annamalai@oracle.com

Live for the Code

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Agenda

- Demo: Monitor temperature readings from food distribution centers
- Apache Kafka Concepts
- SQL Connector for Kafka
  - Database objects
  - SQL syntax examples
  - Performance and scale
- Roadmap

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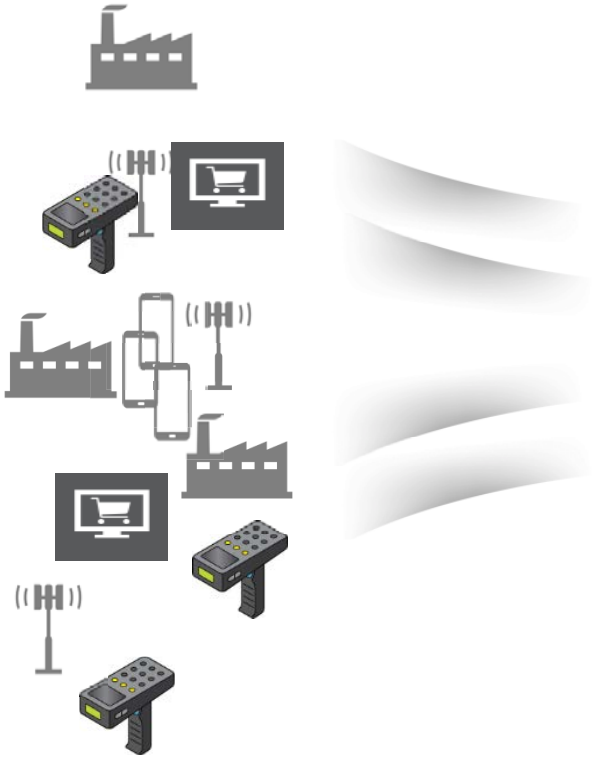
Streaming Data



In real-time: Process data streams as they occur

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Streaming Data Examples

- Sensor data
- Clickstream data
- Machine/equipment
- Network monitoring
- Pipeline monitoring
- Fleet monitoring
- ……

High Velocity

High Volume

Example: 200k/second, 24x7

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Demo

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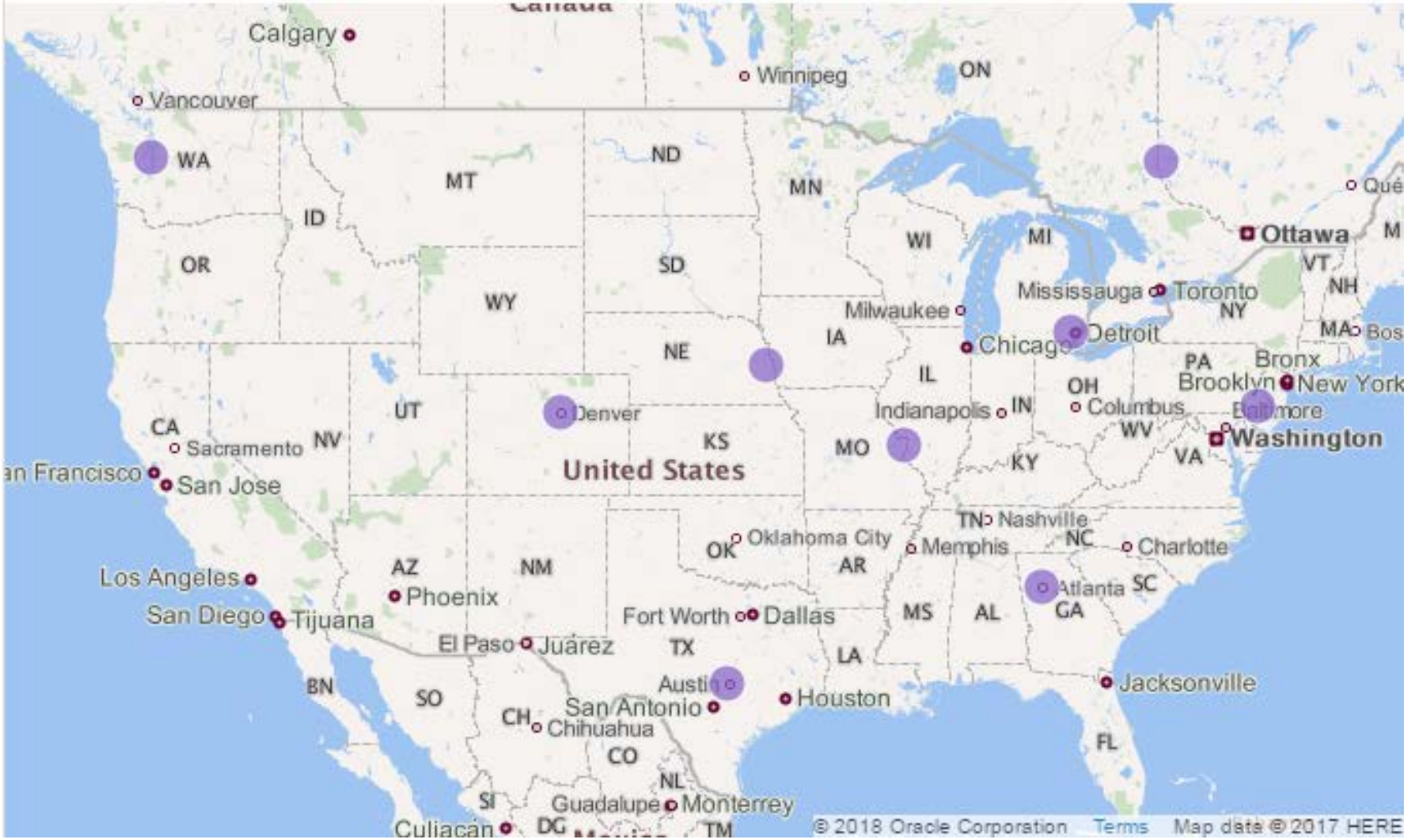
Monitoring Temperature at Food Distribution Centers



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Apache Kafka Concepts

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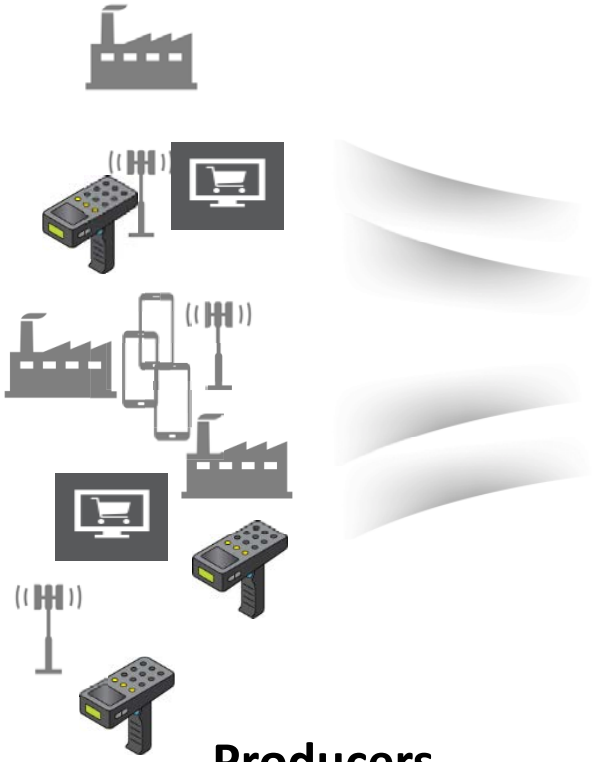
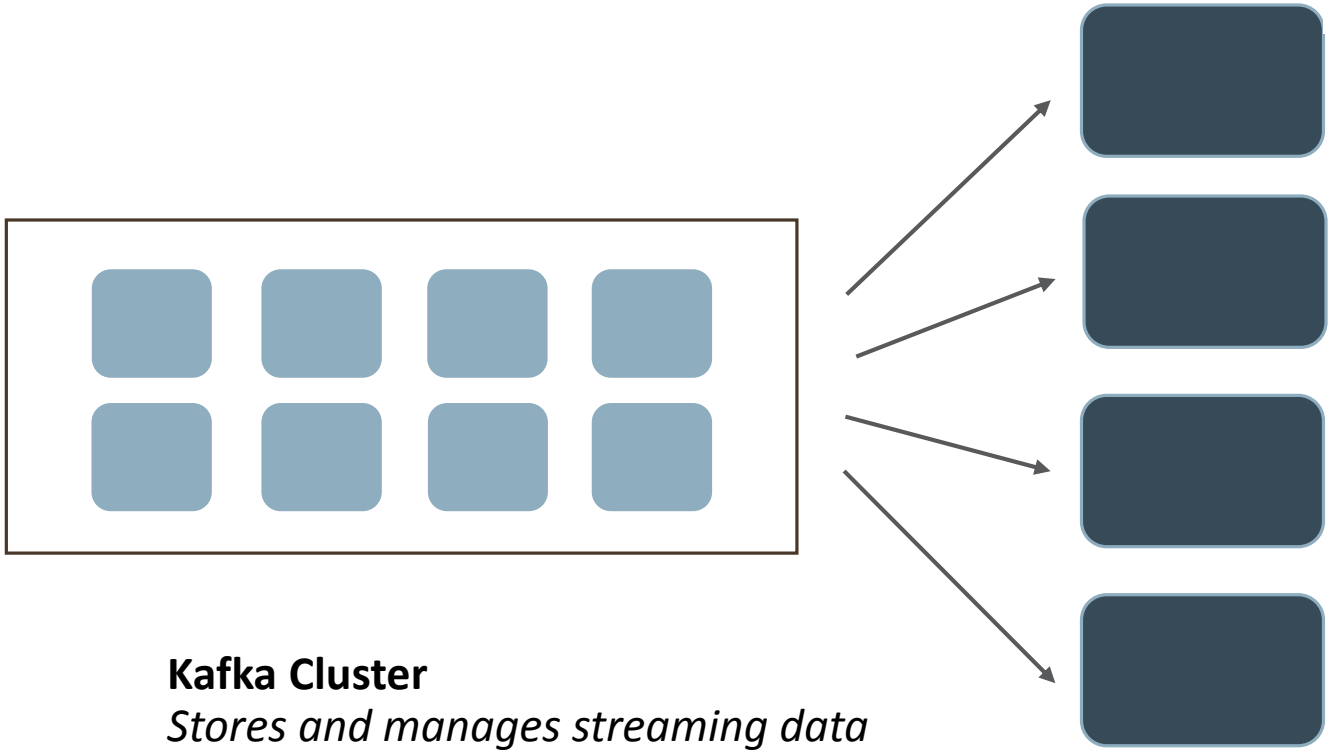
Apache Kafka





Producers
Entities producing streaming data

Kafka Cluster
Stores and manages streaming data in a distributed, replicated, fault-tolerant cluster

Consumers
Applications that read and process messages

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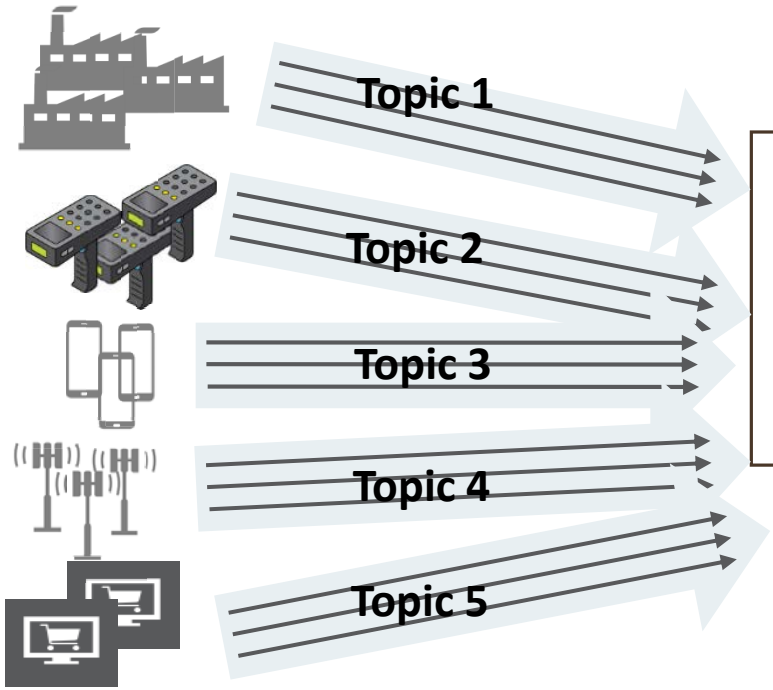
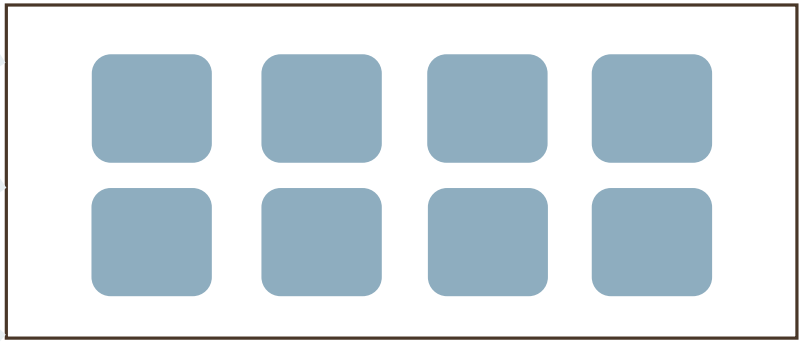
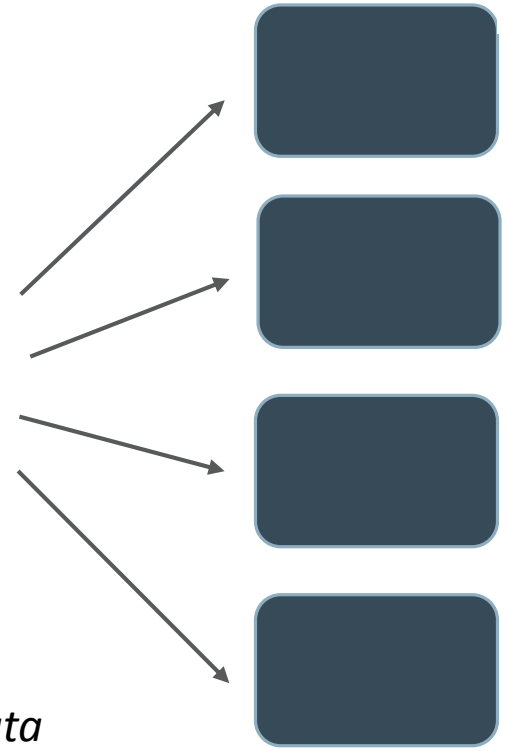
Kafka Topics



Messages with a common format





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Kafka Topic Example

MSGNUMBER,

MSGTIMESTAMP,

SENSORUNITID,

SENSORTYPEID,

TEMPERATURESETTING,

TEMPERATUREREADING

```
1293847,2018-02-02 00:02:09.804,122,68557,34.000,32.618
1293849,2018-02-02 00:02:10.226,129,65144,34.000,33.282
1293851,2018-02-02 00:02:10.104,170,39436,34.000,33.809
1293853,2018-02-02 00:02:09.459,104,9223,34.000,31.624
1293855,2018-02-02 00:02:10.222,127,55628,34.000,31.622
1293857,2018-02-02 00:02:09.392,183,2986,34.000,34.273
1293859,2018-02-02 00:02:10.279,166,34301,34.000,32.546
1293861,2018-02-02 00:02:09.433,162,34858,34.000,34.091
1293863,2018-02-02 00:02:09.792,149,81568,34.000,36.590
1293865,2018-02-02 00:02:10.013,163,20631,34.000,35.723
1293848,2018-02-02 00:02:09.948,170,94548,34.000,34.111
1293850,2018-02-02 00:02:10.018,174,29056,34.000,36.404
1293852,2018-02-02 00:02:09.813,161,71207,34.000,32.124
1293854,2018-02-02 00:02:09.398,121,93751,34.000,32.565
1293856,2018-02-02 00:02:09.389,168,59787,34.000,32.172
1293858,2018-02-02 00:02:09.412,114,79177,34.000,31.725
1293860,2018-02-02 00:02:09.829,144,81195,34.000,35.618
1293862,2018-02-02 00:02:10.004,182,58496,34.000,31.415
1293864,2018-02-02 00:02:10.105,114,62482,34.000,33.363
```

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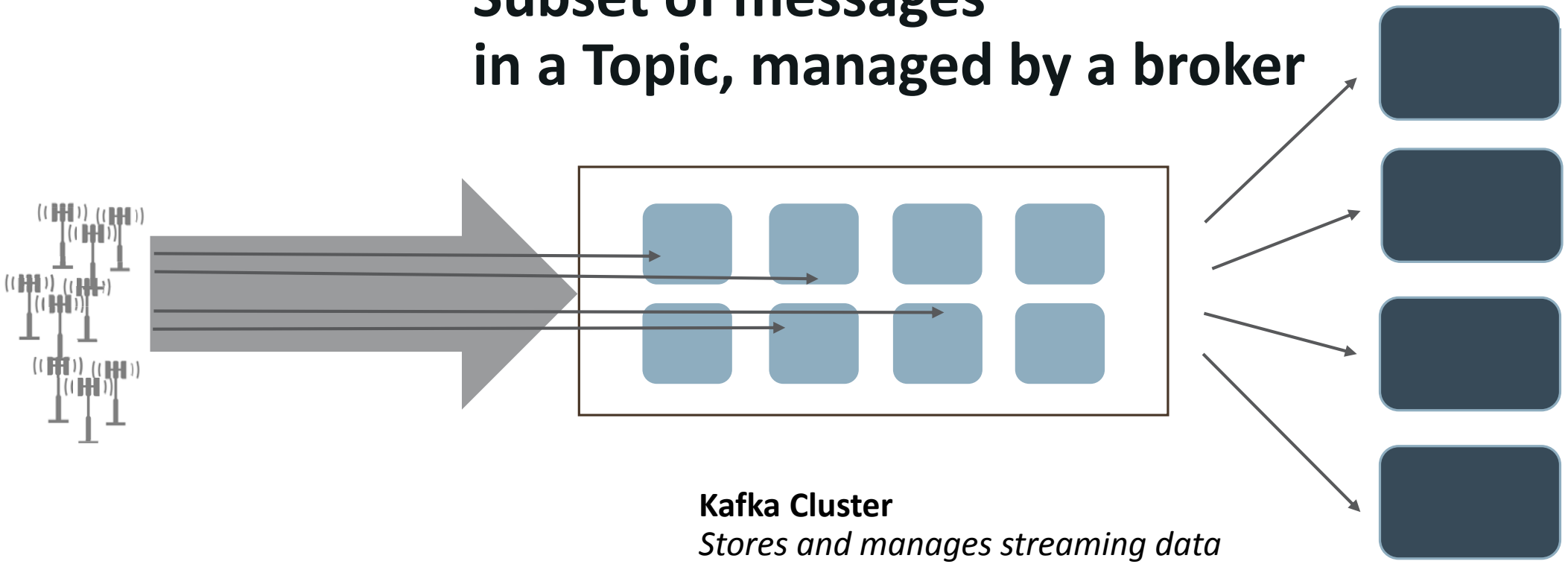
Kafka Topic Partitions

Subset of messages
in a Topic, managed by a broker



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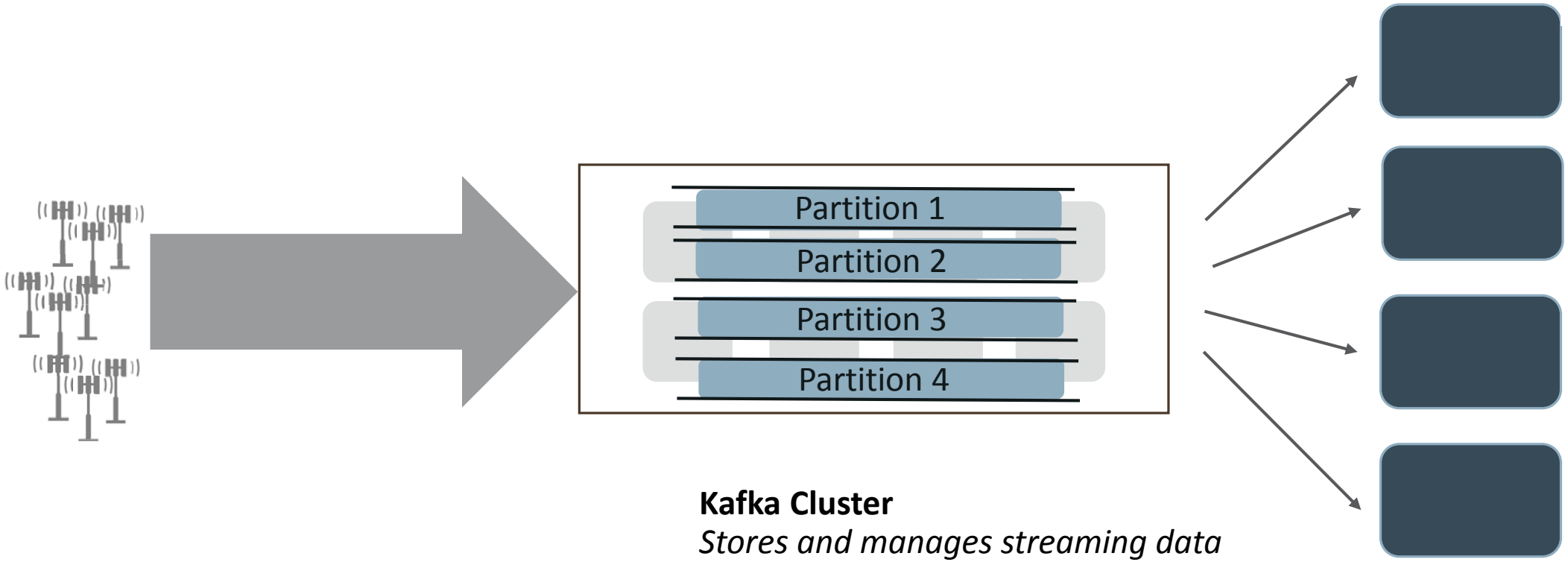
Kafka Topic Partitions



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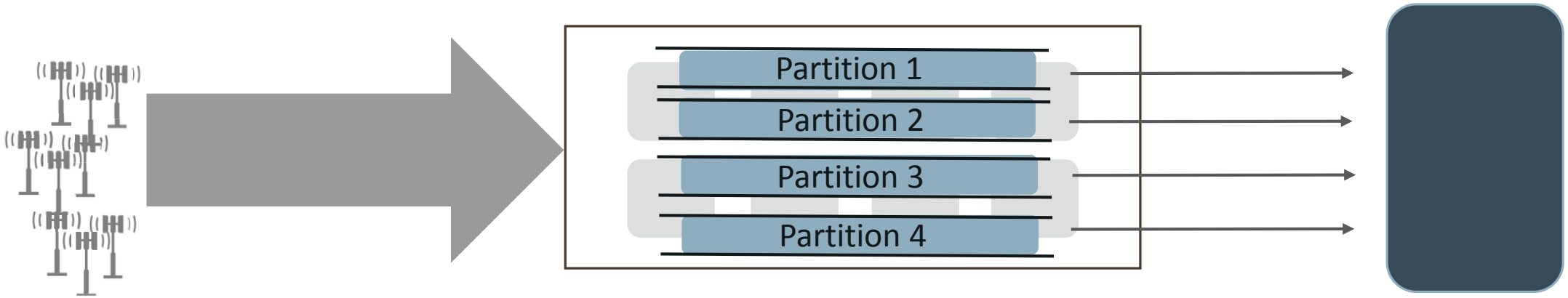
A Kafka Consumer Application

Should read all partitions



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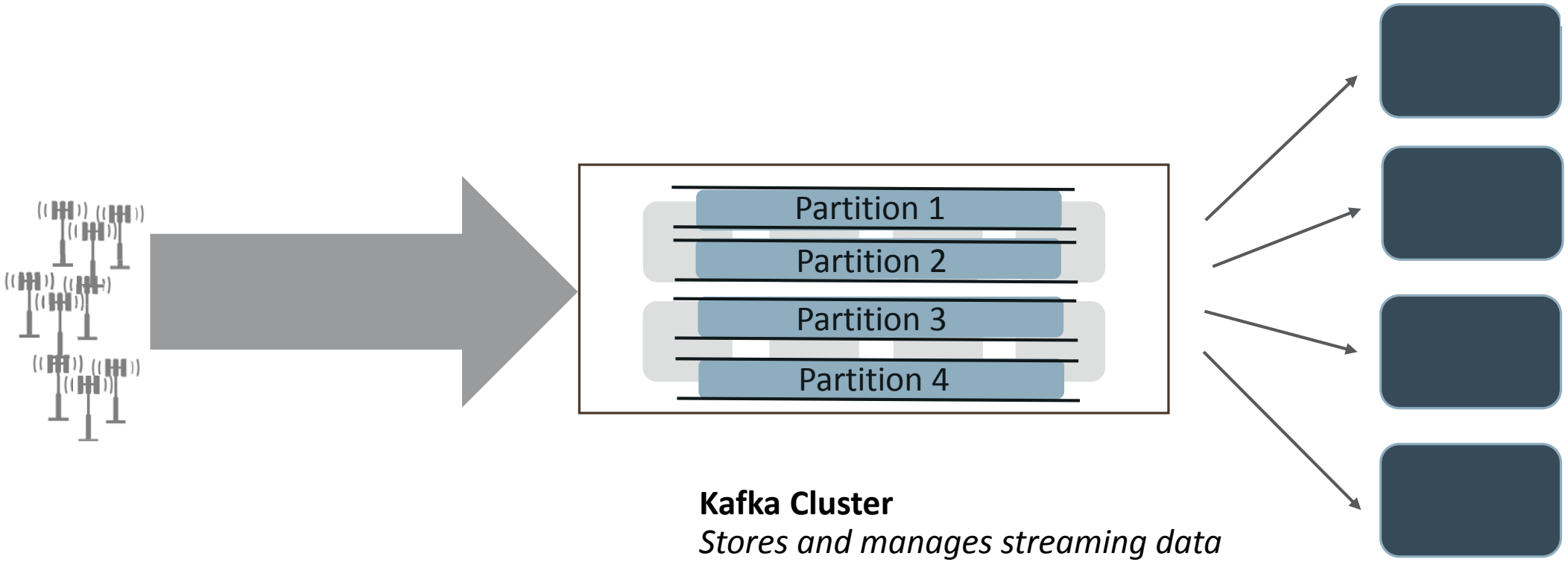
Kafka Topic Partitions



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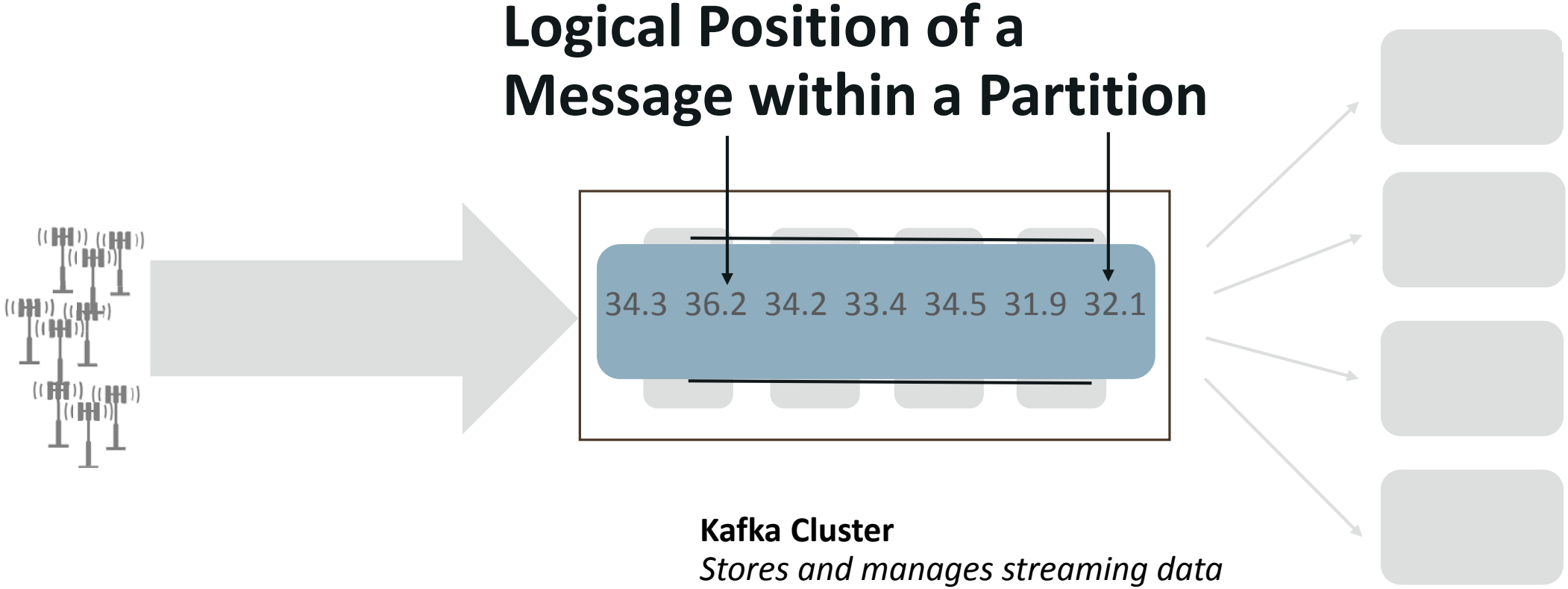
Kafka Topic Partition Offsets



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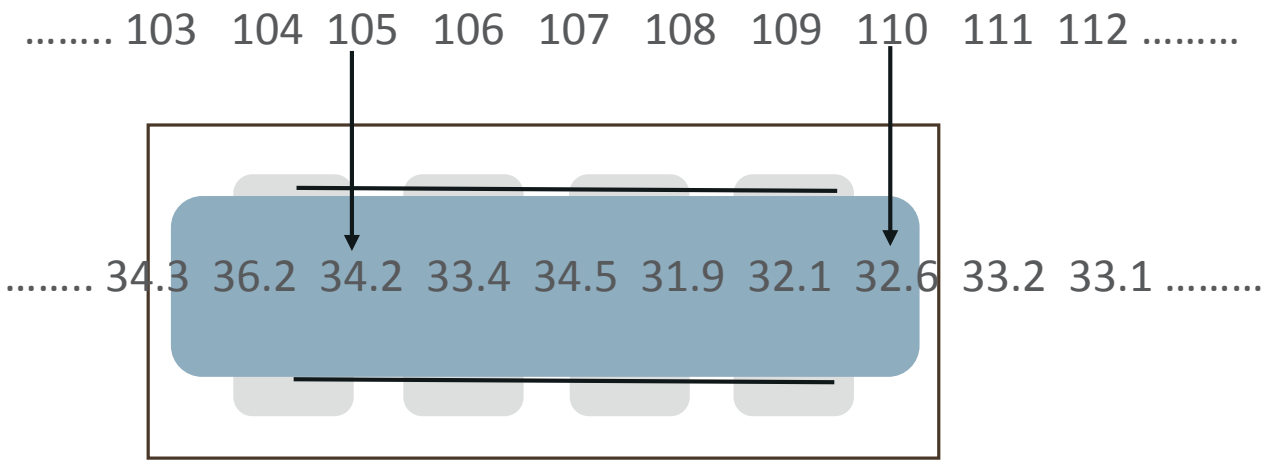
Logical Position (Offset) Maps to Sequence Numbers



- Offset uniquely identifies a message
- Consumers can read from an Offset
- Starting offset is 0
  (at the beginning of a topic)

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Using Data from Kafka Topics

- Kafka Consumer application
- Kafka Streams API
- Stream Kafka topic data into HDFS/Object store/databases using Kafka connectors
- KSQL: Streaming SQL engine for real-time data processing of Kafka topics

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Kafka Consumer Example

With Automatic Offset Commits

```
Properties props = new Properties();
props.put("bootstrap.servers", "localhost:9092");
props.put("group.id", "test");
props.put("enable.auto.commit", "true");
props.put("auto.commit.interval.ms", "1000");
props.put("key.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
props.put("value.deserializer", "org.apache.kafka.common.serialization.StringDeserializer");
KafkaConsumer<String, String> consumer = new KafkaConsumer<>(props);
consumer.subscribe(Arrays.asList("foo", "bar"));
while (true) {
    ConsumerRecords<String, String> records = consumer.poll(100);
    for (ConsumerRecord<String, String> record : records)
        System.out.printf("offset = %d, key = %s, value = %s%n", record.offset(), record.key(), record.value());
}
```

From: https://kafka.apache.org/0101/javadoc/index.html?org/apache/kafka/clients/consumer/KafkaConsumer.html

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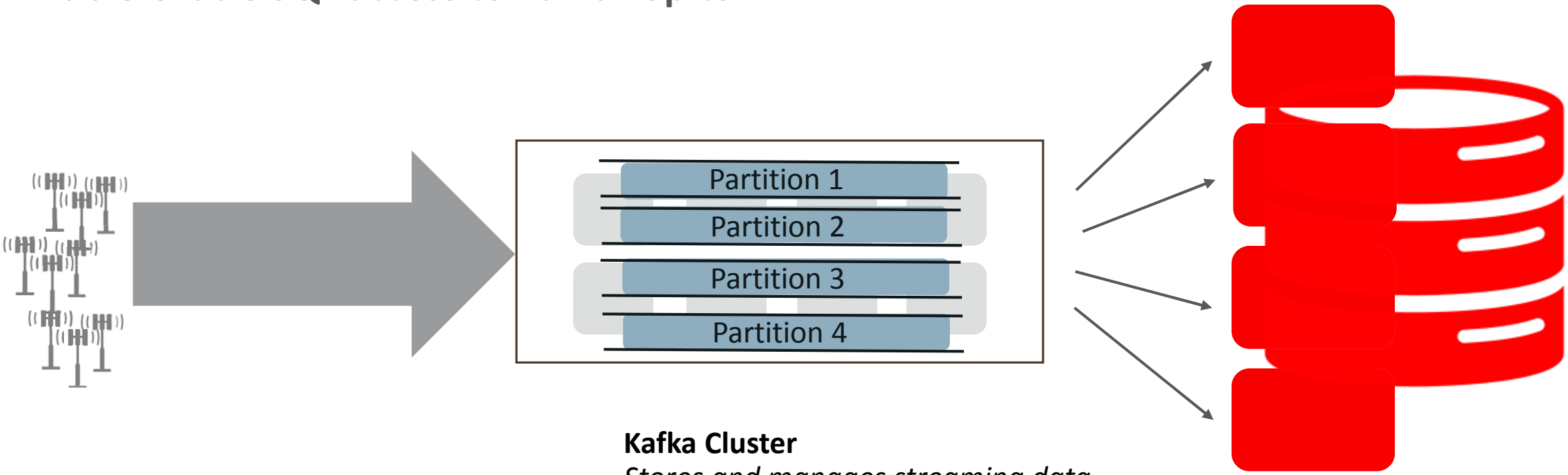
Oracle Database as a Kafka Consumer

Enable Oracle SQL access to Kafka Topics



Producers
Entities producing streaming data

Kafka Cluster
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Oracle Database
External tables and views

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Oracle SQL and Kafka

1. Integrate Kafka messages with Oracle Database applications

2. Enrich Kafka data with Oracle Database table data
   - Feed enriched topics back to Kafka

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1. Integrate Kafka with Database Applications

- Query Kafka messages
  - Integrate and analyze with Oracle Database data
  - Use the full richness of Oracle SQL
- Join data in a Kafka time interval with an Oracle Database table
- Load into Oracle Database table using Oracle SQL

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2. Enrich Kafka Data with Oracle Database Table Data

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SQL Connector for Kafka

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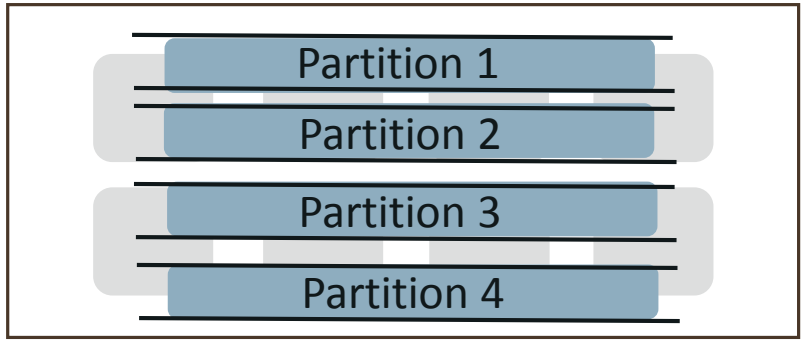
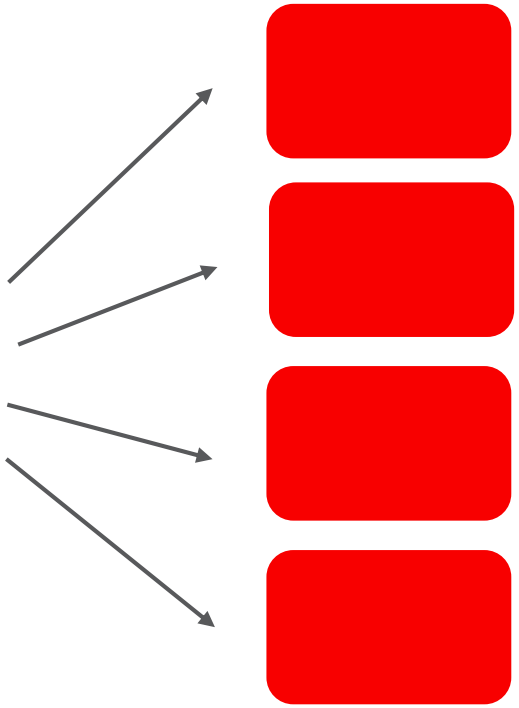
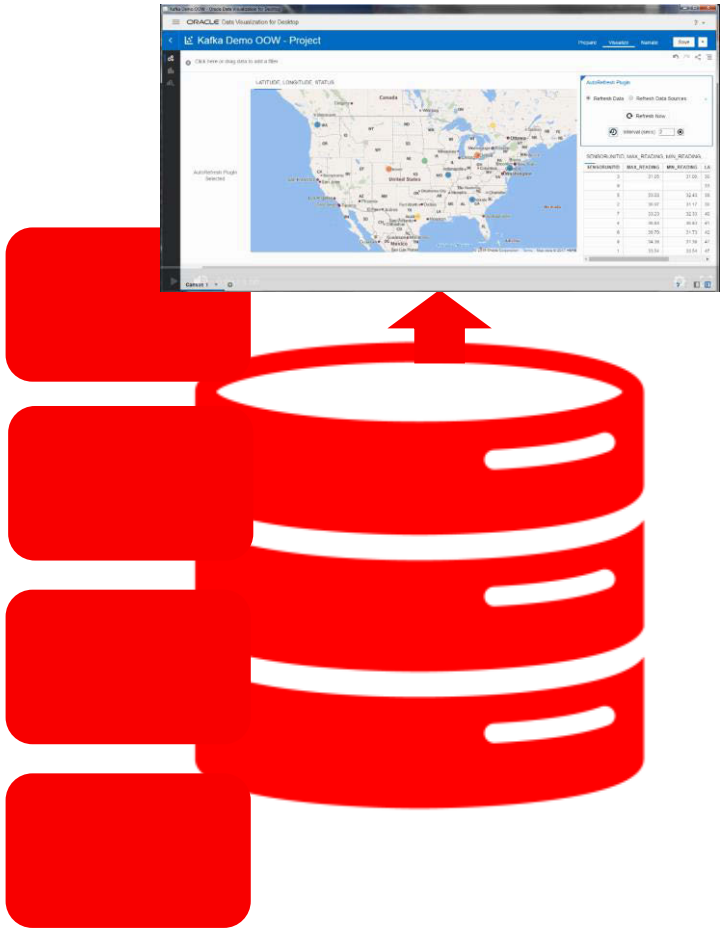
Apache Kafka + Oracle Database







Kafka Cluster

External tables

Views on the external tables

Database applications query views to access Kafka messages

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Database Objects

- Views over Kafka Topics

```
Name                    Null?    Type
------------------- -------- -------------
KAFKA$PARTITION              NUMBER(38)
KAFKA$OFFSET                 NUMBER(38)
KAFKA$TIMESTAMP              NUMBER(38)
MSGNUMBER                    NUMBER
MSGTIMESTAMP                 TIMESTAMP(6)
SENSORTYPEID                 NUMBER
SENSORUNITID                 NUMBER
TEMPERATURESETTING           NUMBER(6,3)
TEMPERATUREREADING           NUMBER(6,3)
```

- Views are created per Topic
- There can be multiple sets of views per Topic: One set per application (Consumer Group)

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Database Objects

- Metadata tables
  - DBMS_KAFKA_CLUSTER
  - DBMS_KAFKA_PARTITION
  - DBMS_KAFKA_LOAD_METRICS
  - DBMS_KAFKA_APPLICATION

- Message schema table

```
Name                   Null?    Type
-------------------- -------- -------------
MSGNUMBER            NOT NULL NUMBER(38)
MSGTIMESTAMP                  TIMESTAMP(6)
SENSORTYPEID                  NUMBER(38)
SENSORUNITID                  NUMBER(38)
TEMPERATURESETTING            NUMBER(6,3)
TEMPERATUREREADING            NUMBER(6,3)
```

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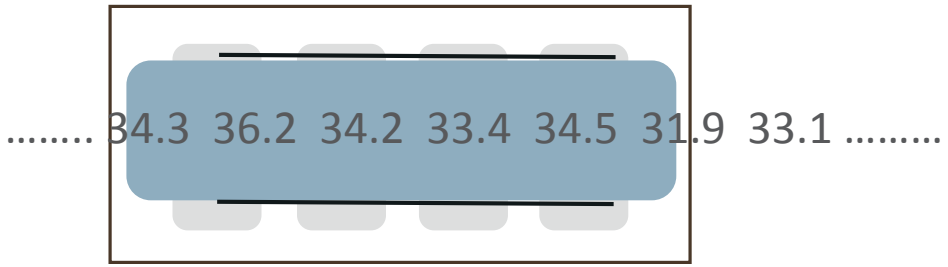
Query Streaming Data with a View

No Need to Persist or Stage Data in a Table




```
Name                    Null?    Type
 ------------------- -------- -------------
 KAFKA$PARTITION              NUMBER(38)
 KAFKA$OFFSET                 NUMBER(38)
 KAFKA$TIMESTAMP              NUMBER(38)
 MSGNUMBER                    NUMBER
 MSGTIMESTAMP                 TIMESTAMP(6)
 SENSORTYPEID                 NUMBER
 SENSORUNITID                 NUMBER
 TEMPERATURESETTING           NUMBER(6,3)
 TEMPERATUREREADING           NUMBER(6,3)
```

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Join Kafka Topic View with Oracle Database Table

```
Name                   Null?    Type
------------------- -------- -------------
KAFKA$PARTITION             NUMBER(38)
KAFKA$OFFSET                NUMBER(38)
KAFKA$TIMESTAMP             NUMBER(38)
MSGNUMBER                   NUMBER
MSGTIMESTAMP                TIMESTAMP(6)
SENSORTYPEID                NUMBER
SENSORUNITID                NUMBER
TEMPERATURESETTING          NUMBER(6,3)
TEMPERATUREREADING          NUMBER(6,3)
```

View on Kafka Topics

```
Name                   Null?    Type
------------------- -------- -------------
SENSORUNITID        NOT NULL NUMBER(38)
LATITUDE                     NUMBER
LONGITUDE                    NUMBER
CITY                         VARCHAR2(30)
```

Database table

Find cities where the temperature fluctuation is more than normal

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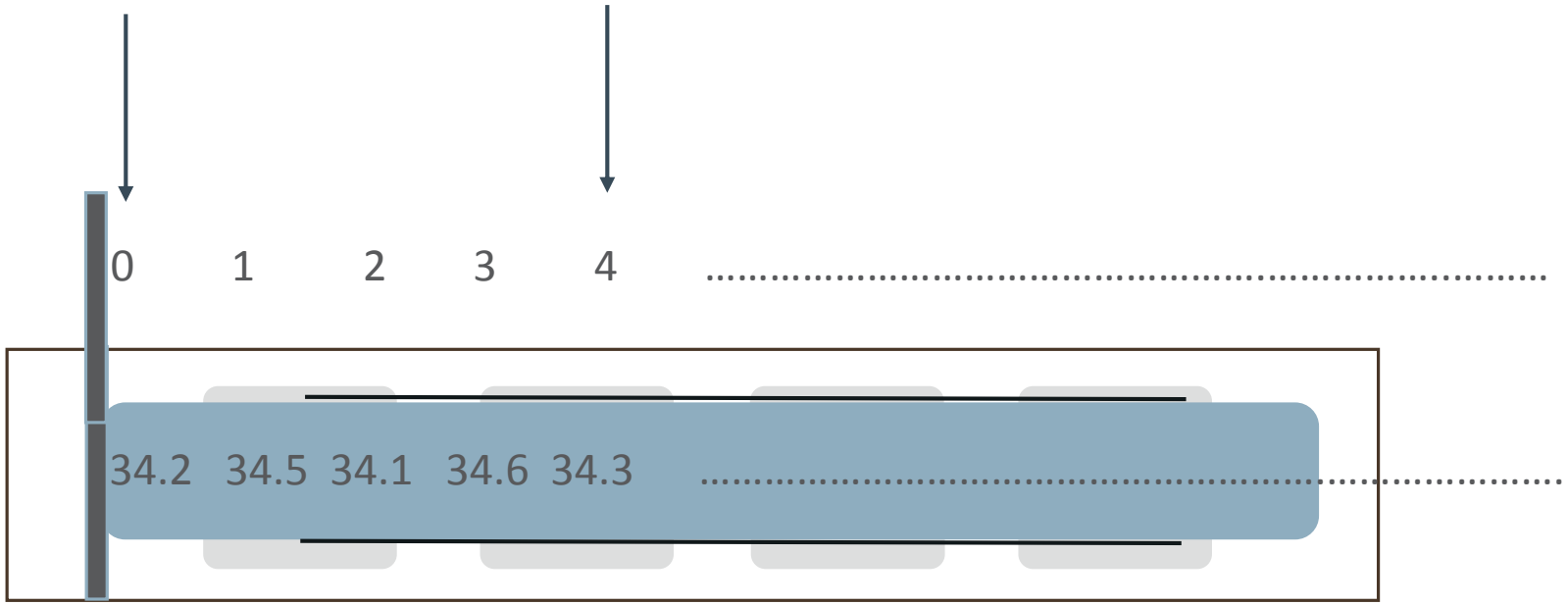
Offset Management



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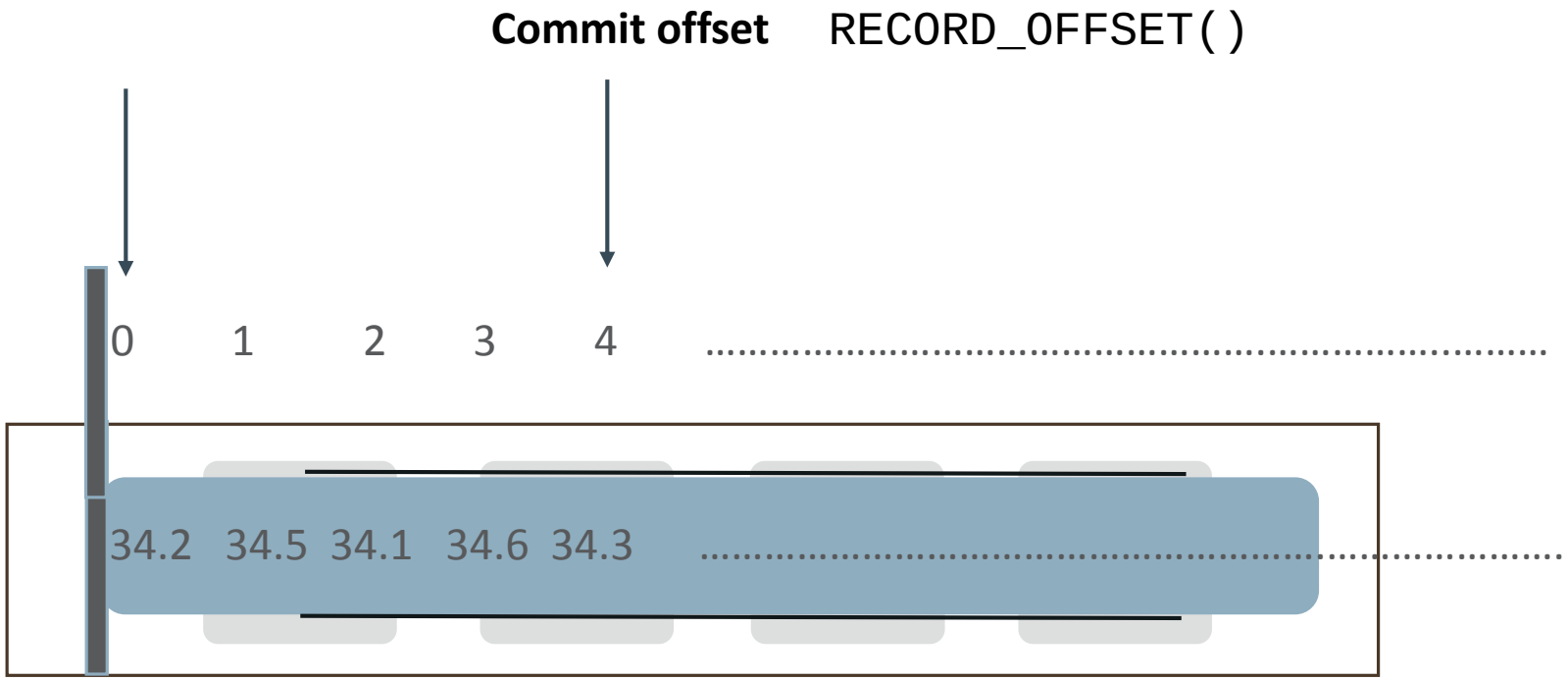
Offset Management



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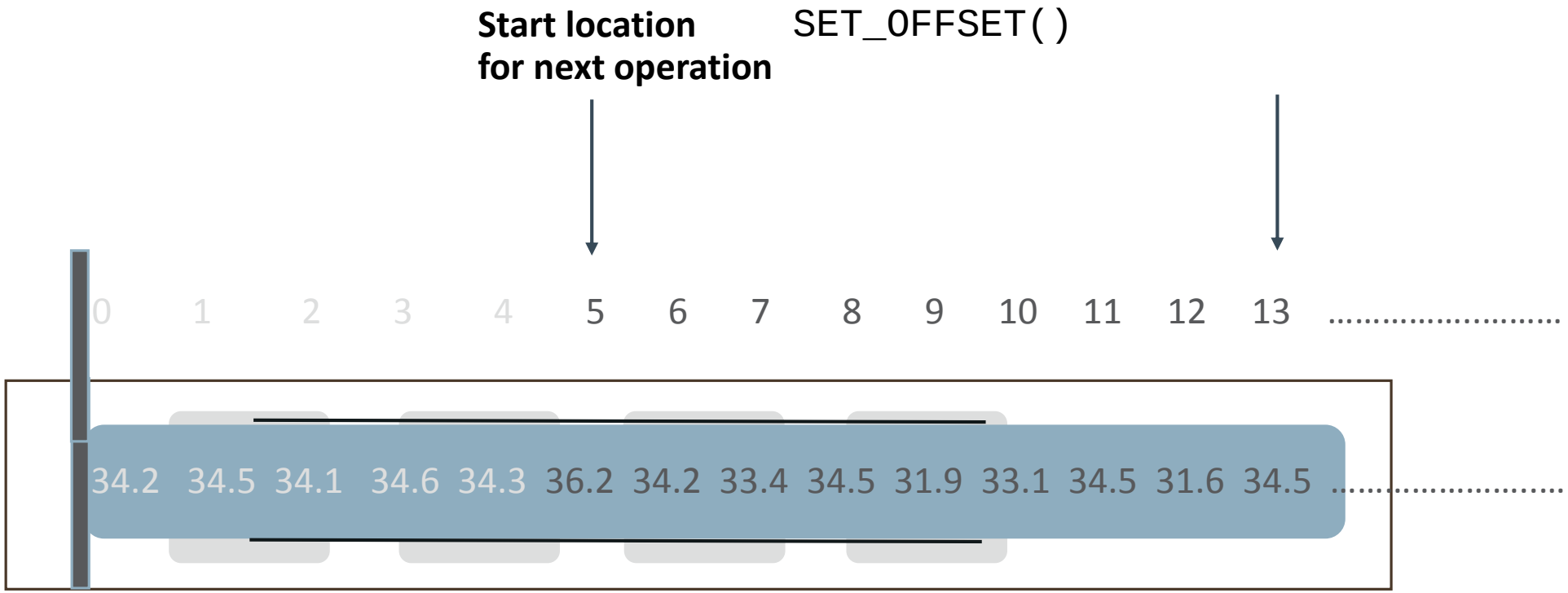
Offset Management



Offsets of each Consumer Group application are managed independently

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SQL Syntax Examples

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1. REGISTER_CLUSTER

```
SQL> BEGIN
          dbms_kafka.register_cluster(‘SENS2',
          ‘<Zookeeper URL>:2181',
          ‘<Kafka broker URL>:9092',
          'DBMSKAFKA_DEFAULT_DIR',
          'DBMSKAFKA_LOCATION_DIR‘
          'Testing DBMS_KAFKA');
     END;
```

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2. Create Views

```
DECLARE
  views_created INTEGER;
  view_prefix   VARCHAR2(128);
BEGIN
 DBMS_KAFKA.CREATE_KAFKA_VIEWS(‘SENS2',
‘MONITORAPP', ‘sensor2', ‘sensor_messages_shape‘,
views_created, view_prefix);
END;
/
```

One view per partition

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3. Query with Oracle SQL

```
SQL> select count(*) from KV_SENS2_MONITORAPP_SENSOR2_0;

SQL> select timestamp, sensorunitid, temperaturereading
from KV_SENS2_MONITORAPP_SENSOR2_0;
```

	TIMESTAMP	SENSORUNITID	TEMPERATUREREADING
1	19-OCT-18 11.07.40.545000000 AM US/EASTERN	7	32.893
2	19-OCT-18 11.07.40.545000000 AM US/EASTERN	5	33.826
3	19-OCT-18 11.07.40.545000000 AM US/EASTERN	0	31.025
4	19-OCT-18 11.07.40.545000000 AM US/EASTERN	1	33.771
5	19-OCT-18 11.07.40.545000000 AM US/EASTERN	5	33.159
6	19-OCT-18 11.07.40.545000000 AM US/EASTERN	3	32.645
7	19-OCT-18 11.07.40.545000000 AM US/EASTERN	6	36.065
8	19-OCT-18 11.07.40.545000000 AM US/EASTERN	2	32.095
9	19-OCT-18 11.07.40.545000000 AM US/EASTERN	6	31.5
10	19-OCT-18 11.07.40.545000000 AM US/EASTERN	9	34.972
11	19-OCT-18 11.07.30.544000000 AM US/EASTERN	0	32.32
12	19-OCT-18 11.07.30.544000000 AM US/EASTERN	1	31.83
13	19-OCT-18 11.07.30.544000000 AM US/EASTERN	1	32.093

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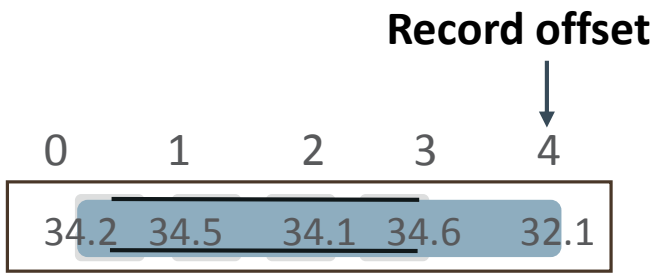
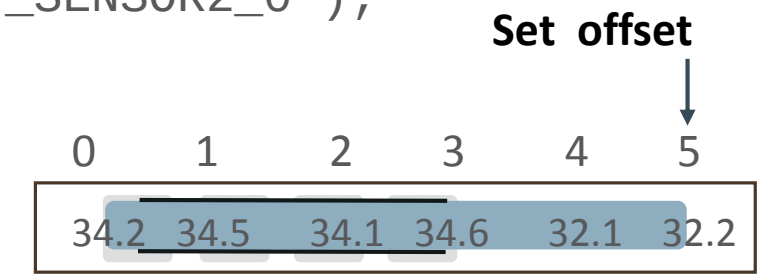
Record Offset and Set Offset

```
SQL> execute dbms_kafka.record_offset('KV_SENS2_MONITORAPP_SENSOR2_0');
```




```
SQL> execute dbms_kafka.set_offset('KV_SENS2_MONITORAPP_SENSOR2_0');
```



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Loading into Oracle Database

```
DECLARE
  rows_loaded number;
BEGIN

dbms_kafka.load_table('SENS2','LOADAPP','sensor2','sensor_m
essages_shape',rows_loaded);
   dbms_output.put_line('rows loaded: ' || rows_loaded);
END;
/
```

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Performance and Scale

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Scaling in Kafka

- Increase number of Partitions

- Increase Consumer instances

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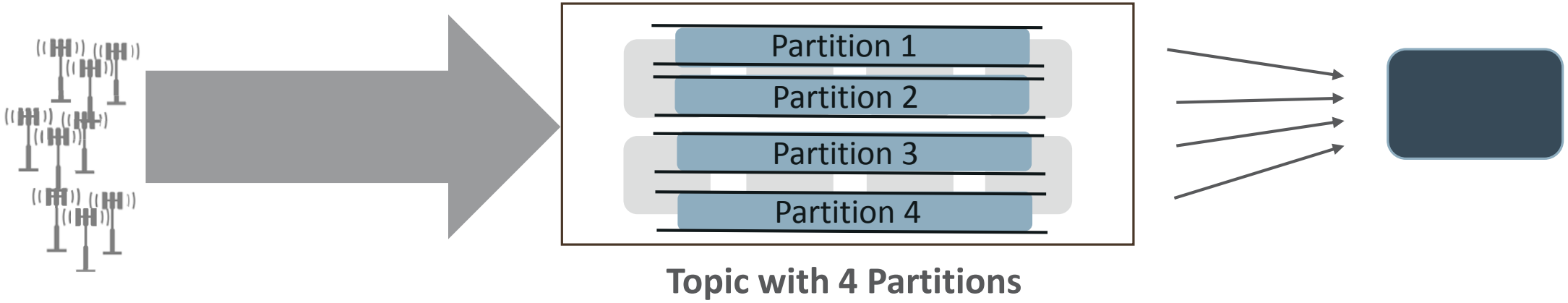
Kafka Consumer Groups

One Consumer reads from all Partitions



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Entities producing streaming data

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Consumers
Applications that read and process messages

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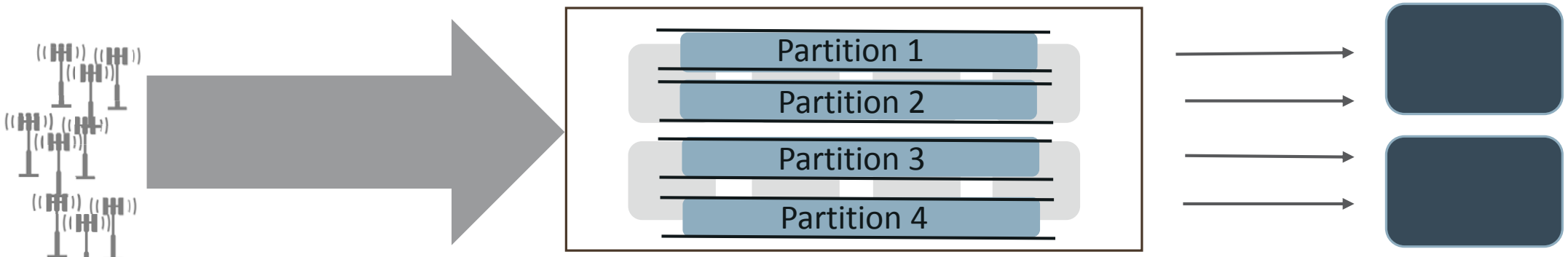
Kafka Consumer Groups

One Consumer reads from two Partitions



Topic with 4 Partitions

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Entities producing streaming data

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Consumers
Applications that read and process messages

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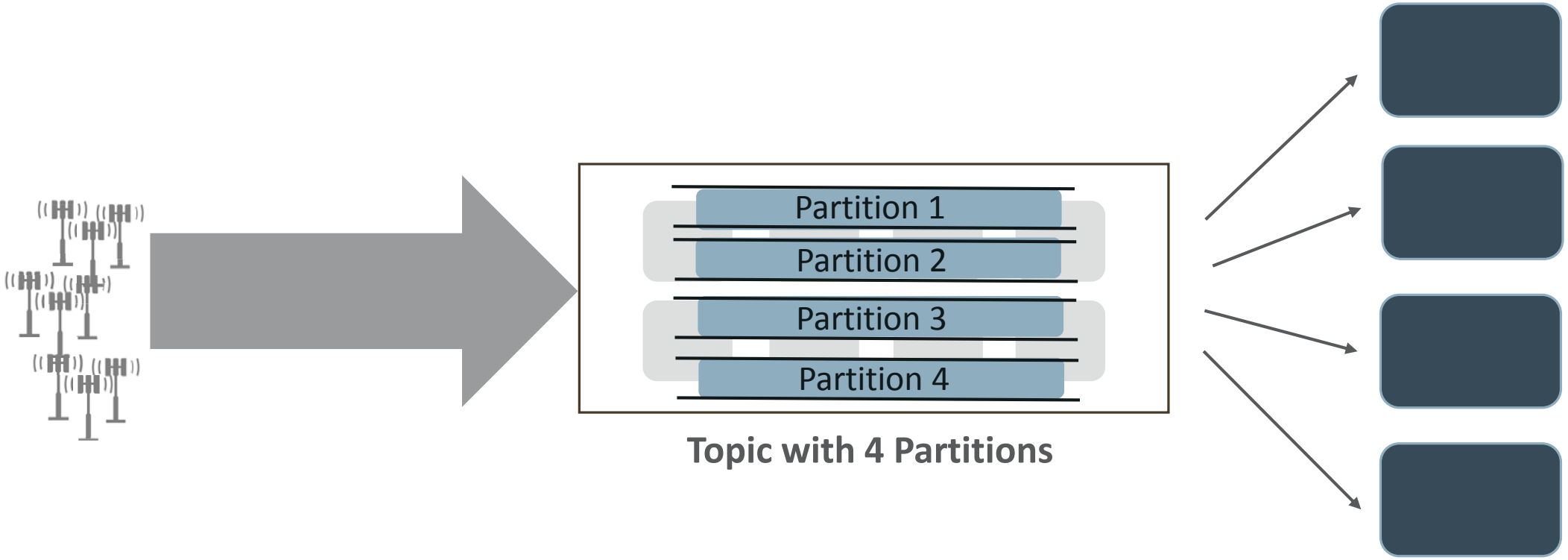
Kafka Consumer Groups

One Consumer per Partition



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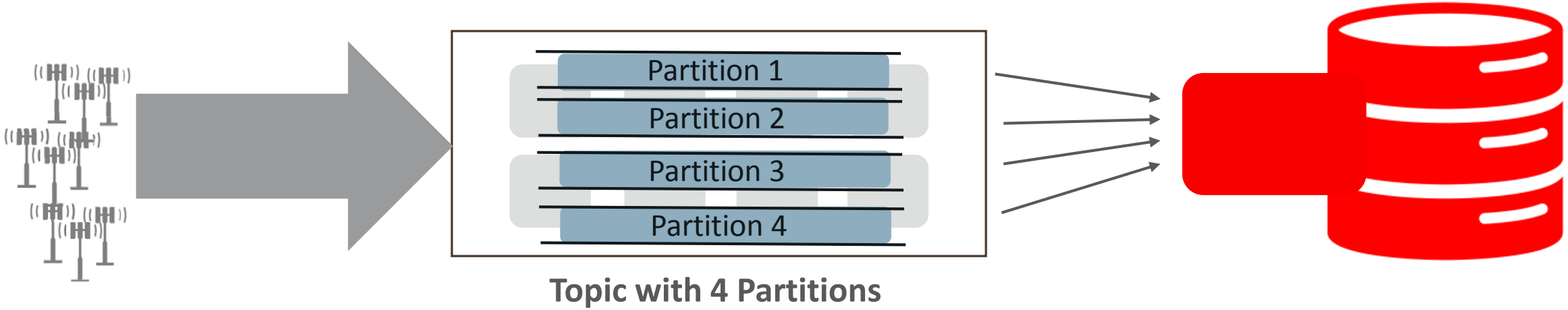
Kafka Consumer Groups

One view reads from all Partitions



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Kafka Cluster
Stores and manages streaming data in a distributed, replicated, fault-tolerant cluster

Database views

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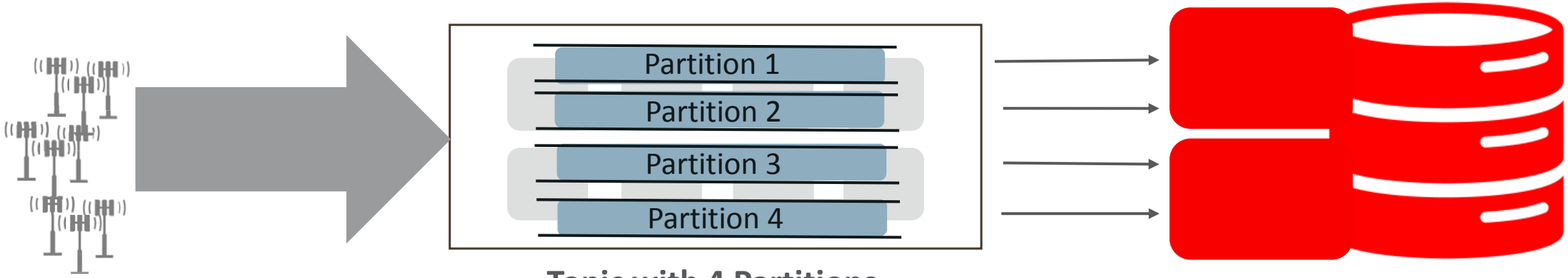
Kafka Consumer Groups

Each view reads from two Partitions



Topic with 4 Partitions

Producers
Entities producing streaming data

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Database views

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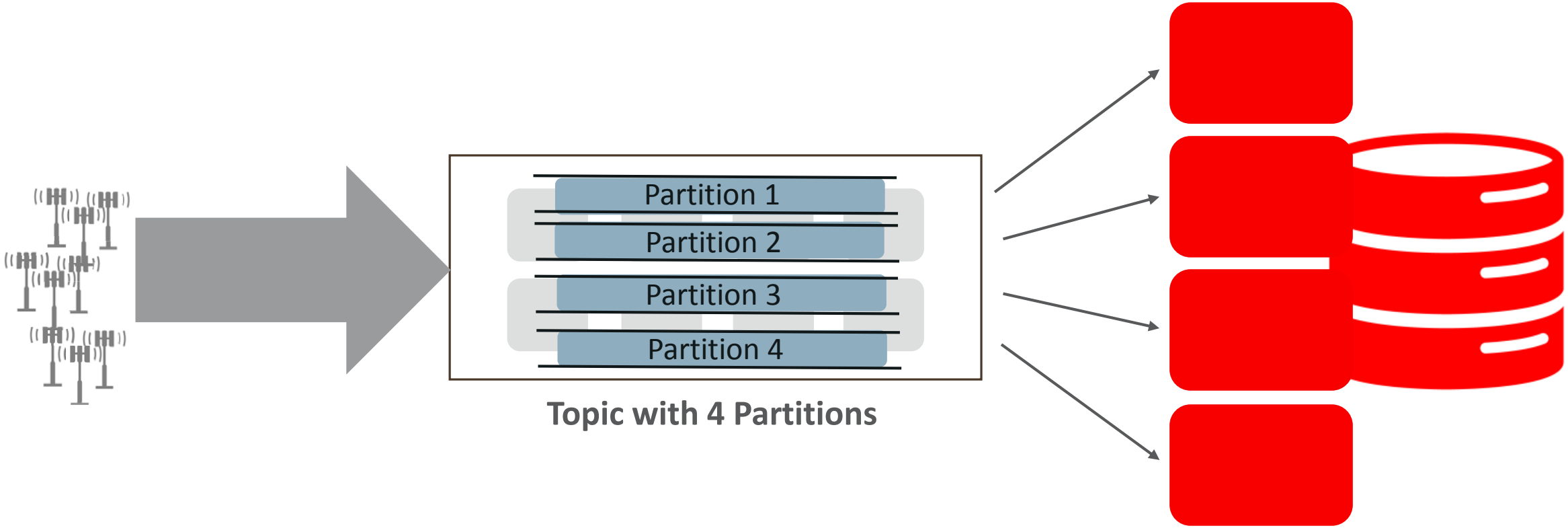
Kafka Consumer Groups

Four views, one per Partition



Producers
Entities producing streaming data

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Database views

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Kafka Partitions and Database Views

- Number of views can be 1……<*total number of partitions*>
- Scale by increasing the number of views

- Can have multiple sets of views for the same Topic
  - A set of views is a ‘Consumer Group’
  - **Offsets for each Consumer Group managed independently**

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Factors that Impact Performance

- Degree of parallelism in the database
- Network bandwidth
  - Between Kafka brokers and database system

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Kafka and Oracle Products and Cloud Services

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Oracle Big Data SQL

Kafka Cluster

Hadoop Cluster with Apache Hive

Big Data SQL external table

Shipping since 2017

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Query Hive table from Oracle Database

Hive table reads from Kafka

```
CREATE TABLE TRAFFIC_JSON_TAB
(
  ID VARCHAR2(256),
  CLIENTID VARCHAR2(256),
  …),
  EVENTTIMEASSTRING VARCHAR2(256),
  SENDER VARCHAR2(256),
  TYPE VARCHAR2(256),
  PROPERTIES VARCHAR2(256),
  DIRECTION VARCHAR2(256),
  RECEIVEDTIME NUMBER(38,0),
  RECEIVEDTIMEASSTRING VARCHAR2(256),
  PAYLOAD VARCHAR2(4000)
)
ORGANIZATION EXTERNAL
(
  TYPE ORACLE_HIVE DEFAULT DIRECTORY DEFAULT_DIR
  ACCESS PARAMETERS
  (
    com.oracle.bigdata.cluster=bigdatalite
    com.oracle.bigdata.tablename=oracletest.traffic_json_tab
  )
)
```

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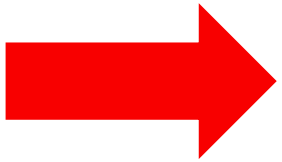
Oracle Event Hub Cloud Service



Enterprise Kafka features in Event Hub

- Scalable and highly available
- Messaging/Event broker
- Security
- Schema registry
- Connectors:
  object storage, databases, other external systems

Access from Database Cloud Service via Database views

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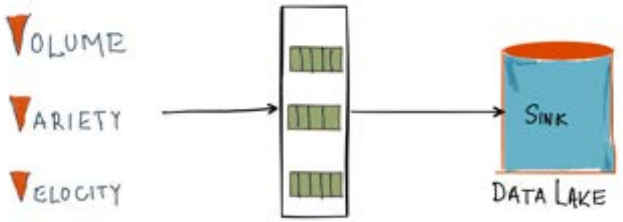
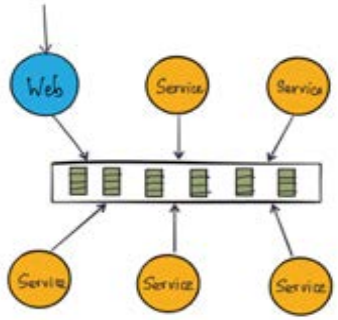
Oracle Event Hub Cloud Service Use Cases

Single Infra for Data Movement, Application Messaging, Events Broker, Stream Analytics

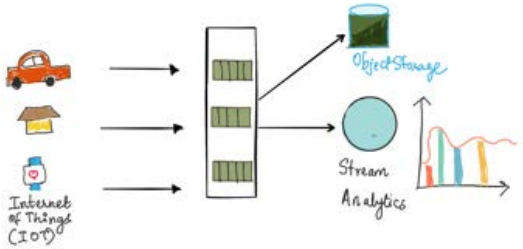
Kafka Use cases	Oracle PaaS Service Add-Ons
Data Movement into data lakes (Firehose) and DB Change propagation (Kafka Connect)	Big Data Cloud
Application messaging for Microservices; replacement for JMS; Events Broker (Kafka Connect, Kafka Streams)	Integration Cloud
Event Processing & Analytics (Kafka Streams and KSQL)	Streaming Analytics
IoT Events and Logs transport (Kafka Produce/Consume, Kafka Connect)	Mobile Cloud



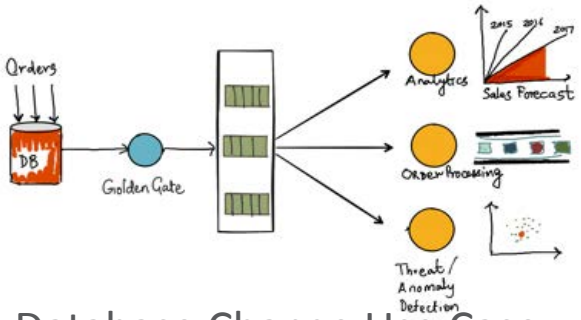
Data Lake Firehose



Application Messaging



IoT Use Case



Database Change Use Case

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Roadmap

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Planned Release Roadmap

- Addition to Big Data Connectors product suite
- BYOL for Cloud deployments
  - Note: Big Data Connectors are included in Big Data Cloud Service and Big Data Cloud@Customer

- Cloud Managed Services
  - Autonomous Data Warehouse Cloud Service (ADWCS)

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Peek into Planned Functionality Roadmap

- Support Kafka Streams
  - Enrich Kafka Topics using Oracle SQL and database tables

- Retrieval based on timestamp information

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Q/A

melliyal.Annamalai@oracle.com

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