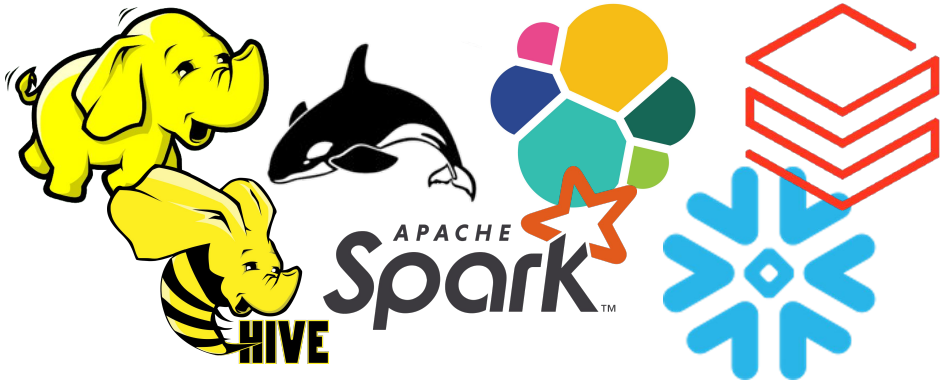
ADALTAS

Big Data Ecosystem



6. Stream processing

What is Streaming?

1. **Unbounded data sets** (in opposition to finite data sets);
2. **Unbounded data processing** (in time);
3. **Low-latency**, approximate and/or speculative results.

Streaming tools

- Distributed **messaging systems**:
  - Publish/consume messages to/from queues
  - Fault-tolerant
- Distributed **stream processing engines**:
  - Exactly-once, fault-tolerant processing
  - Aggregations, event-time windows

Apache Kafka: Functionalities

A **distributed streaming platform**. From Kafka web site:

- **Publish and subscribe to streams of records**, similar to a message queue or enterprise messaging system.
- **Store streams of records** in a fault-tolerant durable way.
- **Process streams of records** as they occur (new).

Kafka: The Messaging System

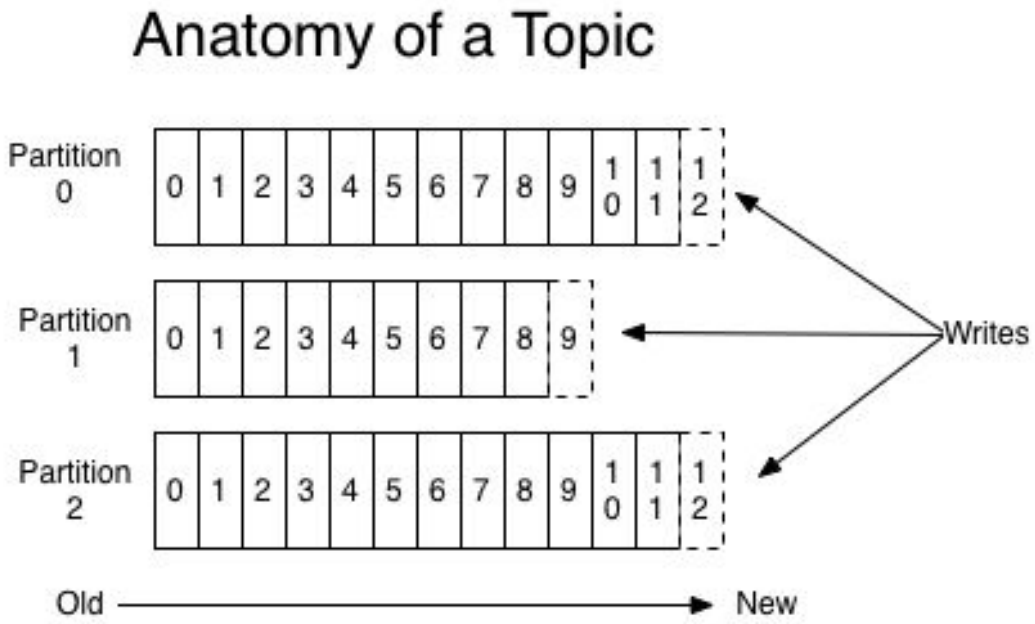
Records are published to **topics**.

- 1 record = (key, value, timestamp)
- 1 record belongs to 1 topic

Kafka: Topics

- 1 topic is split into **1 to N partitions**
- Each topic is **replicated** 1 to M times
- Records **order is guaranteed** within a partition
- Records are persisted given a **retention period**

Kafka: Topics



Kafka: Producers

Kafka is **dumb** (no routing policy) = **producers** are responsible for choosing **which topic and which partition** to write to

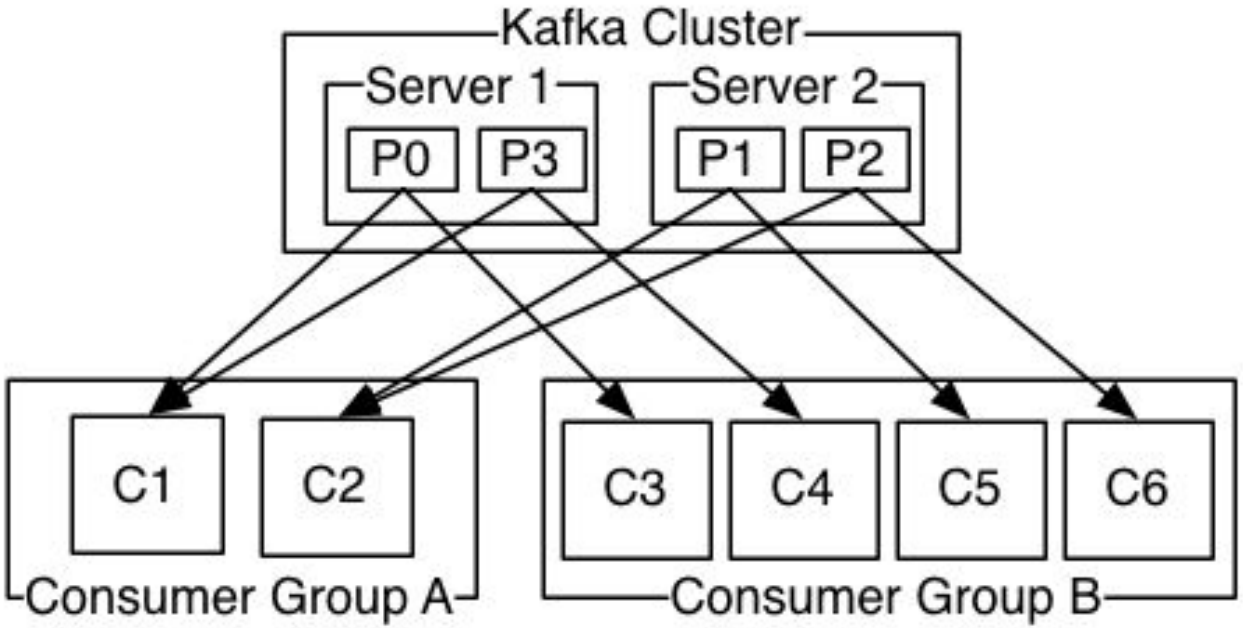
Methods to choose: round-robin, based on key, etc.

Kafka: Consumers

- **Choose the offset** to start reading
- Each record delivered to **1 consumer of each consumer group** (1 partition to 1 consumer)
- **Fair distribution** of records between consumers of a group

  → scalability + fault tolerance

Kafka: Consumers



Kafka: Data distribution

Server = Kafka **broker**

For each partition:

- 1 “leader” → read + write requests
- 0 to N-1 “followers” → replication

Apache Kafka performance

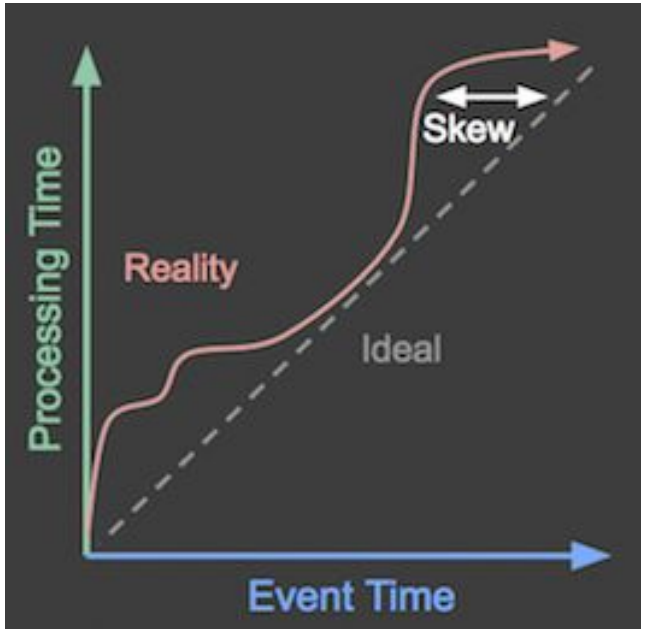
- The performance is **not impacted by the volume** stored
- Allow **scale of processing** → increase consumer instances
- Keep **records order** → 1 consumer receives records from 1 partition
- **Multiple independent "customers"** → 1 offset per consumer

Other use cases

- **Storage system** (especially for logs):
  - Data written to disk + replicated (CP)
  - No performance impact from ↗️ volume
- **Stream processing:** New API **Kafka Streams**

Stream processing: Problematics

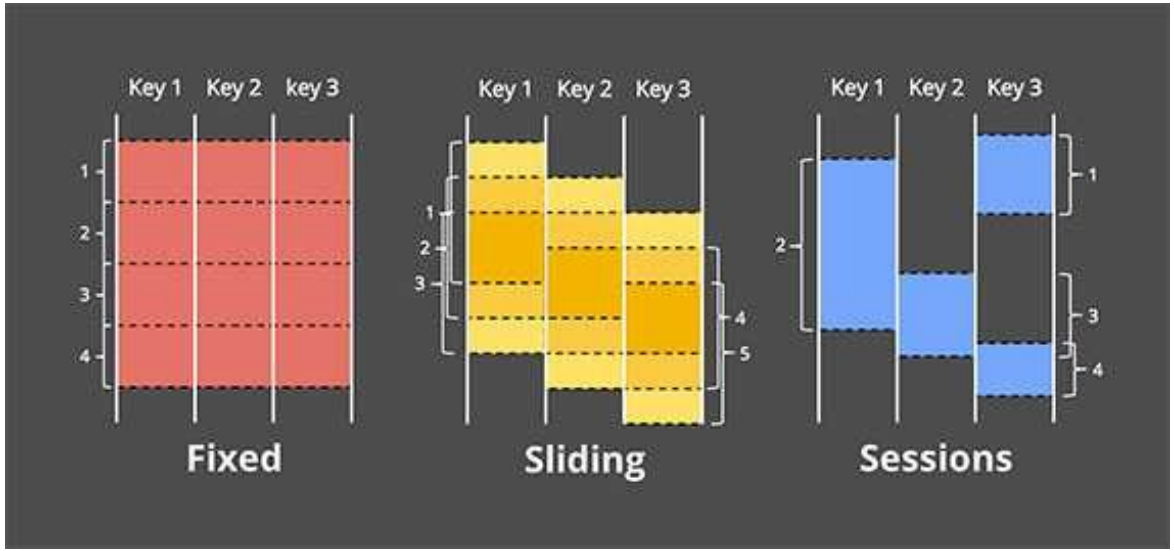
- **Event time** vs **processing time**



Stream processing: Problematics

Windows:

- Needed for aggregations
- Processing or event time ?



Stream processing: Problematics

- **Watermark =** given an event time E and a processing time P, we state that *“at time P, all data generated prior to E have been observed”*
- **Trigger =** time when the output are materialized

Stream processing: Problematics

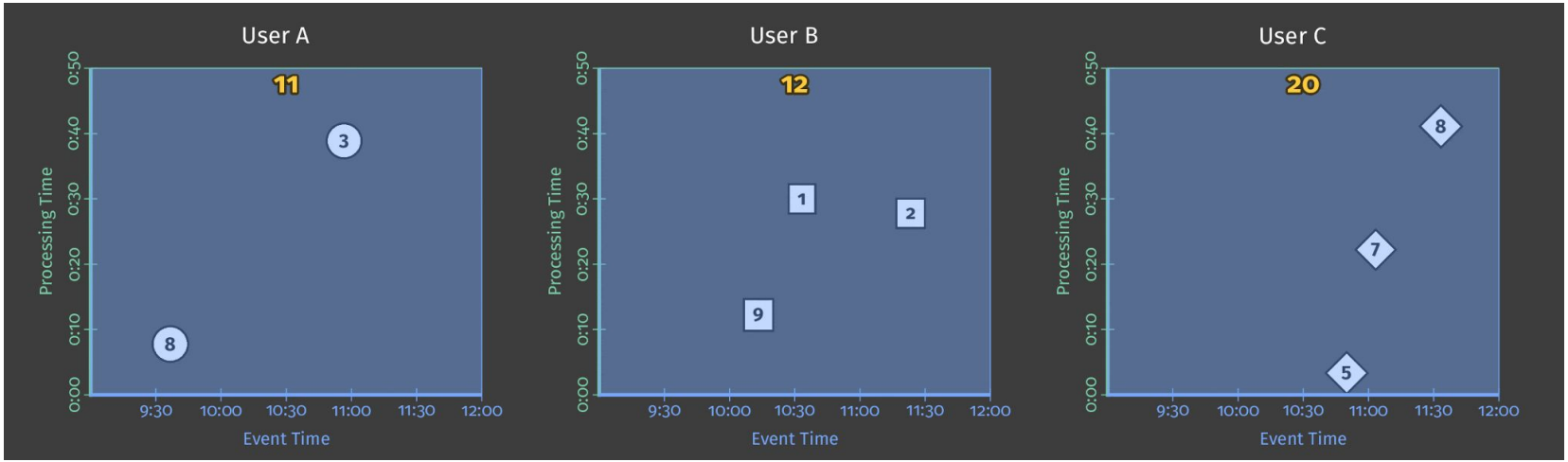
Dataflow model: define the pipeline with 4 questions

1. **What** results are calculated?
2. **Where** in event time are result calculated?
3. **When** in processing time are results materialized?
4. **How** do refinements of results relate?

Stream processing: Problematics

1. **What** results are calculated? → **Aggregation**

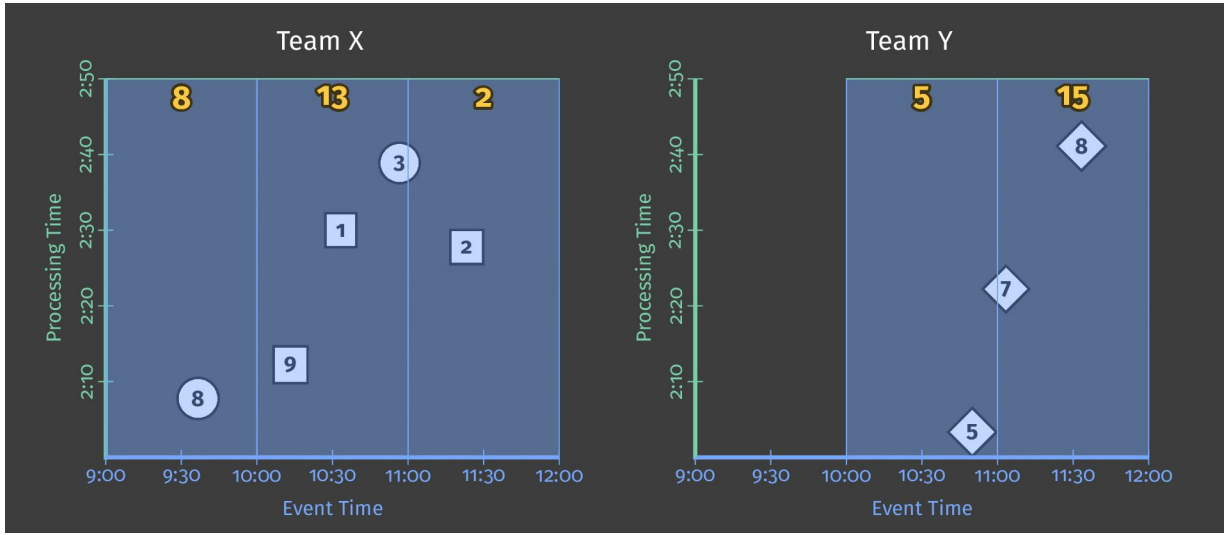
Eg. sum by key



Stream processing: Problematics

2. **When** in event time are results are calculated? → **Windows**

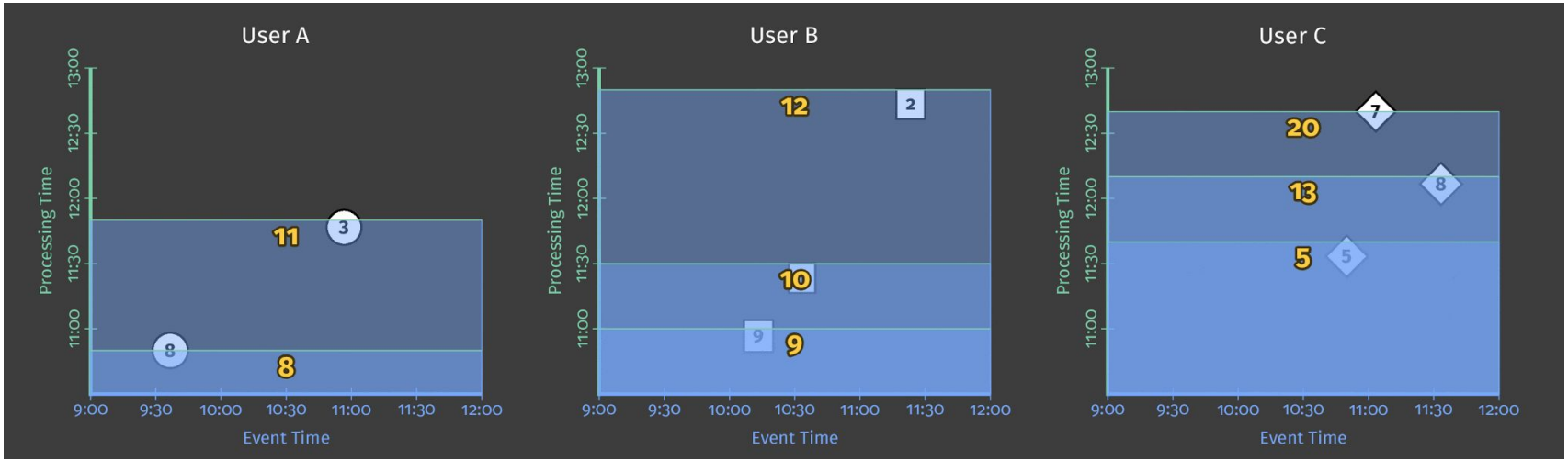
Eg. fixed window of 1 hour



Stream processing: Problematics

3. **When** in processing time are results materialized? → **Triggers**

Eg. every 10 min in processing time if new element(s)



Stream processing: Problematics

3. **Triggers =** watermark, processing time, count...

Stream processing: Problematics

4. **How** do refinements of results relate?

Multiple results for a window:

- Discarding = send each result separately
- Accumulating = send the aggregated result every time
- Both = send aggregate result + retraction message

Stream processing: Problematics

4. **How** do refinements of results relate?

Multiple results for a window:

- Discarding = send each result separately
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Stream processing engines

- Main solutions: Apache **Flink**, Apache **Spark**, Apache Storm, Apache Kafka Streams, Google Dataflow, Apache Samza
- Quick comparison: …?
- Streaming vs micro-batching

Practice with Spark Streaming