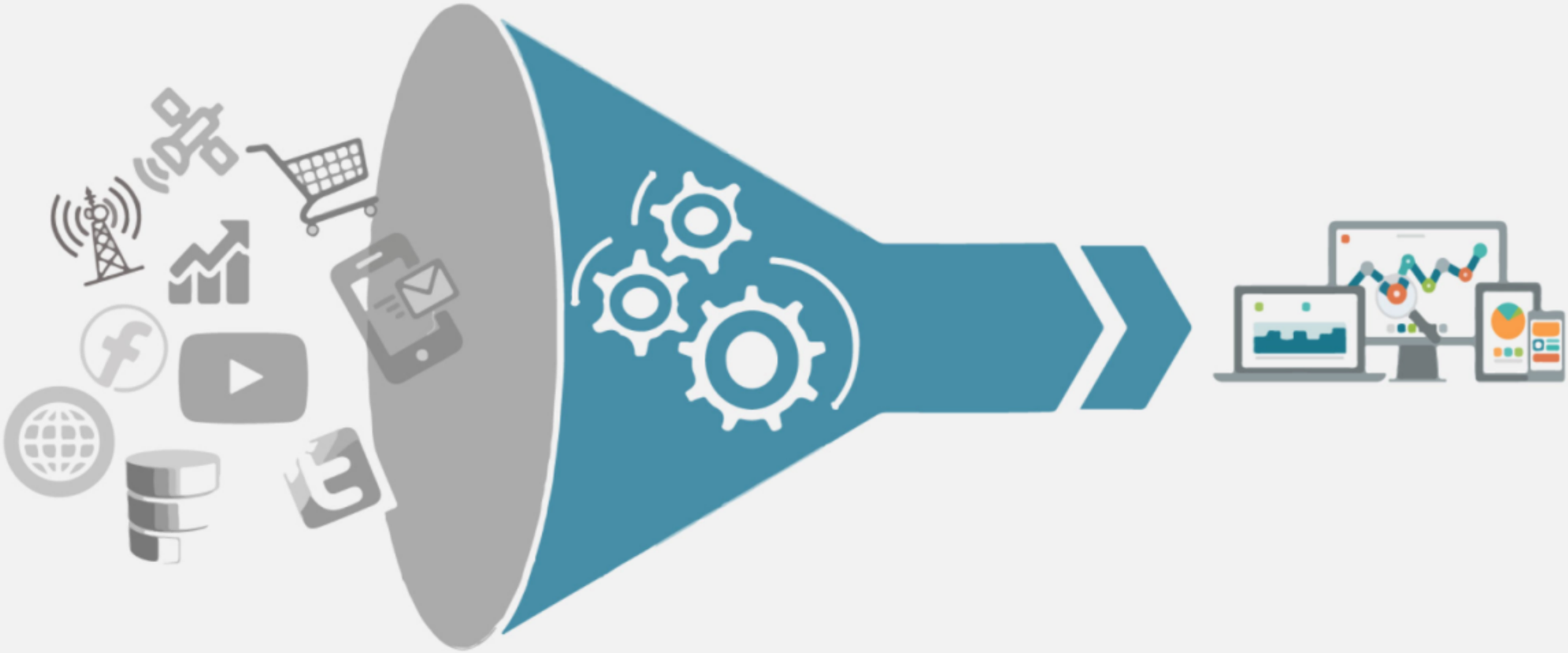

2110446 - Data Science and Data Engineering

Data Ingestion

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CHULA ENGINEERING
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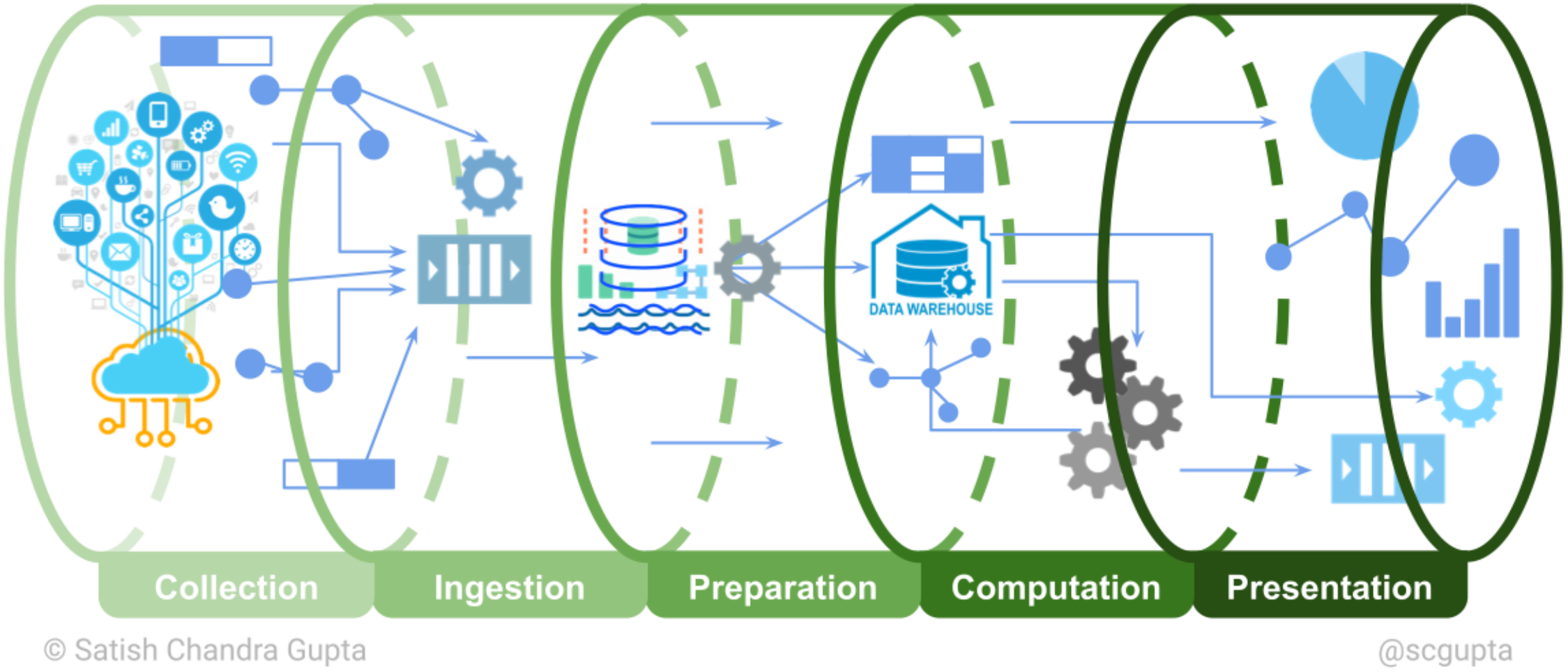
Data Pipeline Value Chain



Source: https://towardsdatascience.com/scalable-efficient-big-data-analytics-machine-learning-pipeline-architecture-on-cloud-4d59efc092b5

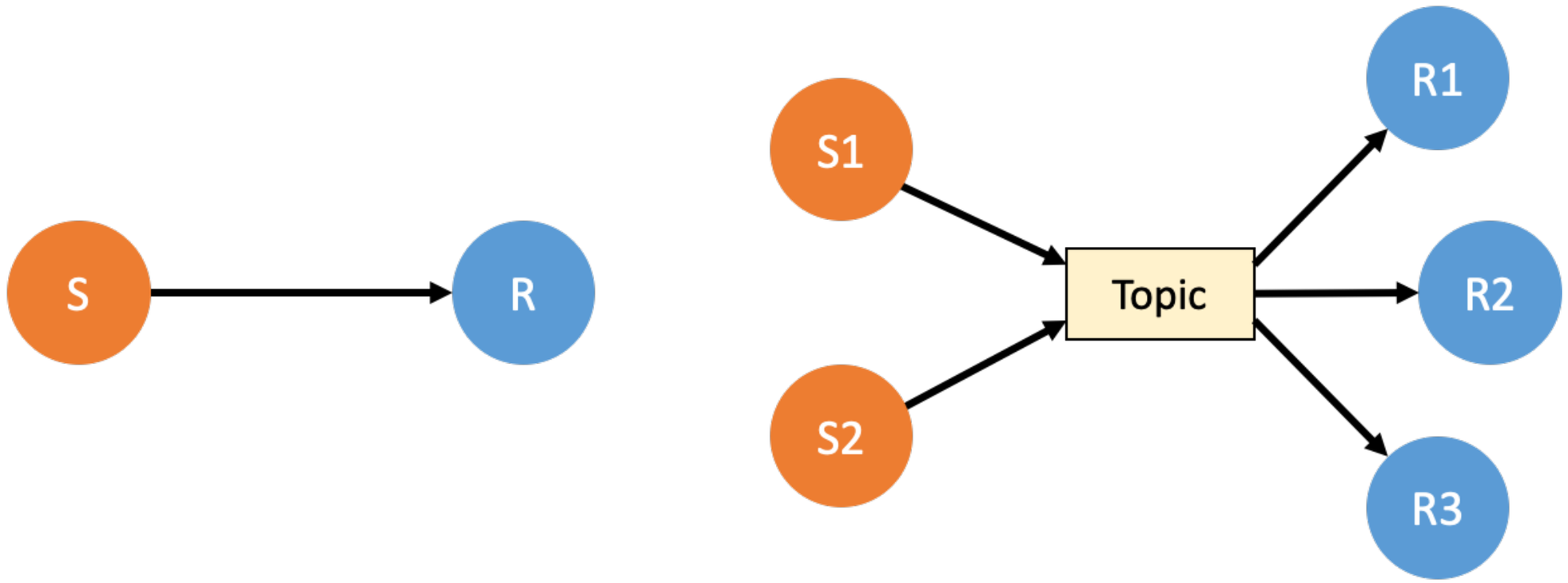
The Tales of Smart Meters

- Devices to measure power consumption
- Data is gathered every 15 minutes
- There are about 20m households in Thailand
- On the average = 22,222 events/ secs
- Assume 1k data each event (power consumption, temperature, etc.)
- Total data = 80GB/hr. or 1.92 TB/ day or > 700TB/year

Data Collection and Data Ingestion Requirements

- Variety of data sources and destinations
- Complex data flow e.g. multiple data sources, multiple destinations, etc.
- Reliable data transfer
- In-flight data processing e.g. data cleansing, data standardization, data fusion
- Scalability and fault tolerance

Modes of Data Transfer



(a) Point-to-point

(b) Publish-subscribe

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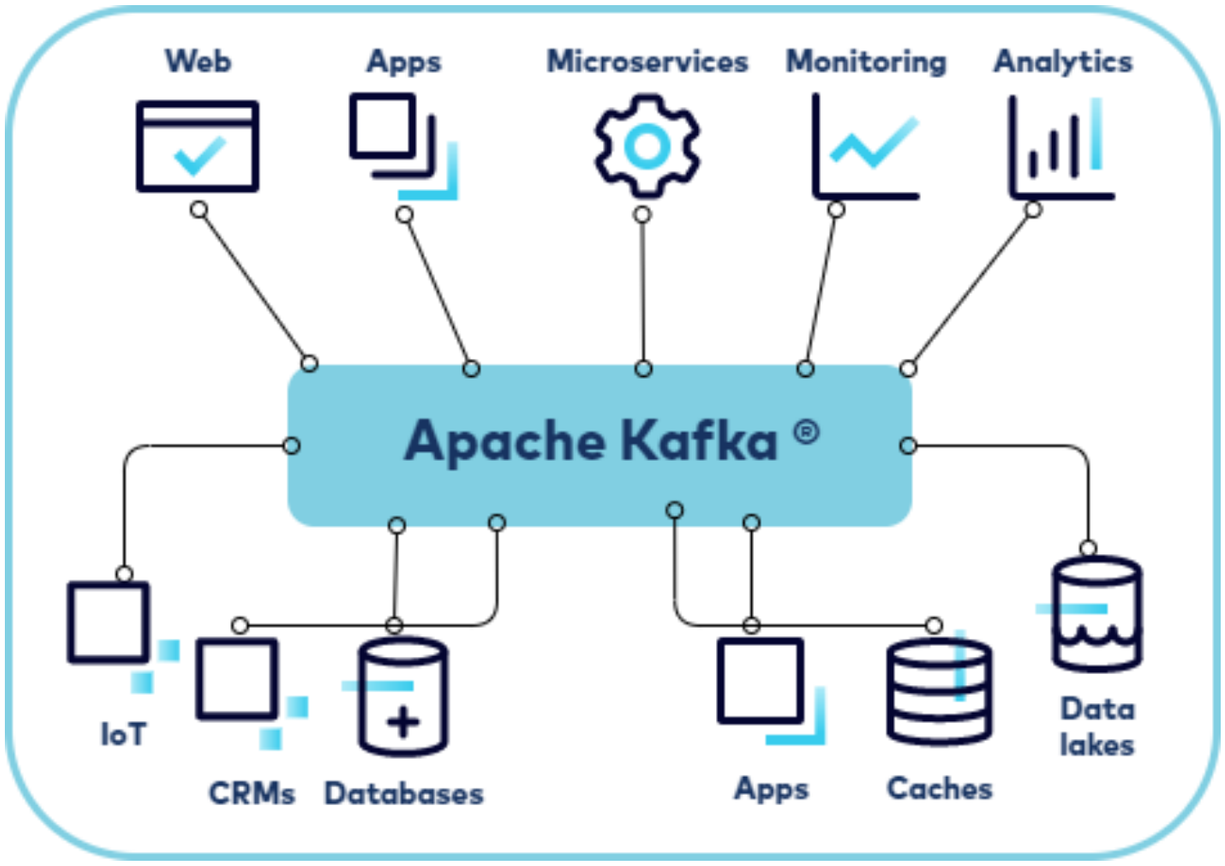
Introduction to Apache Kafka

Data Ingestion

Apache Kafka

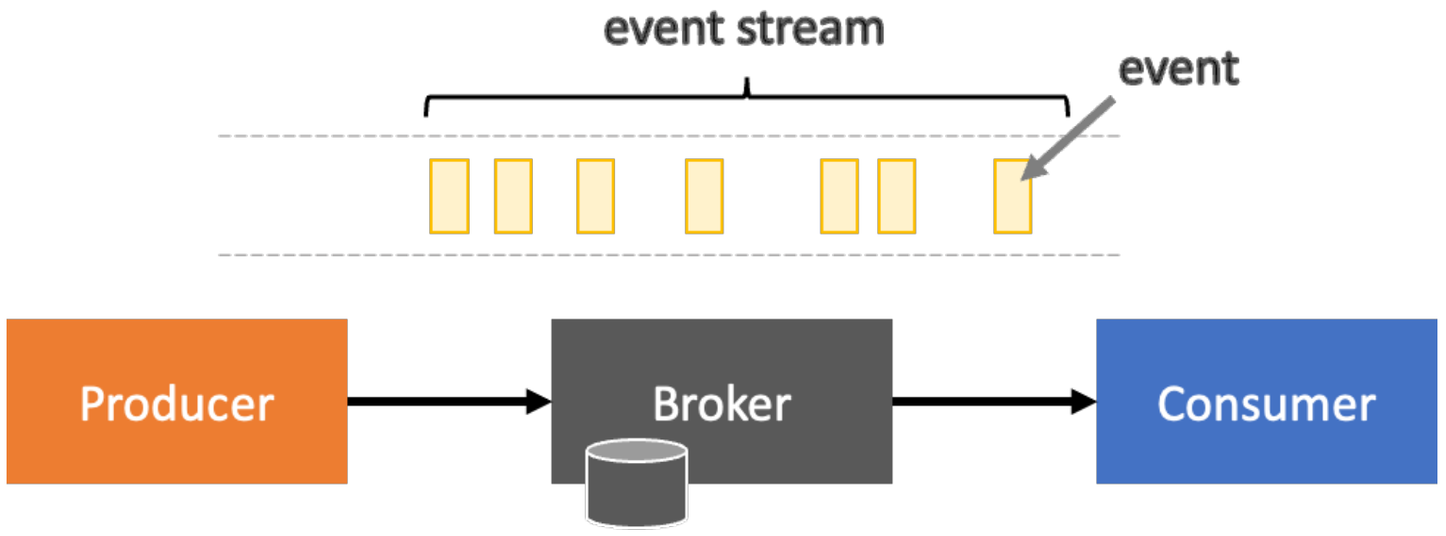
- Popular event stream processing from LinkedIn
- Real-time, reliable data delivery, highly scalable, and fault tolerance
- Being used in many large companies (LinkedIn, Grab, Line, Agoda, Netflix, Airbnb, Paypal, Tencent, Spotify)

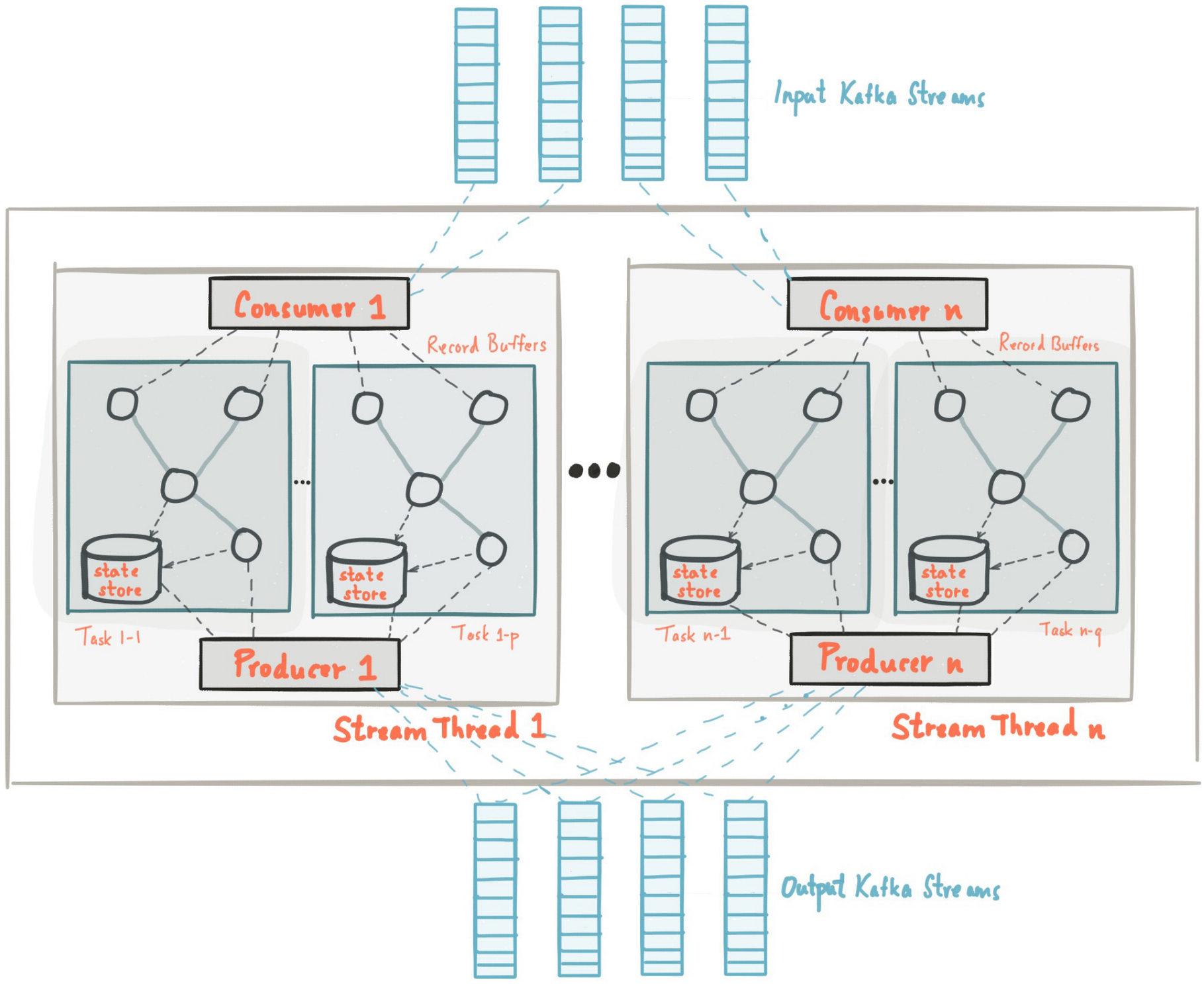


Source: https://docs.confluent.io/kafka/introduction.html

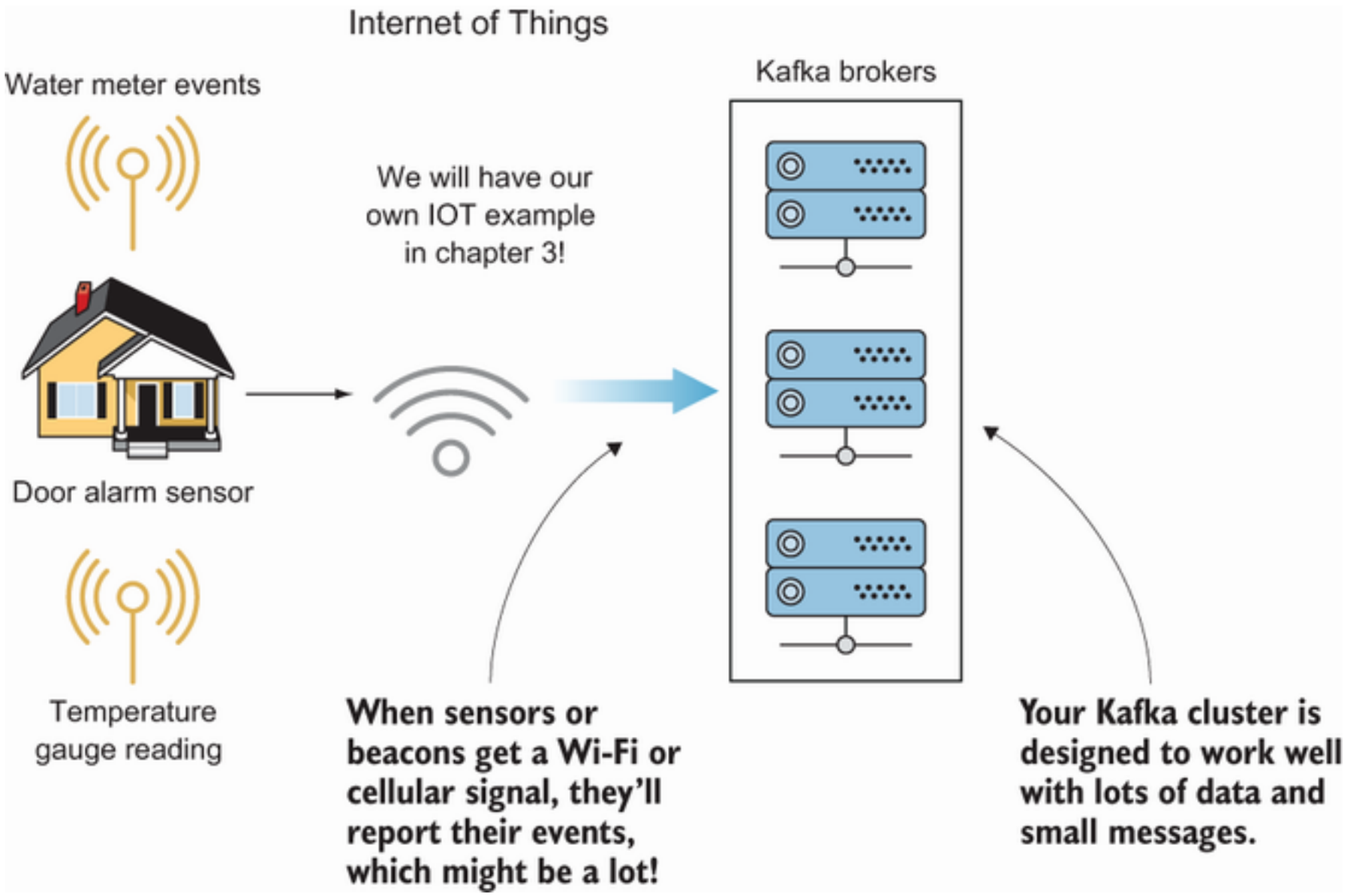
Apache Kafka's Main Capabilities

- Reading and writing records like a message queue
- Storing records with fault tolerance
- Processing streams as they occur




Input Kafka Streams
Consumer 1
Consumer n
Record Buffers
Record Buffers
state store
state store
state store
state store
Task 1-1
Task 1-p
Task n-1
Task n-q
Producer 1
Producer n
Stream Thread 1
Stream Thread n
Output Kafka Streams

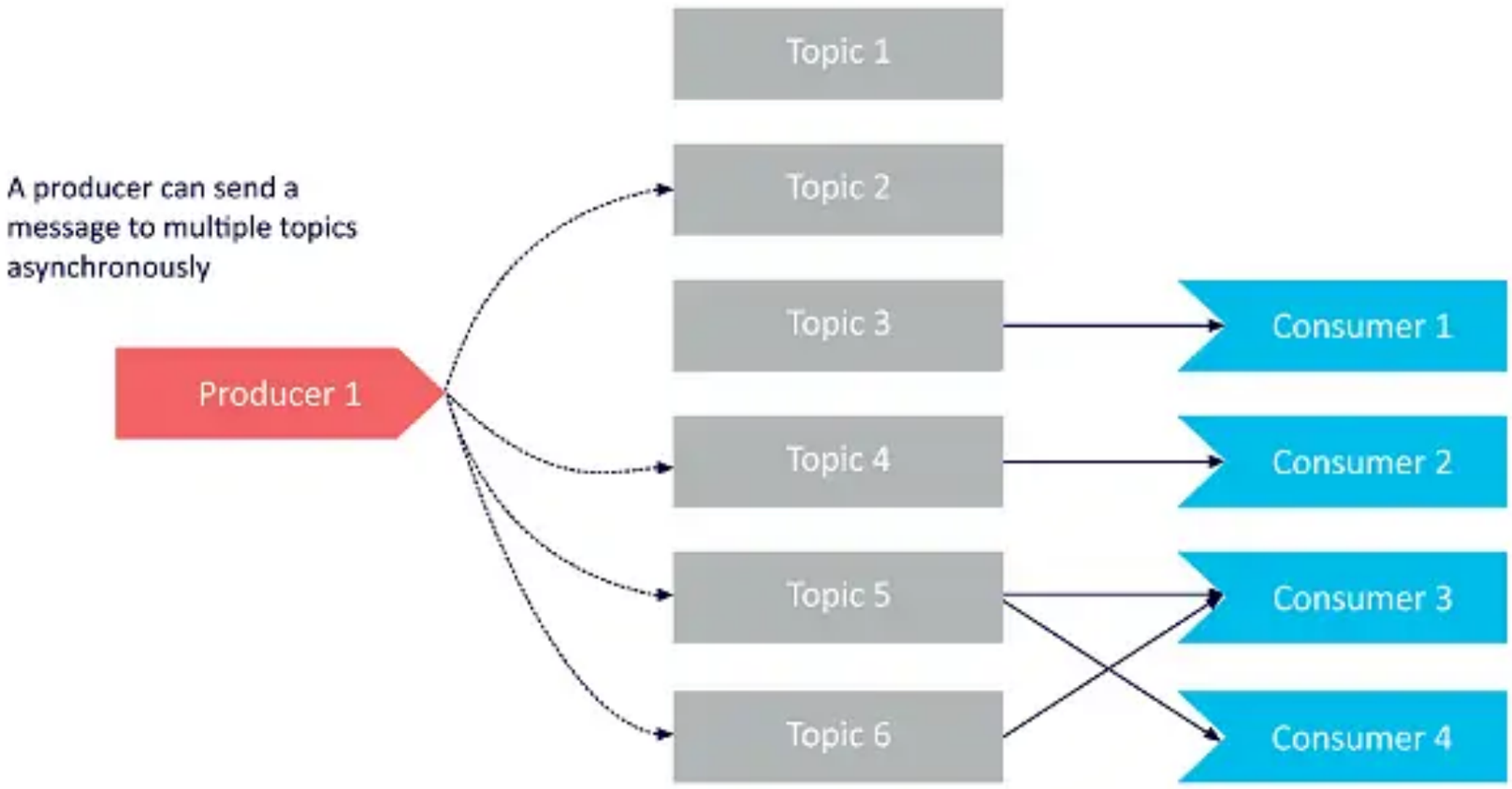
Kafka Example Use Case



Source: Scott, Dylan, Viktor Gamov, and Dave Klein. *Kafka in Action*. Simon and Schuster, 2022.

Kafka Basic Concept

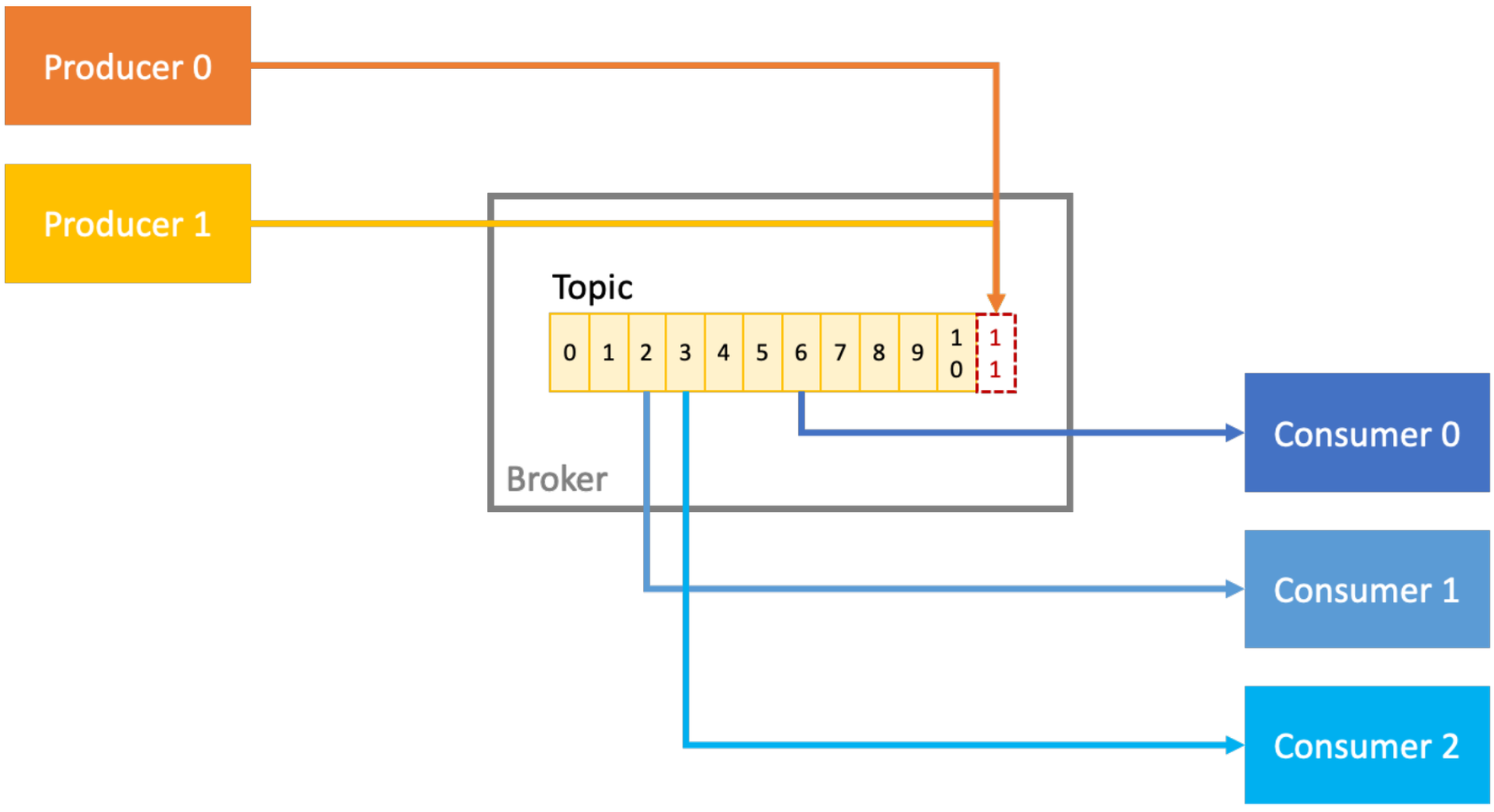
Source: https://www.instaclustr.com/blog/apache-kafka-architecture/



Kafka Topic

- Events or “records” are stored in topics
- Topic allows multi-producer and multi-consumer
- A consumer keeps track of the current record being consumed with “offset”
- A consumer auto commits offset periodically

Kafka Topic and Offsets



Playing with Kafka

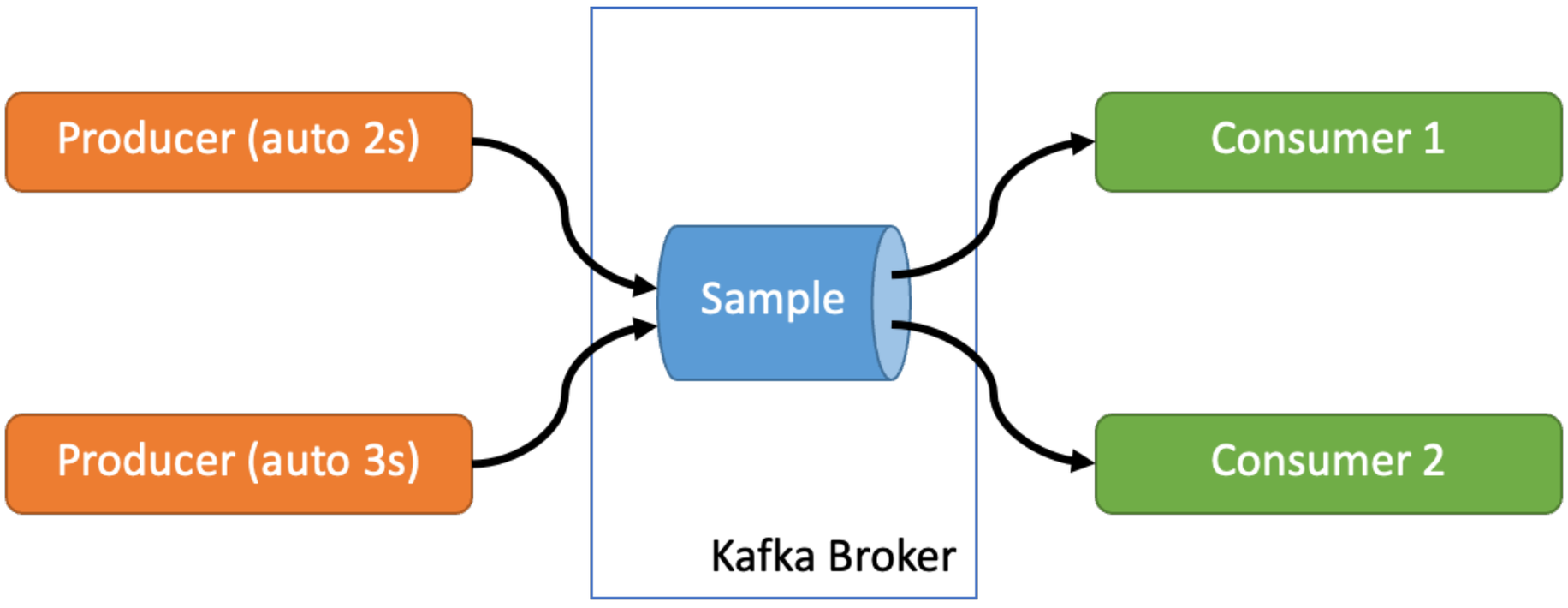
- For client-side: you must install **kafka-python**

  ```
  pip install kafka-python
  ```

- Server-side: use Kafka containers by wurstmeister (https://github.com/wurstmeister/kafka-docker)
  - Kafka broker
  - Zookeeper

- Docker compose file has been provided in the git

Simple Example



ConsumerRecord:

- topic = topic of the message
- offset = offset of the message
- timestamp = epoch milliseconds
- value = message body

Kafka Producer

In [ ]:
```
# import required libraries
from kafka import KafkaProducer
import time
```

In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
```

In [ ]:
```
producer = KafkaProducer(bootstrap_servers=[kafka_broker])
```

In [ ]:
```
for i in range(100):
    s = 'message #{} from producer-0'.format(i)
    producer.send('sample', s.encode('utf-8'))
    time.sleep(2)
```

Kafka Consumer

In [ ]:
```
# import required libraries
from kafka import KafkaConsumer, TopicPartition
```

In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
```

In [ ]:
```
consumer = KafkaConsumer(
    'sample',
    bootstrap_servers=[kafka_broker],
    enable_auto_commit=True,
    value_deserializer=lambda x: x.decode('utf-8'))
```

In [ ]:
```
print('Running Consumer')
for message in consumer:
    print(message)
    print(message.value, message.offset, message.timestamp)
```

More Kafka Consumer

In [ ]:
```
# import required libraries
from kafka import KafkaConsumer
```

In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
```

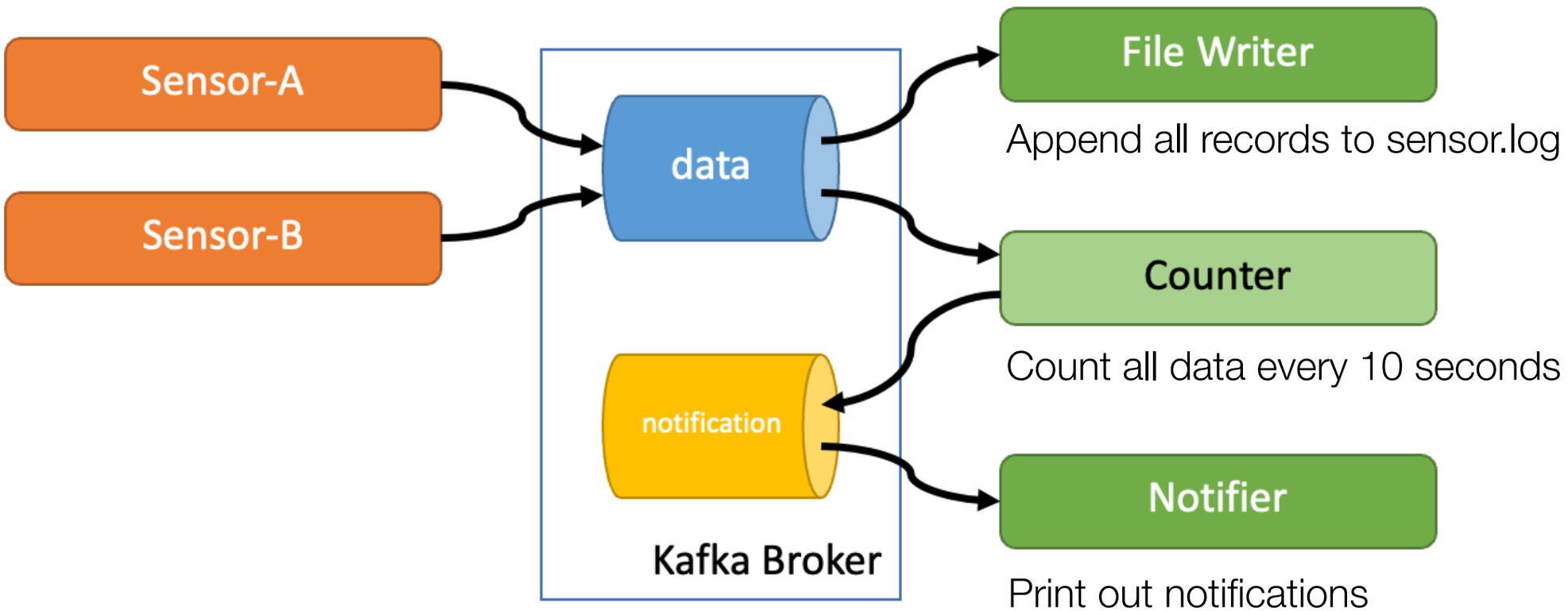
In [ ]:
```
consumer = KafkaConsumer(
     bootstrap_servers=[kafka_broker],
     enable_auto_commit=True,
     value_deserializer=lambda x: x.decode('utf-8'))
```

In [ ]:
```
consumer.subscribe('sample')
```

In [ ]:
```
print('Running Consumer #2')
while(True):
    results = consumer.poll(timeout_ms=1000)
    if len(results) == 0:
        print('no message')
    else:
        for tp, messages in results.items():
            print('topic = {} -- total {} messages'.format(tp.topic, len(messages)))
            print('-----')
            for message in messages:
                print(message)
    print('######################')
```

More Complex Example

```
{"id": "sensor-A", "timestamp": 1645970193, "value": 33}
```



Sensor-A Producer

In [ ]:
```
# import required libraries
from kafka import KafkaProducer
import time, random, json
```

In [ ]:
```
sensor_id = 'sensor-A'
```

In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
topic = 'data'
```

In [ ]:
```
producer = KafkaProducer(bootstrap_servers=[kafka_broker])
```

In [ ]:
```
while(True):
    ts = round(time.time())
    value = round(random.uniform(27, 33))
    data = {
        'id': sensor_id,
        'timestamp': ts,
        'value': value
    }
    s = json.dumps(data)
    print(s)
    producer.send(topic, s.encode('utf-8'))
    time_to_sleep = round(random.uniform(1,3))
    time.sleep(time_to_sleep)
```

FileWriter Consumer

In [ ]:
```
# import required libraries
from kafka import KafkaConsumer
```

In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
```

In [ ]:
```
consumer = KafkaConsumer(
    'data',
    bootstrap_servers=[kafka_broker],
    enable_auto_commit=True,
    value_deserializer=lambda x: x.decode('utf-8'))
```

In [ ]:
```
print('Running FileWriter')
counter = 0
for message in consumer:
    with open('sensor.log', 'a') as f:
        f.write(message.value+'\n')
    counter += 1
    if counter%10 == 0:
        print('{} records'.format(counter))
    if counter >= 100:
        break
```

In [ ]:
```
import threading
import json
import time
from kafka import KafkaProducer, KafkaConsumer
```

In [ ]:
```
class Counter:
    def __init__(self):
        self._lock = threading.Lock()
        self.reset()

    def reset(self):
        with self._lock:
            self.counter = 0

    def incr(self, value):
        with self._lock:
            self.counter += value

    def get(self):
        return self.counter
```

In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
data_topic = 'data'
notification_topic = 'notification'
```

In [ ]:
```
producer = KafkaProducer(bootstrap_servers=[kafka_broker])
```

In [ ]:
```
consumer = KafkaConsumer(
    bootstrap_servers=[kafka_broker],
    enable_auto_commit=True,
    value_deserializer=lambda x: x.decode('utf-8'))
consumer.subscribe(data_topic)
```

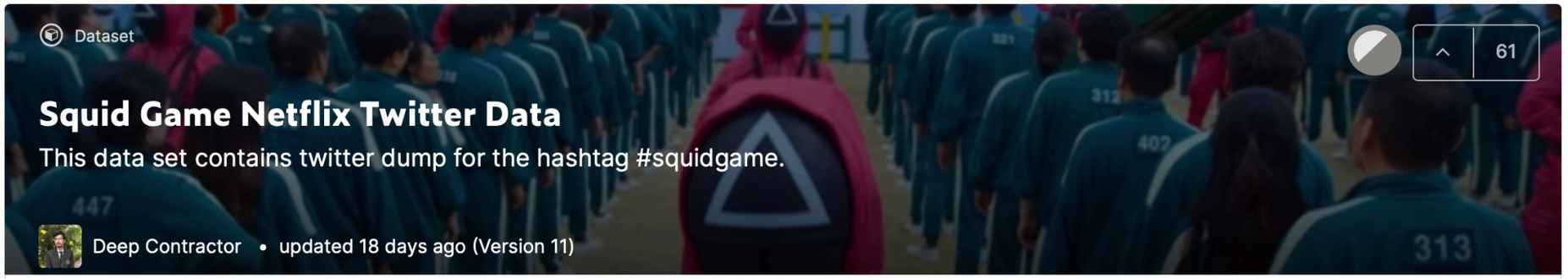
In [ ]:
```
def monitor_thread(interval, counters, topic):
    print('[monitor] starting')
    while True:
        time.sleep(interval)
        for id in counters:
            count = counters[id].get()
            counters[id].reset()
            s = '{} - {} messages during last {} seconds'.format(id, count, interval)
            producer.send(topic, s.encode('utf-8'))
        print('send notificiation', flush=True)
```

In [ ]:
```
monitor_interval = 10
counters = {}
monitor = threading.Thread(target=monitor_thread, args=(monitor_interval, counters, notification_topic), daemon=Tru
monitor.start()
```

In [ ]:
```
for message in consumer:
    m = message.value
    data = json.loads(m)
    if 'id' in data:
        if data['id'] not in counters:
            counters[data['id']] = Counter()
        counters[data['id']].incr(1)
    else:
        print(data, flush=True)
```

AVRO

- Row-based schema-oriented data serialization framework
  - Use JSON to define schema
  - Serialize data in a compact binary format
  - Similar to Java Object Serialization
  - Support both primitive and complex data types (allows hierarchical data structure)
- Primary usage in Big Data
  - Apache Hadoop for persistent data (input/output/checkpoint)
  - A wire format for communication (e.g. Kafka, Spark Streaming)
- Have libraries for many programming languages



Dataset

61

Squid Game Netflix Twitter Data

This data set contains twitter dump for the hashtag #squidgame.

Deep Contractor • updated 18 days ago (Version 11)

Data | Code (2) | Discussion | Activity | Metadata

Download (26 MB) | New Notebook

Usability 10.0 | **License** CC0: Public Domain | **Tags** arts and entertainment, online communities, text data, beginner, exploratory data analysis

Description

- The dataset contains the recent tweets about the record-breaking Netflix show "Squid Game"
- The data is collected using tweepy Python package to access Twitter API.

Data Explorer

261 MB

tweets_v8.csv (26.1 MB)

Detail | Compact | Column

user_name	user_locati...	user_descr...	user_creat...	user_follo...	user_friends	user_favou...	user_verified	date	text
the _ûndër-ratèd niggáh👊🏾		@ManUtd die hard❤️❤️💪🏾💪🏾 YOLO J'ai besoin de quelqu'un qui peut m'aimer au pire🤗 Non, je ne...	2019-09-06 19:24:57+00:00	581	1035	8922	False	2021-10-06 12:05:38+00:00	When life hits and the same time poverty strikes you Gong Yoo : Lets play a game #SquidGame #Netfli...
Best uncle on planet earth			2013-05-08 19:35:26+00:00	741	730	8432	False	2021-10-06 12:05:22+00:00	That marble episode of #SquidGame ruined me. 😭😭😭
marcie		animal crossing. chicken nuggets. baby yoda. smol animals. tv shows. 🏳️‍🌈 pronouns: any	2009-02-21 10:31:30+00:00	562	1197	62732	False	2021-10-06 12:05:22+00:00	#Squidgame time
YoMo.Mdp	Any pronouns	Where the heck is the karma I'm going on my school grave brb #Technosupport	2021-02-14 13:21:22+00:00	3	277	1341	False	2021-10-06 12:05:04+00:00	//Blood on 1st slide I'm joining the squidgame thing, I'm already dead by sugar honeycomb ofc #Squi...
Laura Reactions	France	I talk and I make reactions videos about shows I love #theexpanse #peakyblinders #thelastkingdom #la...	2018-12-19 20:38:28+00:00	330	152	2278	False	2021-10-06 12:05:00+00:00	The two first games, players were killed by the mask guys ; the bloody night and the third game, the...
Peyman 🅚🅐🅘	United Kingdom	Official @KardiaChain $KAI Ambassador Marketing Advisor @kephigallery Graphics and Film Artist https...	2018-01-27 12:07:31+00:00	546	318	6265	False	2021-10-06 12:04:54+00:00	$THG Going to explode to 4B Marketcap very soon. The world first MOBA This game is on another level!...
Aeriaaaa♡		Fujoshi 🙈/ Thai BL-obsessed/Always distracted by poetry 🌸/ CAP 🦙	2021-06-01 14:08:10+00:00	14	110	518	False	2021-10-06 12:04:45+00:00	@B_hundred_Hyun pls use that gun on me. 😩 #BAEKHYUN #EXO #weareoneEXO #SquidGame https://t.co/ksk...

AVRO Schema File

complex types (record, enum, array, map, union, and fixed)

```
{
    "namespace": "example.avro.chula",
    "type": "record",
    "name": "squid_tweets",
    "fields": [
        {"name": "user_name", "type": "string"},
        {"name": "user_location", "type": ["null", "string"]},
        {"name": "user_description", "type": "string"},
        {"name": "user_created", "type": {"type": "long", "logicalType": "local-timestamp-millis"}},
        {"name": "user_followers", "type": "int"},
        {"name": "user_friends", "type": "int"},
        {"name": "user_favourites", "type": "int"},
        {"name": "user_verified", "type": "boolean"},
        {"name": "date", "type": {"type": "long", "logicalType": "local-timestamp-millis"}},
        {"name": "text", "type": "string"},
        {"name": "source", "type": "string"},
        {"name": "is_retweet", "type": "boolean"}
    ]
}
```

primitive types (null, boolean, int, long, float, double, bytes, and string)

AVRO Example in Python

In [1]:
```
import pandas as pd
import fastavro as favro
import json, os
```

In [2]:
```
schema = json.load(open('tweets_v8.avsc'))
parsed_schema = favro.parse_schema(schema)
```

In [3]:
```
parse_dates = ['user_created', 'date']
df = pd.read_csv('tweets_v8.csv', parse_dates=parse_dates, keep_default_na=False)
df.shape
```

Out[3]: (80019, 12)

In [4]:
```
records = df.to_dict('records')
```

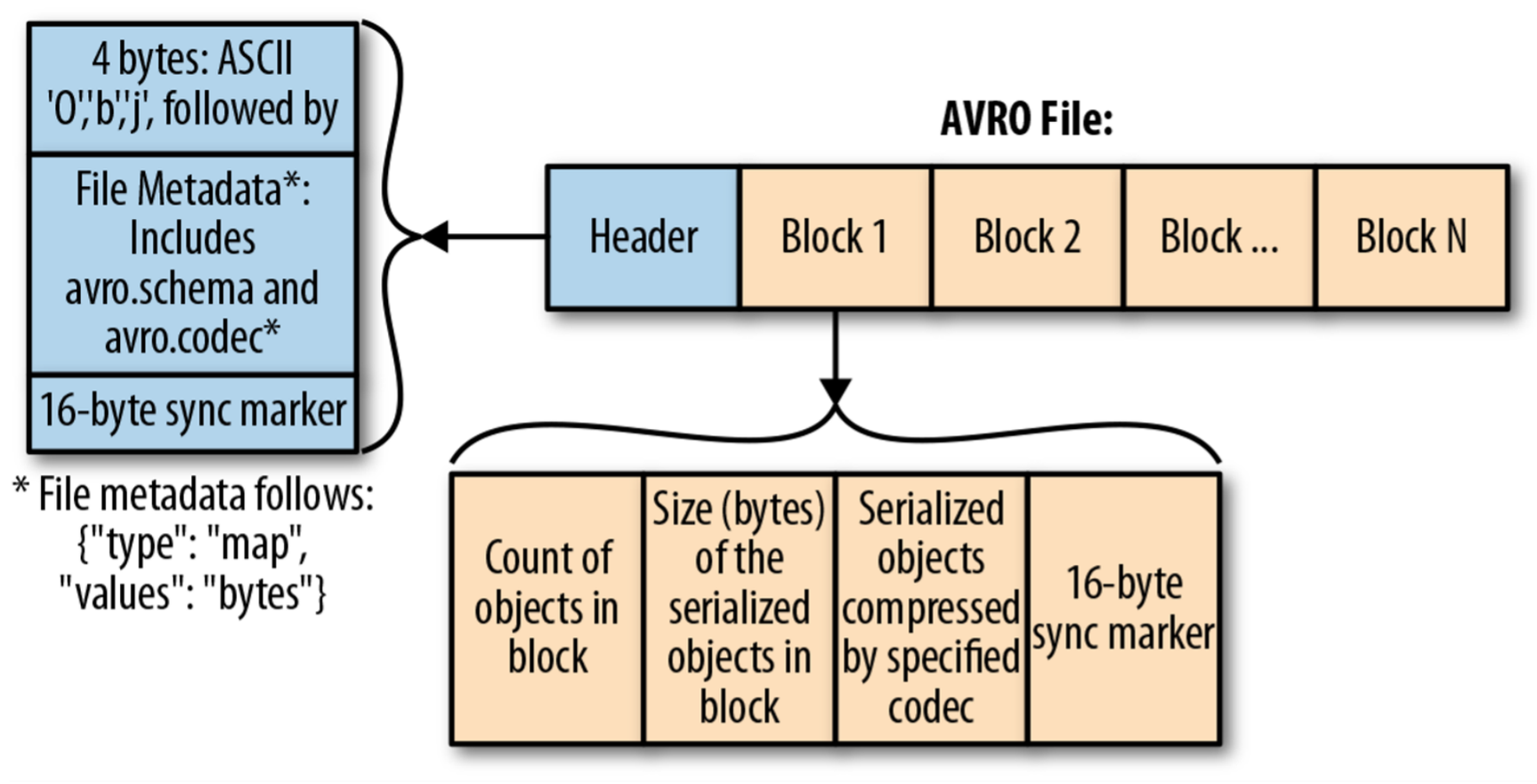
In [5]:
```
with open('tweets_v8.avro', 'wb') as out:
    favro.writer(out, parsed_schema, records)
```

In [6]:
```
with open('tweets_v8_deflate.avro', 'wb') as out:
    favro.writer(out, parsed_schema, records, codec='deflate')
```

In [7]:
```
print('tweets_v8.csv = {:5.2f}MB'.format(os.path.getsize('tweets_v8.csv')/(1024*1024)))
print('tweets_v8.avro = {:5.2f}MB'.format(os.path.getsize('tweets_v8.avro')/(1024*1024)))
print('tweets_v8_deflate.avro = {:5.2f}MB'.format(os.path.getsize('tweets_v8_deflate.avro')/(1024*1024)))
```

```
tweets_v8.csv = 24.89MB
tweets_v8.avro = 20.49MB
tweets_v8_deflate.avro = 11.51MB
```

AVRO File Structure



- Each row is “serialized”, multiple rows store in each block
- Data compressed per block
- Block's sync marker is for MapReduce file splitting

```
00000000  4F 62 6A 01 04 14 61 76 72 6F 2E 63 6F 64 65 63  Obj...avro.codec
00000010  08 6E 75 6C 6C 16 61 76 72 6F 2E 73 63 68 65 6D  .null.avro.schem
00000020  61 DC 0A 7B 22 74 79 70 65 22 3A 20 22 72 65 63  a▄.{"type": "rec
00000030  6F 72 64 22 2C 20 22 6E 61 6D 65 22 3A 20 22 65  ord", "name": "e
00000040  78 61 6D 70 6C 65 2E 61 76 72 6F 2E 63 68 75 6C  xample.avro.chul
00000050  61 2E 73 71 75 69 64 5F 74 77 65 65 74 73 22 2C  a.squid_tweets",
00000060  20 22 66 69 65 6C 64 73 22 3A 20 5B 7B 22 6E 61   "fields": [{"na
00000070  6D 65 22 3A 20 22 75 73 65 72 5F 6E 61 6D 65 22  me": "user_name"
00000080  2C 20 22 74 79 70 65 22 3A 20 22 73 74 72 69 6E  , "type": "strin
00000090  67 22 7D 2C 20 7B 22 6E 61 6D 65 22 3A 20 22 75  g"}, {"name": "u
000000A0  73 65 72 5F 6C 6F 63 61 74 69 6F 6E 22 2C 20 22  ser_location", "
000000B0  74 79 70 65 22 3A 20 5B 22 6E 75 6C 6C 22 2C 20  type": ["null",
000000C0  22 73 74 72 69 6E 67 22 5D 7D 2C 20 7B 22 6E 61  "string"]}, {"na
000000D0  6D 65 22 3A 20 22 75 73 65 72 5F 64 65 73 63 72  me": "user_descr
000000E0  69 70 74 69 6F 6E 22 2C 20 22 74 79 70 65 22 3A  iption", "type":
000000F0  20 22 73 74 72 69 6E 67 22 7D 2C 20 7B 22 6E 61   "string"}, {"na
00000100  6D 65 22 3A 20 22 75 73 65 72 5F 63 72 65 61 74  me": "user_creat
00000110  65 64 22 2C 20 22 74 79 70 65 22 3A 20 7B 22 6C  ed", "type": {"l
00000120  6F 67 69 63 61 6C 54 79 70 65 22 3A 20 22 6C 6F  ogicalType": "lo
```

```
#SquidGame… https://t.co/N4UGv9hxx8",Twitter Web App,False
Laura Reactions,France,I talk and I make reactions videos about shows I love #theexpanse #peakyblinders #thelastkingdom
#lacasadepapel #atla #theboys #thewitcher,2018-12-19 20:38:28+00:00,330,152,2278,False,2021-10-06 12:05:00+00:00,"The two
first games, players were killed by the mask guys ; the bloody night and the third game, they killed each o…
https://t.co/Qf057XDJ7C",Twitter Web App,False
Peyman 🅚🅐🅘,United Kingdom,"Official @KardiaChain $KAI Ambassador
Marketing Advisor @kephigallery
Graphics and Film Artist https://t.co/OsTOSEKrHt",2018-01-27 12:07:31+00:00,546,318,6265,False,2021-10-06
12:04:54+00:00,"$THG
```

```
00000690  74 65 72 20 57 65 62 20 41 70 70 00 1E 4C 61 75  ter Web App..Lau
000006A0  72 61 20 52 65 61 63 74 69 6F 6E 73 02 0C 46 72  ra Reactions..Fr
000006B0  61 6E 63 65 94 02 49 20 74 61 6C 6B 20 61 6E 64  anceö.I talk and
000006C0  20 49 20 6D 61 6B 65 20 72 65 61 63 74 69 6F 6E   I make reaction
000006D0  73 20 76 69 64 65 6F 73 20 61 62 6F 75 74 20 73  s videos about s
000006E0  68 6F 77 73 20 49 20 6C 6F 76 65 20 23 74 68 65  hows I love #the
000006F0  65 78 70 61 6E 73 65 20 23 70 65 61 6B 79 62 6C  expanse #peakybl
00000700  69 6E 64 65 72 73 20 23 74 68 65 6C 61 73 74 6B  inders #thelastk
00000710  69 6E 67 64 6F 6D 20 23 6C 61 63 61 73 61 64 65  ingdom #lacasade
00000720  70 61 70 65 6C 20 23 61 74 6C 61 20 23 74 68 65  papel #atla #the
00000730  62 6F 79 73 20 23 74 68 65 77 69 74 63 68 65 72  boys #thewitcher
00000740  C0 A6 87 83 F9 59 94 05 B0 02 CC 23 00 C0 E7 F0  └ªçâ·Yö.╲.╠#.└τ≡
00000750  D7 8A 5F 9C 02 54 68 65 20 74 77 6F 20 66 69 72  ╫è_£.The two fir
00000760  73 74 20 67 61 6D 65 73 2C 20 70 6C 61 79 65 72  st games, player
00000770  73 20 77 65 72 65 20 6B 69 6C 6C 65 64 20 62 79  s were killed by
00000780  20 74 68 65 20 6D 61 73 6B 20 67 75 79 73 20 3B   the mask guys ;
00000790  20 74 68 65 20 62 6C 6F 6F 64 79 20 6E 69 67 68   the bloody nigh
000007A0  74 20 61 6E 64 20 74 68 65 20 74 68 69 72 64 20  t and the third
000007B0  67 61 6D 65 2C 20 74 68 65 79 20 6B 69 6C 6C 65  game, they kille
000007C0  64 20 65 61 63 68 20 6F E2 80 A6 20 68 74 74 70  d each oΓÇª http
000007D0  73 3A 2F 2F 74 2E 63 6F 2F 51 66 30 35 37 58 44  s://t.co/Qf057XD
000007E0  4A 37 43 1E 54 77 69 74 74 65 72 20 57 65 62 20  J7C.Twitter Web
000007F0  41 70 70 00 26 50 65 79 6D 61 6E 20 F0 9F 85 9A  App.&Peyman ≡ƒàÜ
```

sample.avsc

```
{
   "namespace": "sample.avro",
   "type": "record",
   "name": "Event",
   "fields": [
      {"name": "key", "type": "string"},
      {"name": "value", "type": "string"},
      {"name": "timestamp", "type": "long"}
   ]
}
```

producer

In [ ]:
```
# import required libraries
from kafka import KafkaProducer, KafkaConsumer
import time
```

In [ ]:
```
import avro.schema
import avro.io
import io
```

In [ ]:
```
schema_file = 'sample.avsc'
schema = avro.schema.parse(open(schema_file).read())
```

In [ ]:
```
def serialize(schema, obj):
    bytes_writer = io.BytesIO()
    encoder = avro.io.BinaryEncoder(bytes_writer)
    writer = avro.io.DatumWriter(schema)
    writer.write(obj, encoder)
    return bytes_writer.getvalue()
```

In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change th
kafka_broker = 'venus:9092'
```

In [ ]:
```
producer = KafkaProducer(bootstrap_servers=[kafka_broker])
```

In [ ]:
```
for i in range(100):
    k = 'key{}'.format(i)
    v = 'message #{}'.format(i)
    o = {'key': k, 'value': v, 'timestamp': (int)(time.time()*1000)}
    producer.send('avro', serialize(schema, o))
    time.sleep(2)
```

consumer

In [ ]:
```
# import required libraries
from kafka import KafkaConsumer
```

In [ ]:
```
import avro.schema
import avro.io
import io
```

In [ ]:
```
schema_file = 'sample.avsc'
schema = avro.schema.parse(open(schema_file).read())
```

In [ ]:
```
def deserialize(schema, raw_bytes):
    bytes_reader = io.BytesIO(raw_bytes)
    decoder = avro.io.BinaryDecoder(bytes_reader)
    reader = avro.io.DatumReader(schema)
    return reader.read(decoder)
```

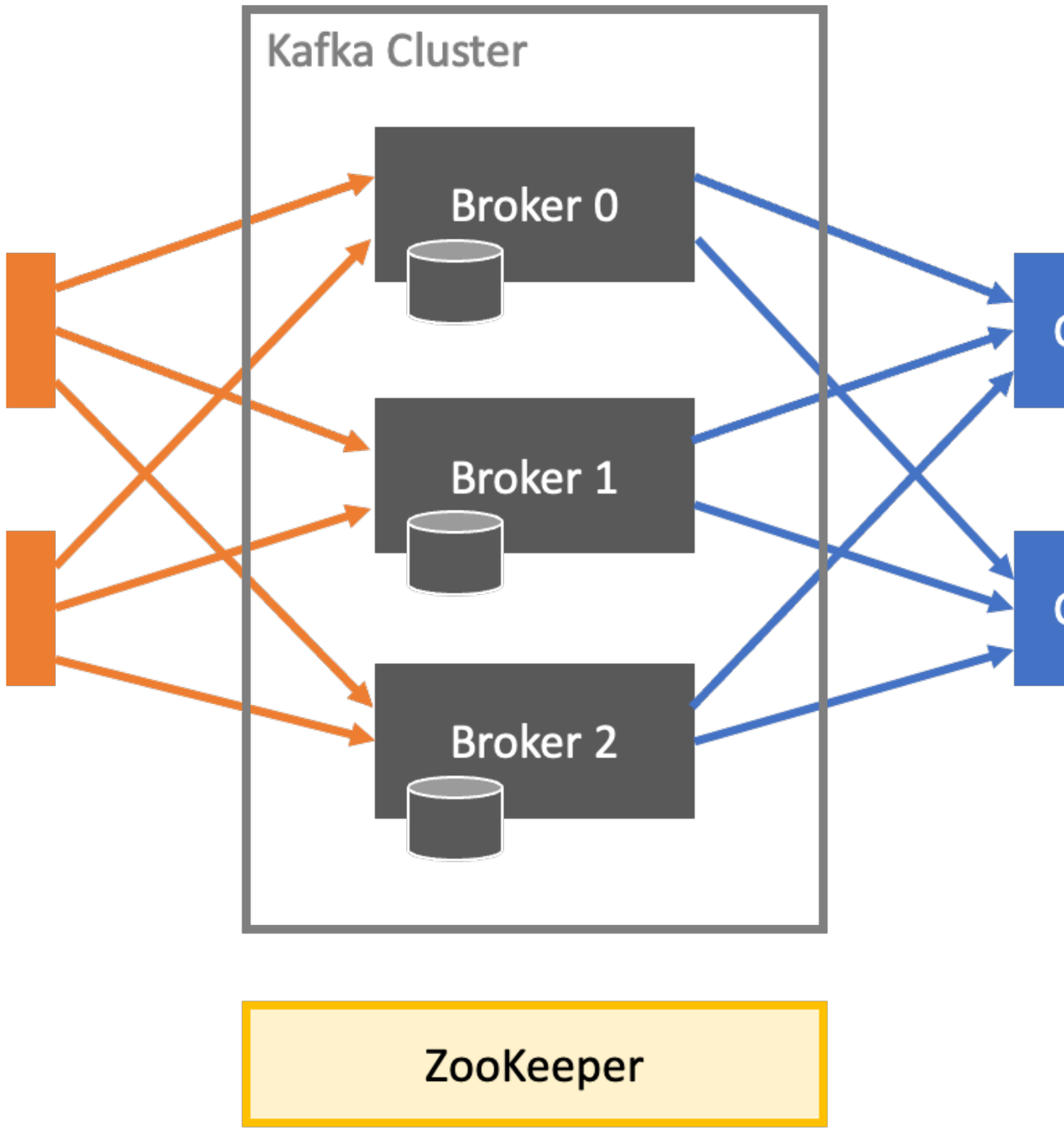
In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
```

In [ ]:
```
consumer = KafkaConsumer(
    'avro',
     bootstrap_servers=[kafka_broker],
     enable_auto_commit=True,
     value_deserializer=lambda x: deserialize(schema, x))
```

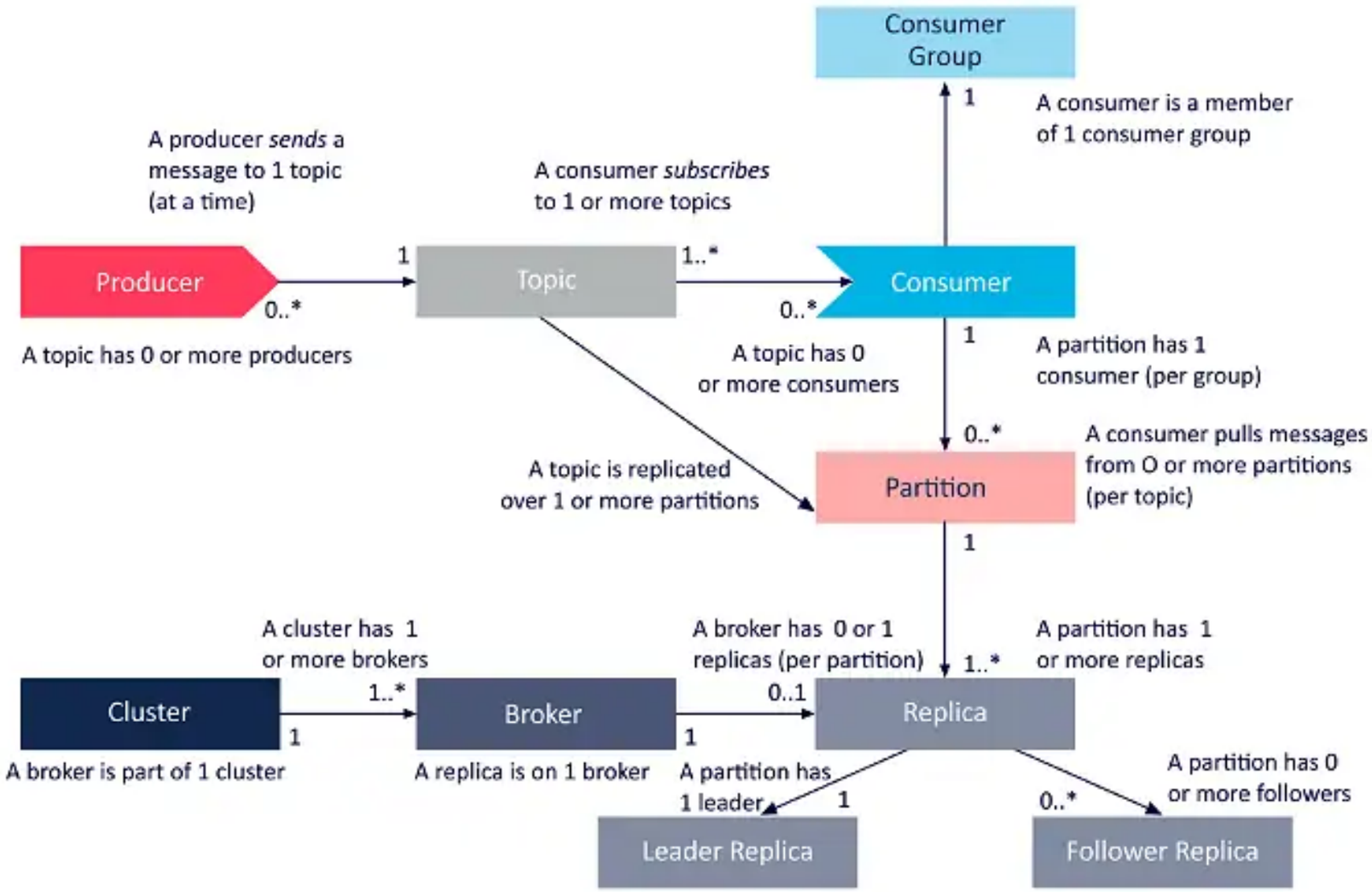
In [ ]:
```
print('Running Consumer with AVRO')
for message in consumer:
    print(message.value)
```

Kafka Architecture

Data Ingestion



Apache Kafka Components



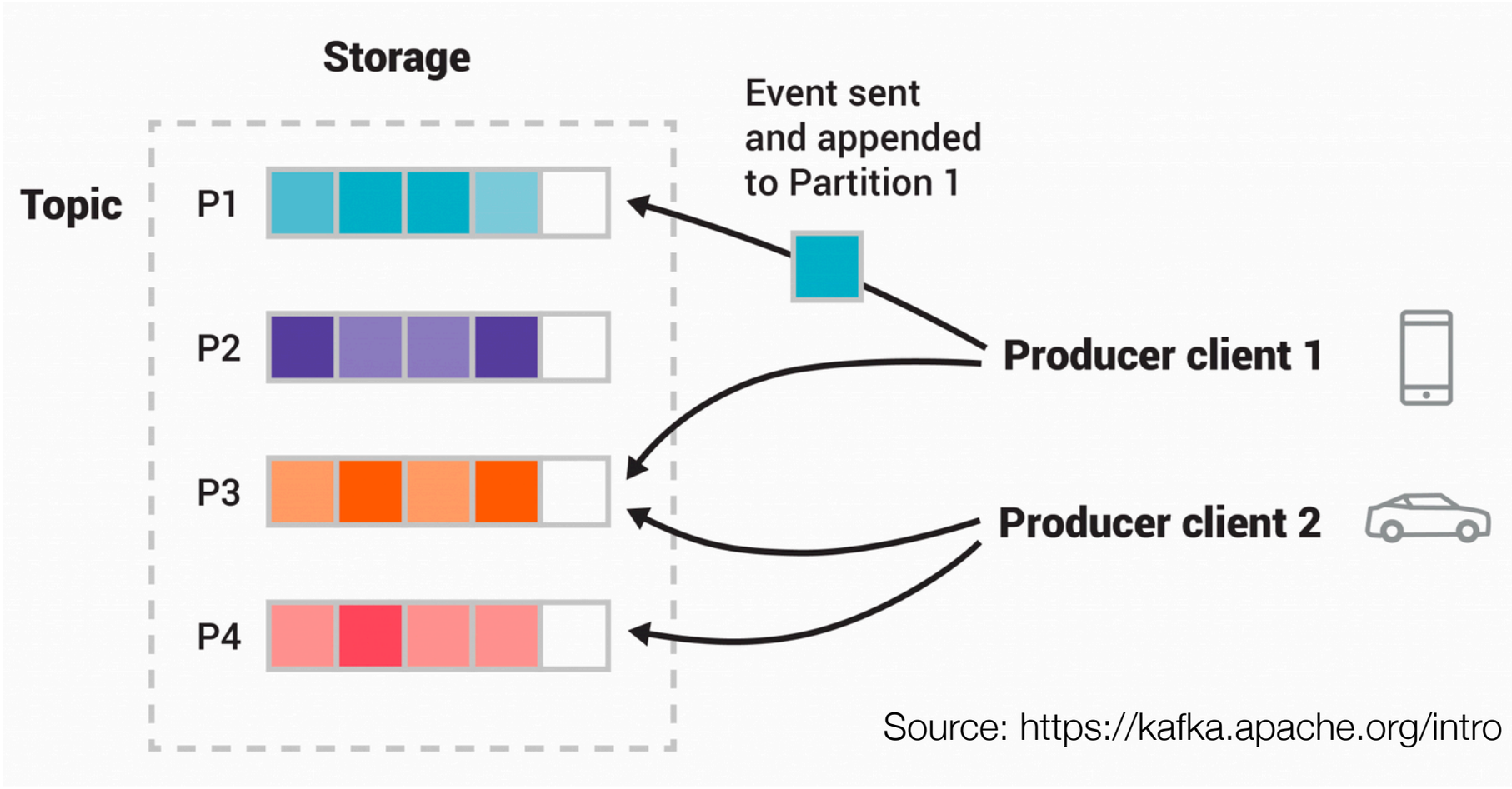
.

Source: https://www.instaclustr.com/blog/apache-kafka-architecture/

Kafka Partition

- A topic can be divided into multiple partitions
- Producer can send messages to a topic and messages will be distributed among partitions without duplication
- Orders of messages in the same partitions are guaranteed, but not across partitions
- For Kafka cluster with multiple brokers, partitions will be evenly distributed between those brokers
- Partition can be replicated to multiple brokers for failover with one broker becomes a leader of the partition and other brokers become followers

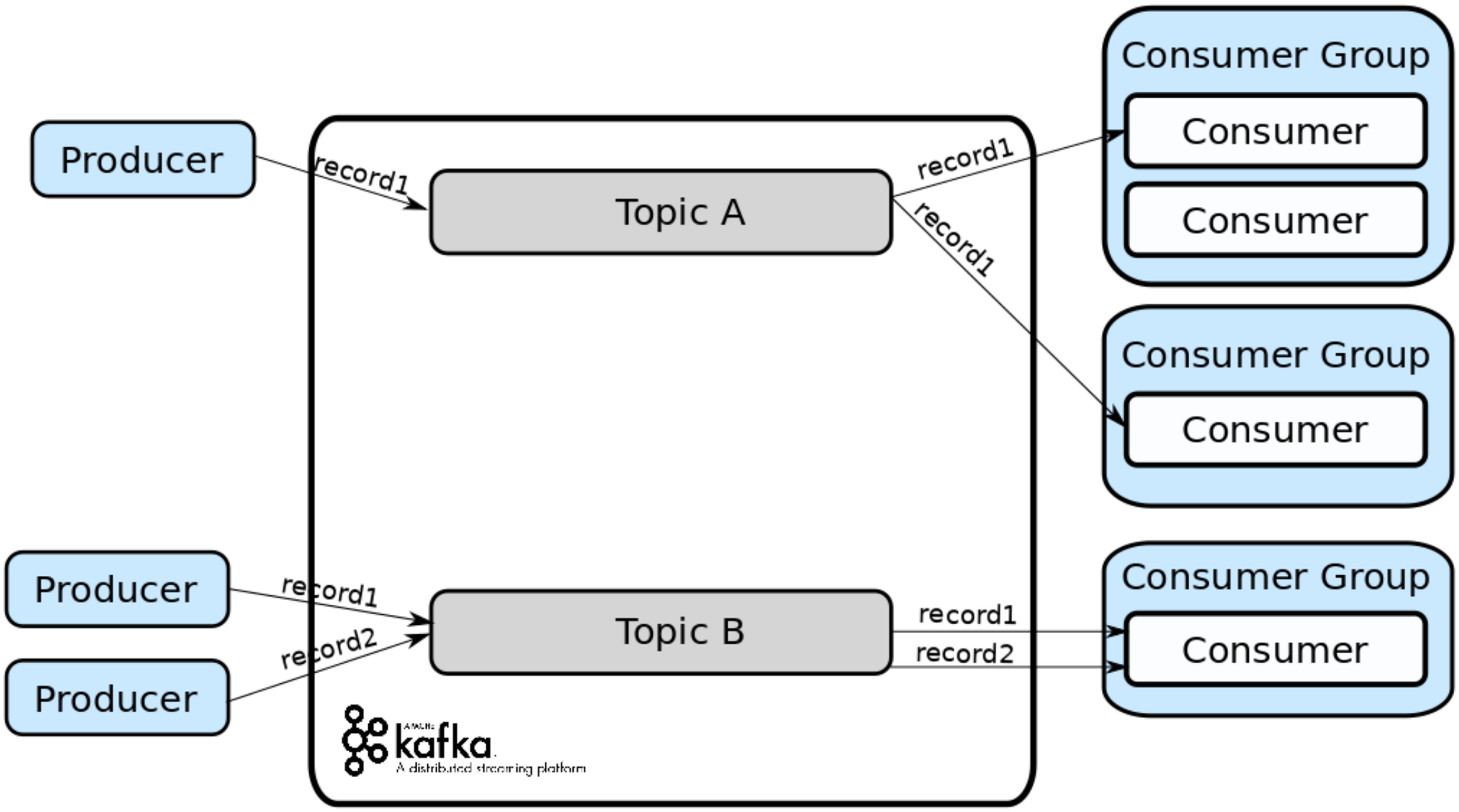
Anatomy of Kafka Topic



Kafka Consumer Group

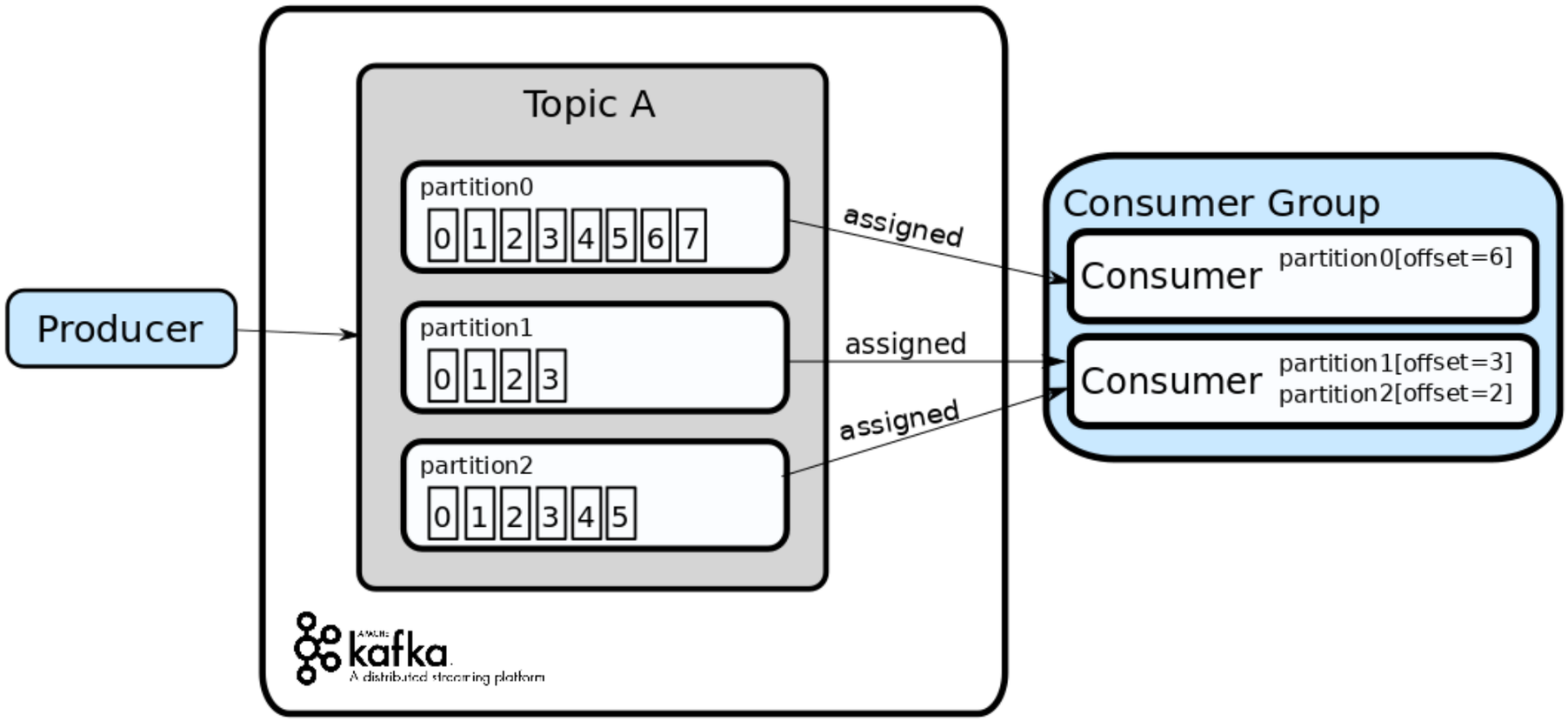
- Consumers can form a consumer group
- Consumers in the same group will be assigned to read from different partitions of the topic; only one consumer will be assigned to each partition
- If there are more partitions than consumers in the group, some consumers may be assigned to handle more than one partition
- It there are more consumers in the group than partitions, some consumers will not be assigned any partition
- If an assigned consumer is out of contact from a broker, another consumer in the group will be assigned to handle the partition
- Kafka periodically reassigns consumers in the group to rebalance the partition handling of the consumer group

Scalability and Reliability with Consumer Group



Source: https://medium.com/hacking-talent/kafka-all-you-need-to-know-8c7251b49ad0

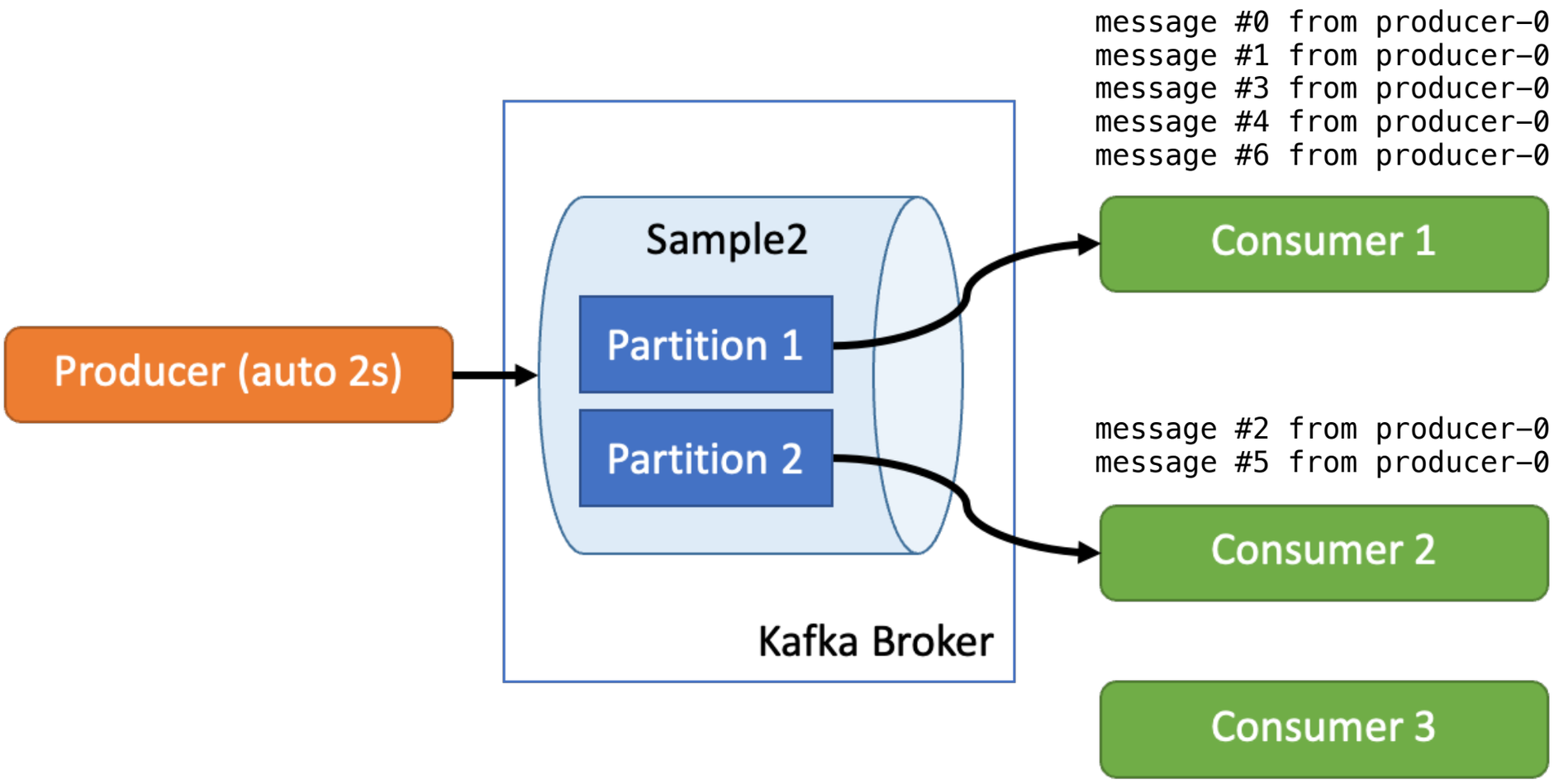
Partitions / Consumer / Consumer Group



- All consumers must send heartbeats every **heartbeat.interval.ms**
- A consumer who has been out of contact for **session.timeout.ms** will be kicked out of the group
- A group will be rebalance if there is no consumer processes records within **max.poll.interval.ms**

Source: https://medium.com/hacking-talent/kafka-all-you-need-to-know-8c7251b49ad0

Consumer Group Example



Consumer Group Example

In [ ]:
```
# import required libraries
from kafka import KafkaConsumer
from time import localtime, strftime
```

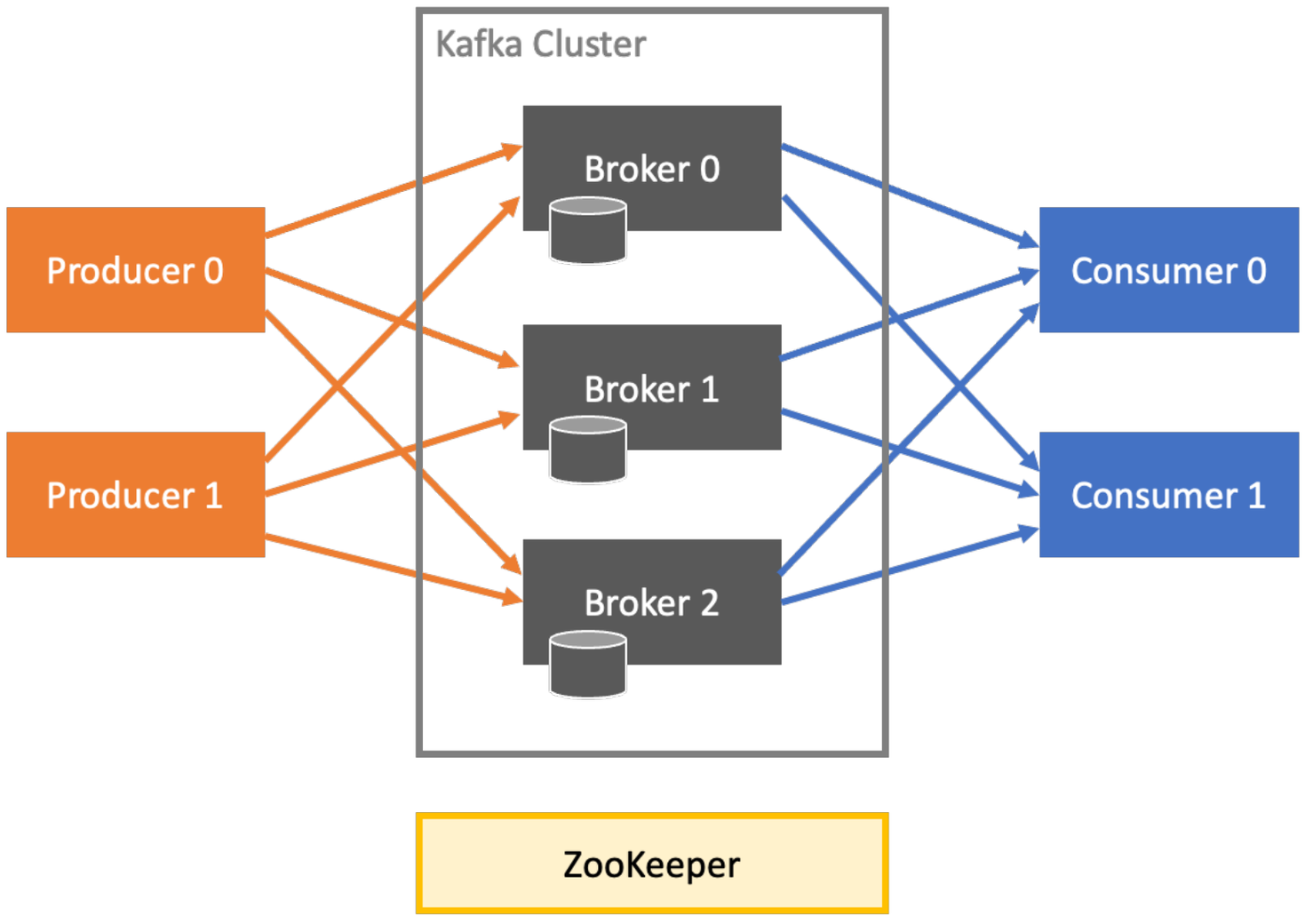
In [ ]:
```
# Connect to kafka broker running in your local host (docker). Change this to your kafka broker if needed
kafka_broker = 'venus:9092'
```

In [ ]:
```
consumer = KafkaConsumer(
    'sample2',
    bootstrap_servers=[kafka_broker],
    enable_auto_commit=True,
    group_id='my-group',
    session_timeout_ms=6000,
    max_poll_interval_ms=6000,
    value_deserializer=lambda x: x.decode('utf-8'))
```

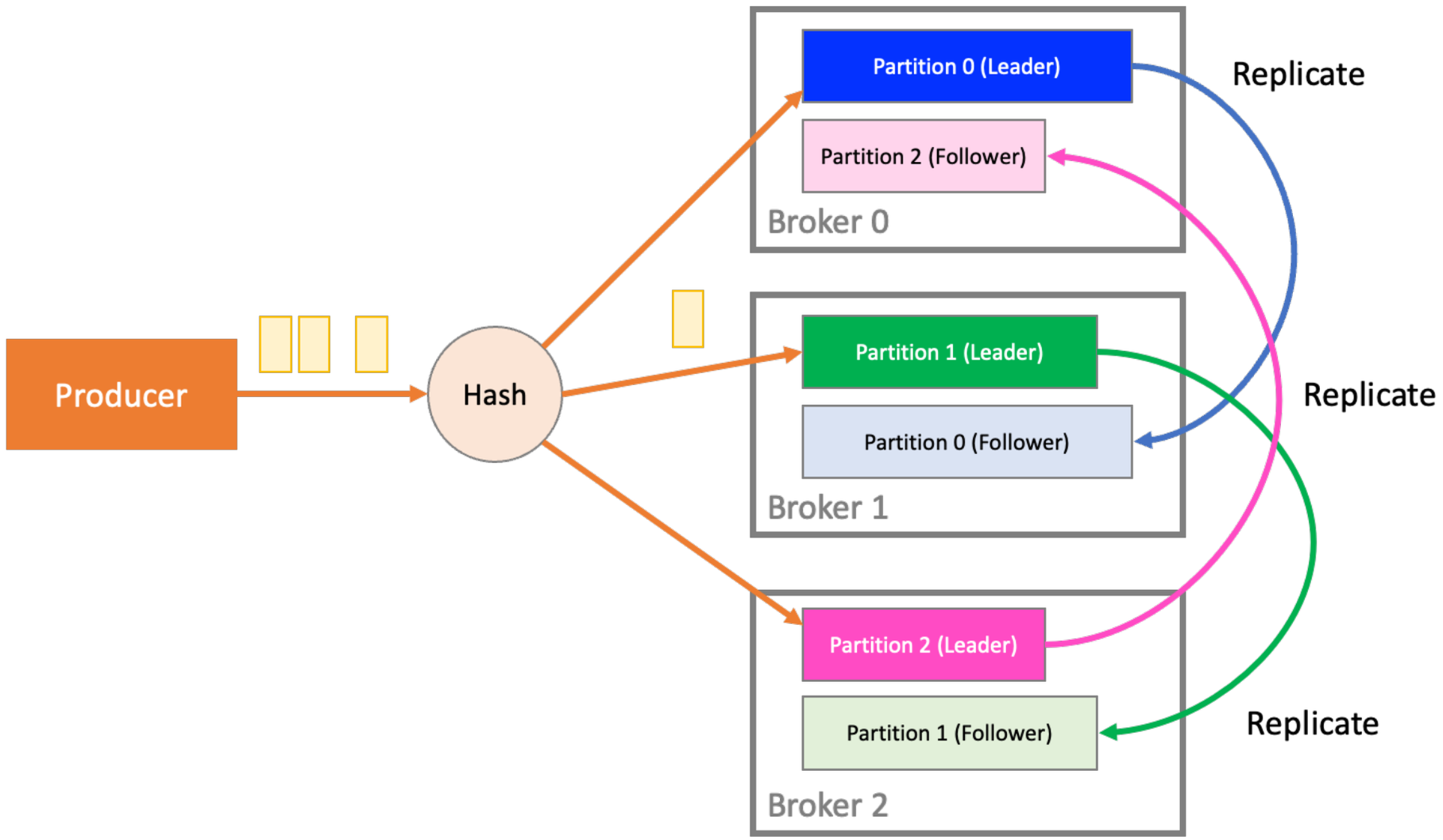
In [ ]:
```
print('Running Consumer Group')
for message in consumer:
    ts = strftime("%H:%M:%S", localtime())
    print('[{}] {}'.format(ts, message.value, message.offset))
    print(consumer.assignment())
```

In [ ]:
```
consumer.close()
```

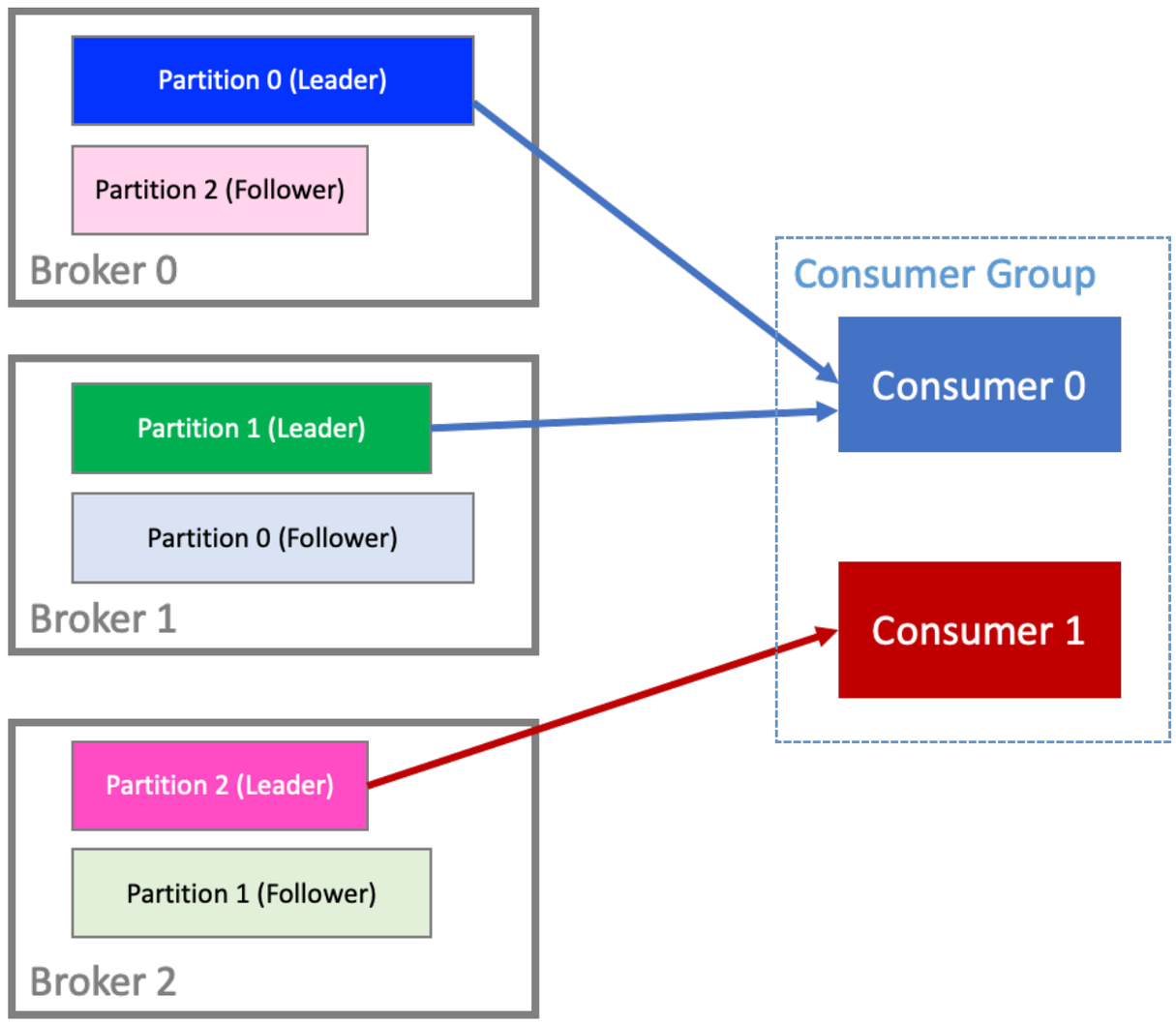
Kafka Cluster



Partitions with Replication in Broker Cluster: Producer



Partitions with Replication in Broker Cluster: Consumer



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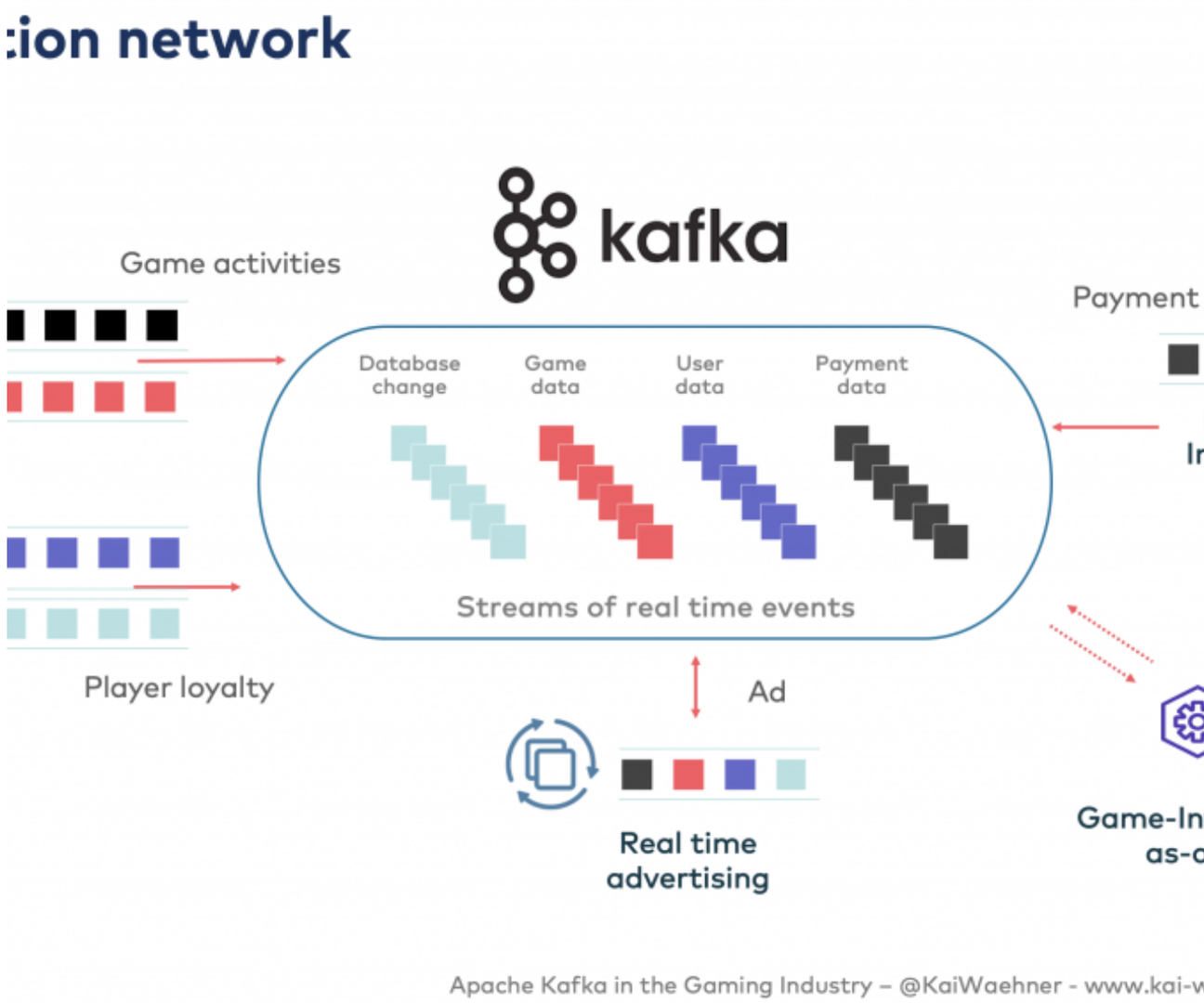
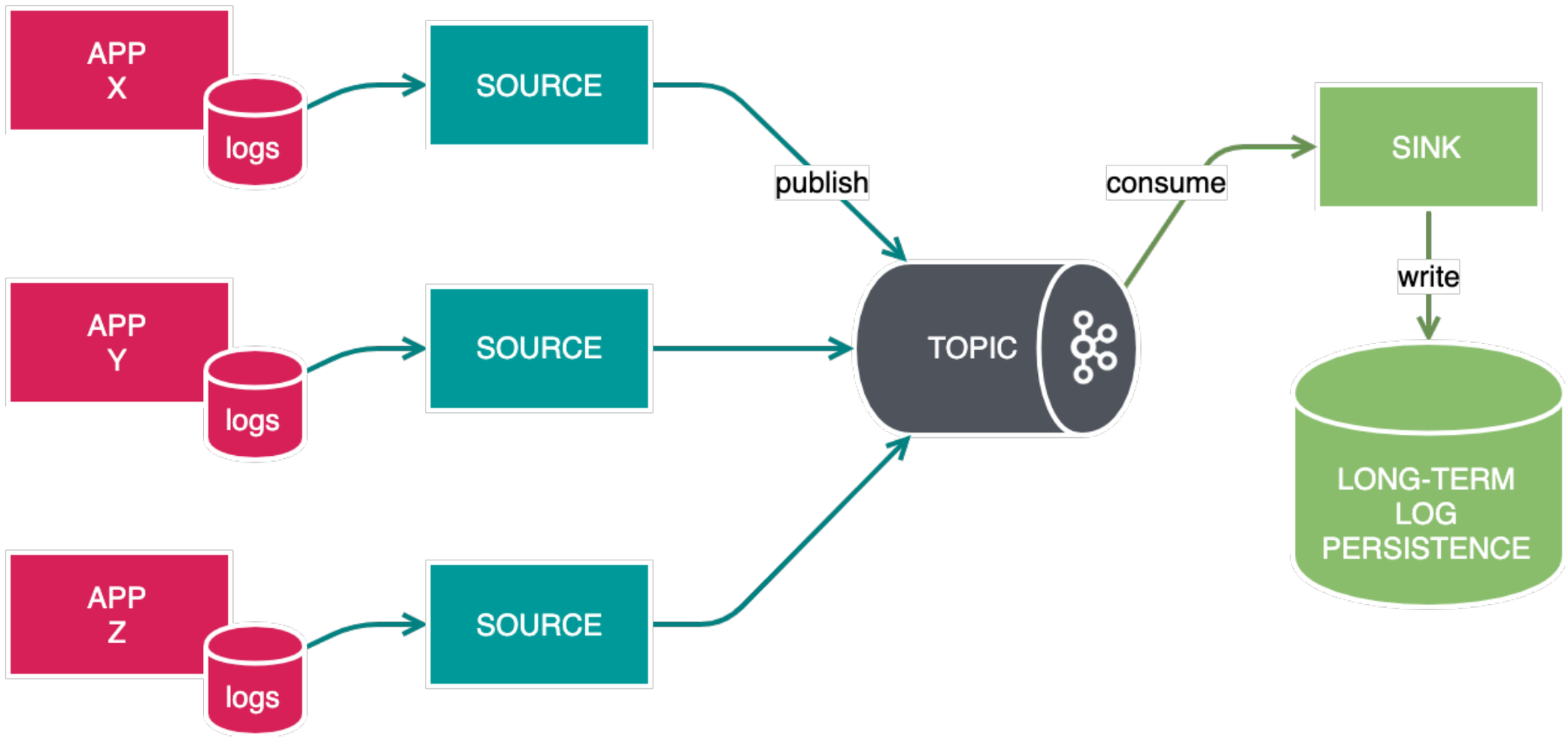
Kafka Use Cases

Data Ingestion

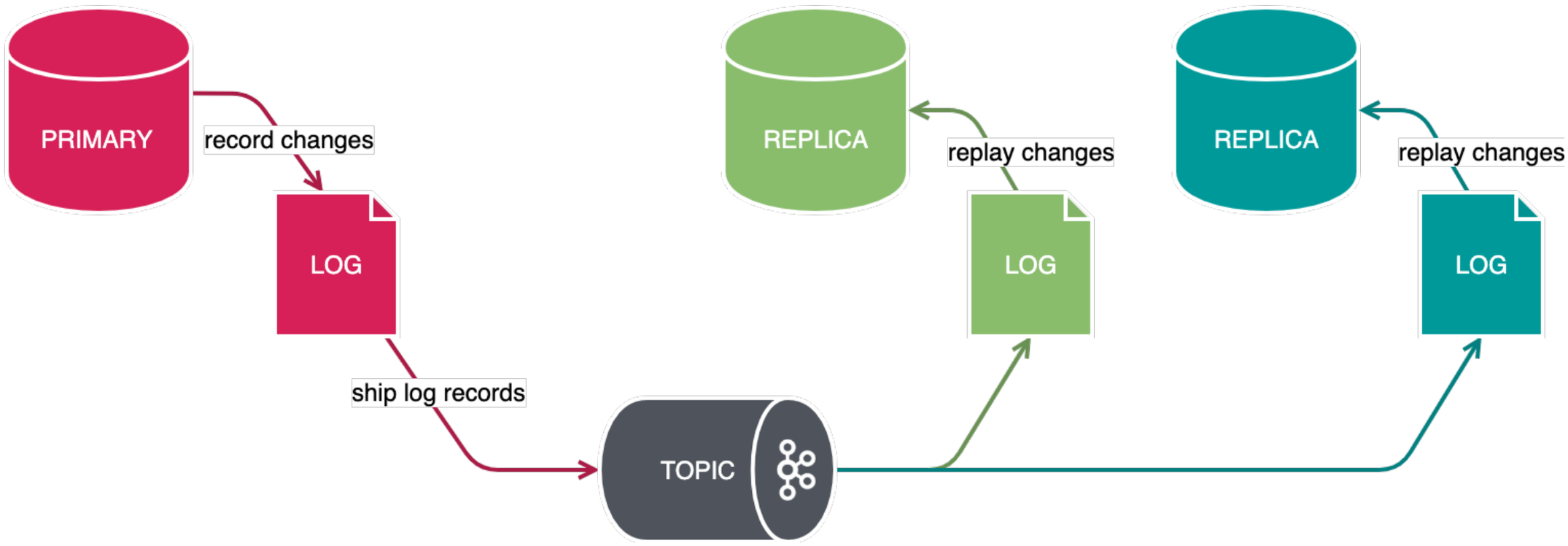


Kafka Use Cases: Log Aggregation



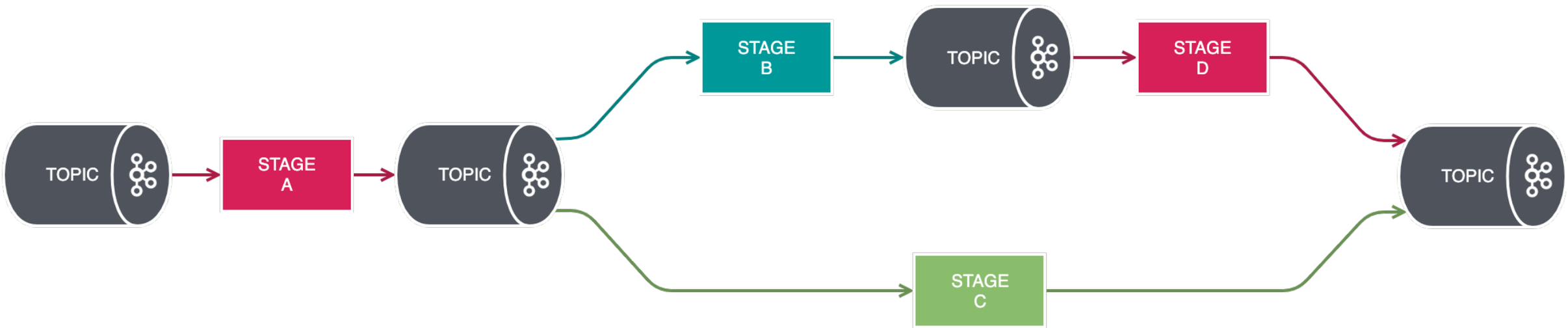
Source: https://medium.com/swlh/apache-kafka-in-a-nutshell-5782b01d9ffb

Kafka Use Cases: Log Shipping



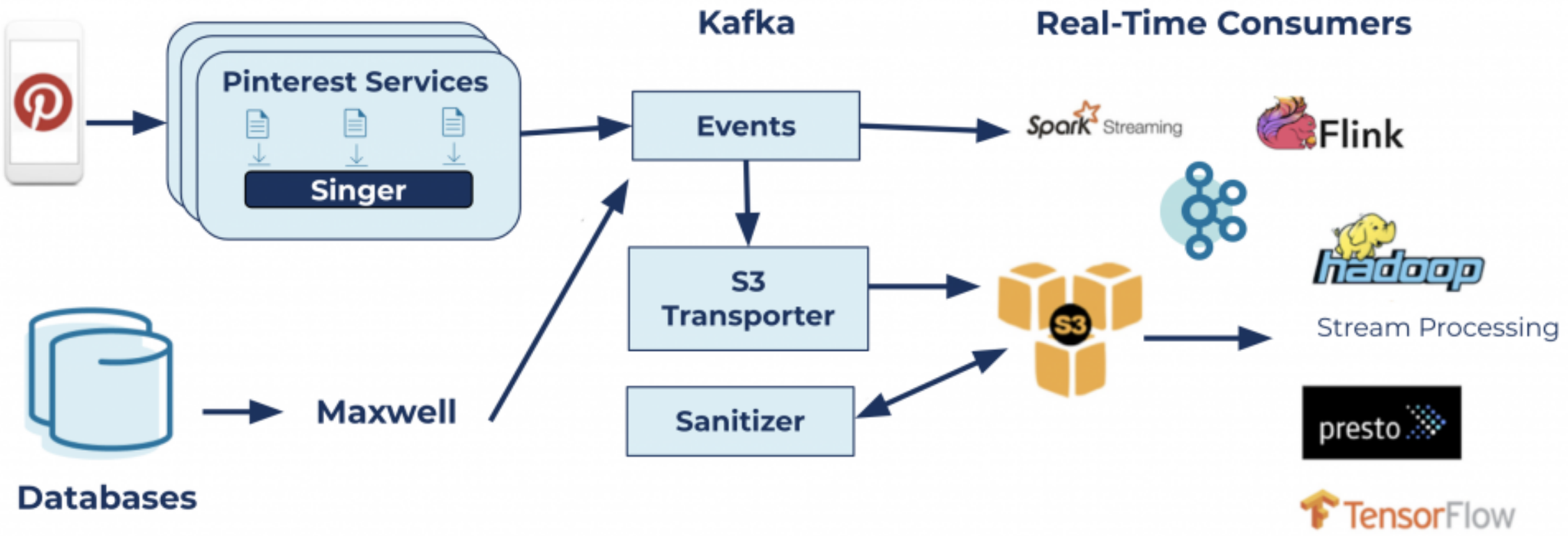
Source: https://medium.com/swlh/apache-kafka-in-a-nutshell-5782b01d9ffb

Kafka Use Cases: Event Driven Architecture Pipeline



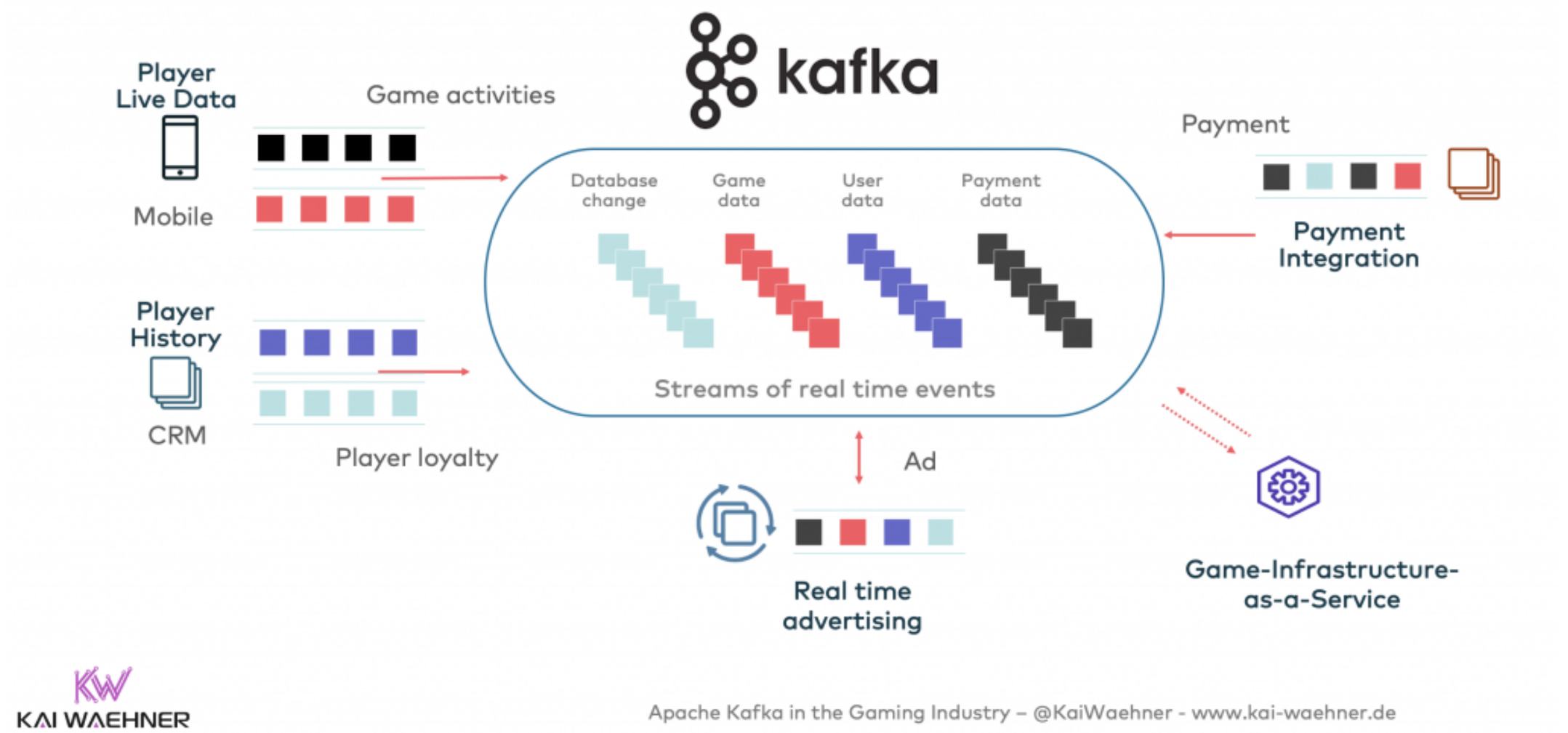
Source: https://medium.com/swlh/apache-kafka-in-a-nutshell-5782b01d9ffb

Kafka @ Pinterest



Source: https://www.confluent.io/blog/running-kafka-at-scale-at-pinterest/

Kafka and Gaming Industry



- In-game advertising
- Micro-transactions and in-game purchases
- Game-Infrastructure-as-a-Service: matchmaking, advertising, leader boards,...
- Partner network: Cross-sell game data, game SDK, game analytics,

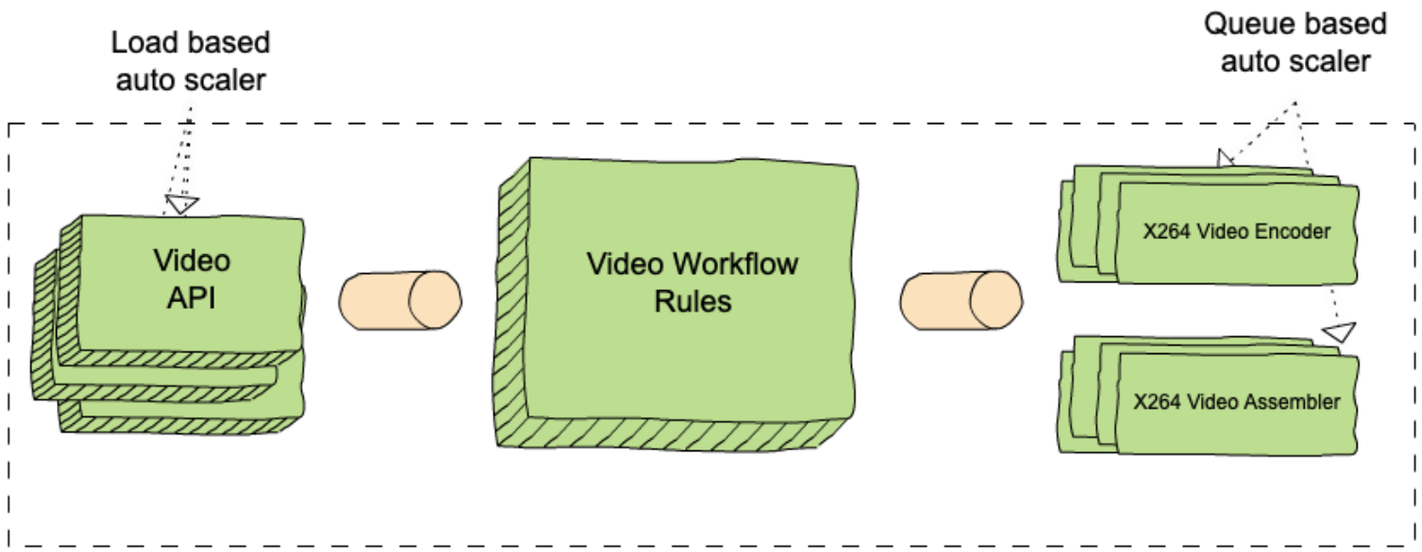
Source: https://dzone.com/articles/apache-kafka-in-the-gaming-industry-use-cases-arch

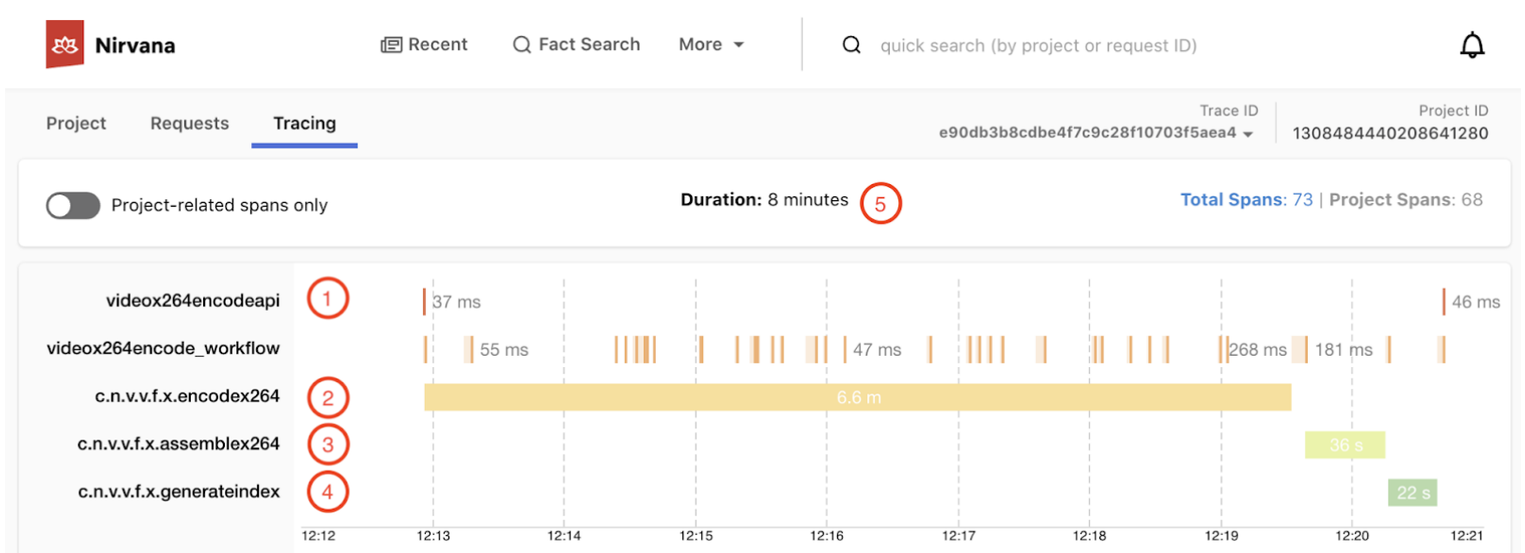
Netflix's Timestone

- A high-throughput, low-latency priority queueing system based on kafka and redis
- Main function is to provide asynchronous communication layer to orchestrate workflows between subsystems of the following internal systems
  - Cosmos - media encoding platform
  - Conductor - general-purpose workflow orchestration engine
  - BDP Scheduler - scheduler for large-scale data pipelines
- Each message contains information regarding to project, function to be executed, deadline, priority, and metadata (for filtering)

Netflix Cosmos Service

Source: “The Netflix Cosmos Platform”, https://netflixtechblog.com/the-netflix-cosmos-platform-35c14d9351ad





1. There is one API call to encode, which includes the video source and a recipe
2. The video is split into 31 chunks, and the 31 encoding functions run in parallel
3. The assemble function is invoked once
4. The index function is invoked once
5. The workflow is complete after 8 minutes

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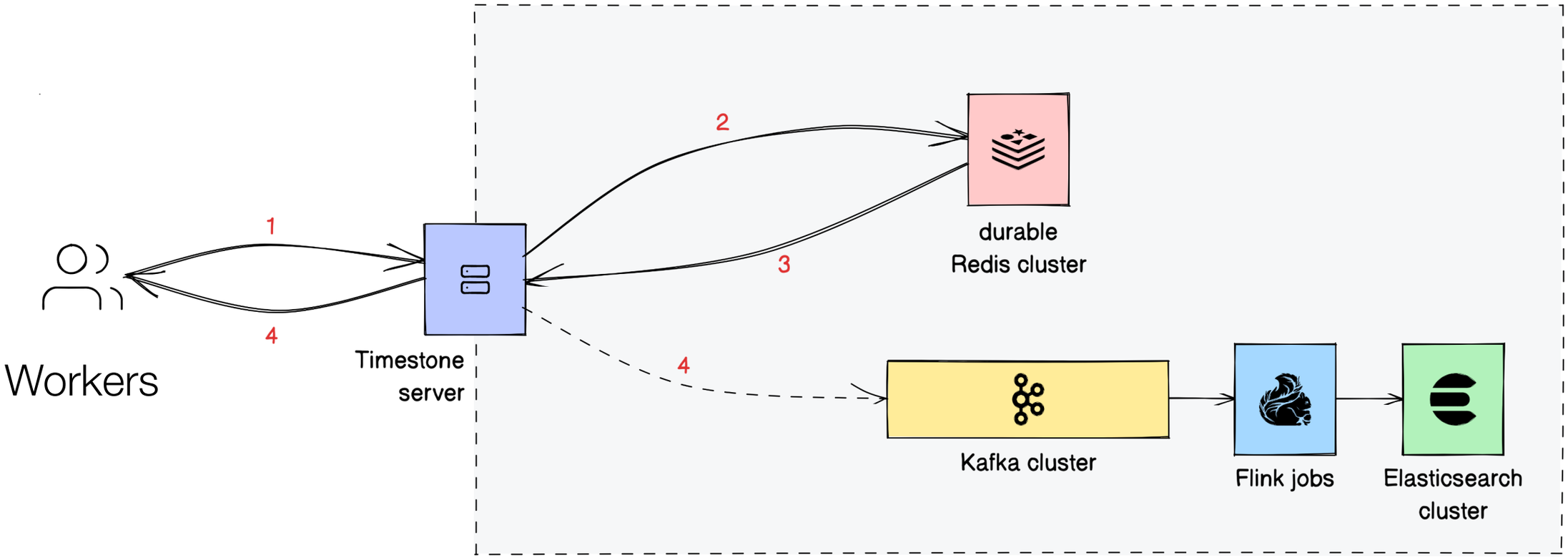
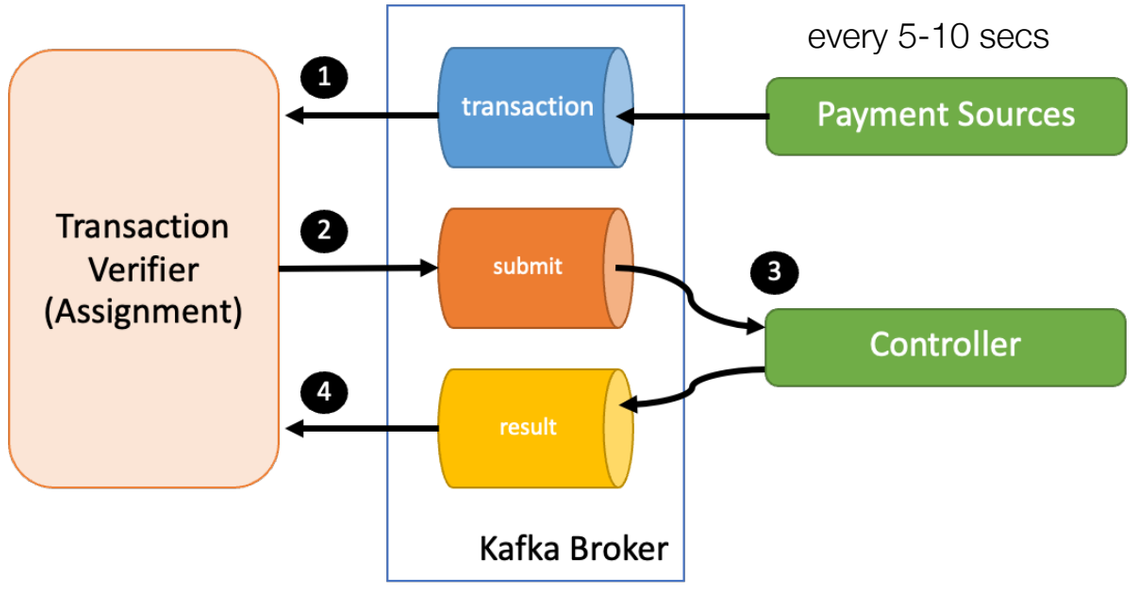
Timestone System Architecture



Assignment: Transaction Verifier

- Each group will receive verifier id (vid) and token from TA
- Create a transaction verifier which performs the following task
    1. Read a transaction from “transaction” topic using transaction.avsc schema, extract transaction information including txid, payer, payee, and amount
    2. Verify transaction information with your token by creating signature using gen_signature function (given in the assignment) and submit your verification (vid, txid, and signature) to “submit” topic using submit.avsc schema
    3. System receives and verify the signature and send the confirmation back to verifier via “result” topic
    4. Verifier receives a confirmation from “result” topic (message with code “200” with matching vid and txid)
- Submit with the following information from result message via google form (URL in the assignment): timestamp, vid, txid, and checksum
- Note: kafka broker’s IP is 35.240.149.229 port 9092



References

- J. Kreps, N. Neha, and R. Jun, "Kafka: A distributed messaging system for log processing”, Proceedings of the NetDB. Vol. 11. 2011.

- E. Koutanov, "Apache Kafka in a Nutshell”, https://medium.com/swlh/apache-kafka-in-a-nutshell-5782b01d9ffb

- M. Valcam, "Kafka: All you need to know”, https://medium.com/hacking-talent/kafka-all-you-need-to-know-8c7251b49ad0

- P. Brebner, "The Power of Apache Kafka Partitions: How to Get the Most out of Your Kafka Cluster”, https://www.instaclustr.com/the-power-of-kafka-partitions-how-to-get-the-most-out-of-your-kafka-cluster/

- M. Carter, "Apache Kafka Architecture: A Complete Guide”, https://www.instaclustr.com/blog/apache-kafka-architecture/

References

- K. Christidis, "Timestone: Netflix's High-Throughput, Low-Latency Priority Queueing System with Built-in Support for Non-Parallelizable Workloads", https://netflixtechblog.com/timestone-netflixs-high-throughput-low-latency-priority-queueing-system-with-built-in-support-1abf249ba95f

- K. Wahner, "Apache Kafka in the Gaming Industry: Use Cases + Architectures", https://dzone.com/articles/apache-kafka-in-the-gaming-industry-use-cases-arch