Top Five Lessons Learned in Building Streaming Applications at Microsoft Bing Scale

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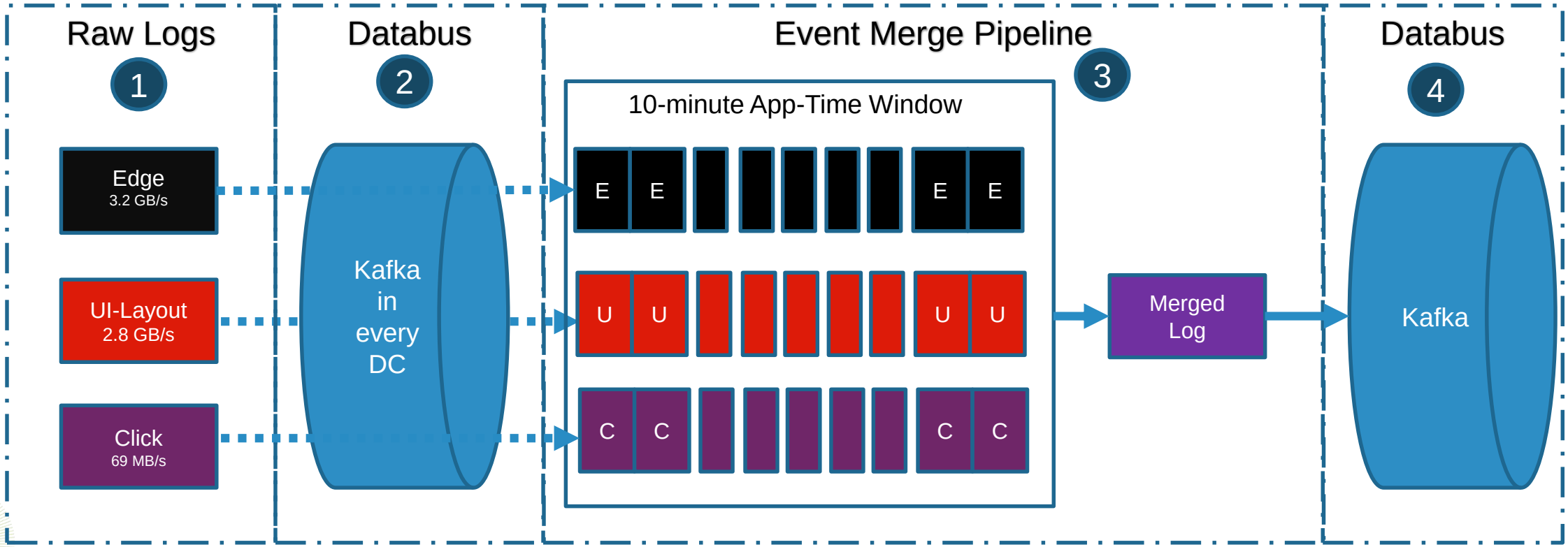
Bing Scale Problem – Log Merging

- Merge Bing query events with click events
- Lambda architecture: batch- and stream-processing shares the same C# library
- Spark Streaming in C#



Mobius Talk

- **Tomorrow afternoon** 3pm at Imperial
  - Mobius: C# Language Binding for Spark

Lesson 1: Use *UpdateStateByKey* to join DStreams

- **Problem**
  - Application time is not supported in Spark 1.6.
- **Solution – UpdateStateByKey**
  - **UpdateStateByKey** takes a custom **JoinFunction** as input parameter;
  - Custom **JoinFunction** enforces time window based on **Application Time**;
  - **UpdateStateByKey** maintains partially joined events as the **state**

Pseudo Code

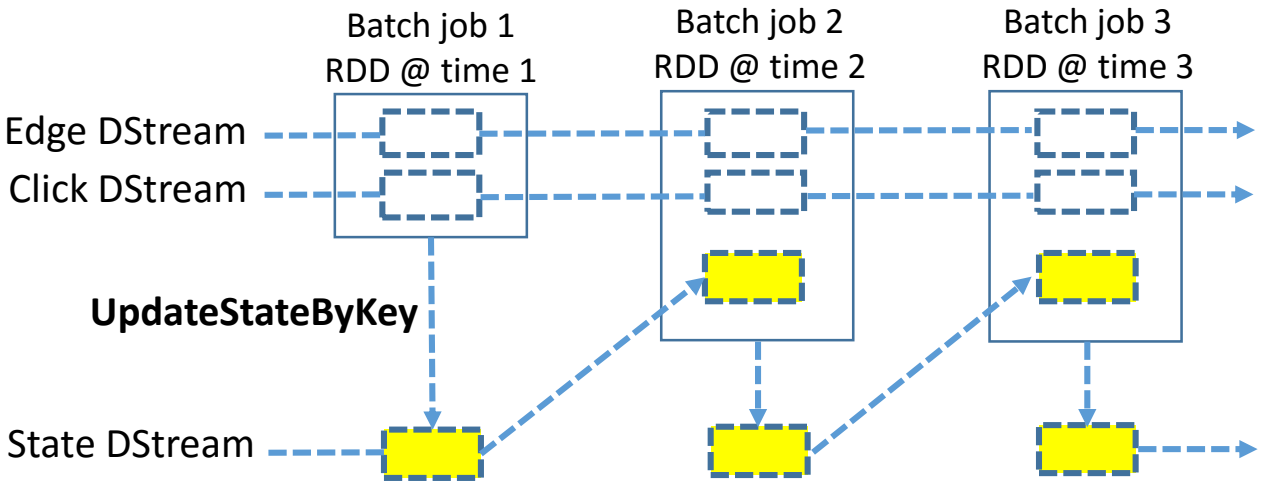
```
Iterator[(K, S)] JoinFunction(
    int pid, Iterator[(K:key, Iterator[V]:newEvents, S:oldState)] events)
{

    val currentTime = events.newEvents.max(e => e.eventTime);

    foreach (var e in events) {
        val newState = <oldState join newEvents>
        if (oldState.min(s => s.eventTime) + TimeWindow < currentTime) // TimeWindow 10minutes
            <output to external storage>
        else
            return (key, newState)
    }
}
```

***UpdateStateByKey* C# API**

PairDStreamFunctions.cs, https://github.com/Microsoft/Mobius



Lesson 2: Dynamic Repartition with Kafka Direct Approach

- **Problem**
  - **Unbalanced Kafka partition**s caused delay in the pipeline
- **Solution** – Dynamic Repartition
  1. Repartition data from one Kafka partition into multiple RDDs without extra shuffling cost of DStream.Repartition
  2. Repartition threshold is configurable per topic

Pseudo Code

```
class DynamicPartitionKafkaRDD(kafkaPartitionOffsetRanges)
  override def getPartitions {
    // repartition threshold per topic loaded from config
    val maxRddPartitionSize = Map<topic, partitionSize>

    // apply max repartition threshold
    kafkaPartitionOffsetRanges.flatMap { case o =>
      val rddPartitionSize = maxRddPartitionSize(o.topic)
      (o.fromOffset until o.untilOffset by rddPartitionSize).map(
        s => (o.topic, o.partition, s, (o.untilOffset, s + rddPartitionSize)))
    }
  }
```

Source Code

DynamicPartitionKafkaRDD.scala - https://github.com/Microsoft/Mobius

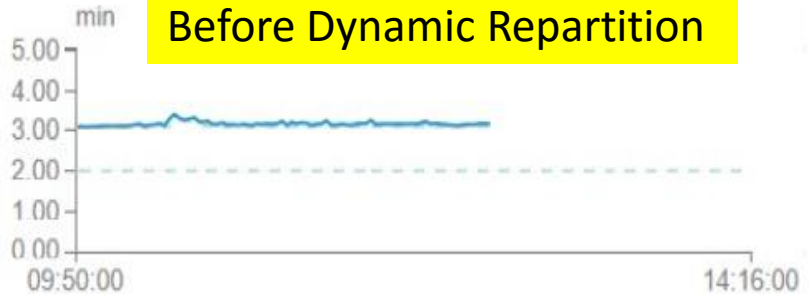
2-minute interval

Processing Time (?)
Avg: 3 minutes 10 seconds

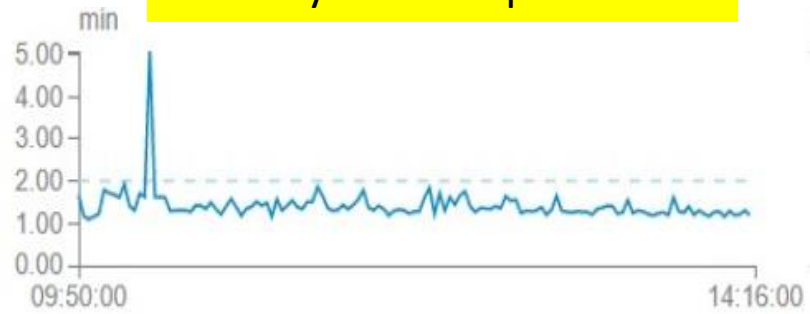
Input Rate
Avg: 100371.54 events/sec

Processing Time (?)
Avg: 1 minute 24 seconds

Before Dynamic Repartition



After Dynamic Repartition



Lesson 3: On-time Kafka fetch job submission

- **Problem**
  - Overall job delay accumulates due to transient slow/hot Kafka broker issue.
- **Solution**
  - Submit Kafka Fetch job on batch interval in a separate thread, even when previous batch delayed.

Pseudo Code

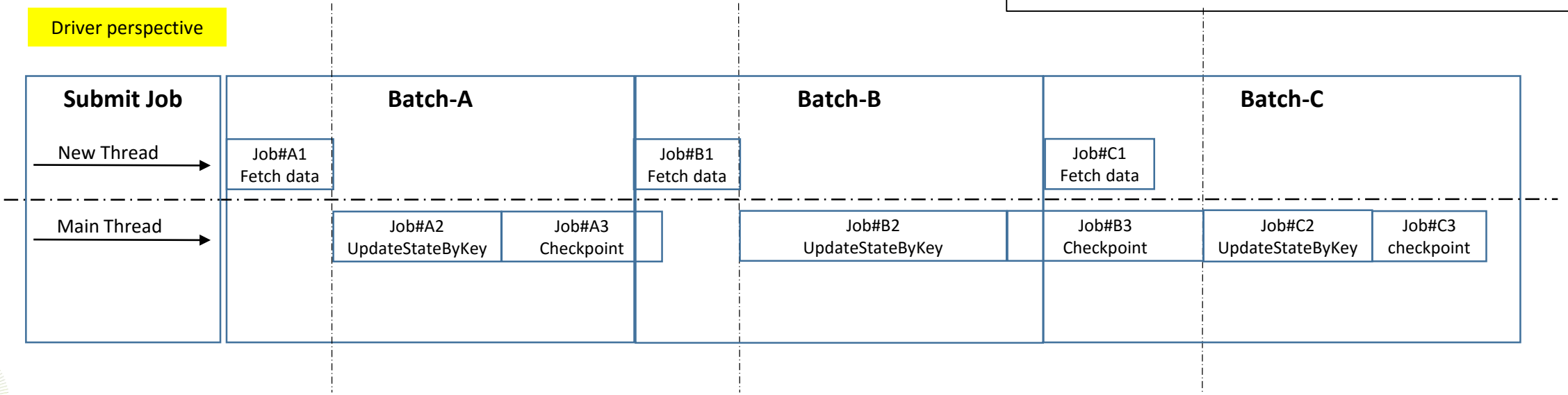
```
class CSharpStateDStream
  override def compute {
    val lastState = getOrCompute (validTime - batchInterval)

    val rdd = parent.getOrCompute(validTime)
    if (!lastBatchCompleted) {
      // if last batch not complete yet
      // run Fetch data job to materialize rdd in a separate thread
      rdd.cache()
      ThreadPool.execute(sc.runJob(rdd))
      // wait for job to complele
    }

    <compute UpdateStateByKey Dstream>
  }
```

Source Code

CSharpDStream.scala - https://github.com/Microsoft/Mobius



Lesson 4: Parallel Kafka metadata refresh

- **Problem**
  - Fetching Kafka metadata from multiple data centers often takes more time than expected.
- **Solution**
  - Customize *DirectKafkaInputDStream*, move metadata refresh for each {topic, data-center} to a separate thread

Pseudo Code

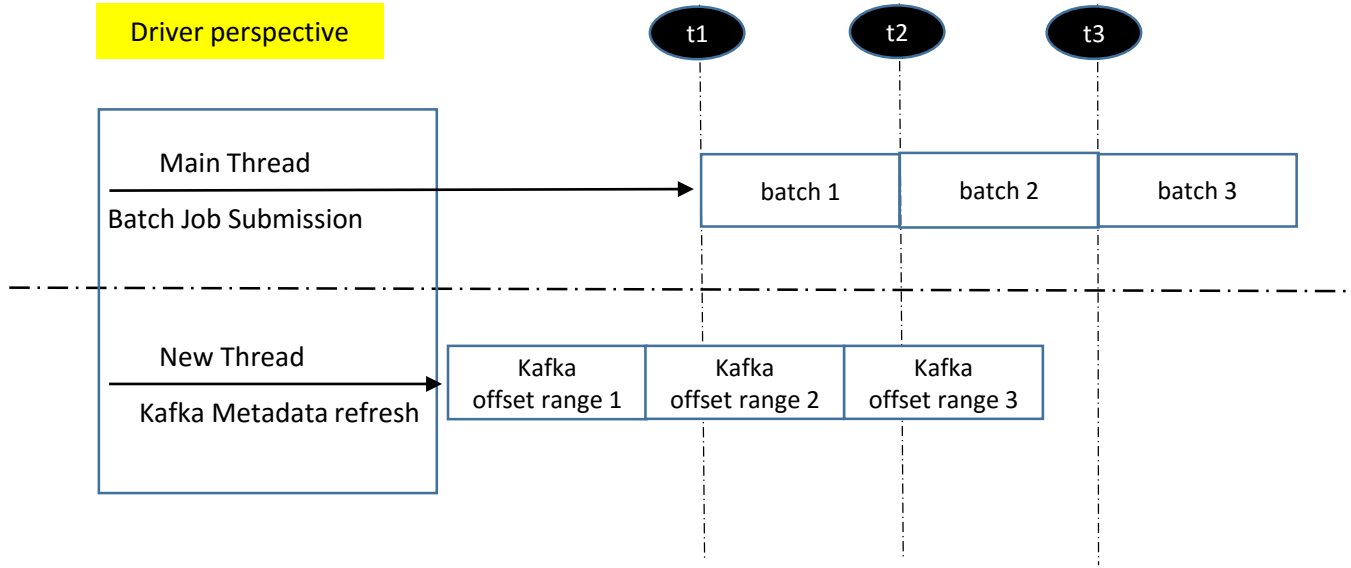
```
class DynamicPartitionKafkaInputDStream {

  // starts a separate schedule thread at refreshOffsetsInterval
  refreshOffsetsScheduler.scheduleAtFixedRate(
    <get offset ranges>
    <enqueue offset ranges>
  )

  override def compute {
    <dequeue offset ranges nonblockingly>
    <generate kafka RDD>
  }
}
```

Source Code

DynamicPartitionKafkaInputDStream.scala - https://github.com/Microsoft/Mobius



Lesson 5: Parallel Kafka metadata refresh + RDD materialization

- **Problem**
  - Kafka data fetch and data processing not in parallel
- **Solution**
  - Take Lesson 4 further
  - In metadata refresh thread, materialize and cache Kafka RDD

Pseudo Code

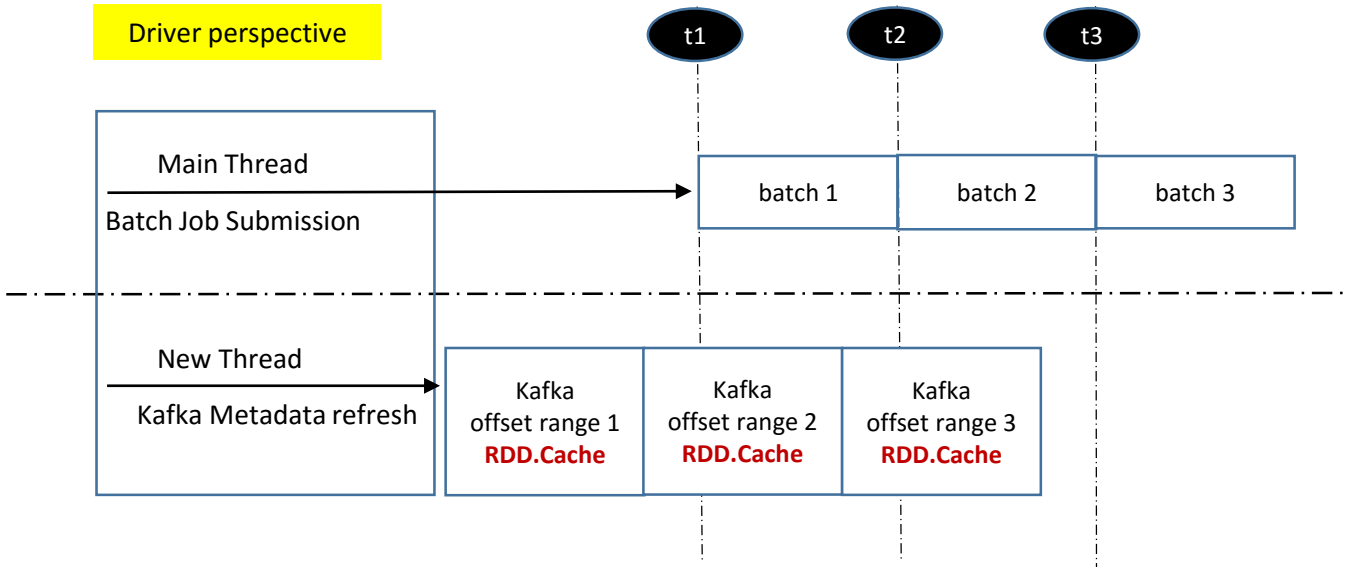
```
class DynamicPartitionKafkaInputDStream

  // starts a separate schedule thread at refreshOffsetsInterval
  refreshOffsetsScheduler.scheduleAtFixedRate(
    <get offset ranges>
    <generate kafka RDD>
    // materialize and cache
    sc.runJob(kafkaRdd.cache)
    <enqueue kafka RDD>
  )

  override def compute {
    <dequeue kafka RDD nonblockingly>
  }
```

Source Code

DynamicPartitionKafkaInputDStream.scala - https://github.com/Microsoft/Mobius



THANK YOU.

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