

數據串流平臺：Kafka

授課講師

蔡昀翰

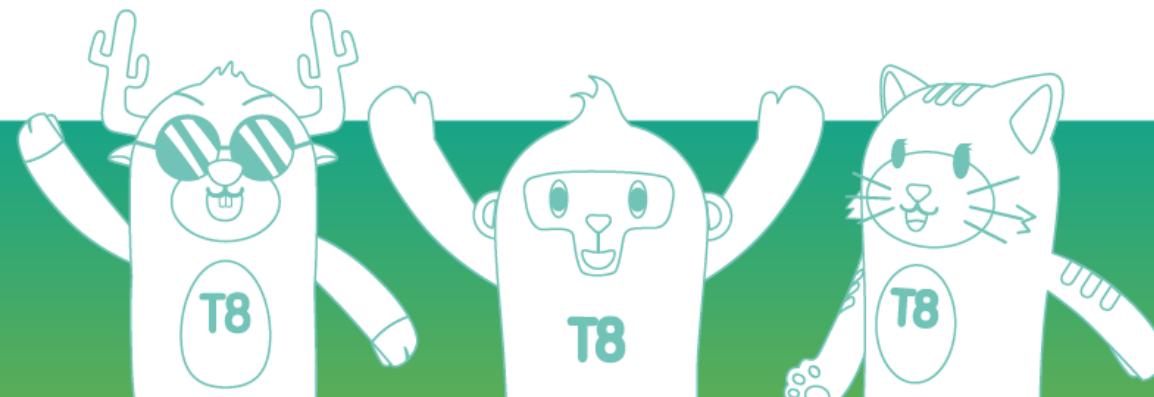
教材編寫

郭二文原著、蔡昀翰編修

緯
育 *TibaMe*

即學 · 即戰 · 即就業

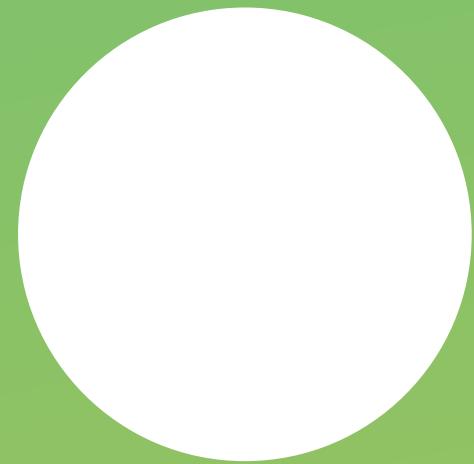
<https://www.tibame.com/>



課程大綱

- ◆ Module 1 : Introduction to Kafka and the ecosystem
- ◆ Module 2 : Basic Concepts of Apache Kafka
- ◆ Module 3 : Hands-on Practice of Apache Kafka
- ◆ Module 4 : Basic Topic Configurations
- ◆ Module 5 : Log Cleanup Policies
- ◆ Module 6 : Guidelines of Topic Configurations
- ◆ Module 7 : Hands-on Practice of Topic Configurations
- ◆ Module 8 : Broker Configurations Example
- ◆ Module 9 : Kafka Producers
- ◆ Module 10 : Consumer Groups
- ◆ Module 11 : Rebalance
- ◆ Module 12 : Kafka Consumers

授課講師介紹



蔡昀翰

專長

Data Pipeline Development in Big Data.

簡歷

Inno Technology Co., Ltd - Data Engineer

老師的話

大家加油。

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學習本課程須知

先備知識

<https://tinyurl.com/vqx7s5d>

學習目標 (1)

- A. 了解 Kafka Ecosystem 及基礎操作。
- B. Kafka 參數設定
- C. Kafka 生產者與消費者應用

學習方式

- A. 依課堂講授內容進行研讀
- B. 依課堂 Hands-On 操作

須完成 哪些作業 或考試

- A. 末節課堂完成 25 題測驗



一起修煉吧！



Module 1 : Introduction to Kafka and the Ecosystem

- 1-1 : Why Apache Kafka
- 1-2 : Use cases of Apache Kafka
- 1-3 : Kafka ecosystem
Architecture & Administration
Monitoring Tools

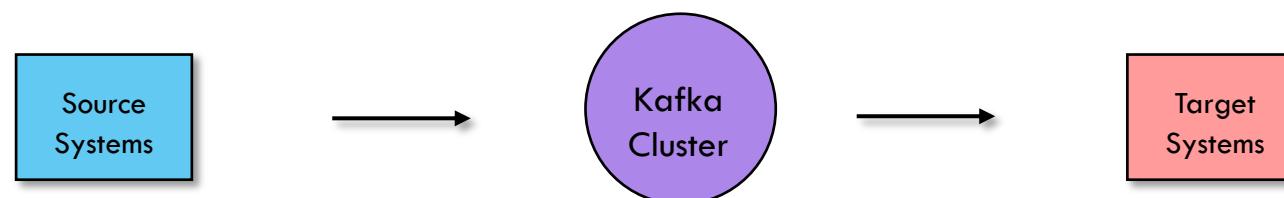
Course Objectives

- What is Kafka
- Learn about the Kafka ecosystem (high level)
- Learn Apache Kafka core API
 - Topics, Partitions
 - Brokers, Replication, Zookeeper
 - Producers, Consumers, Consumer Groups
- Get started with a broker setup on own machine using Docker-Compose

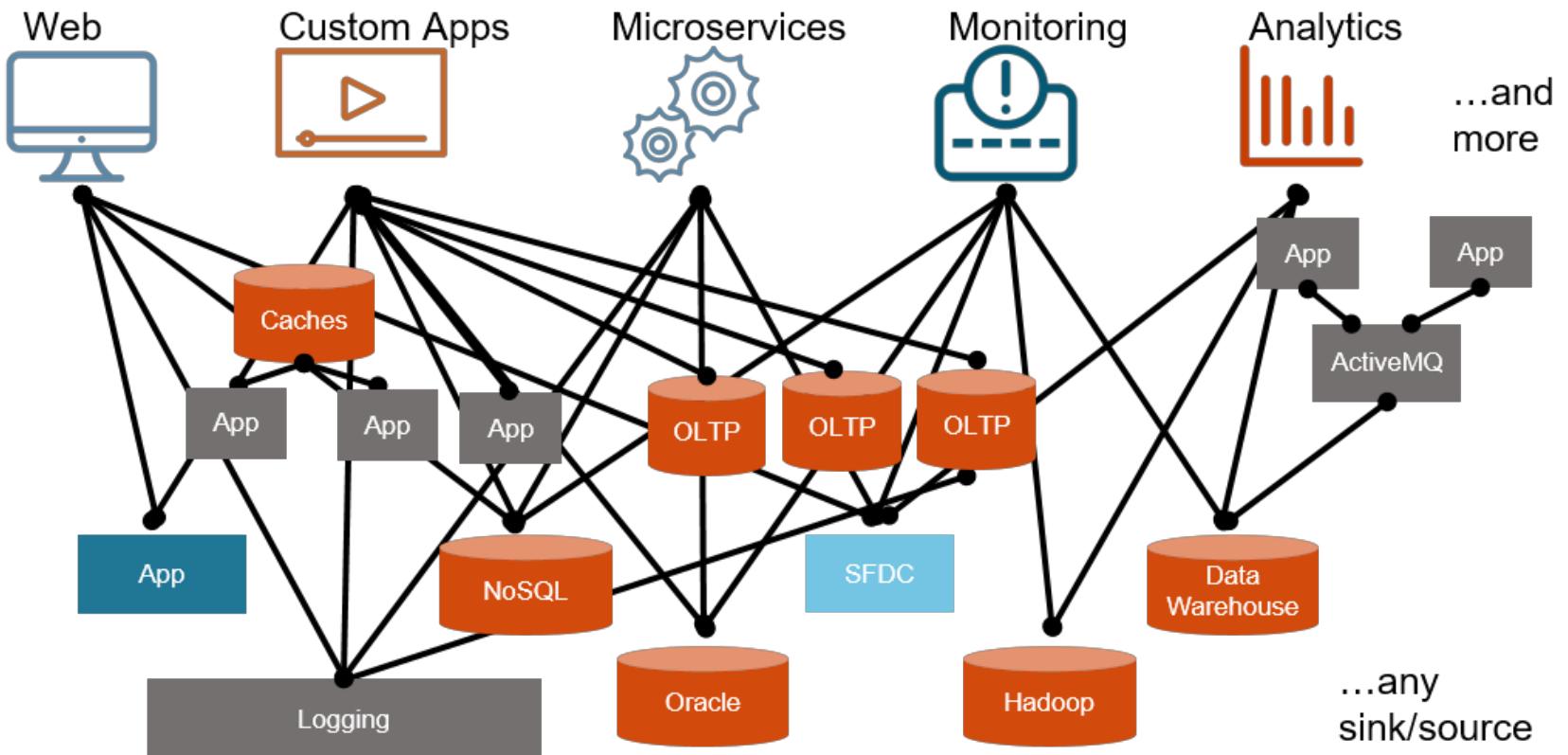
What is Apache Kafka

Kafka was developed at LinkedIn back in 2010

- Apache Kafka was originally developed by [LinkedIn](#), and open sourced in early 2011.
- Written in Scala and Java.
- The project aims to provide a unified, high-throughput, low-latency platform for handling **real-time** data feeds

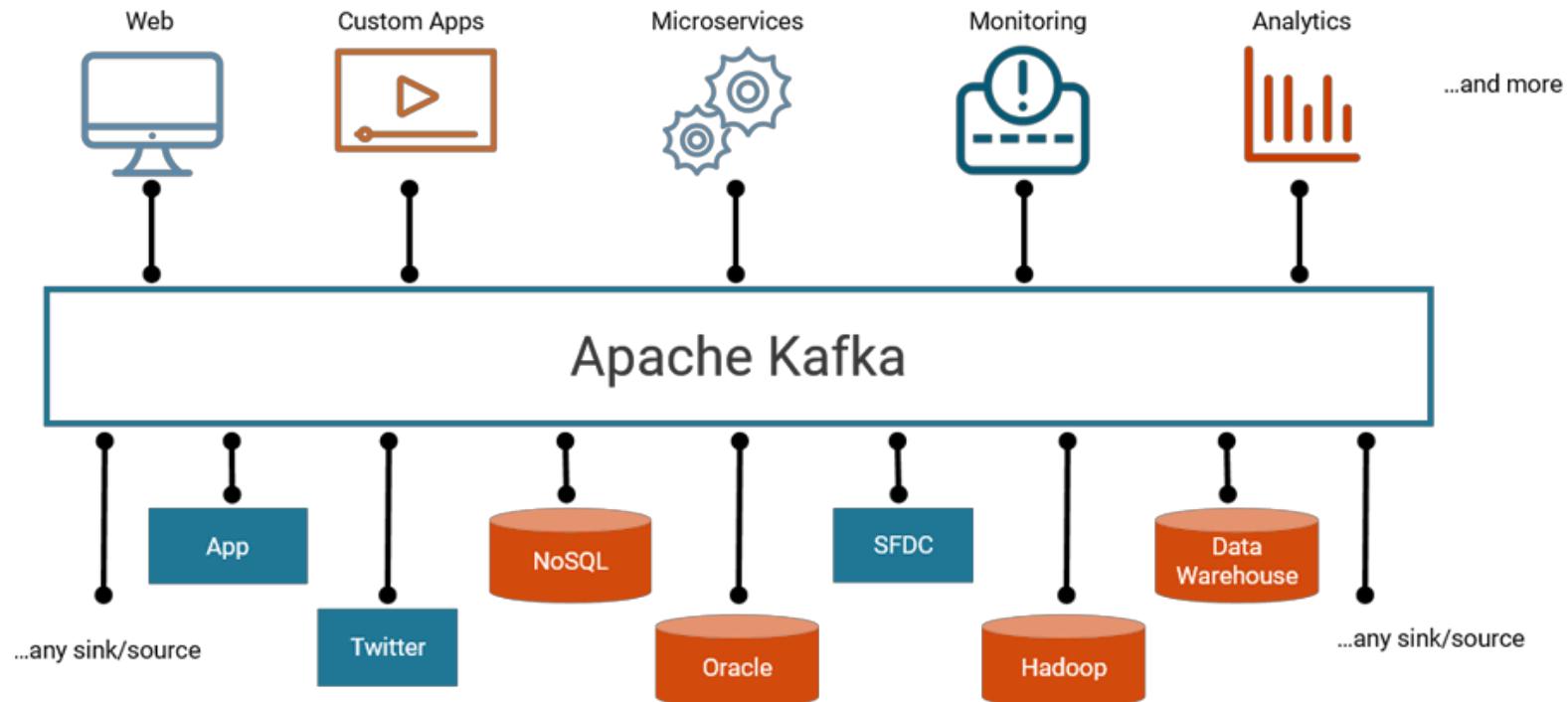


Why Apache Kafka Integration become very complicate



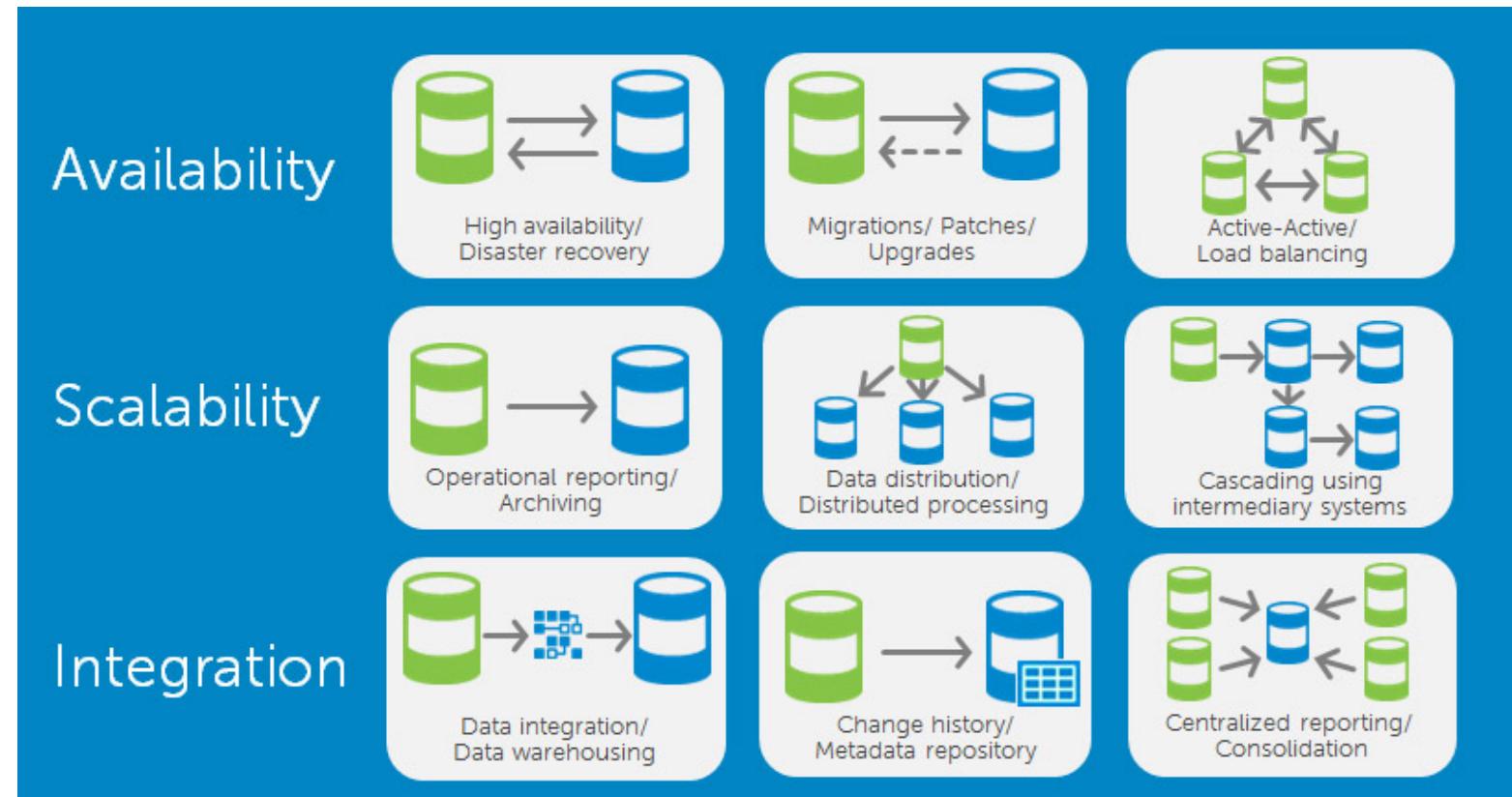
Ref# 4

Why Apache Kafka: Decoupling of data streams

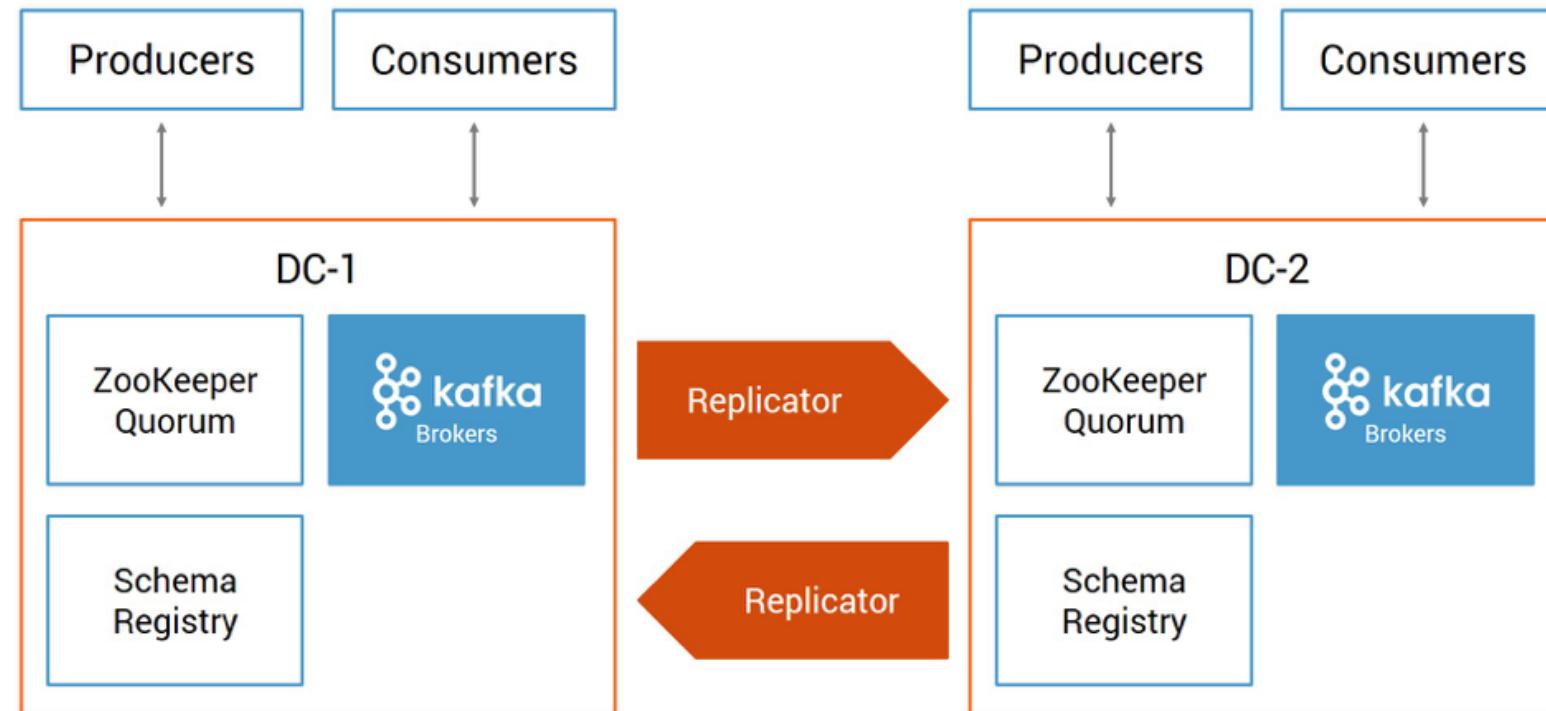


Ref# 4

Why Apache Kafka Data is very important



Why Apache Kafka: Decoupling of data location



Ref# 4

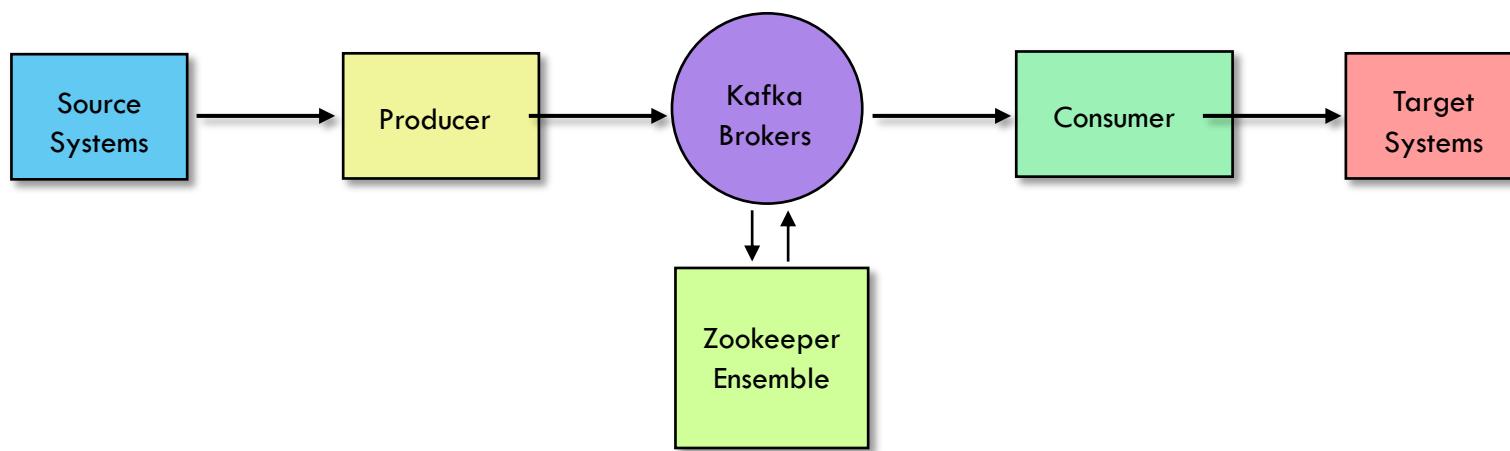
Why Apache Kafka

- Distributed, resilient architecture, fault tolerant
- Horizontal scalability
- High performance (latency of less than 10 ms) – real time
- Used by the 2000+ firms:
 - LinkedIn
 - Netflix
 - AirBnb
 - Yahoo
 - Walmart

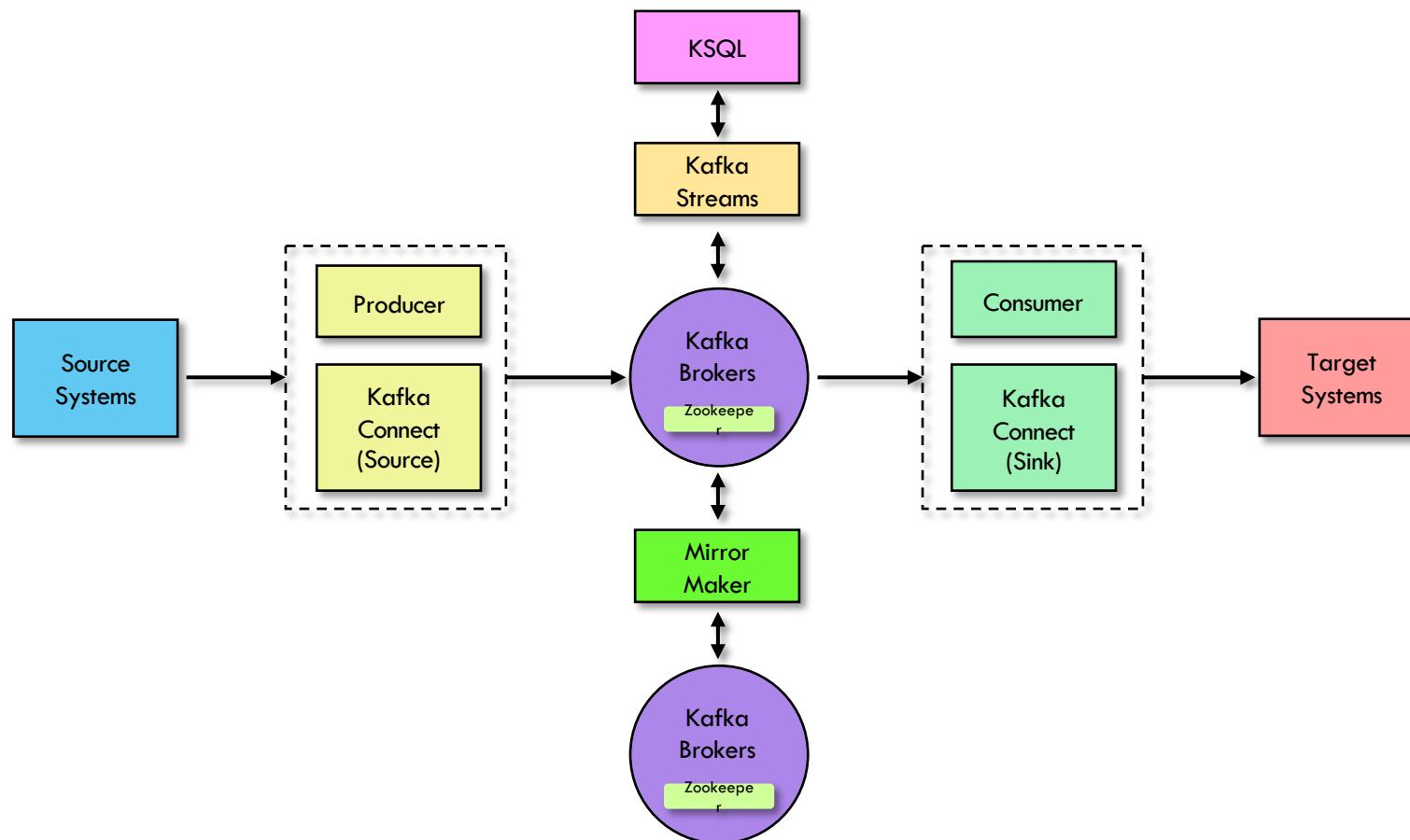
Apache Kafka: Use cases

- Messaging System
- Activity Tracking
- Gather metrics from many different locations (IoT / Industry 4.0)
- Application Logs gathering (Industry 4.0)
- Stream processing (with the Kafka Streams API or Spark for example)
- De-coupling of system dependencies
- Integration with Spark, Flink, Storm, Hadoop, and many other Big Data technologies

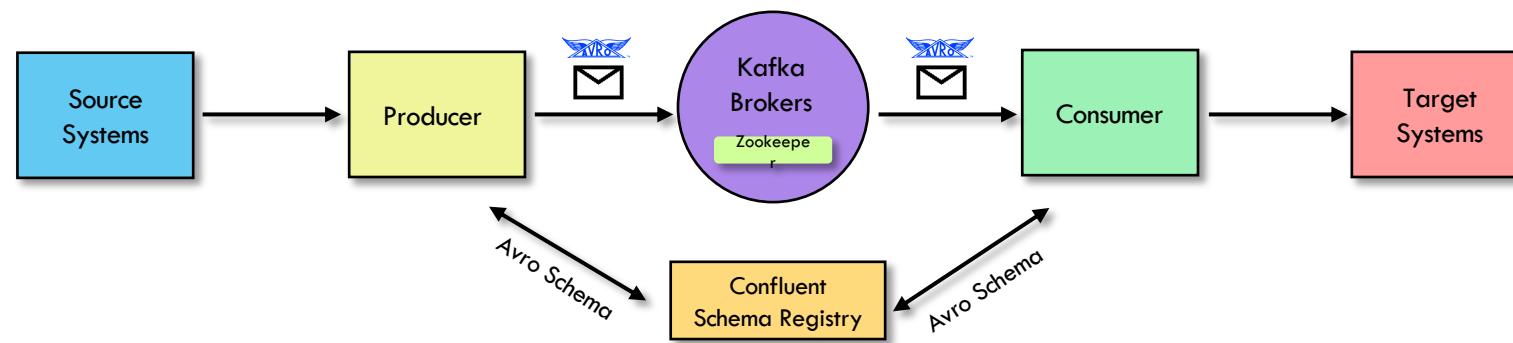
Kafka Ecosystem: Kafka Core



Kafka Ecosystem: Kafka Extended API



Kafka Ecosystem: Confluent Components - Schema Registry

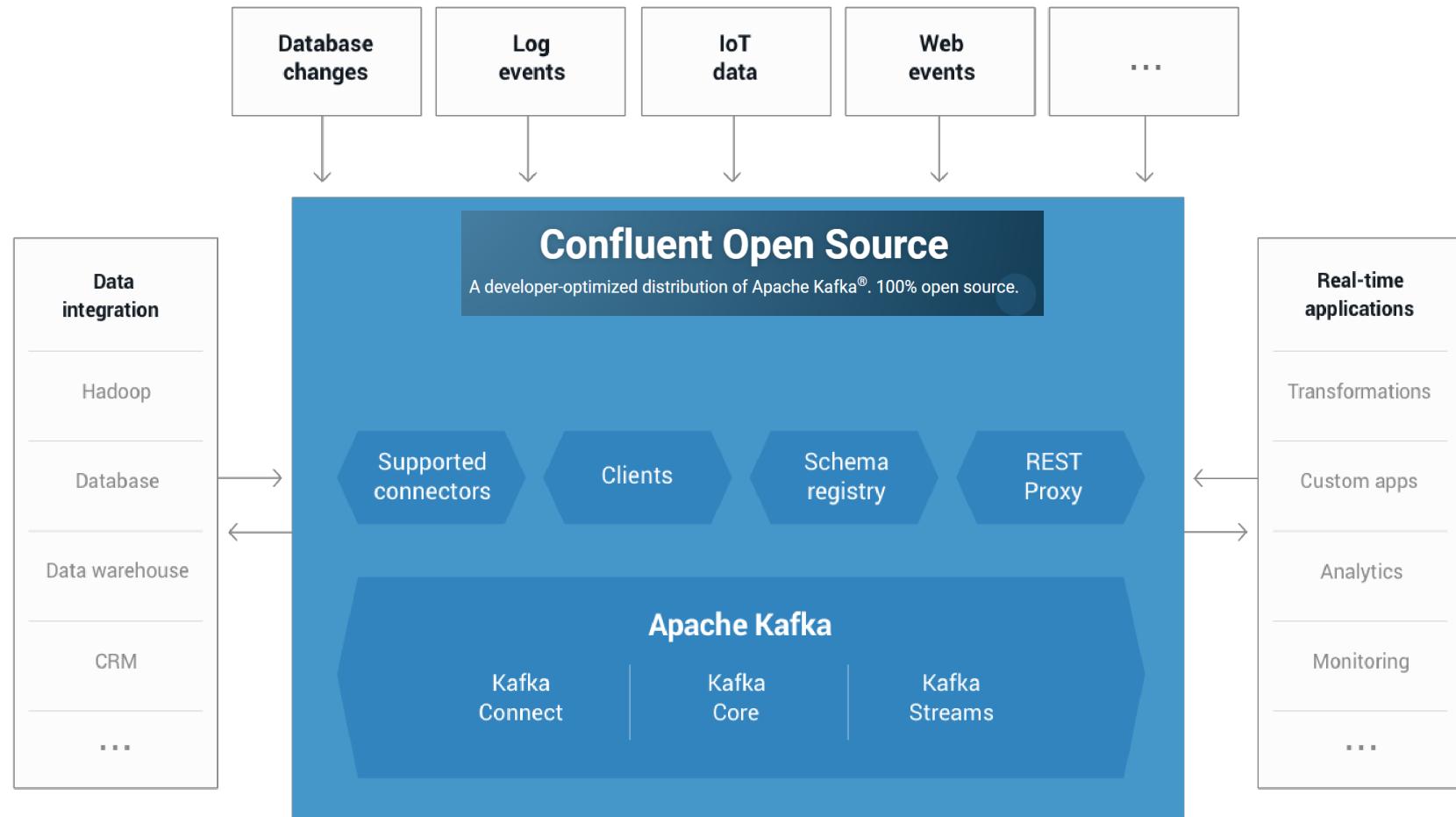


Kafka Ecosystem : Administration and Monitoring Tools

- Topics UI (Landoop): View the topics content
- Schema UI (Landoop): Explore the Schema registry
- Connect UI (Landoop): Create and monitor Connect tasks
- Kafka Manager (Yahoo): Overall Kafka Cluster Manager
- Burrow (LinkedIn): Kafka Consumer Lag Checking
- Exhibitor (Netflix): Zookeeper Configuration, Monitoring, Backup
- Kafka Tools (LinkedIn): Broker and topics admin tasks simplified
- Kafkat (Airbnb): More broker and topics admin tasks simplified
- JMX Dump: Dump JMX metrics from Brokers

Kafka in the Enterprise Architecture

Confluent Open Source Version



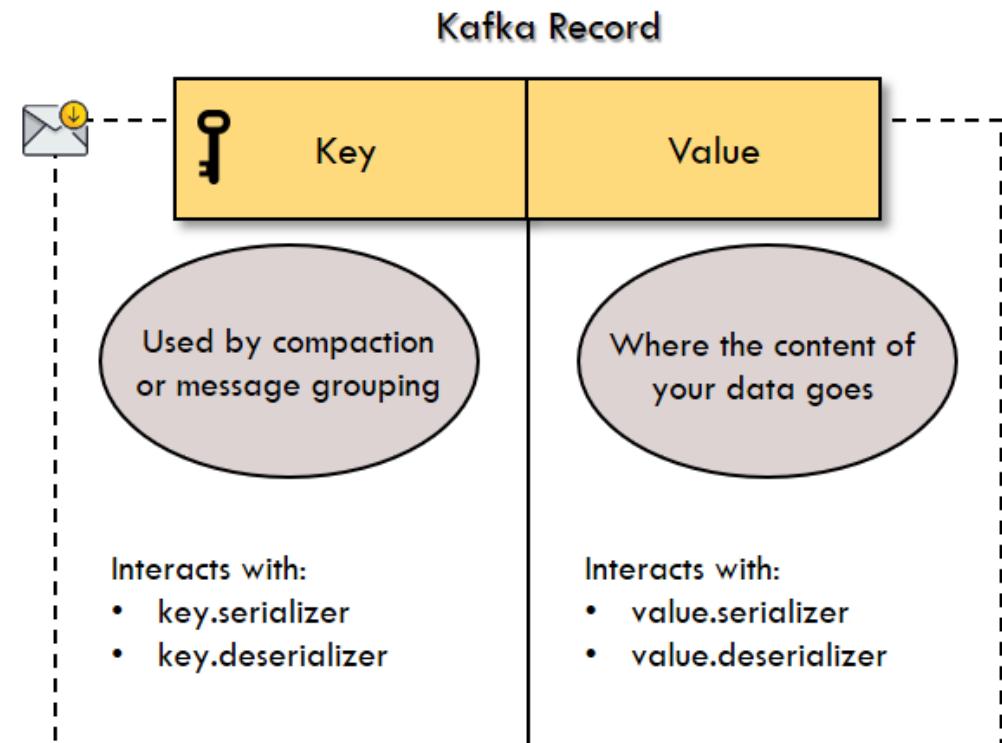
Ref#4

Module 2 : Basic Concepts of Apache Kafka

- 2-1 : Topics and partitions
- 2-2 : Broker
- 2-3 : Producer & Consumer

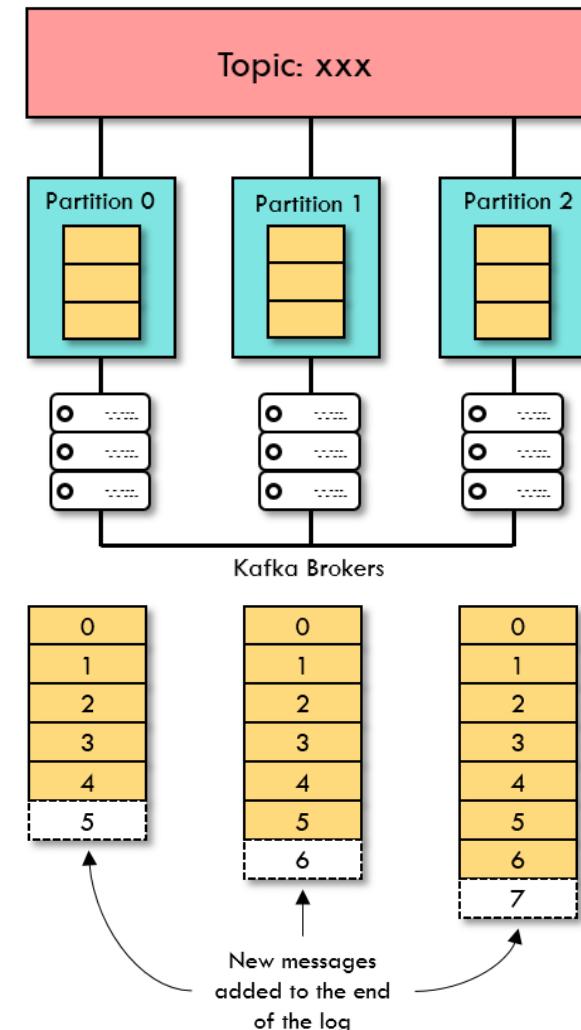
Kafka Record

- Every message publish to Kafka called “**Record**”
- **Record** contain two parts:
 - **Key**
 - Used by compaction or for message grouping
 - **Value**
 - The content of data goes



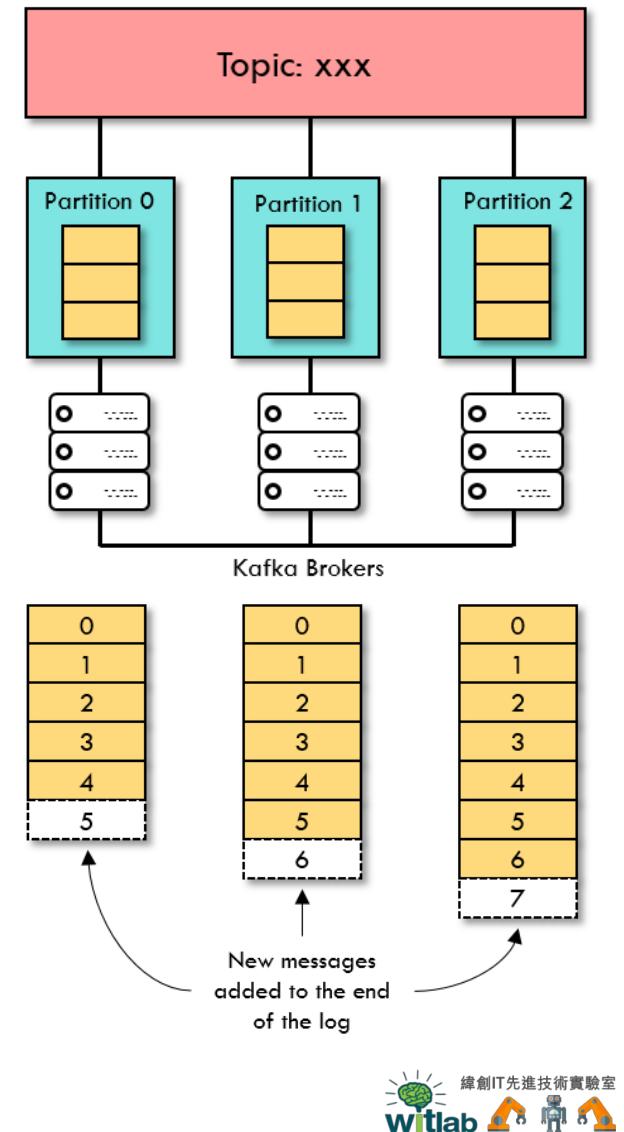
Topics and partitions

- **Topics:** a particular stream of data
 - Similar to a table in a database (without all the constraints)
 - You can have as many topics as you want
 - A topic is identified by its name
- Topics are split in **partitions**
 - Each partition is ordered
 - Each message within a partition gets an incremental id, called offset



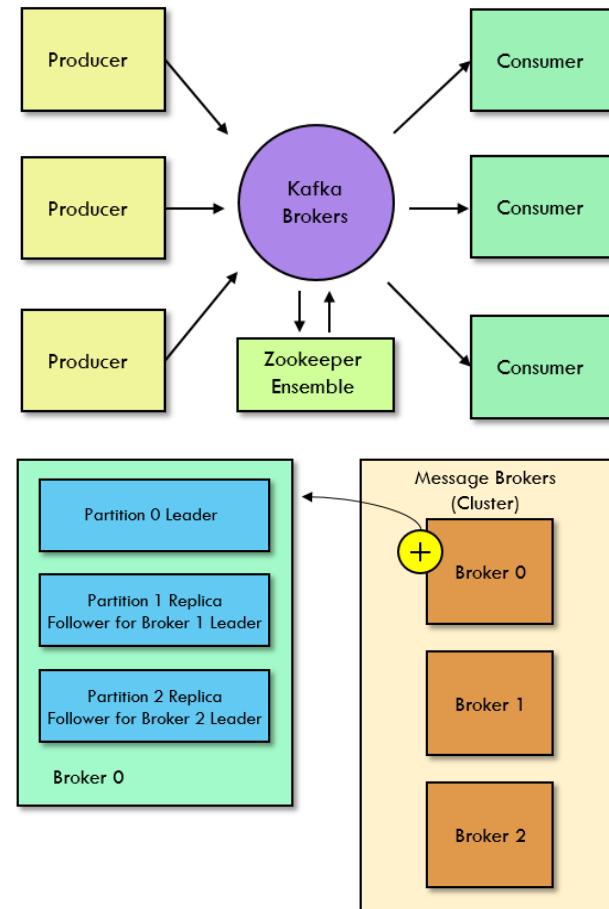
Topics and partitions

- **Offset** only have a meaning for a specific partition.
 - E.g. offset 3 in partition doesn't represent the same data as offset 3 in another partition
- Order is guaranteed only within a partition (not across partitions)
- Data is kept only for a limited time (default is **one weeks**)
- Once the data is written to a partition, it can't be changed (immutability)
- Data is assigned randomly to a partition unless a **key** is provided (more on this later)
- You can have as many partitions per topics as you want)



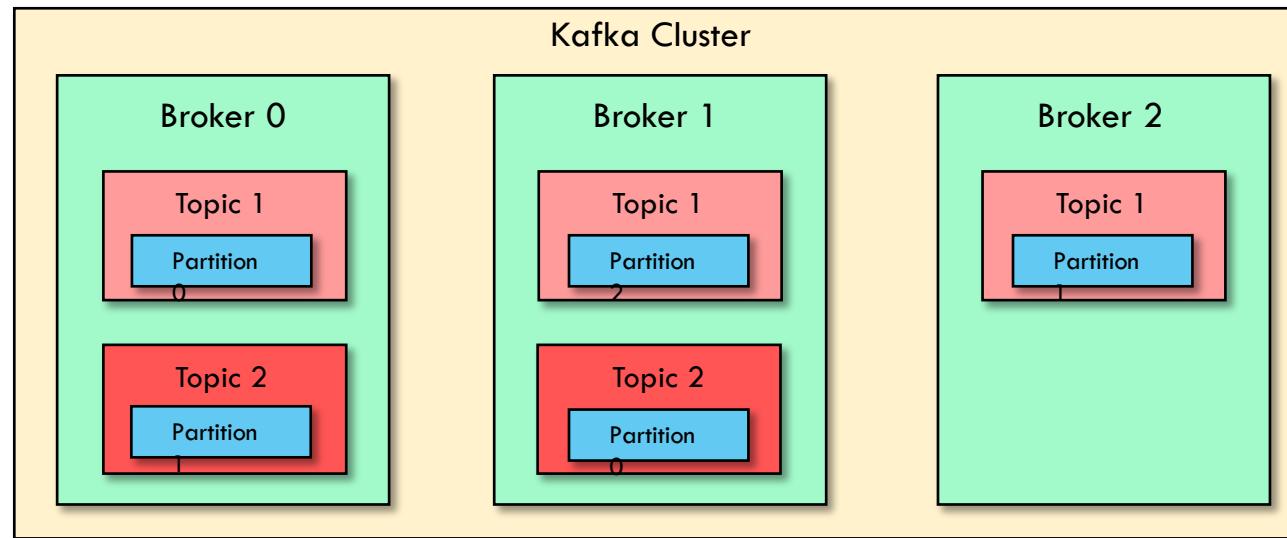
Brokers

- A Kafka cluster is composed of multiple **brokers** (servers)
- Each broker is identified with its ID (integer)
- Each broker contains certain topic partitions
- After connecting to any broker (called a bootstrap broker), you will be connected to the entire cluster
- A good number to get started is **3** brokers, but some big clusters have over 100 brokers



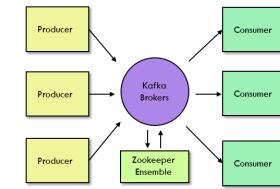
Brokers and topics

- Example of 2 topics (3 partitions and 2 partitions)

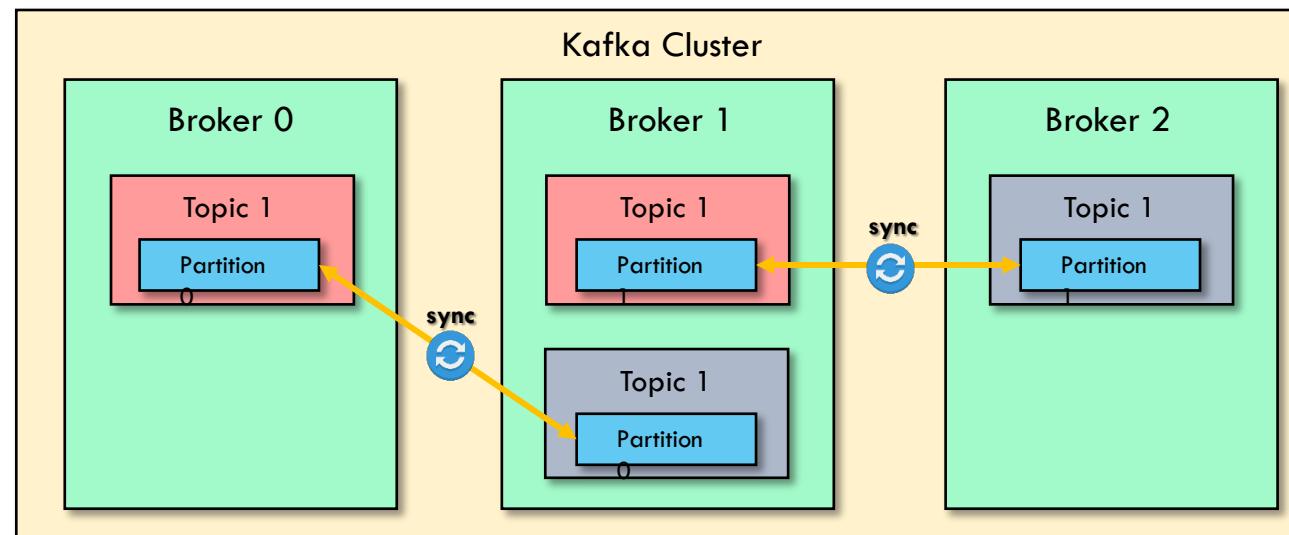


- Data is distributed and Broker 2 doesn't have any Topic 2 data

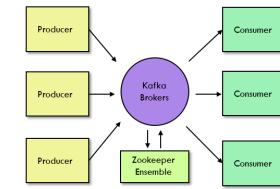
Topic replication factor



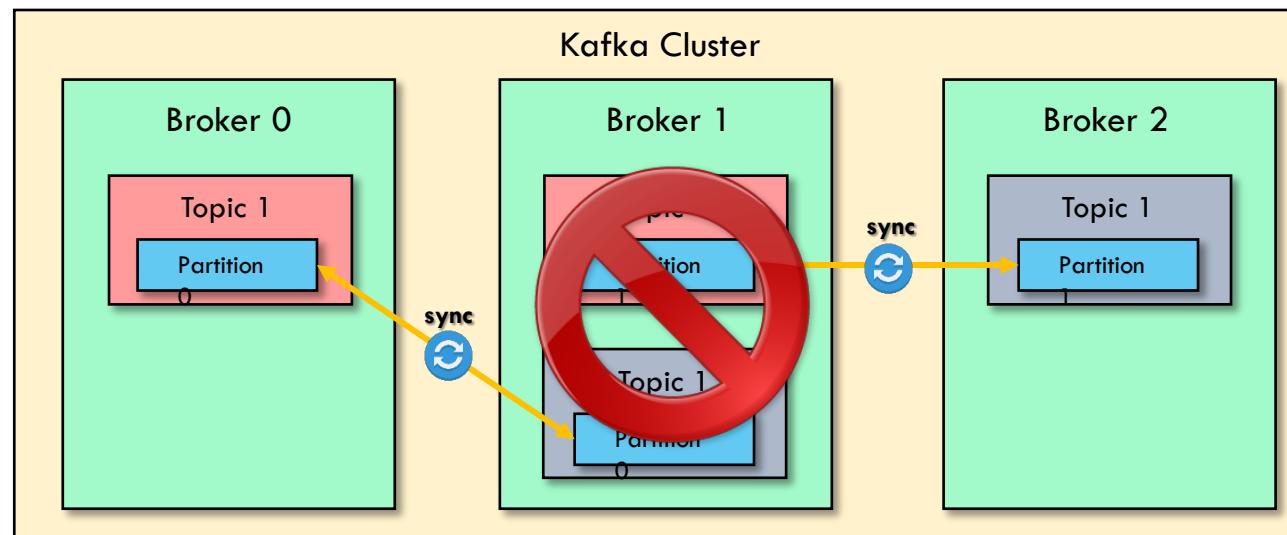
- Topics should have a replication factor > 1 (usually between 2 and 3)
- This way if a broker is down, another broker can serve the data
- Example: 1 **topic** with 2 **partitions** and **replication factor of 2**



Topic replication factor

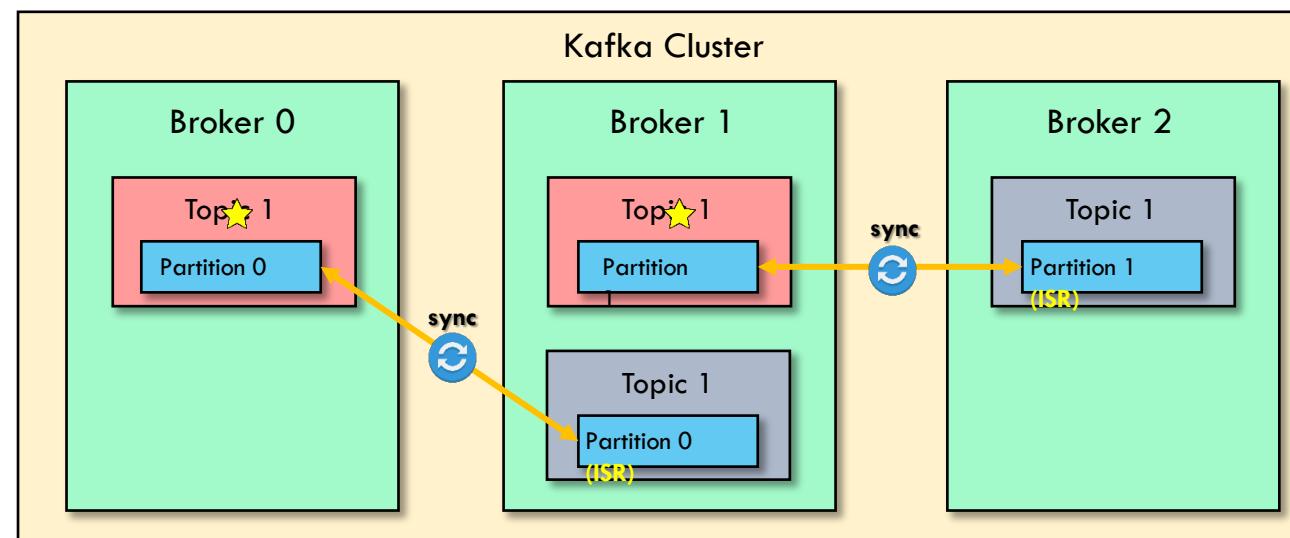
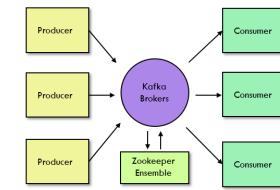


- Example: we lost Broker 1
- Result: Broker 0 and 2 can still serve the data



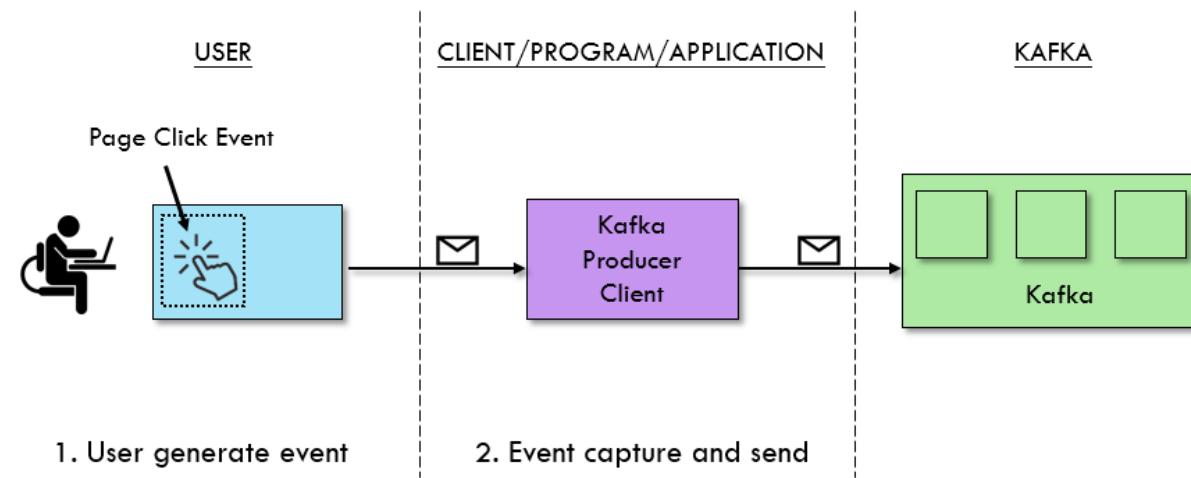
Concept of Leader for a partition

- At any time only 1 broker can be a leader for a given partition
 - Only that leader can retrieve and serve data for a partition
 - The other brokers will synchronize the data
 - There each partition has: one **leader**, and multiple **ISR** (in-sync replica)



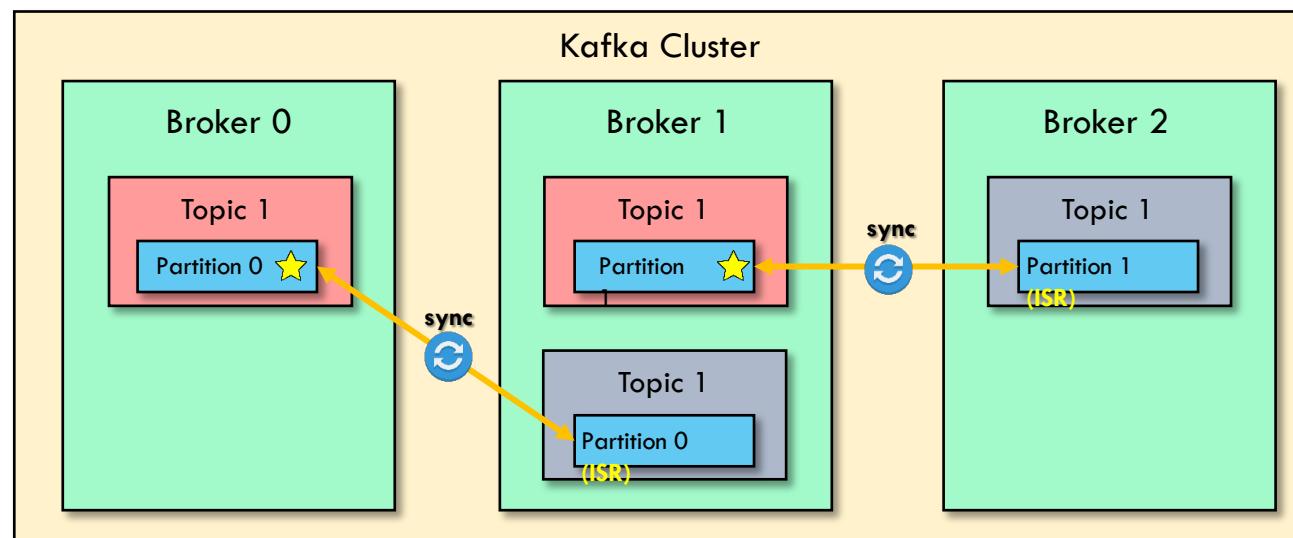
Producers

- **Producers** write data to **topics**.
- They only have to specify the topic name and one broker to connect to, and Kafka will automatically take care of routing the data to the right brokers.



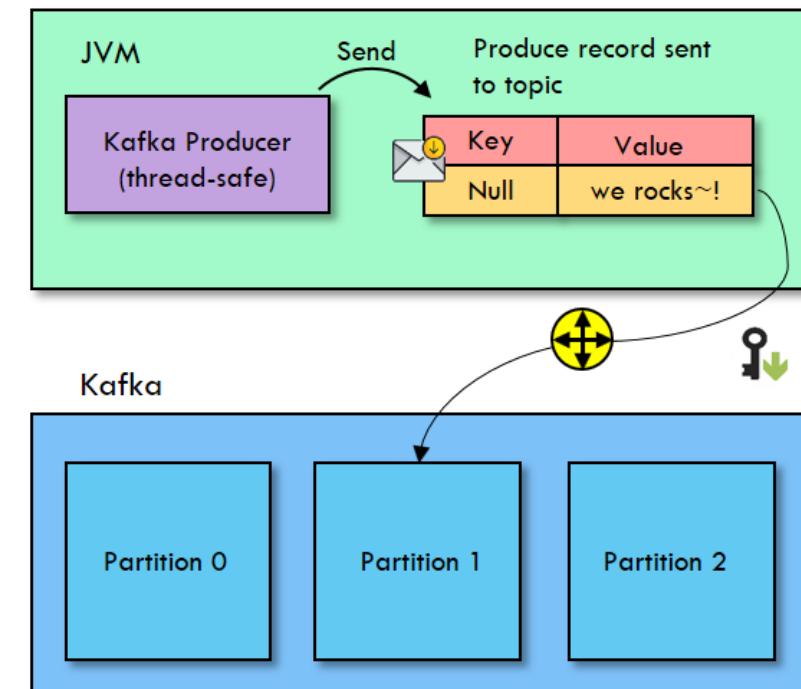
Producers: Broker acknowledgement

- Producer can choose to receive acknowledgement of data writes:
 - **acks = 0** : Producer won't wait for acknowledgement (possible data loss)
 - **acks = 1** : Producer will wait for leader acknowledgement (limited data loss)
 - **acks = all (-1)** : Leader + replicas acknowledgment (no data loss)

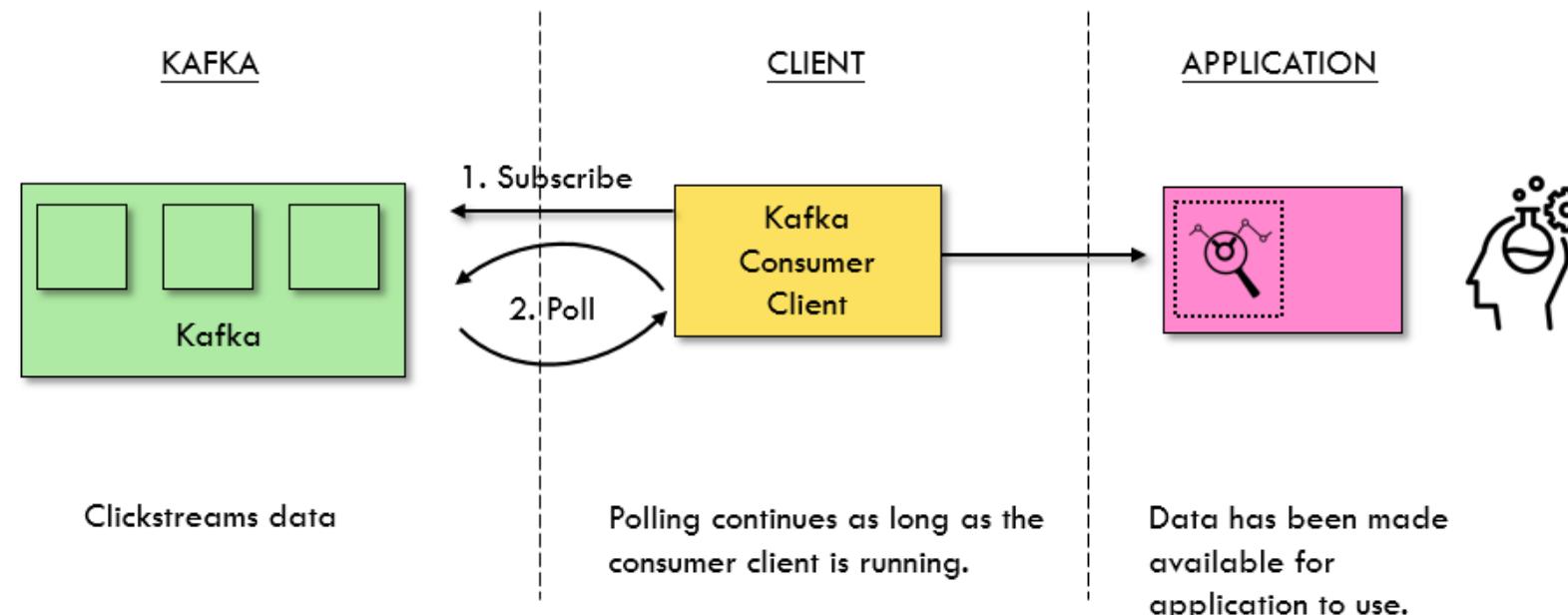


Producers: Message keys

- Producers can choose to send a key with the message
- If a **key** is sent, then the producer has the guarantee that all messages for that key will always go to the same partition
- This enables to guarantee ordering for a specific **key**

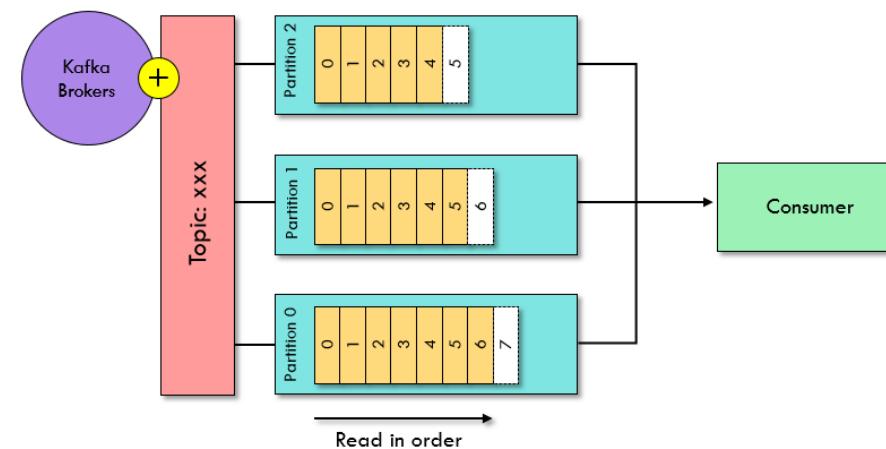
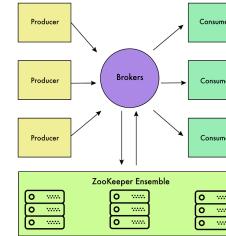


Kafka Consumer



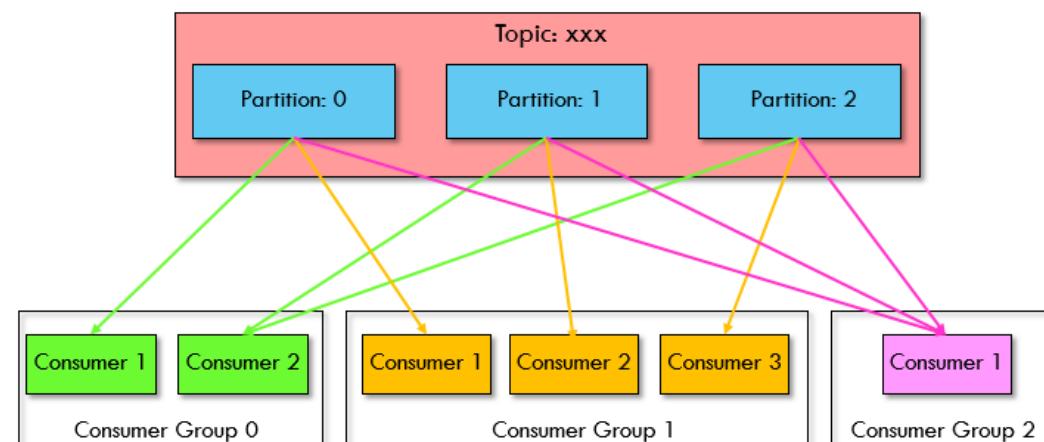
Consumers

- **Consumers** read data from a topic
- They only have to specify the topic name and one broker to connect to, and Kafka will automatically take care of pulling the data from the right brokers
- Data is read in order **for each partitions**



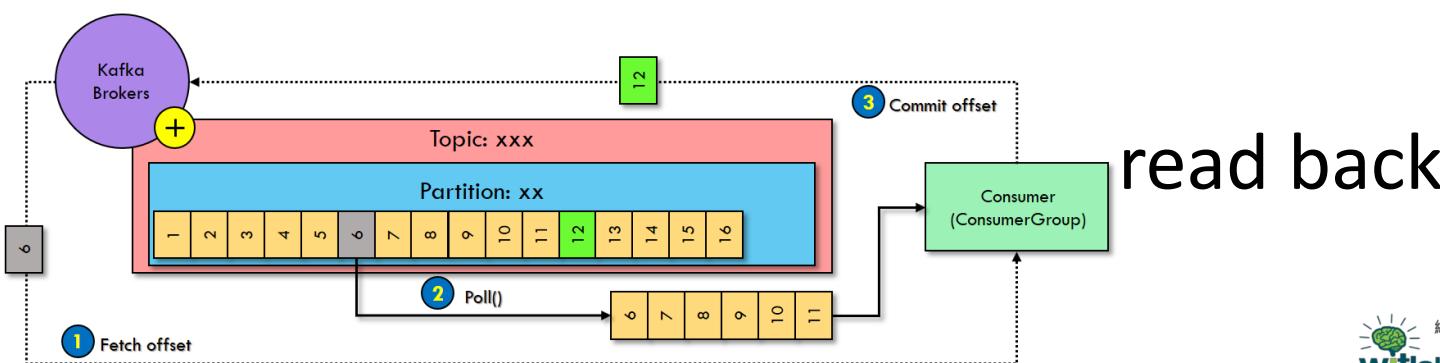
Consumer Groups

- Consumers read data in **consumer groups**
- Each consumer within a group reads from exclusive partitions
- You should control consumers instances less or equal than partitions (otherwise some will be inactive)



Consumer Offsets

- Kafka stores the offsets at which a **consumer group** has been reading
- The **offsets** commit live in a Kafka topic named “**__consumer_offsets**”
 - Key = [group, topic, partition] , Value=offset
- When a consumer has processed data received from Kafka, it should commit the offset back to Kafka
- If a consumer wants to resume reading from where it left off, it can fetch the offset from Kafka

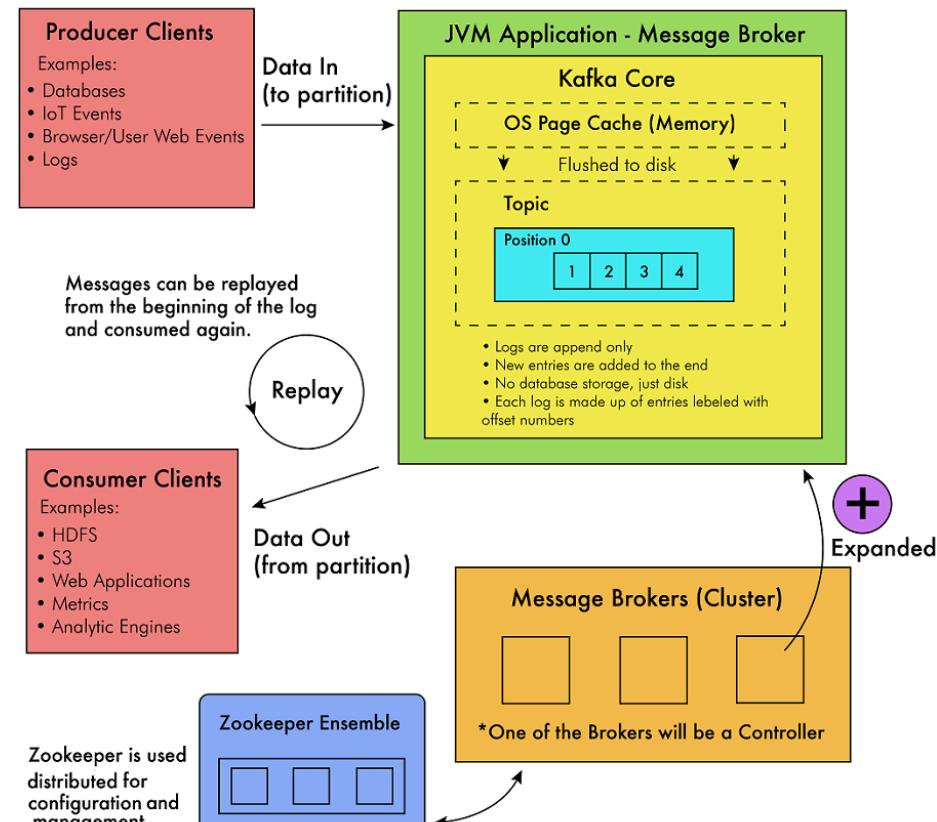


- Messages are appended to a **topic-partition** in the order they are sent
- Consumers read messages in the order stored in a **topic-partition**
- With a replication factor of N, producers and consumers can tolerate up to N-1 brokers being down
- This is why a replication factor of 3 is a good idea:
 - Allows for one broker to be taken down for maintenance
 - Allows for another broker to be taken down unexpectedly
- As long as the number of partitions remains constant for a topic (no new partitions), the same key will always go to the same partition

Delivery semantics for consumers

- As learned before, consumers choose when to commit offsets.
- **At most once:** offsets are committed as soon as the message is received. If the processing goes wrong, the message will be lost (it won't be read again).
- **At least once:** offsets are committed after the message is processed. If the processing goes wrong, the message will be read again. This can result in duplicate processing of messages. Make sure your processing is **idempotent** (i.e. processing again the message won't impact your systems)
- **Exactly once:** Very difficult to achieve / need strong engineering. Since version 0.11, Kafka start to support Exactly-once.

Terminology of Kafka



Ref#2

Module 3 : Hands-on Practice of Apache Kafka

- 3-1 : Kafka Topic Operations
- 3-2 : Producer
- 3-3 : Consumer

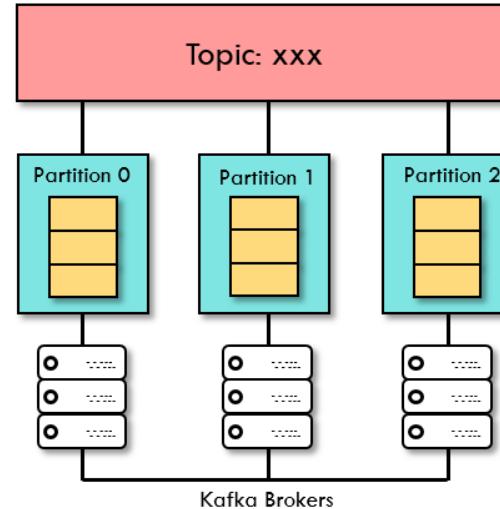
- In your Centos 7 VM - Go into Kafka docker container

- \$ su root
- \$ systemctl start docker
- \$ cd ~
- \$ ls
- \$ git clone <https://github.com/semicolon1709/kafka-tutorial-docker-env.git>
- \$ cd kafka-tutorial-docker-env
- \$ docker-compose up -d
- \$ docker exec -it kafka bash

Kafka Topic operations

create, list, delete, describe

- Create
 - kafka-topics --create --zookeeper zookeeper:2181 --replication-factor 1 --partitions 1 --topic test
- List
 - kafka-topics --list --zookeeper zookeeper:2181
- Describe
 - kafka-topics --describe --zookeeper zookeeper:2181 --topic test
- Delete
 - kafka-topics --delete --zookeeper zookeeper:2181 --topic test



Kafka Topic: create

```
$ kafka-topics \  
  --create \  
  --zookeeper zookeeper:2181 \  
  --replication-factor 1 --partitions 1 \  
  --topic test
```

```
root@kafka:/# kafka-topics --create \  
>   --zookeeper zookeeper:2181 \  
>   --replication-factor 1 \  
>   --partitions 1 \  
>   --topic test  
Created topic "test".
```

在container裡頭的
zookeeper服務的
Hostname

Topic "test" is created!

Kafka Topic: list

```
$ kafka-topics \  
  --list \  
  --zookeeper zookeeper:2181
```

```
root@kafka:/# kafka-topics --list --zookeeper zookeeper:2181  
__confluent.support.metrics  
test
```

The command will list
out all existing “topics”

Kafka Topic: describe

```
$ kafka-topics \  
  --describe \  
  --zookeeper zookeeper:2181 \  
  --topic test
```

```
root@kafka:/# kafka-topics --describe --zookeeper zookeeper:2181 --topic test  
Topic:test      PartitionCount:1      ReplicationFactor:1      Configs:  
          Topic: test      Partition: 0      Leader: 1      Replicas: 1      Isr: 1
```

The command tells
many details of a
“topic”

Kafka Topic: delete

```
$ kafka-topics \  
  --delete \  
  --zookeeper zookeeper:2181 \  
  --topic test
```

```
root@kafka:/# kafka-topics --delete --zookeeper zookeeper:2181 --topic test  
Topic test is marked for deletion.  
Note: This will have no impact if delete.topic.enable is not set to true.
```

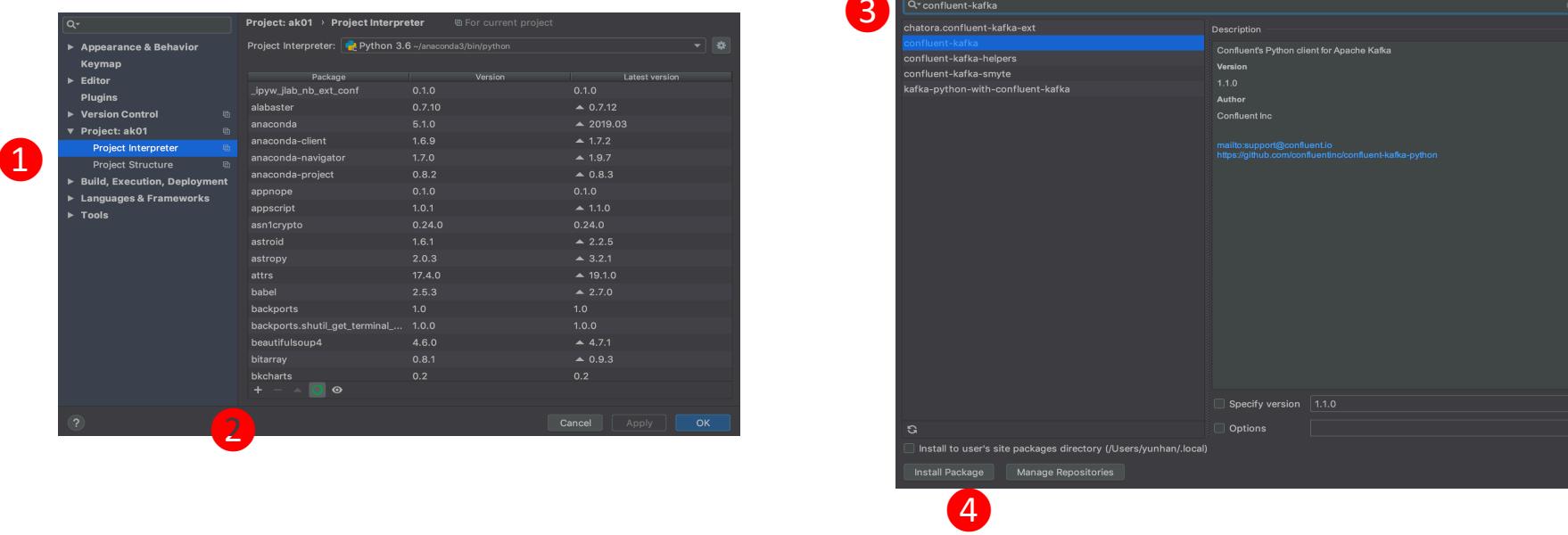
The command will has the
“topic” marked for deletion!

Hands-on Practice



- Python (In your Windows Host)

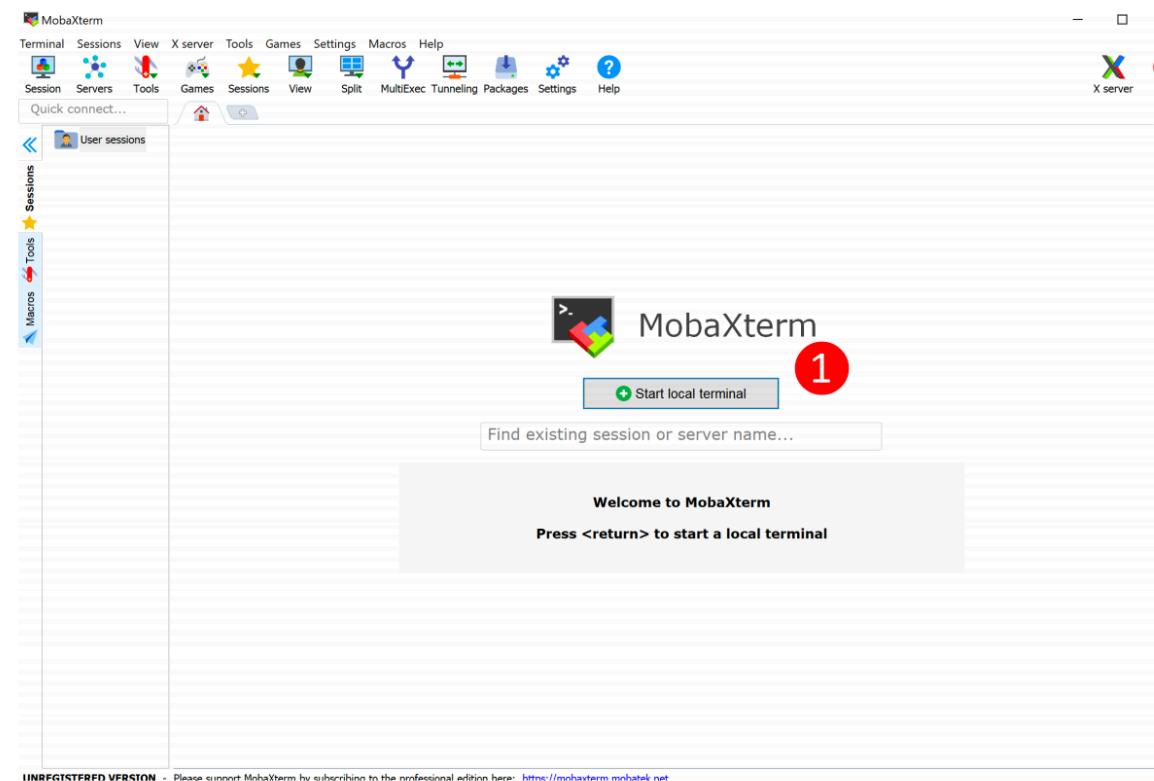
- Install PyCharm (<https://www.jetbrains.com/pycharm/>)
- Open Project with PyCharm: Kafka-Tutorial/02_document/ak01
- File -> Setting -> Project Interpreter -> + -> search confluent-kafka -> install package



Hands-on Practice

Connecting to Kafka on VM from Windows – SSH Tunneling

- MobaXterm (command) - Kafka-Tutorial/01_software/MobaXterm_Portable_v12.4



Hands-on Practice

Connecting to Kafka on VM from Windows – SSH Tunneling

- MobaXterm (command) - Kafka-Tutorial/01_software/MobaXterm_Portable_v12.4

The diagram illustrates the components of the SSH tunnel command shown in the terminal window. Three colored callout boxes point to specific parts of the command:

- A blue box labeled "Windows Host Port" points to the first "9092" in the command: `ssh -L 9092:localhost:9092 yht@192.168.142.153`.
- An orange box labeled "Target Host IP: Port" points to the "localhost" part of the command.
- A green box labeled "user@VM Host IP" points to the "yht@192.168.142.153" part of the command.

```
[2020-01-10 11:42.15] ~  
[yht.DESKTOP-CT89A71] > ssh -L 9092:localhost:9092 yht@192.168.142.153
```

• Important:
This is MobaXterm Personal Edition. The Professional edition allows you to customize MobaXterm for your company: you can add your own logo, your parameters, your welcome message and generate either an MSI installation package or a portable executable.
We can also modify MobaXterm or develop the plugins you need.
For more information: <https://mobaxterm.mobatek.net/download.html>

創建一個新的Topic – test3 - In Kafka docker (Centos 7 VM)

- kafka-topics \
 --create \
 --zookeeper zookeeper:2181 \
 --replication-factor 1 --partitions 1 \
 --topic test3

Hands-on Practice

- Producer - console: In Kafka docker (Centos 7 VM)
kafka-console-producer \
--broker-list localhost:9092 \
--topic test3
- Consumer - python: PyCharm (Windows Host)
RUN Python Code kafka_consumer.py

Hands-on Practice

- Producer - console: In Kafka docker (Centos 7 VM)
kafka-console-producer \
--broker-list localhost:9092 \
--topic test3
- Consumer - console: In Kafka docker (Centos 7 VM)
kafka-console-consumer \
--bootstrap-server localhost:9092 \
--topic test3

Hands-on Practice

- Producer - python: PyCharm (Windows Host)
RUN Python Code kafka_producer.py
- Consumer - console: In Kafka docker (Centos 7 VM)
kafka-console-consumer \
--bootstrap-server localhost:9092 \
--topic test3

Hands-on Practice

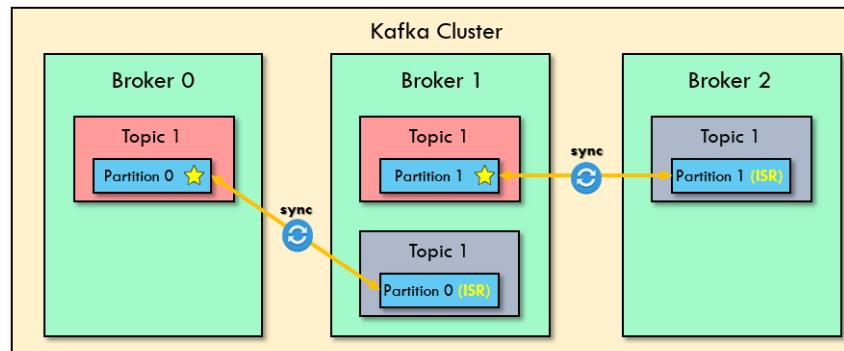
- Producer - python: PyCharm (Windows Host)
RUN Python Code kafka_producer.py
- Consumer - python : PyCharm (Windows Host)
RUN Python Code kafka_consumer.py

Module 4 : Basic Topic Configurations

- 4-1 : Partitions
- 4-2 : Replication Factors
- 4-3 : Segments

Partitions Count, Replication Factor

- The two **most important** parameters when creating a topic.
- The impact performance and durability of the system overall



- It is best to get the parameters right the first time!
 - If the **Partitions Count** increases during a topic life-cycle, you will break your keys ordering guarantees
 - If the **Replication Factor** increases during a topic life-cycle, you put more pressure on your cluster, which can lead to unexpected performance decrease

Partitions Count

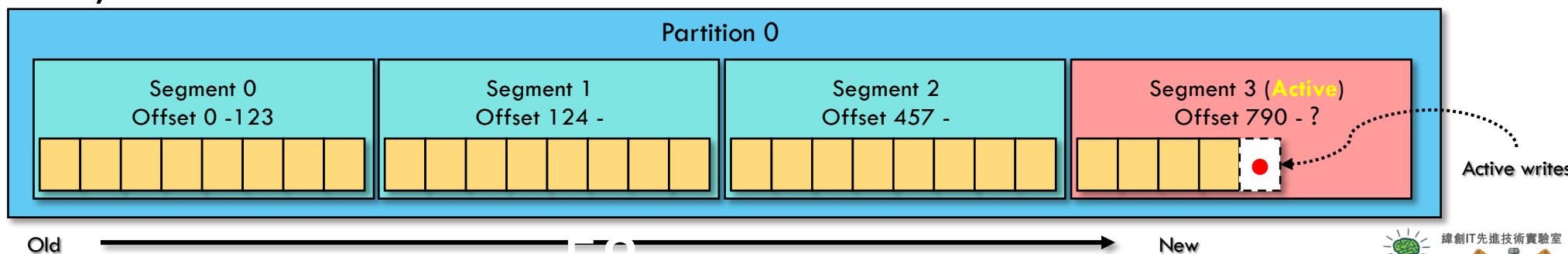
- Roughly, each partition can get a throughput of 10 MB / sec
- More partitions implies:
 - Better parallelism, better throughput
 - BUT more files opened on your system
 - BUT if a broker fails (unclean shutdown), lots of concurrent leader elections
 - BUT added latency to replicate (in the order of milliseconds)
- Guidelines:
 - Partitions per topic = (1 to 2) x (# of brokers), max 10 partitions
 - Example: in a 3 brokers setup, 3 or 6 partitions is a good number to start with

Replication Factor

- Should be at least **2**, maximum of **3**
- The higher the replication factor:
 - Better resilience of your system (N-1 brokers can fail)
 - BUT longer replication (higher latency if acks=all)
 - BUT more disk space on your system (50% more if RF is 3 instead of 2)
- Guidelines:
 - Set it to **2** (if you have 3 brokers)
 - Set it to **3** (if you have greater than 5 brokers)
 - If replication performance is an issue, get a better broker instead of less replication factor

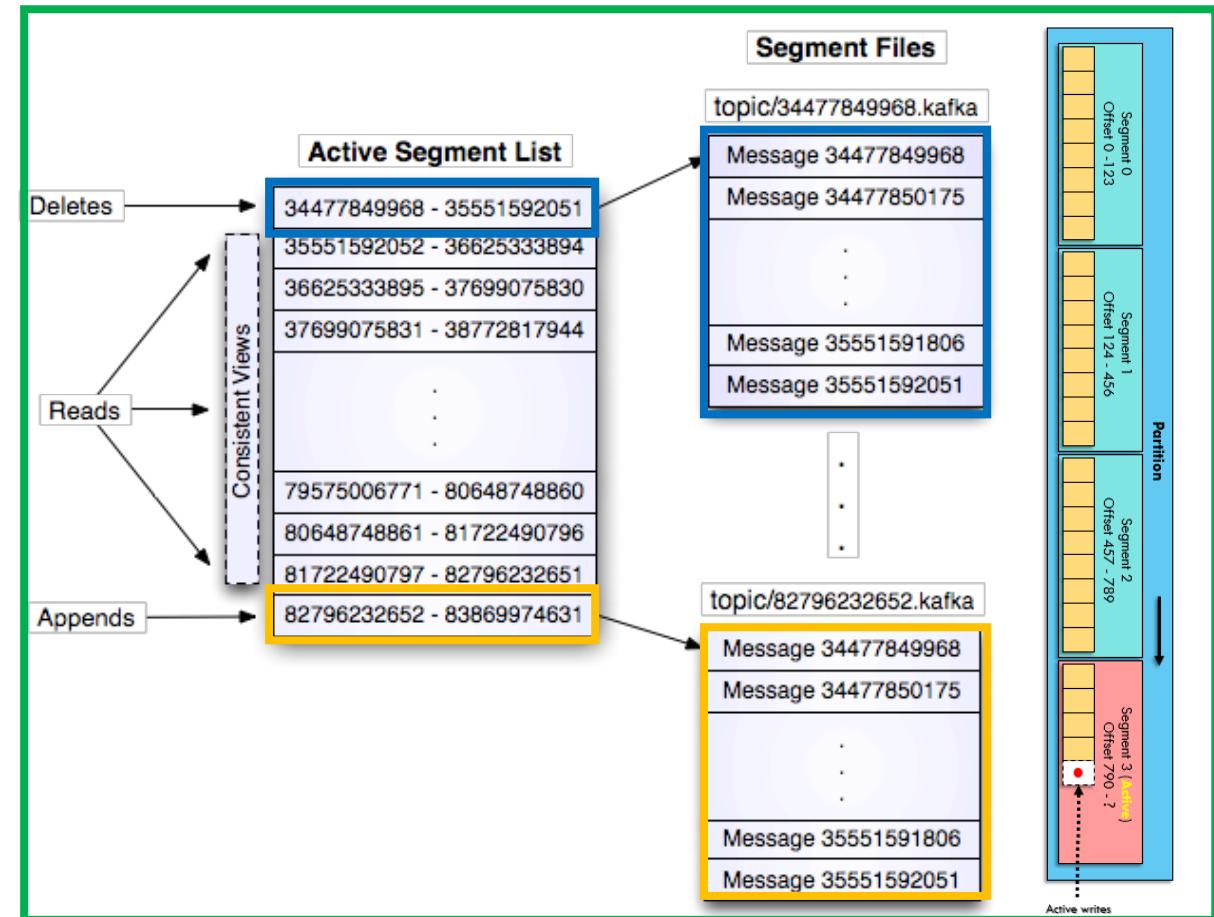
Partitions and Segments

- Topics are made of **partitions** (we already know that)
- Partitions are made of ... **segments** (files)!
- Only one **segment** is ACTIVE (the one data is being written to)



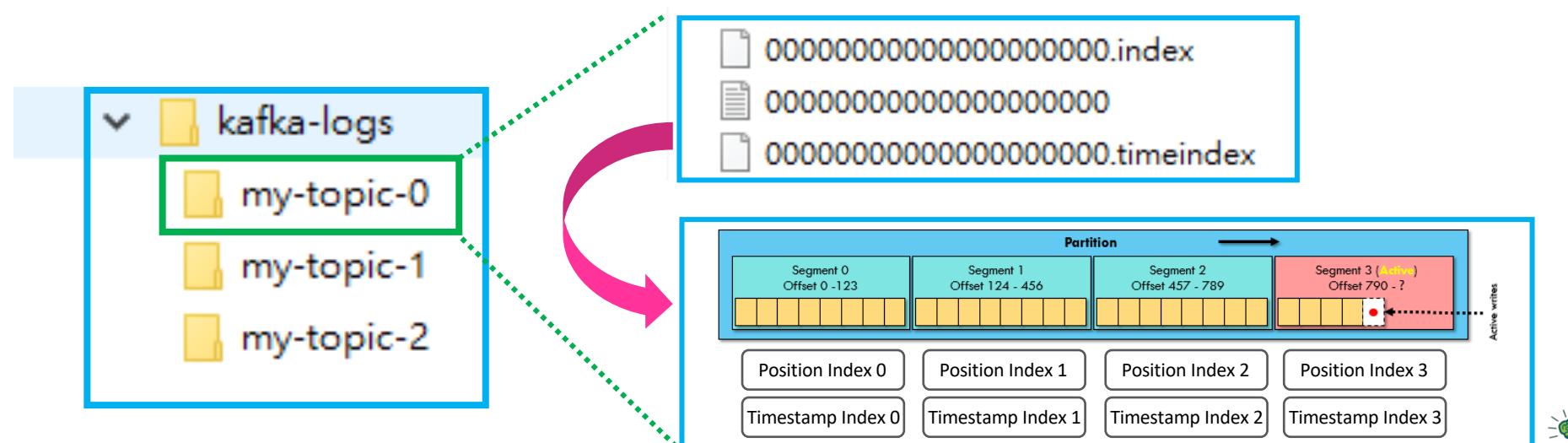
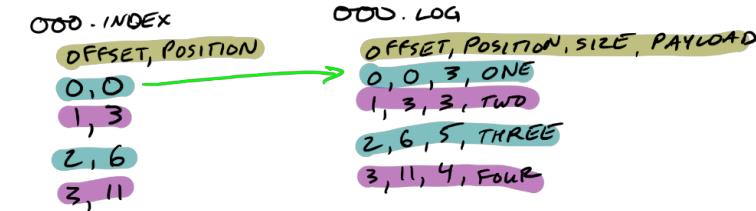
Partitions and Segments

- Two segment settings:
 - **log.segment.bytes**: the max size of a single segment in bytes
 - **segment.ms**: the time kafka will wait before committing the segment if not full



Segments and Indexes

- Segments come with **two** indexes (files):
 - An offset to position index: allows Kafka where to read to find a message
 - A timestamp to offset index: allow Kafka to find messages with a timestamp
- Therefore, Kafka knows where to find data in a constant time!



Segments and Indexes

Create Topic (test4)



```
$ kafka-topics  
  --create  
  --zookeeper zookeeper:2181  
  --replication-factor 1 --partitions 1  
  --topic test4
```

```
root@kafka:/# kafka-topics --create --zookeeper zookeeper:2181 \  
>   --replication-factor 1 --partitions 1 --topic test4  
Created topic "test4".
```

請注意**partitions**的數量與**topic**名稱

在**kafka**的資料目錄下會
找到對應的**folder**名稱

```
root@kafka:/# cd /var/lib/kafka/data  
root@kafka:/var/lib/kafka/data#  
root@kafka:/var/lib/kafka/data# ls -l test4-0  
total 0  
-rw-r--r-- 1 root root 10485760 Sep  6 08:57 00000000000000000000000000000000.index  
-rw-r--r-- 1 root root      0 Sep  6 08:57 00000000000000000000000000000000.log  
-rw-r--r-- 1 root root 10485756 Sep  6 08:57 00000000000000000000000000000000.timeindex  
-rw-r--r-- 1 root root      0 Sep  6 08:57 leader-epoch-checkpoint
```

Segments: Why should I care?

- A small **log.segment.bytes** (size, default: 1GB) means:
 - More segments per partitions
 - Log Compaction happens more often
 - BUT Kafka has to keep more files opened (Error: Too many open files)
- Ask yourself: how fast will I have new segments based on throughput?
- A small **log.roll.hours** or **log.roll.ms**(time, default 1 week) means:
 - You set a max frequency for log compaction (more frequent triggers)
 - Maybe you want daily compaction instead of weekly?
- Ask yourself: how often do I need log compaction to happen?

Module 5 : Log Cleanup Policies

5-1 : Delete

5-2 : Compact

5-3 : Clean up Policy Configurations

Log Cleanup Policies



- Many Kafka clusters make data expire, according to a **policy**
- That concept is called “**log cleanup**”.
 - Policy 1: **log.cleanup.policy=delete** (Kafka default for all user topics)
 - Delete based on age of data (default is a week)
 - Delete based on max size of log (default is -1 == infinite)
 - Policy 2: **log.cleanup.policy=compact** (Kafka default for topic **_consume_offsets**)
 - Delete based on keys of your messages
 - Will delete old duplicate keys **after** the active segment is committed
 - Infinite time and space retention

Log Cleanup: Why and When?

- Deleting data from Kafka allows you to:
 - Control the size of the data on the disk, delete obsolete data
 - Overall: Limit maintenance work on the Kafka Cluster
- How often does log cleanup happen?
 - Log cleanup happens on your **partition segments!**
 - Smaller / More segments means that log cleanup will happen more often!
 - Log cleanup shouldn't happen too often => takes CPU and RAM resources
 - The cleaner checks for work every 15 seconds (**log.cleaner.backoff.ms**)

Log Cleanup Policy: log.cleanup.policy=delete

- **log.retention.hours:**

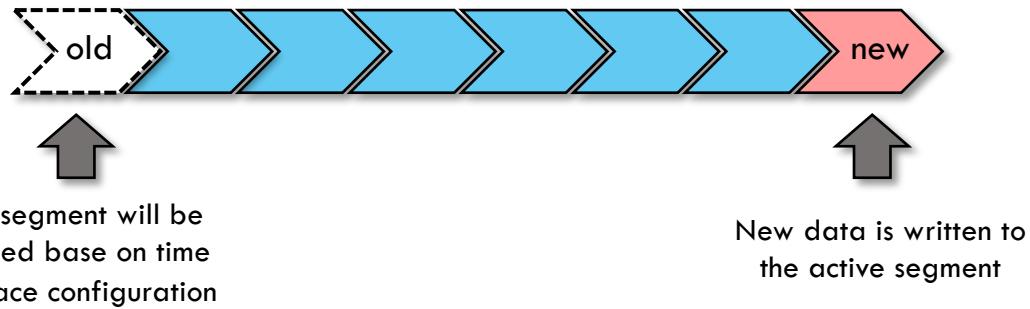
- Number of hours to keep data for (default is 168 – one week)
- Higher number means more disk space
- Lower number means that less data is retained (your consumers may need to replay more data than less)

- **log.retention.bytes:**

- Max size in Bytes for each partition (default is -1 == infinite)
- Useful to keep the size of a log under a threshold

Log Cleanup Policy: Delete

log.cleanup.policy=delete



Use cases – two common pair of options:

- One week of retention:
 - **log.retention.hours = 168** and **log.retention.bytes = -1**
- Infinite time retention bounded by 500 MB:
 - **log.retention.hours = 17520** and **log.retention.bytes = 524288000**

Log Cleanup Policy: Compact

log.cleanup.policy=compact

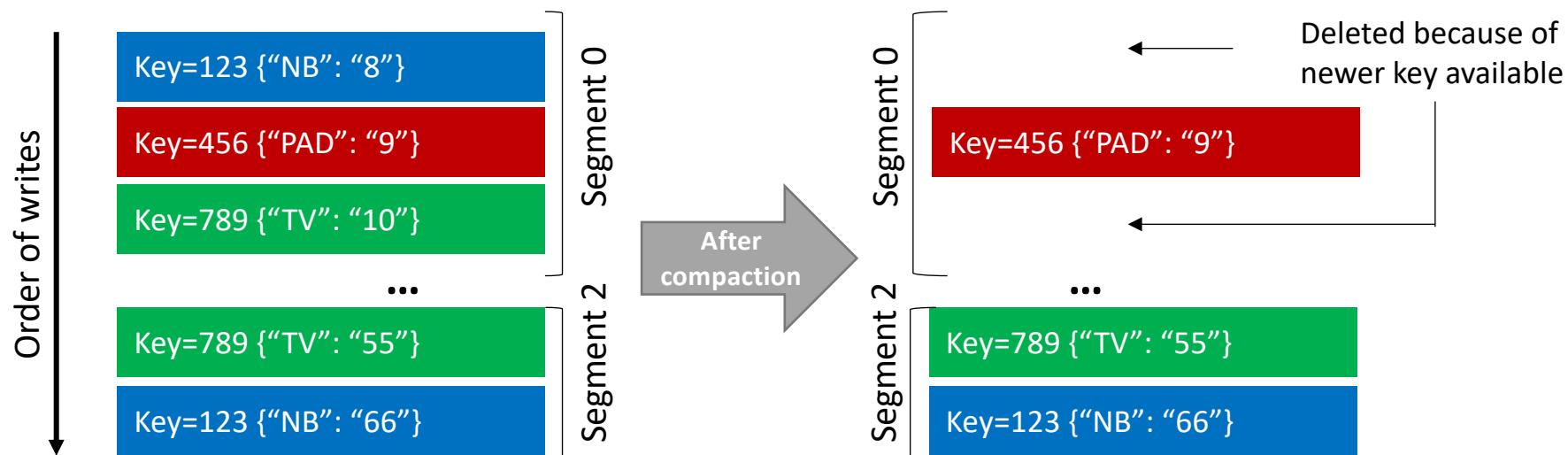


- Log compaction ensures that your log contains *at least the last known value for a specific key within a partition*
- Very useful if we just require a SNAPSHOT instead of full history (such as for a data table in a database)
- The idea is that we only keep the latest “update” for a key in our log

Log Cleanup Policy: Example

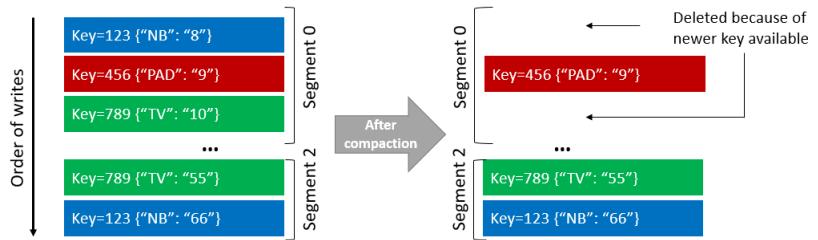
log.cleanup.policy=compact

- Our topic is: **product-inventory**
- We want to keep the most recent inventory for our products



Log Cleanup Policy: Example

`log.cleanup.policy=compact`



1

```
root@kafka:/# kafka-topics --zookeeper zookeeper:2181 --create \
>   --topic product-inventory \
>   --partitions 1 --replication-factor 1 \
>   --config cleanup.policy=compact \
>   --config min.cleanable.dirty.ratio=0.00001 \
>   --config segment.ms=1000
Created topic "product-inventory".
```

特別去設定這個topic的一些參數來展現log-compaction的效果

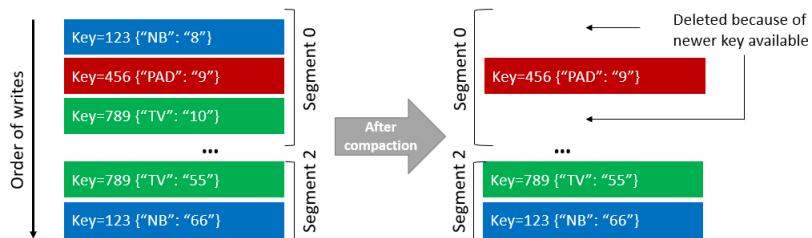
2

```
root@kafka:/# kafka-configs --zookeeper zookeeper:2181 \
>   --entity-type topics \
>   --entity-name product-inventory \
>   --describe
Configs for topic 'product-inventory' are min.cleanable.dirty.ratio=0.00001,cleanup.policy=compact,segment.ms=1000
```

檢查topic的參數

Log Cleanup Policy: Example

`log.cleanup.policy=compact`



再開一個
Console-
producer來發
佈資料

2 Producer#1

```
root@kafka:/# kafka-console-producer --broker-list kafka:9092 \
> --topic product-inventory \
> --property parse.key=true \
> --property key.separator=,
>123,{"NB":"8"}
456,{"PAD":"9"}
789,{"TV":"10"}
456,{"PAD":"7"}
789,{"TV":"11"}
456,{"PAD":"6"}
789,{"TV":"12"}
456,{"PAD":"5"}
789,{"TV":"13"}
```

3 貼上範例資料

1 Consumer#1

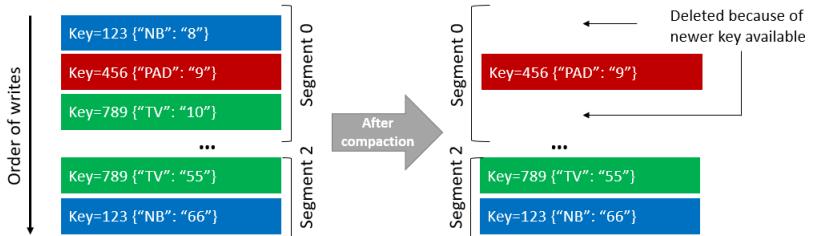
```
root@kafka:/# kafka-console-consumer \
> --bootstrap-server kafka:9092 \
> --topic product-inventory \
> --from-beginning \
> --property print.key=true \
> --property key.separator=,
123,{"NB":"8"}
456,{"PAD":"9"}
789,{"TV":"10"}
456,{"PAD":"7"}
789,{"TV":"11"}
456,{"PAD":"6"}
789,{"TV":"12"}
456,{"PAD":"5"}
789,{"TV":"13"}
```

4 即時收到發佈
的範例資料

開一個Console-
consumer訂閱這個
“product-inventory”
的topic

Log Cleanup Policy: Example

`log.cleanup.policy=compact`



Producer#1

```
root@kafka:/# kafka-console-producer --broker-list kafka:9092 \
> --topic product-inventory \
> --property parse.key=true \
> --property key.separator=,
>789,{"TV":"55"}\n123,{"NB":"66"}\n
```

6

貼上最後2筆範例資料

Console-consumer
確實地收到了最後
發佈的最後2筆範
例資料

Consumer#1

```
root@kafka:/# kafka-console-consumer \
> --bootstrap-server kafka:9092 \
> --topic product-inventory \
> --from-beginning \
> --property print.key=true \
> --property key.separator=,
123,{"NB":"8"}\n456,{"PAD":"9"}\n789,{"TV":"10"}\n456,{"PAD":"7"}\n789,{"TV":"11"}\n456,{"PAD":"6"}\n789,{"TV":"12"}\n456,{"PAD":"5"}\n789,{"TV":"13"}\n789,{"TV":"55"}\n123,{"NB":"66"}\n
```

7

Consumer#2

```
root@kafka:/# kafka-console-consumer \
> --bootstrap-server kafka:9092 \
> --topic product-inventory \
> --from-beginning \
> --property print.key=true \
> --property key.separator=,
123,{"NB":"8"}\n456,{"PAD":"5"}\n789,{"TV":"13"}\n789,{"TV":"55"}\n123,{"NB":"66"}\n
```

8

再開一個Console-
consumer訂閱這個
“product-inventory”的
topic

Consumer#2

經過compact之
後的結果！



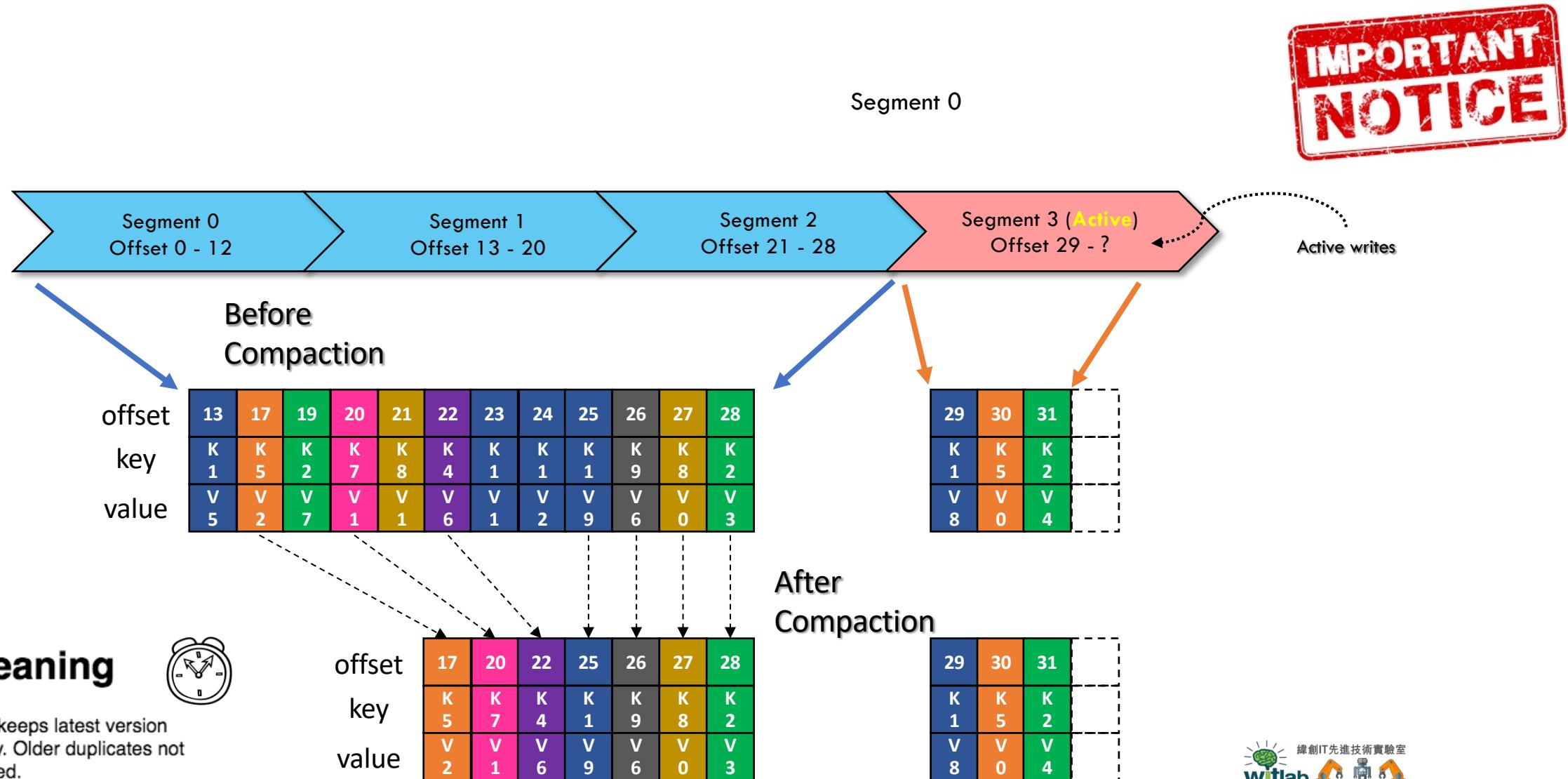
等待10秒後....

5

00:00
TIMER

Log Cleanup Policy: Example

`log.cleanup.policy=compact`

**Cleaning**

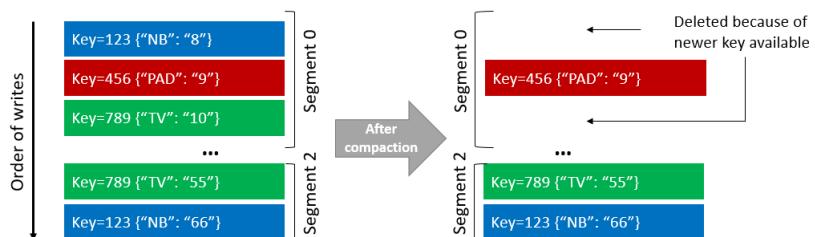
Only keeps latest version
of key. Older duplicates not
needed.

Log Compaction: Example

log.cleanup.policy=compact



- Any consumer that is reading *from the head of a log* will still see all the messages sent to the topic
- Ordering of message is kept, log compaction only removes some messages, but does not re-order them
- The offset of a message is immutable (it never changes). Offsets are just skipped if a message is missing



Module 6 : Guidelines of Topic Configurations

- 6-1 : Log Compression
- 6-2 : Other advanced configurations
- 6-3 : Why should I care about topic configuration?

Log Compression

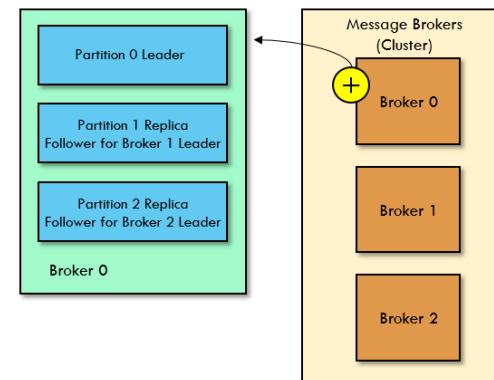
- Topics can be compressed using **compression.type** setting.
- Options are '**gzip**', '**snappy**', '**lz4**', '**uncompressed**', '**producer**'
- If you need compression, ideally you keep default as 'producer'.
 - The producer will perform the compression on its side
 - The broker will take the data as is => Saves CPU resources on the broker
- If compression is enabled, make sure you're sending batches of data
- Data will be uncompressed by the consumer!
- Compression only makes sense if you're sending **non-binary** data (**json**, **xml**, **text...**), don't enable compression for **binary** data (**parquet**, **protobuf**, **avro...**)

Other advanced configurations

- **max.message.bytes** (default is **1MB**): if your messages get bigger than 1MB, increase this parameter on the topic and your consumers buffer
- **min.insync.replicas** (default is **1**): if using acks=all, specify how many brokers need to acknowledge the write
- **unclean.leader.election.enable** (**danger zone!** – default **false**): if set to true, it will allow replicas which are not in sync to become leader as a last resort if all ISRs are offline. This can lead to data loss. If set to false, the topic will go offline until the ISRs come back up

Why should I care about topic configuration?

- Brokers have defaults for all the topic configuration parameters
- These parameters impact **performance** and **topic behavior**
- Some topics may need different values than the defaults
 - Replication Factor
 - Number of Partitions
 - Message size
 - Compression level
 - Log Cleanup Policy
 - Other configurations
- A list of configuration can be found at:
 - <https://kafka.apache.org/documentation/#topicconfigs>



Module 7 : Hands-on Practice of Topic Configurations

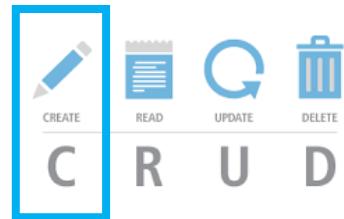
- 7-1 : Create Topic
- 7-2 : Alter Topic
- 7-3 : Delete Topic

Topic configuration example:



- Configurations pertinent to topics have both a **server default** as well an optional **per-topic override**.
- *If no per-topic configuration is given the server default is used.*
- The override can be set at topic creation time by giving one or more **--config** options.

Topic configuration example: (Create)



- Configurations pertinent to topics have both a server default as well an optional per-topic override.
- If no per-topic configuration is given the server default is used.

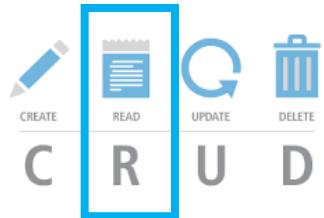
**kafka-topics **

```
--zookeeper zookeeper:2181 \
--create \
--topic my-topic \
--partitions 3 \
--replication-factor 1 \
--config max.message.bytes=64000 \
--config flush.messages=1
```

```
streamgeeks.org - PuTTY
$ kafka-topics --create \
> --zookeeper localhost:2181 \
> --topic my-topic \
> --partitions 3 \
> --replication-factor 1 \
> --config max.message.bytes=64000 \
> --config flush.messages=1
Created topic "my-topic".
```

Kafka會先載入預設的config, 然後再加上特別設定的config!

Topic configuration example: (Query)



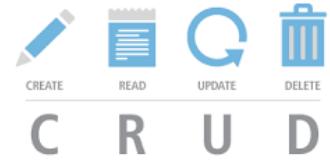
```
kafka-topics \
--zookeeper zookeeper:2181 \
--topic my-topic \
--describe
```

```
streamgeeks.org - PuTTY
$ kafka-topics --create \
> --zookeeper localhost:2181 \
> --topic my-topic \
> --partitions 3 \
> --replication-factor 1 \
> --config max.message.bytes=64000 \
> --config flush.messages=1
Created topic "my-topic".
```

```
streamgeeks.org - PuTTY
$ kafka-topics --zookeeper localhost:2181 \
> --topic my-topic \
> --describe
Topic:my-topic PartitionCount:3      ReplicationFactor:1      Configs:max.message.bytes=64000,flush.messages=1
      Topic: my-topic Partition: 0    Leader: 0      Replicas: 0      Isr: 0
      Topic: my-topic Partition: 1    Leader: 0      Replicas: 0      Isr: 0
      Topic: my-topic Partition: 2    Leader: 0      Replicas: 0      Isr: 0
```

Kafka會先載入預設的config, 然後再加上特別設定的config!

Topic configuration example: (Update)



```
kafka-topics \
--zookeeper zookeeper:2181 \
--topic my-topic \
--alter \
--config max.message.bytes=128000
```

為了讓修改Kafka的相關設定有一個共同的Utility工具,Kafka建議使用“[kafka-configs](#)”來修改Topic設定

The screenshot shows a terminal window titled "streamgeeks.org - PuTTY". The command entered is:

```
$ kafka-topics --zookeeper localhost:2181 \
> --topic my-topic \
> --alter \
> --config max.message.bytes=128000
```

A yellow box highlights the command `--config max.message.bytes=128000`. A dashed yellow arrow points from this box to a warning message in the terminal output:

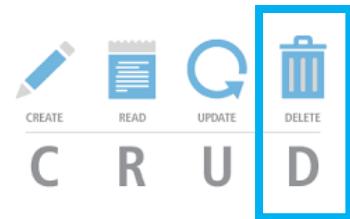
WARNING: Altering topic configuration from this script has been deprecated and may be removed in future releases.
Going forward, please use kafka-configs.sh for this functionality.

The terminal then shows the updated configuration:

```
Updated config for topic "my-topic".
$ kafka-topics --zookeeper localhost:2181 \
> --topic my-topic \
> --describe
Topic:my-topic PartitionCount:3      ReplicationFactor:1      Configs:max.message.bytes=128000 flush.messages=1
  Topic: my-topic Partition: 0    Leader: 0      Replicas: 0    Isr: 0
  Topic: my-topic Partition: 1    Leader: 0      Replicas: 0    Isr: 0
  Topic: my-topic Partition: 2    Leader: 0      Replicas: 0    Isr: 0
```

A yellow speech bubble on the right says "修改的設定生效了!" (The modified setting has taken effect!).

Topic configuration example: (Remove)



```
kafka-topics \
--zookeeper zookeeper:2181 \
--topic my-topic \
--alter \
--delete-config max.message.bytes
```

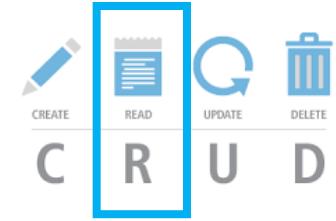
```
streamgeeks.org - PuTTY
$ kafka-topics --zookeeper localhost:2181 \
> --topic my-topic \
> --alter \
> --delete-config max.message.bytes
WARNING: Altering topic configuration from this script has been deprecated and may be removed in future releases.
          Going forward, please use kafka-configs.sh for this functionality
Updated config for topic "my-topic".
$ kafka-topics --zookeeper localhost:2181 \
> --topic my-topic \
> --describe
Topic:my-topic PartitionCount:3      ReplicationFactor:1      Configs:flush.messages=1
      Topic: my-topic Partition: 0      Leader: 0            Replicas: 0    Isr: 0
      Topic: my-topic Partition: 1      Leader: 0            Replicas: 0    Isr: 0
      Topic: my-topic Partition: 2      Leader: 0            Replicas: 0    Isr: 0
$
```

Kafka移除了指定的設定!

witlab 緯創IT先進技術實驗室

Topic configuration example: (Query)

** 2nd method - preferred **



```
kafka-configs \
--zookeeper zookeeper:2181 \
--entity-type topics \
--entity-name my-topic \
--describe
```

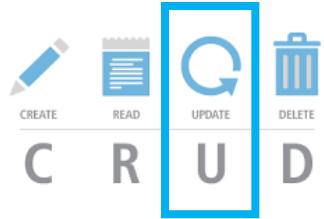
使用kafka-configs的工具可以讓我們對Kafka的不同的entity-type來進行設定。包括:
(topics/clients/users/brokers)

指定要修改的entity-name來進行設定。包括:
(topic name/client id/user principal
name/broker id)

```
streamgeeks.org - PuTTY
$ kafka-configs --zookeeper localhost:2181 \
> --entity-type topics \
> --entity-name my-topic \
> --describe
Configs for topic 'my-topic' are flush.messages=1
$
```

Kafka configuration

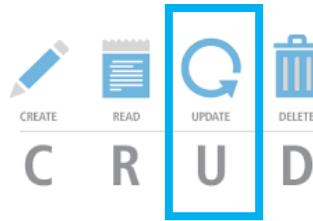
kafka-configs



entity-type: **topics**

- cleanup.policy
- compression.type
- delete.retention.ms
- file.delete.delay.ms
- flush.messages
- flush.ms
- follower.replication.throttled.replicas
- index.interval.bytes
- leader.replication.throttled.replicas
- max.message.bytes
- message.format.version
- message.timestamp.difference.max.ms
- message.timestamp.type
- min.cleanable.dirty.ratio
- min.compaction.lag.ms
- min.insync.replicas
- preallocate
- retention.bytes
- retention.ms
- segment.bytes
- segment.index.bytes
- segment.jitter.ms
- segment.ms
- unclean.leader.election.enable

Topic configuration example: (Update) ** 2nd method - preferred**

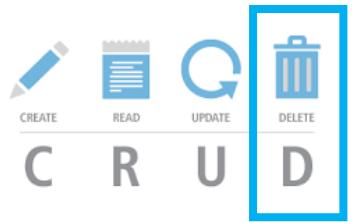


```
kafka-configs \
--zookeeper zookeeper:2181 \
--entity-type topics \
--entity-name my-topic \
--alter \
--add-config max.message.bytes=128000
```

A screenshot of a terminal window titled "streamgeeks.org - PuTTY". The command entered was the one shown above, followed by "flush.messages=1" and "describe". The output shows the configuration was updated successfully, and the current configuration for the topic "my-topic" includes "max.message.bytes=128000" and "flush.messages=1". A yellow speech bubble points to the terminal output with the text "修改的設定生效了!" (The modified setting has taken effect!).

```
streamgeeks.org - PuTTY
$ kafka-configs --zookeeper localhost:2181 \
> --entity-type topics \
> --entity-name my-topic \
> --alter \
> --add-config max.message.bytes=128000
Completed Updating config for entity: topic 'my_topic'.
$ kafka-configs --zookeeper localhost:2181 \
> --entity-type topics \
> --entity-name my-topic \
> --describe
Configs for topic 'my-topic' are max.message.bytes=128000 flush.messages=1
$
```

Topic configuration example: (Remove) ** 2nd method - preferred**



```
kafka-configs \
--zookeeper zookeeper:2181 \
--entity-type topics \
--entity-name my-topic \
--alter \
--delete-config
max.message.bytes
```

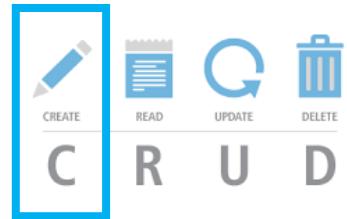
```
streamgeeks.org - PuTTY
$ kafka-configs --zookeeper localhost:2181 \
> --entity-type topics \
> --entity-name my-topic \
> --alter \
> --delete-config max.message.bytes
Completed Updating config for entity: topic 'my-topic'
$ kafka-configs --zookeeper localhost:2181 \
> --entity-type topics \
> --entity-name my-topic \
> --describe
Configs for topic 'my-topic' are flush.messages=1
$
```

Module 8 :

Broker Configurations Example

- 8-1 : Update
- 8-2 : Query
- 8-3 : Remove

Broker configuration



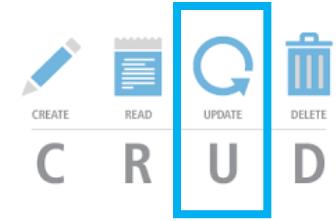
- From Kafka version **1.1** onwards, some of the broker configs can be updated *without* restarting the broker.
- See the *Dynamic Update Mode* column in Broker Configs for the update mode of each broker config.
 - read-only: Requires a broker restart for update
 - per-broker: May be updated dynamically for each broker
 - cluster-wide: May be update dynamically as a cluster-wide default

NAME	DESCRIPTION	TYPE	DEFAULT	VALID VALUES	IMPORTANCE	DYNAMIC UPDATE MODE
zookeeper.connect	Zookeeper host string	string			high	read-only
log.flush.interval.ms	The maximum time in ms that a message in any topic is kept in memory before flushed to disk. If not set, the value in log.flush.scheduler.interval.ms is used	long	null		high	cluster-wide

<https://kafka.apache.org/documentation/#brokerconfigs>

Kafka configuration

kafka-configs

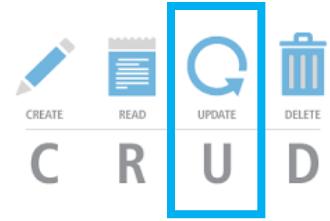


entity-type: brokers

- advertised.listeners
- background.threads
- compression.type
- follower.replication.throttled.rate
- leader.replication.throttled.rate
- listener.security.protocol.map
- listeners
- log.cleaner.backoff.ms
- log.cleaner.dedupe.buffer.size
- log.cleaner.delete.retention.ms
- log.cleaner.io.buffer.load.factor
- log.cleaner.io.buffer.size
- log.cleaner.io.max.bytes.per.second
- log.cleaner.min.cleanable.ratio
- log.cleaner.min.compaction.lag.ms
- log.cleaner.threads
- log.cleanup.policy
- log.flush.interval.messages
- log.flush.interval.ms
- log.index.interval.bytes
- log.index.size.max.bytes
- log.message.timestamp.difference.max.ms
- log.message.timestamp.type
- log.preallocate

Kafka configuration (Cont.)

kafka-configs

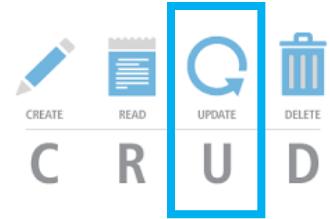


entity-type: brokers

- log.retention.bytes
- log.retention.ms
- log.roll.jitter.ms
- log.roll.ms
- log.segment.bytes
- log.segment.delete.delay.ms
- message.max.bytes
- metric.reporters
- min.insync.replicas
- num.io.threads
- num.network.threads
- num.recovery.threads.per.data.dir
- num.replica.fetchers
- principal.builder.class
- replica.alter.log.dirs.io.max.bytes.per.second
- sasl.enabled.mechanisms
- sasl.jaas.config
- sasl.kerberos.kinit.cmd
- sasl.kerberos.min.time.before.relogin
- sasl.kerberos.principal.to.local.rules
- sasl.kerberos.service.name
- sasl.kerberos.ticket.renew.jitter
- sasl.kerberos.ticket.renew.window.factor
- sasl.mechanism.inter.broker.protocol

Kafka configuration (Cont.)

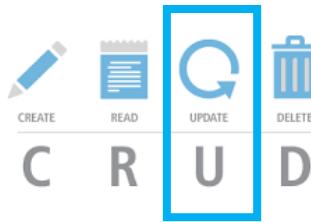
kafka-configs



entity-type: brokers

- ssl.cipher.suites
- ssl.client.auth
- ssl.enabled.protocols
- ssl.endpoint.identification.algorithm
- ssl.key.password
- ssl.keymanager.algorithm
- ssl.keystore.location
- ssl.keystore.password
- ssl.keystore.type
- ssl.protocol
- ssl.provider
- ssl.secure.random.implementation
- ssl.trustmanager.algorithm
- ssl.truststore.location
- ssl.truststore.password
- ssl.truststore.type
- unclean.leader.election.enable

Broker configuration example: (Update)



- To alter the current broker configs for broker id 0 (for example, the number of log cleaner threads):

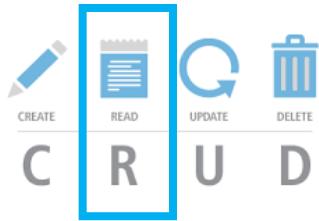
```
kafka-configs \
--bootstrap-server localhost:9092 \
--entity-type brokers \
--entity-name 1 \
--alter \
--add-config background.threads=20
```

A screenshot of a terminal window titled "streamgeeks.org - PuTTY". The command entered is:

```
$ kafka-configs --bootstrap-server localhost:9092 \
> --entity-type brokers \
> --entity-name 0 \
> --alter \
> --add-config background.threads=20
Completed updating config for broker: 0.
```

A yellow callout bubble points from the terminal output to the text "修改成功!" (Success!) located below the terminal window.

Broker configuration example: (Query)

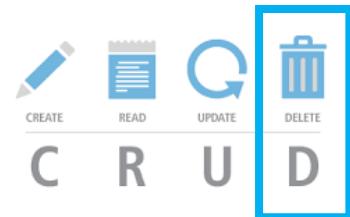


```
kafka-configs \
--bootstrap-server localhost:9092 \
--entity-type brokers \
--entity-name 1 \
--describe
```

The terminal window shows the command being run and its output. A yellow box highlights the output text: "Configs for broker 0 are: background.threads=20 sensitive=false synonyms=[DYNAMIC_BROKER_CONFIG:background.threads=20, DEFAULT_CONFIG:background.threads=10]". A yellow speech bubble points to this text with the message: "修改成功! 從UI上可以看到設定的結果以及Broker原本預設的設定。" (Success! You can see the results and the original default settings from the UI.)

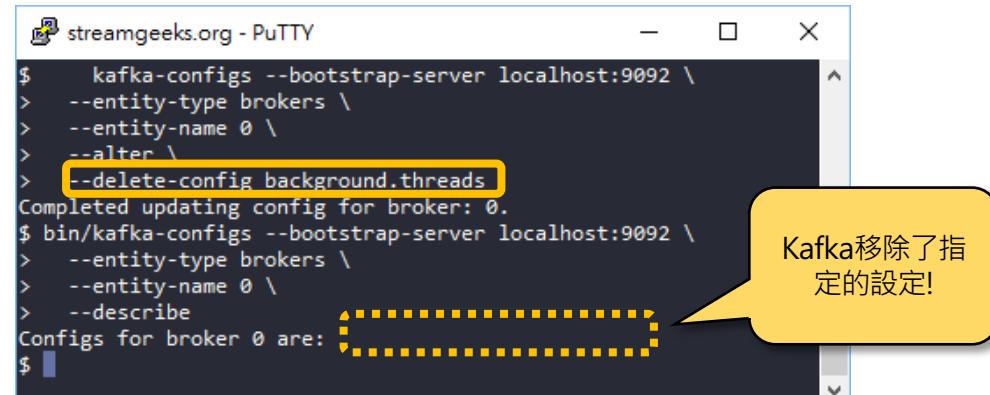
```
streamgeeks.org - PuTTY
$ kafka-configs --bootstrap-server localhost:9092 \
> --entity-type brokers \
> --entity-name 0 \
> --describe
Configs for broker 0 are:
background.threads=20 sensitive=false synonyms=[DYNAMIC_BROKER_CONFIG:background.threads=20, DEFAULT_CONFIG:background.threads=10]
```

Broker configuration example: (Remove)



- To delete a config override and revert to the statically configured or default value for broker id 0 (for example, the number of log cleaner threads):

```
kafka-configs \
--bootstrap-server localhost:9092 \
--entity-type brokers \
--entity-name 1 \
--alter \
--delete-config background.threads
```



A terminal window titled 'streamgeeks.org - PuTTY' showing Kafka configuration commands. The command `--delete-config background.threads` is highlighted with a yellow box. A speech bubble points to the output: 'Kafka移除了指定的設定!' (Kafka removed the specified setting!).

```
$ kafka-configs --bootstrap-server localhost:9092 \
> --entity-type brokers \
> --entity-name 0 \
> --alter \
> --delete-config background.threads
Completed updating config for broker: 0.
$ bin/kafka-configs --bootstrap-server localhost:9092 \
> --entity-type brokers \
> --entity-name 0 \
> --describe
Configs for broker 0 are:
```

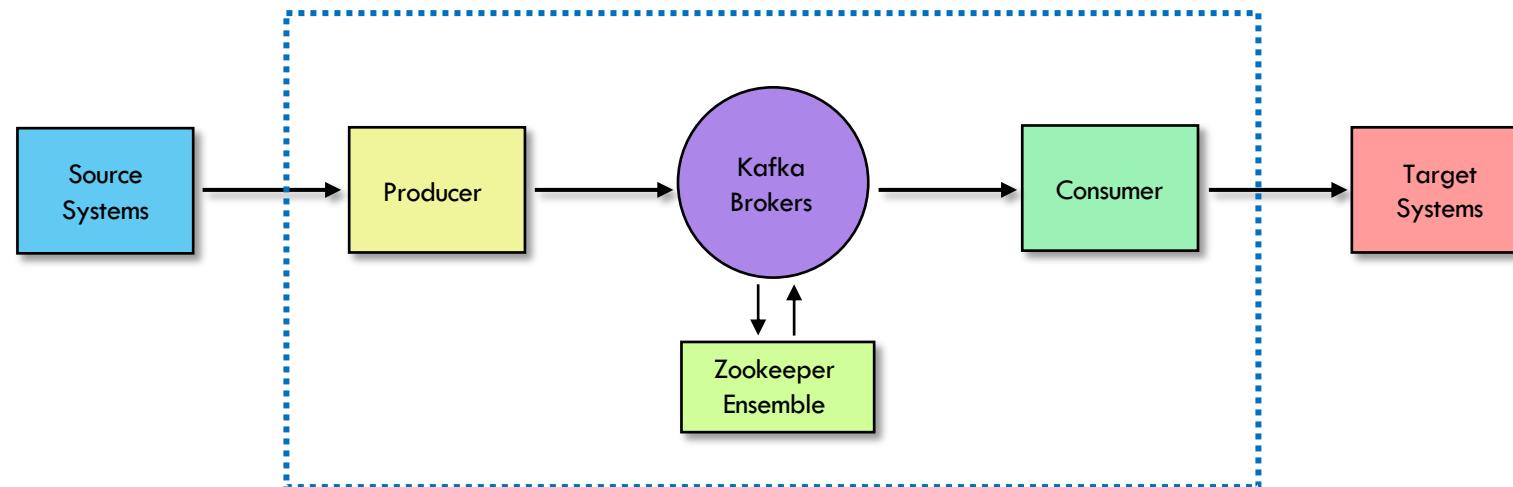
Where are these configuration stored?

- Dynamic per-broker configurations stored in ZooKeeper
- Dynamic cluster-wide default configurations stored in ZooKeeper
- Static broker configurations from server.properties
- Kafka default, see broker configurations
 - <https://kafka.apache.org/documentation/#brokerconfigs>

Module 9： Kafka Producers

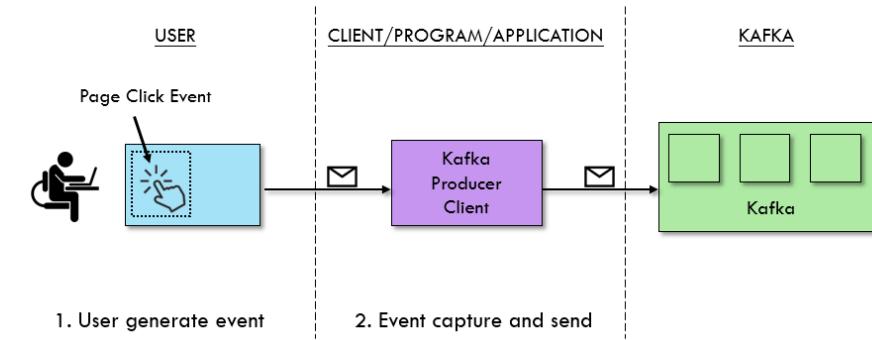
- 9-1 : Fire-and-forget
- 9-2 : Synchronous send
- 9-3 : Asynchronous send

Kafka Ecosystem: Kafka Core

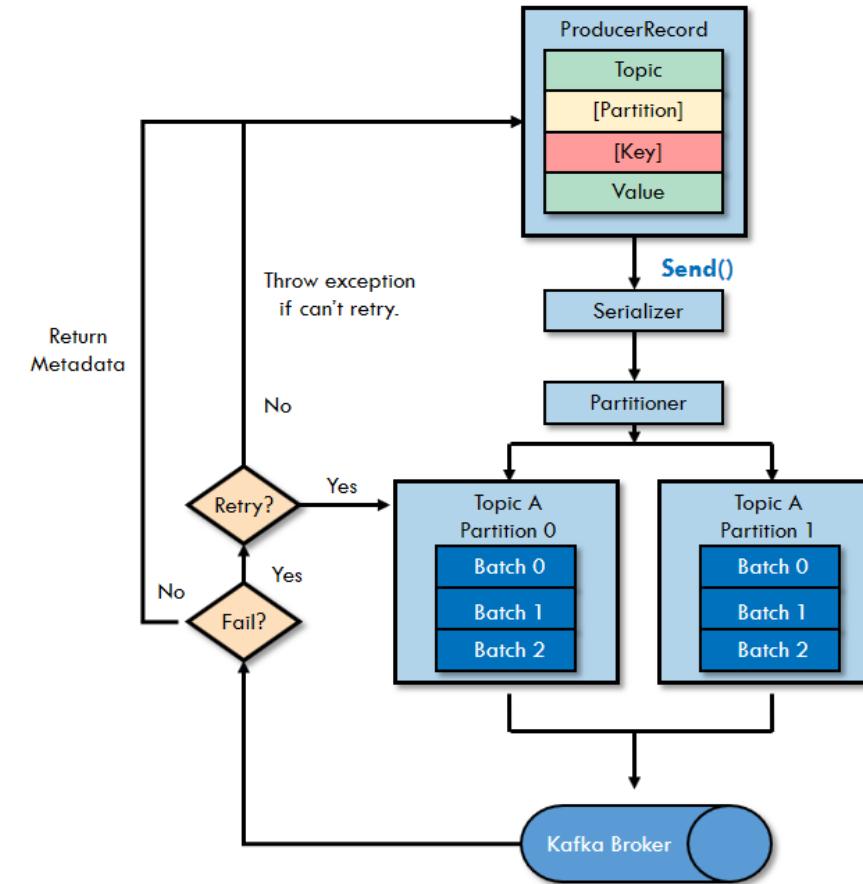
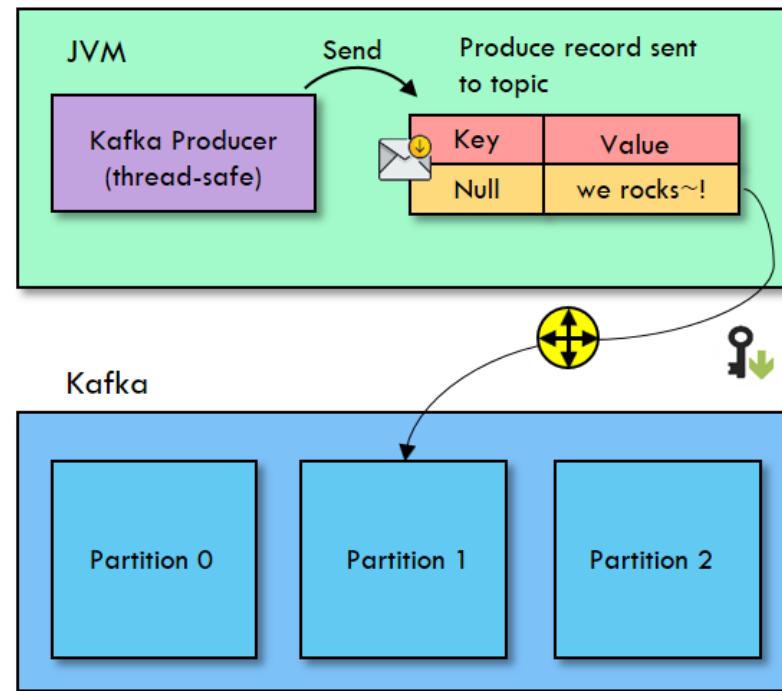


Open Project with PyCharm: Kafka-Tutorial/02_document/ak03

Kafka Producers: Writing Messages to Kafka



Producer Overview



Three primary methods of sending messages

- **Fire-and-forget**

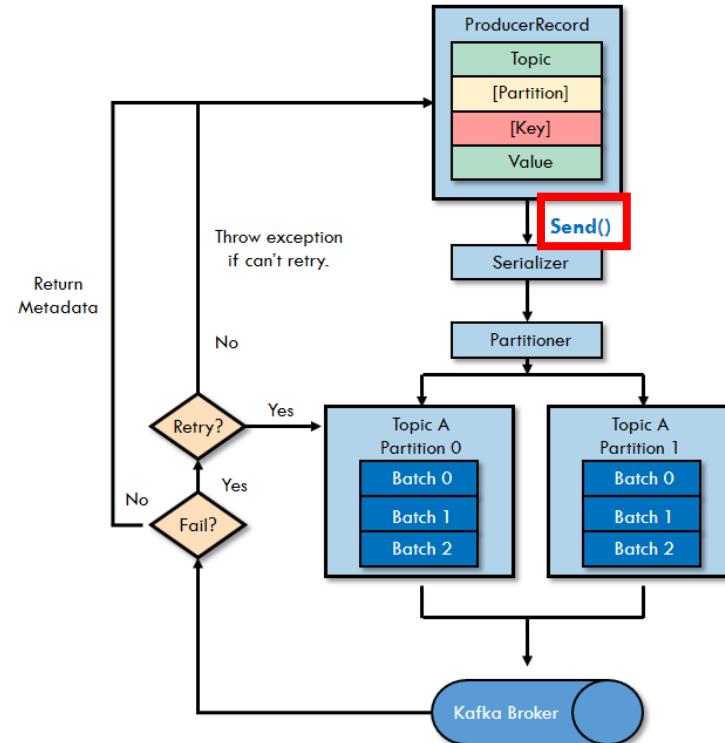
- We send a message to the server and don't really care if it arrives successfully or not.

- **Synchronous send**

- We send a message, and **wait** to see if the **produce()** was successful or not.

- **Asynchronous send**

- We call the **produce()** method with a **callback function**, which gets triggered when it receives a response from the Kafka broker.

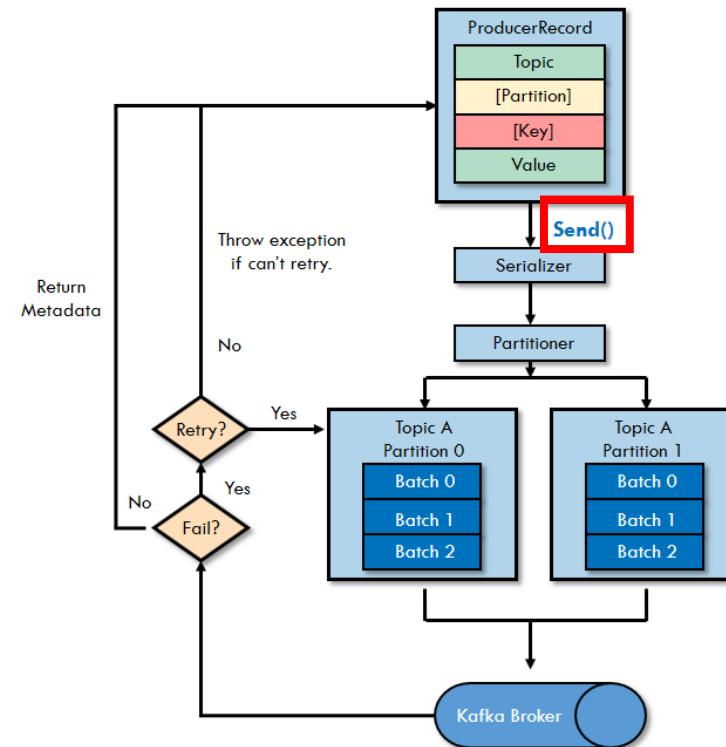


Three primary methods of sending messages (Fire-and-forget)

- Producer_01_FireAndForget

```
# ** 示範: Fire - and -forget **
# 在以下的"produce()"過程，我們並沒有去檢查訊息發佈的結果
# 因此這種方法的throughput最高，但也不知道訊息是否發佈成功或失敗

for i in range(msgCount):
    producer.produce(topicName, key=str(i), value='msg_{}'.format(i))
```

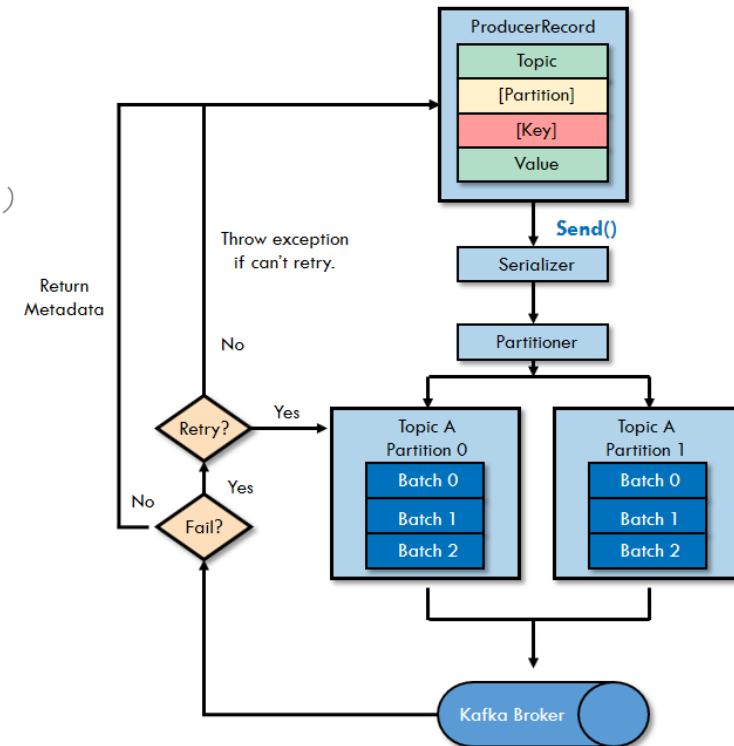


Three primary methods of sending messages (Synchronous send)

- Producer_02_Sync

```
# produce(topic, [value], [key], [partition], [on_delivery], [timestamp], [headers])
# ** 示範：Synchronous Send **
# librdkafka(C++)的produce都是用async實作,
# 所以使用confluent_kafka的client作sync發佈的話,
# 只能採produce()搭配flush()實作。
# 由於這種方法是一筆一筆的送。因此這種方法的throughput最差
# (通常不會用Kafka來做這種事)

for i in range(msgCount):
    producer.produce(topicName, key=str(i), value='msg_{}'.format(i))
    producer.flush() # <-- 每次produce()後就呼叫flush(), 就實作了Sync Producer的功能
    if i % 10000 == 0:
        print('Send {} messages'.format(i))
```



Three primary methods of sending messages (Asynchronous send)

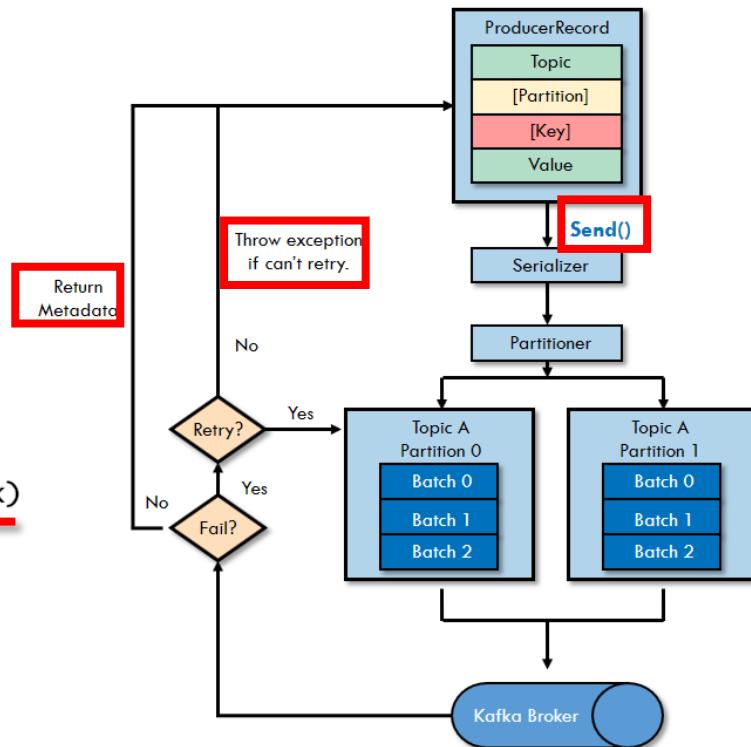
- Producer_03_Async

```

...
// ** 示範：Asynchronous Send **
// 透過一個Callback函式我們可以非同步地取得由Broker回覆訊息發佈的ack結果
// 這種方法可以取得Broker回覆訊息發佈的ack結果，同時又可以取得好的throughput（建議的作法）
...

for i in range(msgCount):
    producer.produce(topicName, key=str(i), value='msg_'+str(i), callback=delivery_callback)
    producer.poll(0) # 呼叫poll來讓client程式去檢查內部的Buffer，並觸發callback

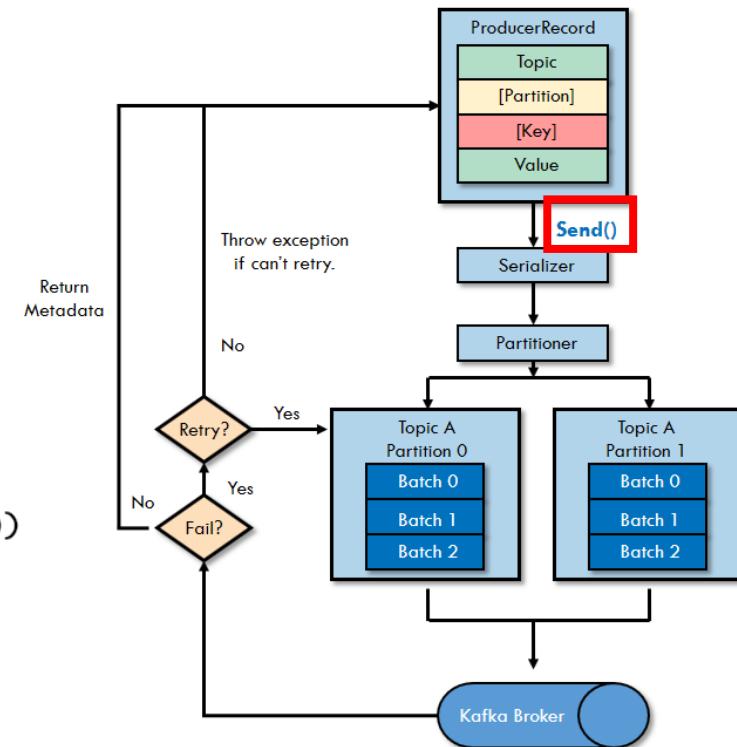
```



Three primary methods of sending messages (Asynchronous send)

- Producer_03_Async
 - Callback function

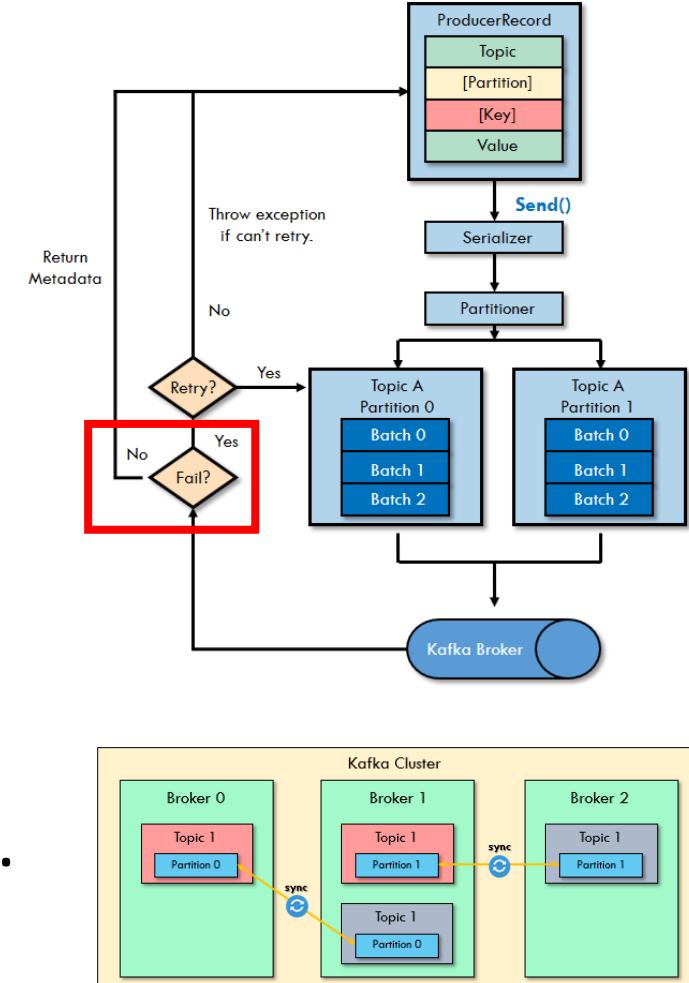
```
def delivery_callback(err, msg):
    if err:
        sys.stderr.write('% Message failed delivery: %s\n' % err)
    else:
        # 為了不讓打印訊息拖慢速度，我們每1萬打印一筆record Metadata來看
        if int(msg.key()) % 10000 == 0:
            sys.stderr.write('% Message delivered to topic:[{}]\n'.format(msg.topic()))
```



Configuring Producers

- **acks=0**, the producer will not wait for a reply from the broker before assuming the message was sent successfully.
- **acks=1**, the producer will receive a success response from the broker the moment the leader replica received the message.
- **acks=all**, the producer will receive a success response from the broker once all in-sync replicas received the message.

```
props = {
    # Kafka集群在那裡?
    'bootstrap.servers': 'localhost:9092',
    'error_cb': error_cb,
    'acks': "all"
}
```

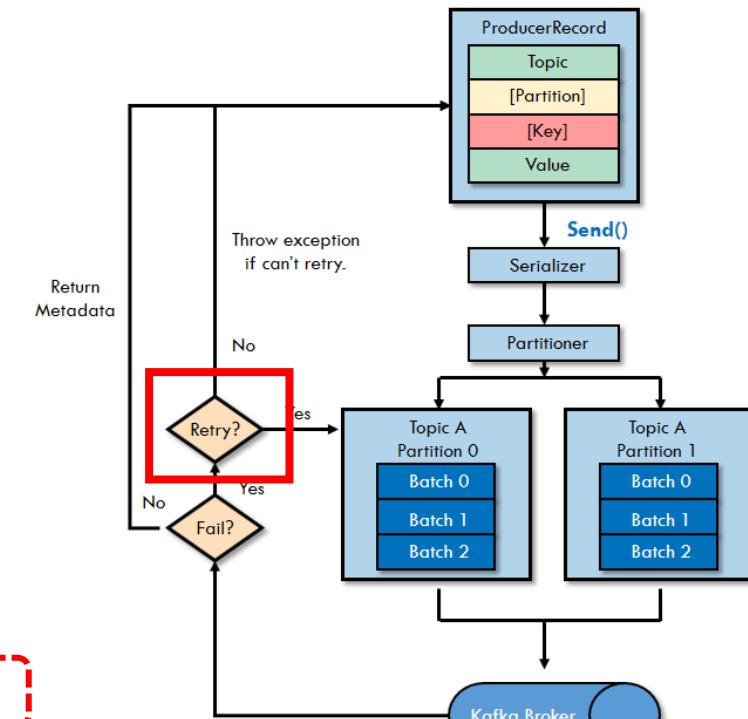


Configuring Producers

- **retries**

- control how many times the producer will **retry** sending the message before giving up and notifying the client of an issue.

```
props = {  
    # Kafka集群在那裡?  
    'bootstrap.servers': 'localhost:9092',  
    'error_cb': error_cb,  
    'retries': '10'  
}
```

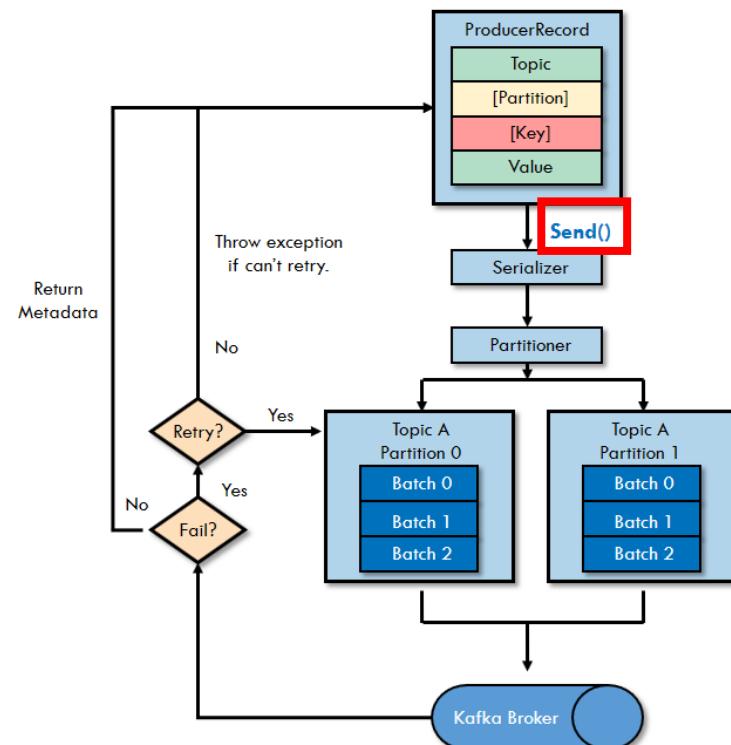


Configuring Producers

- **max.in.flight.requests.per.connection**

- controls how many messages the producer will send to the server without receiving responses.
- Setting this to **1** will guarantee that messages will be written to the broker in the order in which they were sent, even when **retries** occur.

```
props = {  
    # Kafka集群在那裡?  
    'bootstrap.servers': 'localhost:9092',      # <  
    'error_cb': error_cb,                      # 誤  
    'max.in.flight.requests.per.connection': '1'  
}
```

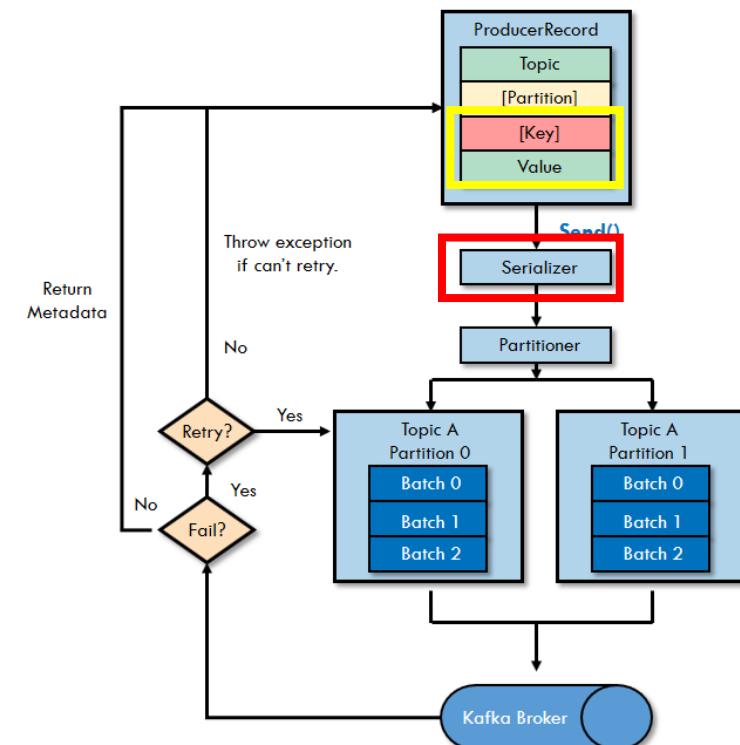


Configuring Producers - Serializers

Kafka lets us publish and subscribe to streams of records and the records can be of any type (JSON, String, POJO, etc.)

JAVA

- **key.serializer & value.serializer**
 - **String – StringSerializer**
 - JSON, XML, Delimited Text, etc..
 - Integer - IntegerSerializer
 - Long - LongSerializer
 - Double - DoubleSerializer
 - ByteBuffer - ByteBufferSerializer
 - **byte[] – ByteArraySerializer**
 - Avro, ProtoBuf, etc..

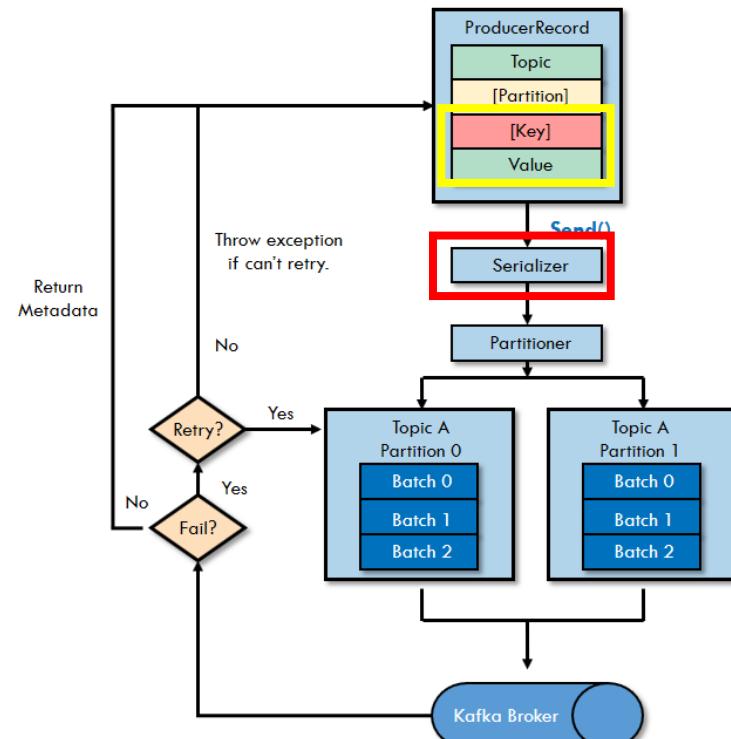


- Producer_04_Json

```

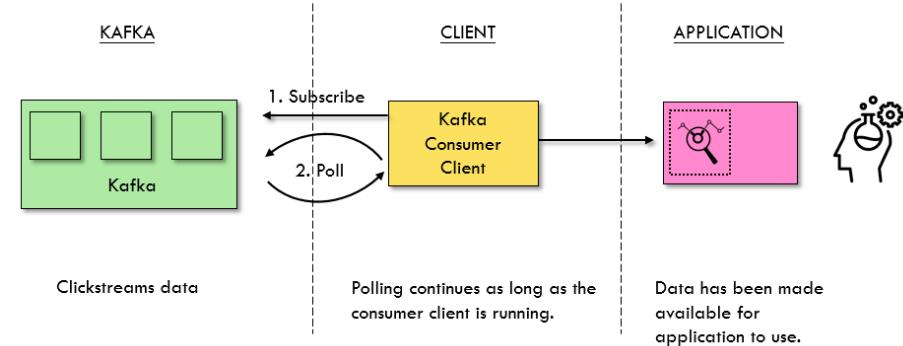
// ** 示範：如何將資料包成物件並轉換成JSON字串送入Kafka **
// 由於一般應用場景的資料都是包括了很多的資料欄位及不同的資料型別。通常都會使用一個類別物件來做為資料傳遞的容器。
// 因此如何把一個Data Transfer Object (DTO)序列化送進Kafka是相當關鍵的步驟
```
for i in range(msgCount):
 fakeNumber = str(i)
 # 讓我們產生假的Employee資料
 employee = Employee(id='emp_id_'+fakeNumber,
 firstName='fn_'+fakeNumber,
 lastName='ln_'+fakeNumber,
 deptId='dept_id_'+str(i % 10),
 hireDate=epoch_now_mills(),
 wage=float(i),
 sex=True
)
 # 轉換成JSON字串
 employeeJson = json.dumps(employee.__dict__)
```

```



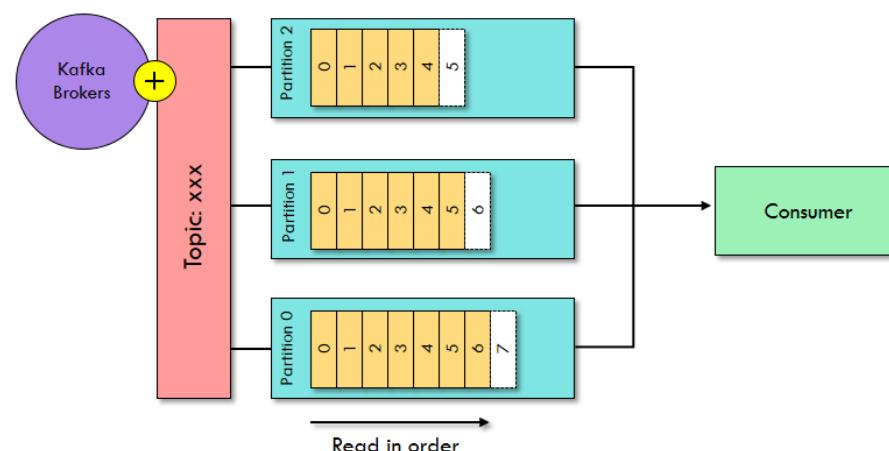
Module 10 : Consumer Groups

- 10-1 : Groups Coordinator
- 10-2 : Consumer Leader
- 10-3 : Consumer Groups Example



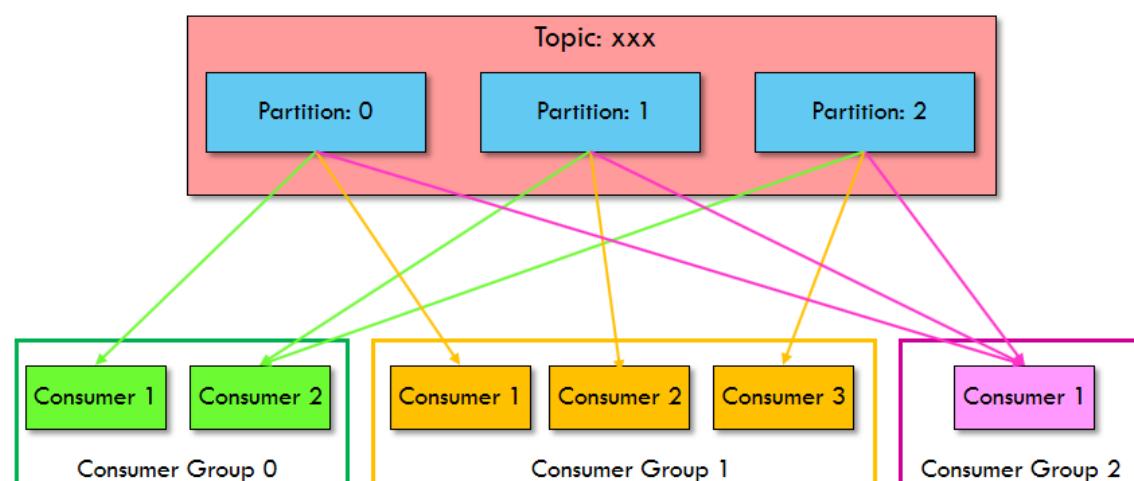
Kafka Consumers: Reading Messages from Kafka

- **Consumers** read data from a topic
- They only have to specify the topic name and one broker to connect to, and Kafka will automatically take care of pulling the data from the right brokers
- Data is read in order **for each partitions**



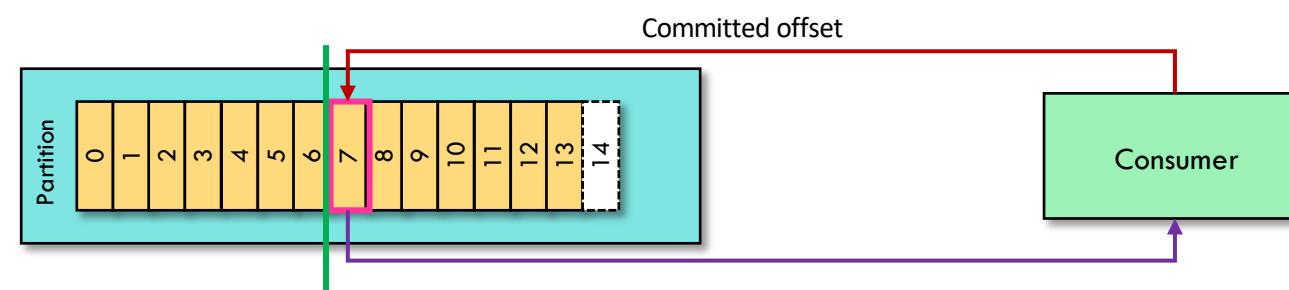
Consumer Groups

- Consumers read data in **consumer groups**
- Each consumer within a group reads from exclusive partitions
- You cannot have more consumers than partitions (otherwise some will be inactive)



Consumer Offsets

- Kafka stores the offsets at which a **consumer group** has been reading
- The **offsets** commit live in a Kafka topic named “**__consumer_offsets**”
- When a consumer has processed data received some Kafka, it should be **committing the offsets**
- If a consumer process dies, it will be able to read back from where it left off thanks to consumer offsets!

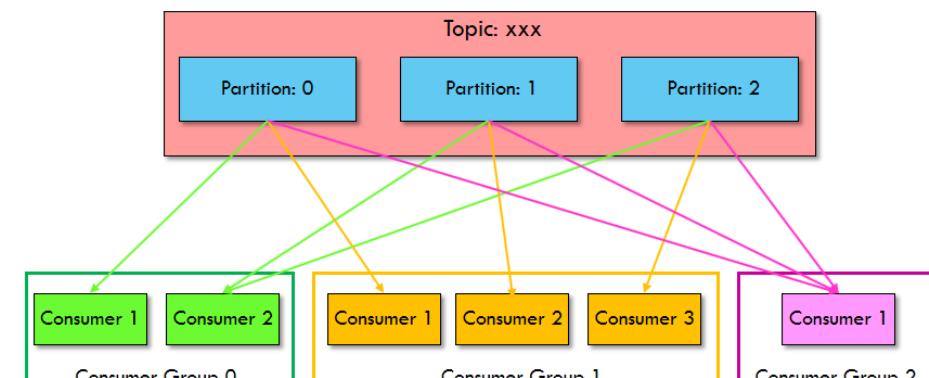


Configuring Consumers

- **group.id**

- Kafka consumers are typically part of a **consumer group**. When multiple consumers are subscribed to a topic and belong to the same consumer group, each consumer in the group will receive messages from a different subset of the partitions in the topic.

```
props = {  
    'bootstrap.servers': 'localhost:9092',  
    'group.id': 'iii',  
    'auto.offset.reset': 'earliest',  
    'error_cb': error_cb  
}
```

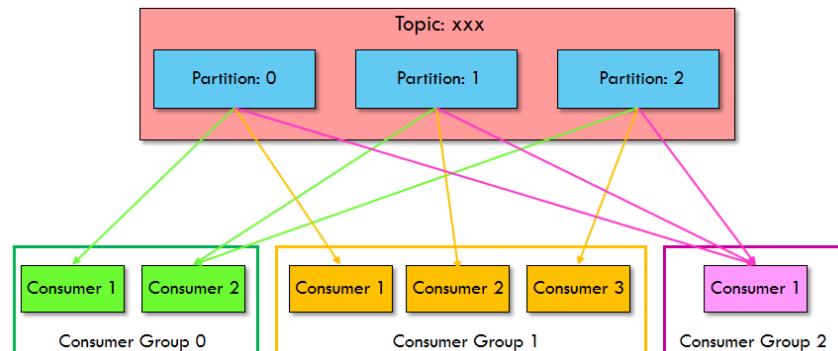


Consumers and Consumer Groups

Create a topic with 4 partitions



```
$ kafka-topics \
--create \
--zookeeper zookeeper:2181 \
--replication-factor 1 --partitions 4 \
--topic ak03.four_partition
```



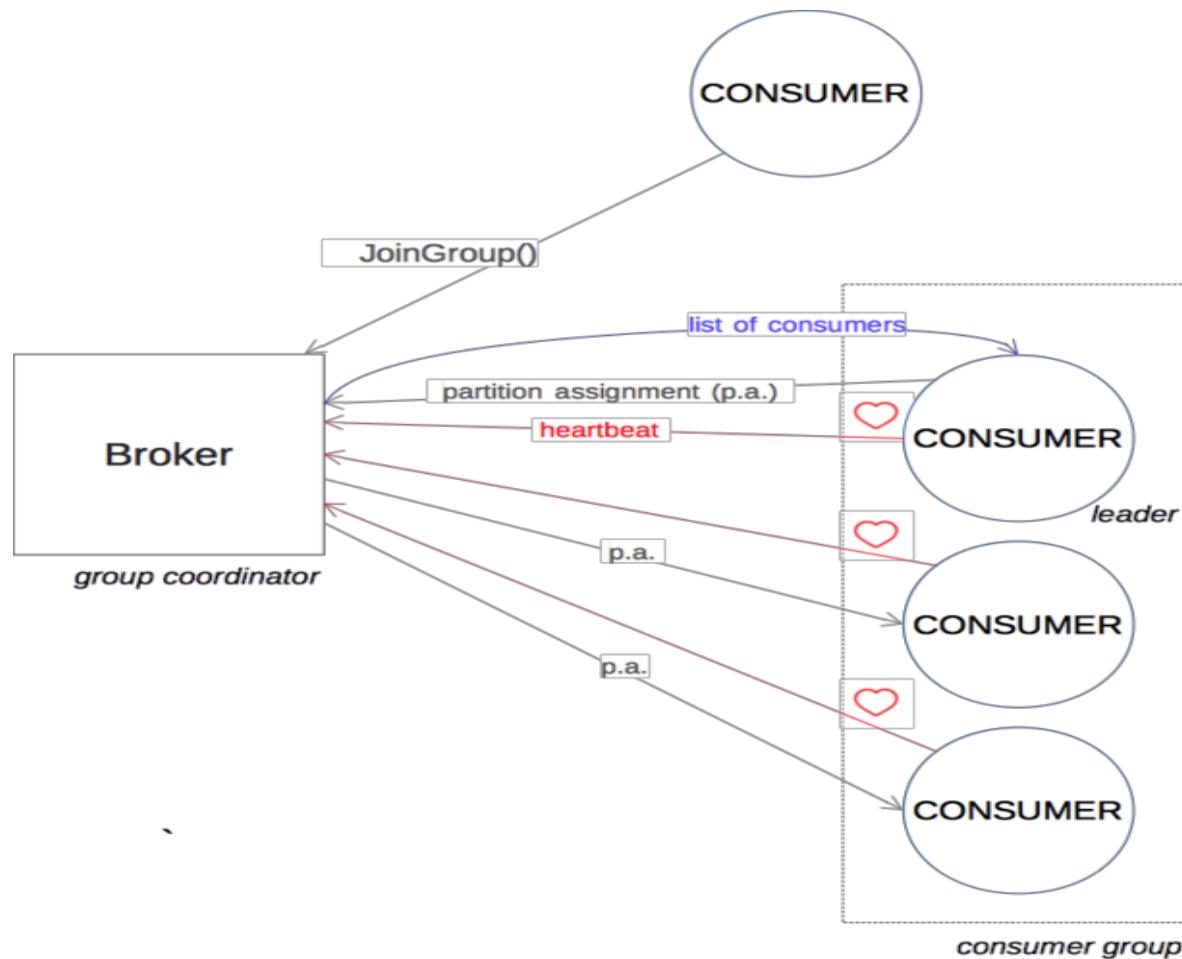
```
root@kafka:/# kafka-topics --create \
> --zookeeper zookeeper:2181 \
> --replication-factor 1 \
> --partitions 4 \
> --topic ak03.four_partition
WARNING: Due to limitations in metric names,
ues it is best to use either, but not both.
Created topic "ak03.four_partition".
```

在container裡頭的
zookeeper服務的
Hostname

Topic is
created!

Consumers and Consumer Groups

ConsumerCoordinator



Consumers and Consumer Groups

Producer_01_CGroup : Publish Event:



```
# produce(topic, [value], [key], [partition], [on_delivery], [timestamp], [headers])
for i in range(msgCount):
    producer.produce(topicName, key=str(i), value='msg_' + str(i))
    producer.poll(0) # <-- (重要) 呼叫poll來讓client程式去檢查內部的Buffer
    print('key={}, value={}'.format(str(i), 'msg_' + str(i)))
    time.sleep(3) # 讓主執行緒停個3秒
```

每3秒發佈一筆訊息！

這個**Producer**的目的是持續發佈有序列號的訊息來觀察**ConsumerGroup**的概念！

Consumers and Consumer Groups



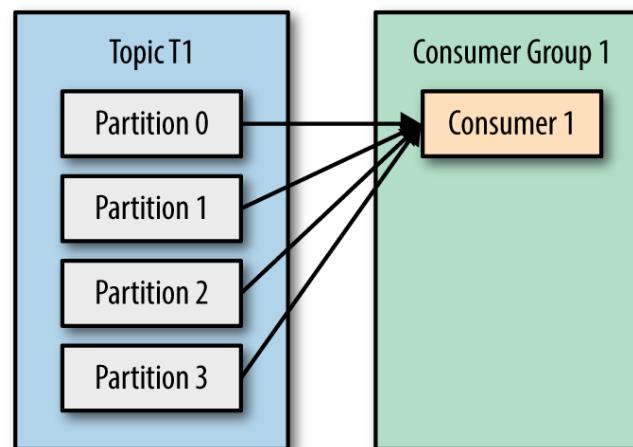
- Consumer_01_Cgroup
 - One Consumer instance

跑第1個instance, 並
觀察log

```
python (python3.7)
Setting newly assigned partitions: [ak03.fourpartition-0, ak03.fourpartition-1, ak03.fourpartition-2, ak03.fourpartition-3]
ak03.fourpartition-0-0 : (4 , msg_4)
ak03.fourpartition-0-1 : (6 , msg_6)

ak03.fourpartition-1-0 : (0 , msg_0)
ak03.fourpartition-1-1 : (2 , msg_2)
ak03.fourpartition-2-0 : (5 , msg_5)
ak03.fourpartition-3-0 : (1 , msg_1)
ak03.fourpartition-3-1 : (3 , msg_3)
```

One Consumer with four partitions



Consumers and Consumer Groups



- Consumer_01_Cgroup
 - Two Consumer instance

```
python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-0, ak03.fourpartition-1, ak03.fourpartition-2, ak03.fourpartition-3]
ak03.fourpartition-1-5 : (19 , msg_19)

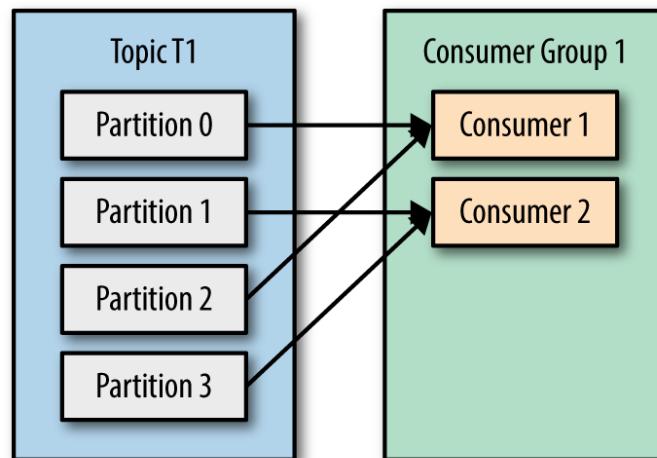
Setting newly assigned partitions: [ak03.fourpartition-2, ak03.fourpartition-3]

ak03.fourpartition-2-4 : (20 , msg_20)

python (python3.7)
Setting newly assigned partitions: [ak03.fourpartition-0, ak03.fourpartition-1]

ak03.fourpartition-0-4 : (21 , msg_21)
ak03.fourpartition-0-5 : (23 , msg_23)
ak03.fourpartition-1-6 : (25 , msg_25)
```

One Consumer with four partitions



跑第2個instance, 並
觀察log

Consumers and Consumer Groups



- Consumer_01_Cgroup
 - Four Consumer instance

```
x python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-3]
Setting newly assigned partitions: [ak03.fourpartition-3]

ak03.fourpartition-3-10 : (39 , msg_39)

x python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-0, ak03.fourpartition-1]
Setting newly assigned partitions: [ak03.fourpartition-1]

ak03.fourpartition-1-10 : (38 , msg_38)

x python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-2]
Setting newly assigned partitions: [ak03.fourpartition-2]

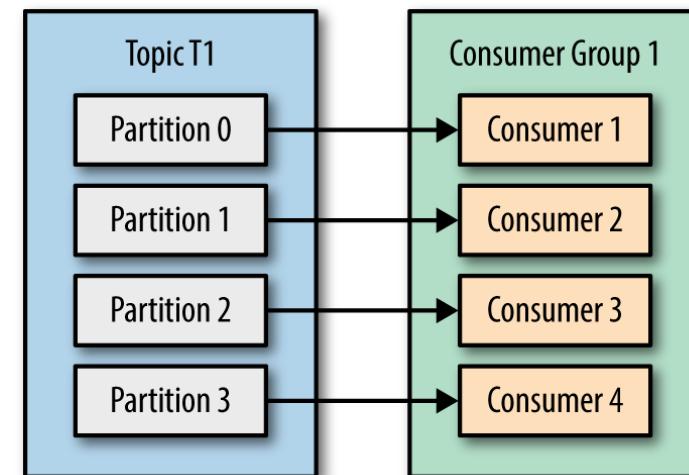
ak03.fourpartition-2-8 : (36 , msg_36)

x python (python3.7)
Setting newly assigned partitions: [ak03.fourpartition-0]

ak03.fourpartition-0-7 : (35 , msg_35)

ak03.fourpartition-0-8 : (37 , msg_37)
```

Three Consumer with four partitions



跑第4個instance, 並
觀察log

Consumers and Consumer Groups



- Consumer_01_Cgroup
 - Five Consumer instance

```
x python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-3]
Setting newly assigned partitions: []

x python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-1]
Setting newly assigned partitions: [ak03.fourpartition-1]

ak03.fourpartition-1-11 : (44 , msg_44)

x python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-2]
Setting newly assigned partitions: [ak03.fourpartition-2]

ak03.fourpartition-2-9 : (41 , msg_41)

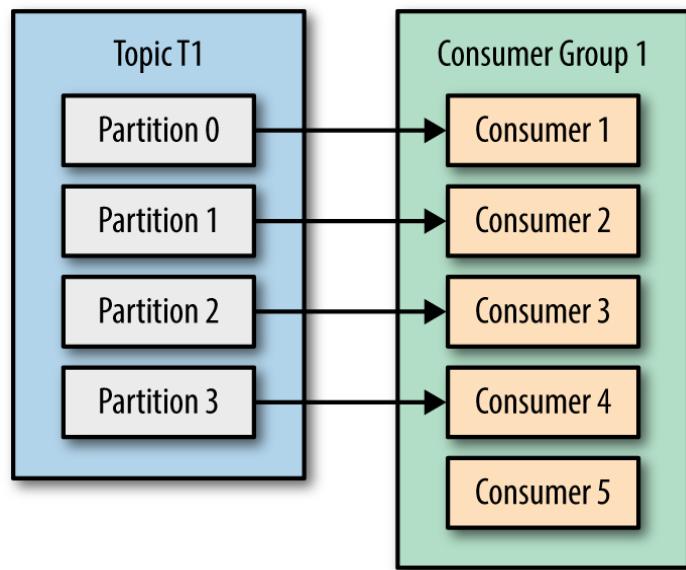
x python (python3.7)
Revoking previously assigned partitions: [ak03.fourpartition-0]
Setting newly assigned partitions: [ak03.fourpartition-0]

ak03.fourpartition-0-9 : (40 , msg_40)
ak03.fourpartition-0-10 : (42 , msg_42)

x python (python3.7)
Setting newly assigned partitions: [ak03.fourpartition-3]

ak03.fourpartition-3-11 : (45 , msg_45)
ak03.fourpartition-3-12 : (47 , msg_47)
```

Five Consumer with four partitions



跑第5個instance, 並
觀察log

Module 11 : Rebalance

- 11-1 : What is Rebalance
- 11-2 : Rebalance Process
- 11-3 : Rebalance Listener

What is Rebalance?



- Every consumer in a **consumer group** is assigned one or more topic partitions exclusively, and **Rebalance** is the re-assignment of partition ownership among consumers.
- A Rebalance happens when:
 - a consumer JOINS the group
 - a consumer SHUTS DOWN cleanly
 - a consumer is considered DEAD by the group coordinator. This may happen after a crash or when the consumer is busy with a long-running processing
 - new partitions are added

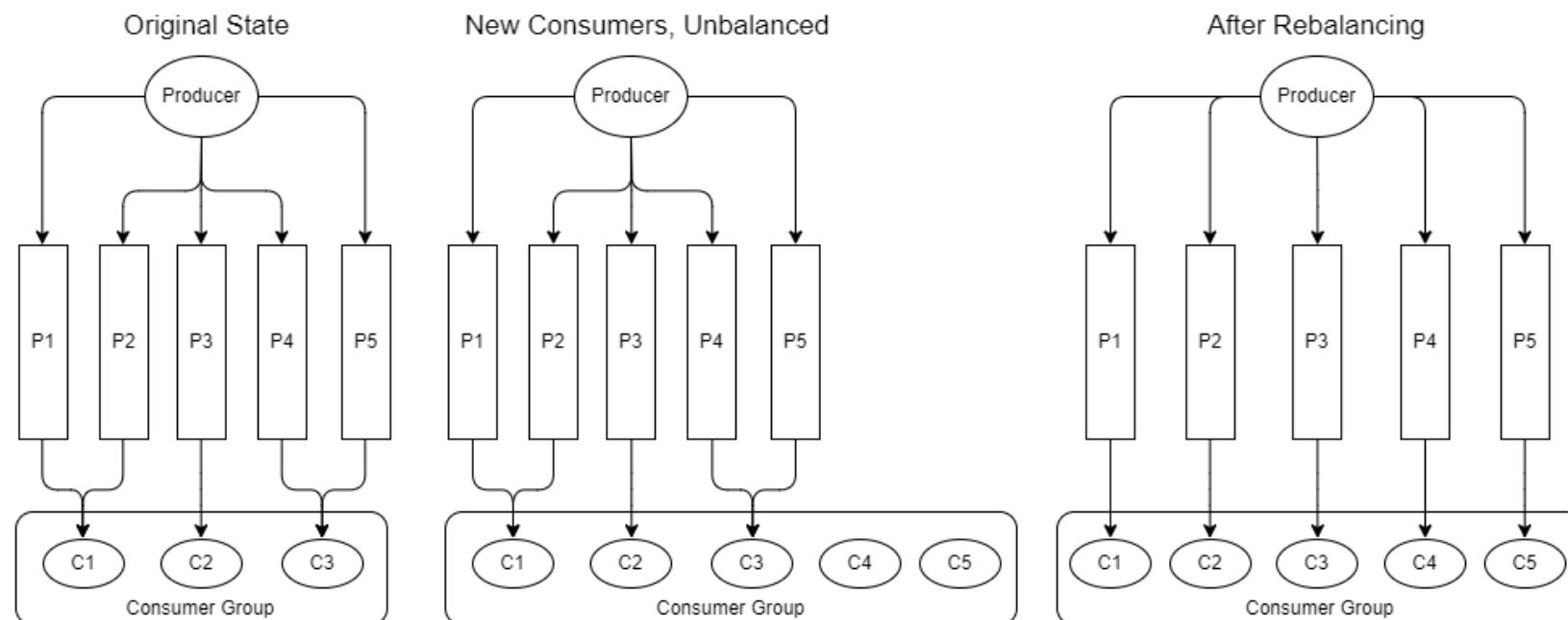
Rebalance process



- **Rebalance** can be more or less described as follows:
 - The leader receives a list of all consumers in the group from the group coordinator and is responsible for assigning a subset of partitions to each consumer.
 - After deciding on the partition assignment the group leader sends the list of assignments to the group coordinator, which sends this information to all the consumers.

Rebalance process

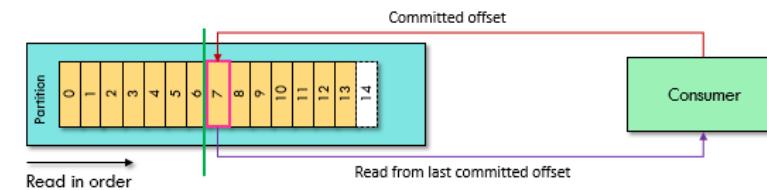
**IMPORTANT
NOTICE**



Module 12 : Kafka Consumers

- 12-1 : Automatic Commit
- 12-2 : Synchronous Commit
- 12-3 : Asynchronous Commit

Commits and Offsets



- Whenever we call **consume()**, broker returns records that consumers in our group have not read yet.
- This means that Kafka client tracking which records were read by a consumer of the group.
- We call the action of updating the current position in the partition a **commit**.

```
while True:  
    # 請求Kafka把新的訊息吐出來  
    records = consumer.consume(num_messages=500, timeout=1.0)  
    if records is None:  
        continue
```

Commits and Offsets

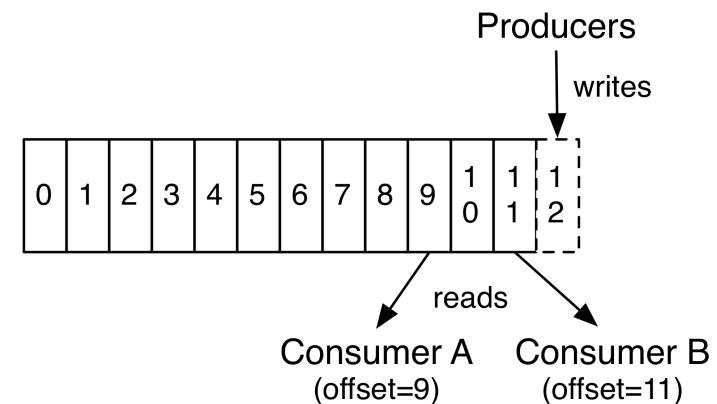
- How does a consumer commit an offset?
- Kafka client produces a message to Kafka, to a special **consumer_offsets** topic, with the committed offset for each partition.
- If a consumer crashes or a new consumer joins the consumer group, it will trigger a **partition rebalance**.
- After a **rebalance**, each consumer may be assigned a new set of partitions than the one it processed before.
- The consumer will read the latest committed offset of each partition and continue from there.

- Managing offsets has a big impact on the client application.
- The Kafka Consumer API provides multiple ways of committing offsets:
 - Automatic Commit
 - Synchronous Commit (previous **consume()** offset)
 - Asynchronous Commit (previous **consume()** offset)
 - Combining Synchronous and Asynchronous Commits (previous **consume()** offset)
 - Commit Specified Offset

Configuring Consumers

- **auto.offset.reset**

- This property controls the behavior of the consumer when it starts reading a partition for which it doesn't have a committed offset.
- The default is “**latest**,” which means that lacking a valid offset, the consumer will start reading from the newest records
- The alternative is “**earliest**,” which means that lacking a valid offset, the consumer will read all the data in the partition, starting from the very beginning.



- Configure below configurations:
 - `enable.auto.commit=true`
 - `auto.commit.interval.ms=5000 (default)`
- Every **five** seconds the consumer will commit the largest offset your client received from `consume()`.
- Whenever you `consume()`, the consumer checks if it is time to commit, and if it is, it will commit the offsets it returned in the last `consume()`.

- Consumer_02_AutoCommit

```
props = {
    'bootstrap.servers': 'localhost:9092',
    'group.id': 'iii',
    'auto.offset.reset': 'earliest',
    'enable.auto.commit': True,
    'auto.commit.interval.ms': 5000,
    'on_commit': print_commit_result,
    'error_cb': error_cb
}

while True:
    # 請求Kafka把新的訊息吐出來
    records = consumer.consume(num_messages=500, timeout=1.0) # 批次讀取
    if records is None:
        continue
```

```
ak03.test-0-1 : (1 , msg_1)
ak03.test-0-2 : (2 , msg_2)
# Committed offsets for: ak03.test-0 {offset=3}
ak03.test-0-3 : (3 , msg_3)
ak03.test-0-4 : (4 , msg_4)
# Committed offsets for: ak03.test-0 {offset=5}
ak03.test-0-5 : (5 , msg_5)
```

- With **auto-commit** enabled, a call to `consume()` *will always commit the last offset returned by the previous `consume()`*. It doesn't know which events were actually processed, so it is critical to always process all the events returned by `consume()` before calling `consume()` again.
- Automatic commits are convenient, but they don't give developers enough control to avoid duplicate messages.

- The consumer API has the option of committing the current offset at a point that makes sense to the application developer rather than based on a timer.
- Configure below configurations:
 - **auto.commit.offset=false**
- Offsets will only be committed when the application explicitly chooses to do so.
- The simplest and most reliable commit method is Synchronous Commit. With confluent-kafka lib, **commit(asynchronous=False)**, default value for asynchronous is True, represents synchronous commit,

Commits and Offsets: Sync Commit

- Consumer_03_CommitSync

```
props = {
    'bootstrap.servers': 'localhost:9092',
    'group.id': 'iii',
    'auto.offset.reset': 'earliest',
    'enable.auto.commit': False,
    'error_cb': error_cb
}
```

```
while True:
    records_pulled = False # 用來檢查是否有有效的record被取出來

    # 請求Kafka把新的訊息吐出來
    records = consumer.consume(num_messages=500, timeout=1.0) # 批次讀取
    if records is None:
        continue

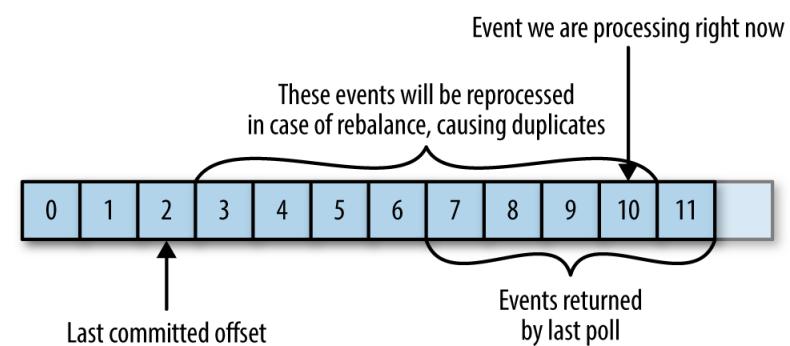
    for record in records:
        # 檢查是否有錯誤
        if record is None:
            continue
        if record.error(): ...
        else:
            records_pulled = True
            # ** 在這裡進行商業邏輯與訊息處理 **
            # 取出相關的metadata
            topic = record.topic()
            partition = record.partition()
            offset = record.offset()
            timestamp = record.timestamp()
            # 取出msgKey與msgValue
            msgKey = try_decode_utf8(record.key())
            msgValue = try_decode_utf8(record.value())

            # 秀出metadata與msgKey & msgValue訊息
            print('%s-%d-%d : (%s , %s)' % (topic, partition, offset, msgKey, msgValue))

            # 同步地執行commit (Sync commit)
            if records_pulled:
                offsets = consumer.commit(asynchronous=False)
```

Commits and Offsets: Sync Commit

- This **commit(asynchronous=False)** will commit the latest offset returned by **consume()** and return once the offset is committed, throwing an exception if commit fails for some reason.
- Make sure you call **commit(asynchronous=False)** after you are done processing all the records in the collection.
- When **rebalance** is triggered, all the messages from the beginning of the most recent batch until the time of the rebalance will be processed twice.



- One drawback of manual commit is that the application is **blocked** until the broker responds to the commit request.
- Another option is the **commit(asynchronous=True)**. Since default value is True, you can just call **commit()**. Instead of waiting for the broker to respond to a commit, we just send the request and continue on:

- Consumer_04_CommitAsync

```
props = {  
    'bootstrap.servers': 'localhost:9092',  
    'group.id': 'iii',  
    'auto.offset.reset': 'earliest',  
    'enable.auto.commit': False,  
    'on_commit': print_commit_result,  
    'error_cb': error_cb  
}
```

```
while True:  
    records_pulled = False # 用來檢查是否有有效的record被取出來  
    # 請求Kafka把新的訊息吐出來  
    records = consumer.consume(num_messages=500, timeout=1.0) # 批次讀取  
    if records is None:  
        continue  
    for record in records:  
        # 檢查是否有錯誤  
        if record is None:  
            continue  
        if record.error():...  
        else:  
            records_pulled = True  
            # ** 在這裡進行商業邏輯與訊息處理 **  
            # 取出相關的metadata  
            topic = record.topic()  
            partition = record.partition()  
            offset = record.offset()  
            timestamp = record.timestamp()  
            # 取出msgKey與msgValue  
            msgKey = try_decode_utf8(record.key())  
            msgValue = try_decode_utf8(record.value())  
  
            # 秀出metadata與msgKey & msgValue訊息  
            print('%s-%d-%d : (%s , %s)' % (topic, partition, offset, msgKey, msgValue))  
    # 異步地執行commit (Async commit)  
    if records_pulled:  
        consumer.commit()
```

- **Synchronous commit** will retry the commit until it either succeeds or encounters a non-retrieable failure.
- **Asynchronous commit** will not retry.
- **Asynchronous commit** gives you an option to pass in a callback that will be triggered when the broker responds.

```
def print_commit_result(err, partitions):
    if err is not None:
        print('# Failed to commit offsets: %s: %s' % (err, partitions))
    else:
        for p in partitions:
            print('# Committed offsets for: %s-%s {offset=%s}' % (p.topic, p.partition, p.offset))
```

Commits and Offsets: Combining Sync and Async Commits

- Consumer_05_CommitSyncAsync

```
while True:  
    records_pulled = False # 用來檢查是否有有效的record被取出來  
    # 請求Kafka把新的訊息吐出來  
    records = consumer.consume(num_messages=500, timeout=1.0) # 批次讀取  
    if records is None: continue  
    for record in records:  
        if record is None: continue  
        if record.error(): ...  
        else:  
            records_pulled |= True  
            topic = record.topic()  
            partition = record.partition()  
            offset = record.offset()  
            timestamp = record.timestamp()  
            msgKey = try_decode_utf8(record.key())  
            msgValue = try_decode_utf8(record.value())  
            print('%s-%d-%d : (%s , %s)' % (topic, partition, offset, msgKey, msgValue))  
            # 異步地執行commit (Async commit)  
            if records_pulled:  
                consumer.commit()  
    except KeyboardInterrupt as e:  
        sys.stderr.write('Aborted by user\n')  
    except Exception as e:  
        sys.stderr.write(str(e))  
  
finally:  
    # 步驟6. 關掉Consumer實例的連線  
    consumer.commit(asynchronous=False)  
    consumer.close()
```

- Committing the latest offset only allows you to commit as often as you finish processing batches.
- What if `consume()` returns a huge batch and you want to commit offsets in the middle of the batch to avoid having to process all those rows again if a rebalance occurs?
- You can't just call `commit()` or `commit(asynchronous=False)` — this will commit the last offset returned, which you didn't get to process yet.
- Consumer API allows you to call `commit()` and `commit(asynchronous=False)` and pass a map of `partitions` and `offsets` that you wish to commit.

Commits and Offsets: Commit Specified Offset

- Consumer_06_CommitSpecified

```
while True:  
    records_pulled = False # 用來檢查是否有有效的record被取出來  
    # 請求Kafka把新的訊息吐出來  
    records = consumer.consume(num_messages=500, timeout=1.0) # 批次讀取  
    if records is None:  
        continue  
    for record in records:  
        # 檢查是否有錯誤  
        if record is None:  
            continue  
        if record.error(): ...  
        else:  
            # ** 在這裡進行商業邏輯與訊息處理 **  
            # 取出相關的metadata  
            topic = record.topic()  
            partition = record.partition()  
            offset = record.offset()  
            timestamp = record.timestamp()  
            # 取出msgKey與msgValue  
            msgKey = try_decode_utf8(record.key())  
            msgValue = try_decode_utf8(record.value())  
  
            # 秀出metadata與msgKey & msgValue訊息  
            print('%s-%d-%d : (%s , %s)' % (topic, partition, offset, msgKey, msgValue))  
  
            consumer.commit(record) # 非同步的commit
```

- If you know your consumer is about to lose ownership of a partition, you will want to commit offsets of the last event you've processed.
- The consumer API allows you to run your own code when partitions are added or removed from the consumer.
- You do this by passing `on_revoke` and `on_assign` when calling the `subscribe()` method

Commits and Offsets: RebalanceListener

- Consumer_07_CommitSpecified

```
# 當發生Re-balance時, 如果有partition被assign時被呼叫
def print_assignment(consumer, partitions):
    result = '[{}]'.format(','.join([p.topic + '-' + str(p.partition) for p in partitions]))
    print('Setting newly assigned partitions:', result)

# 當Re-balance被觸發後, Commit現在process的offsets
def commit_on_revoke(consumer, partitions):
    global offsets_dict
    for k, v in offsets_dict.items():
        consumer.commit(v) # 進行異步的commit

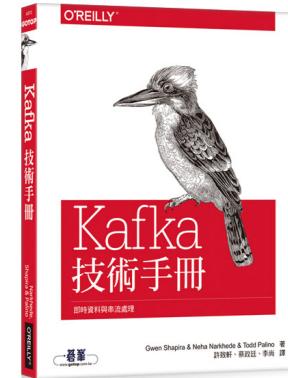
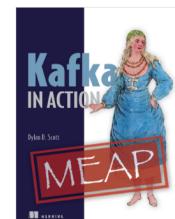
    result = '[{}]'.format(','.join([p.topic + '-' + str(p.partition) for p in partitions]))
    print('Revoking previously assigned partitions: ' + result)

# 當發生commit時被呼叫
def print_commit_result(err, partitions):...

if __name__ == '__main__':
    ...
    props = {...}

# 步驟2. 產生一個Kafka的Consumer的實例
consumer = Consumer(props)
# 步驟3. 指定想要訂閱訊息的topic名稱
topicName = 'ak03.four_partition'
# 步驟4. 讓Consumer向Kafka集群訂閱指定的topic
consumer.subscribe([topicName], on_assign=print_assignment, on_revoke=commit_on_revoke)
```

1. Kafka 技術手冊 | 即時資料與串流處理
(Kafka: The Definitive Guide) – O'REILLY



2. Kafka In Action - MANNING



3. Learn Apache Kafka for Beginners – Udemy
(Stephane Maarek)

4. Confluent Document of Kafka – [confluent.io](https://www.confluent.io)





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