Kafka Design Exercises

Lesson Objectives

- Use Kafka to solve real world scenarios

Approach

- We present a particular use case/problem
- Work as groups to:
  - Come up with your solution
  - Present it to the class
- Discuss
  - Compromises & comparisons
  - Performance implications
  - Lessons learned

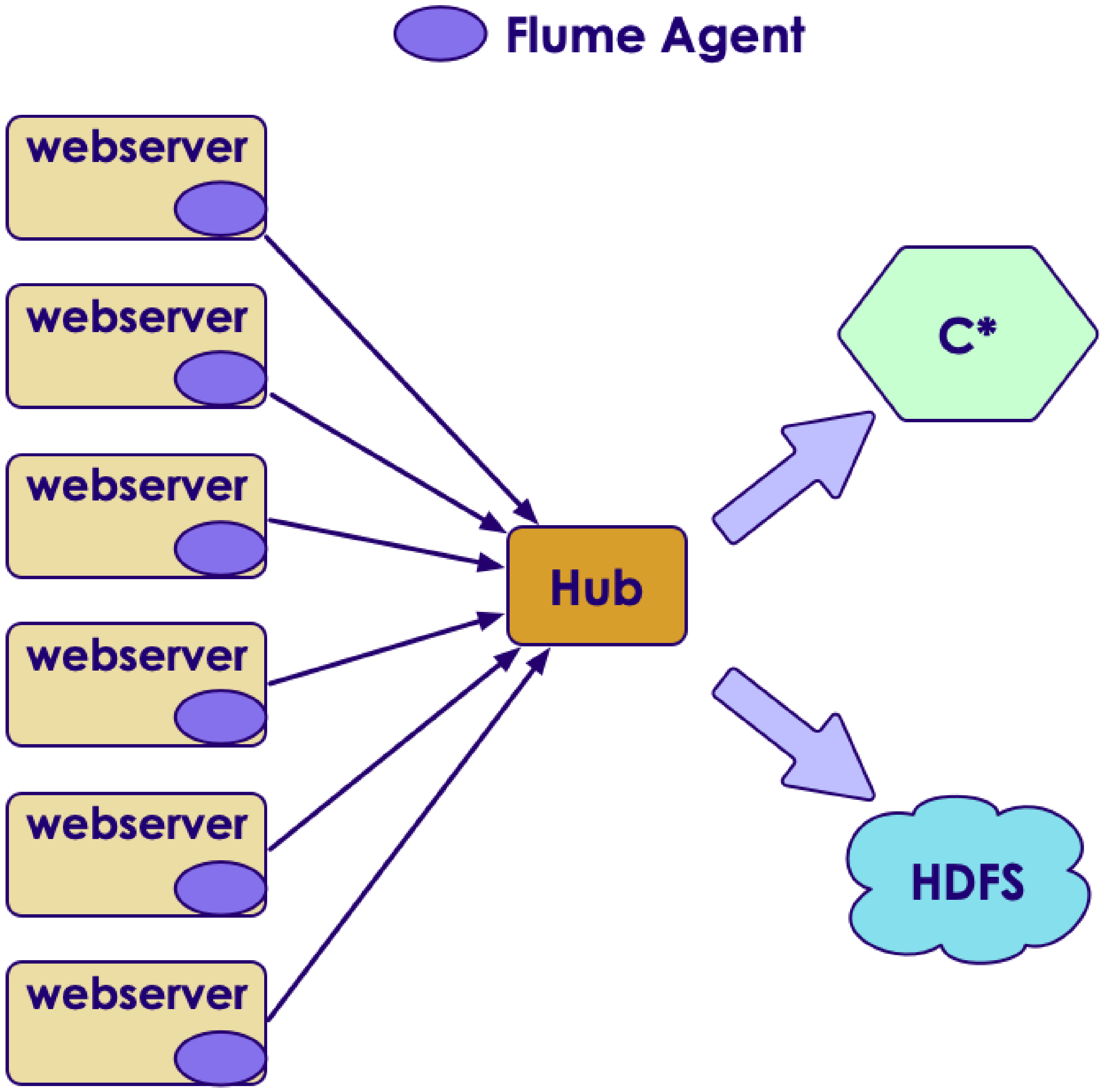
Next: Log Collection

Log Collection and Processing

- Collect and analyze logs on massive scale
- Use cases:
    - Large data center
        - Keep track of logins
        - Detect attacks
    - Web properties (e-commerce sites or LinkedIn)
        - Log user activities
        - Analyze user activities (which button users click most...etc.)
- Distributed log collection
    - Need to collect from multiple sources (100s or even 1000s)
- Tools
    - Flume (part of Hadoop ecosystem)
    - Kafka (distributed message queue)
    - Log Stash

Distributed Log Collection Tools: Flume

- Part of Hadoop ecosystem
- Works on `agent -> hub` model
- Agents run on `log source` and keep sending data upstream
- Can handle failures



Log Processing: Log format

- Logs contain:
  - Timestamp
  - Source (hostname or application_name)
  - Severity (info, error)
  - message

```
2020-01-10 13:21:43 - web1.example.com - ERROR - page not found /login.html
```

- Design a system to ingest the log files on a continuously basis
- Goal: To analyze the logs
  - Find log events for a certain host (latest event first)
  - Find log events of a particular severity
- **Answer next slide**

Solution: Gather logs into Kafka

- **Kafka Connect**: Use syslog plugin to ingest data into Kafka
  - https://docs.confluent.io/current/connect/kafka-connect-syslog/index.html
- LogStash
  - Can parse pretty much any log files
  - And send them to any 'stash'
  - Has input / output plugins for Kafka (can read from / write to Kafka)
- Log4J
  - Log4j has appenders to Kafka
- Roll your Own
  - Apache Commons has a Tailor class

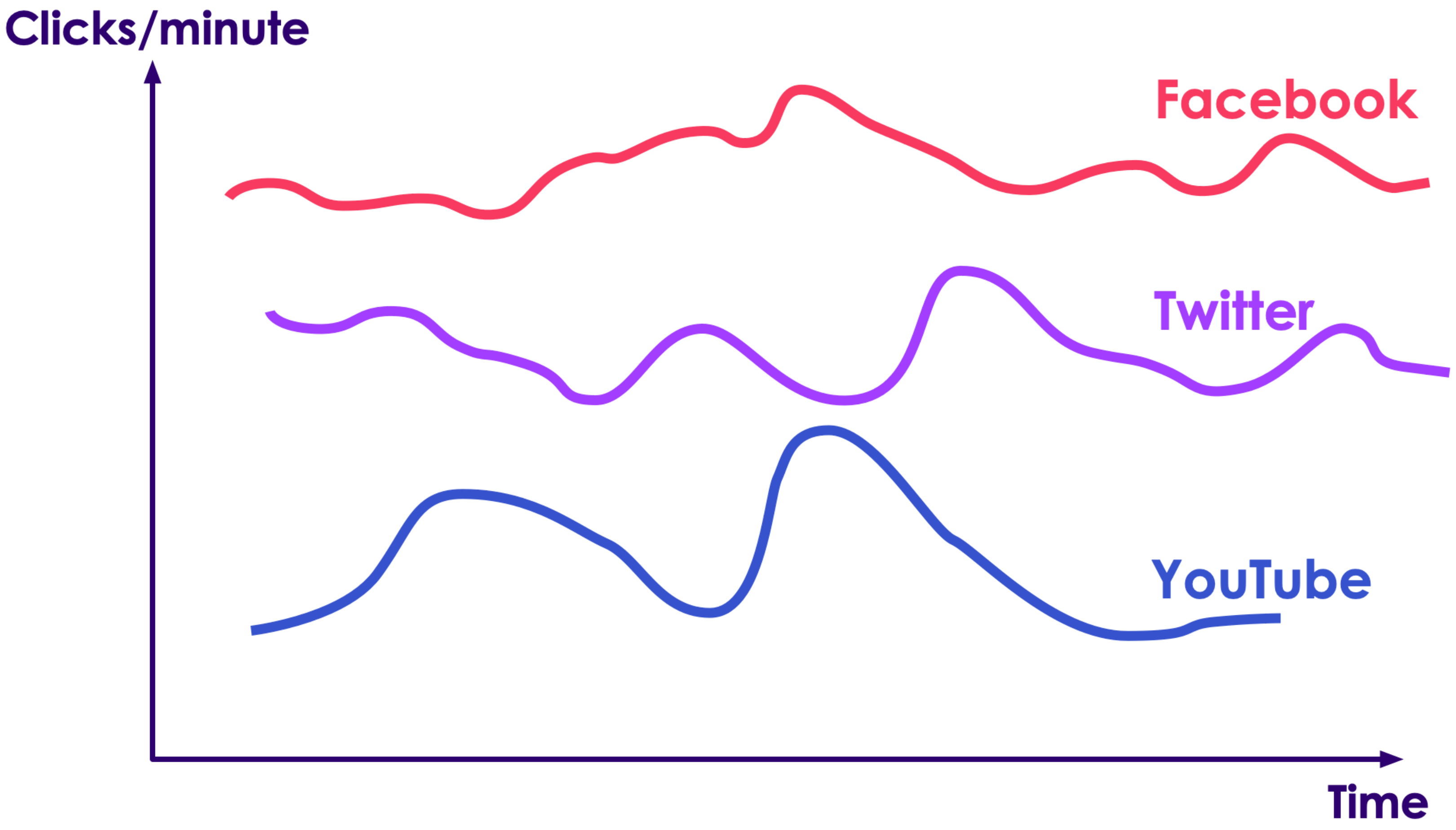
Next: Clickstream Processing

Quiz: Processing Clickstream Data

- Here is a sample clickstream data

```
{
    "timestamp" :1451635200055,
    "session":"session_57" ,
    "domain":"twitter.com" ,
    "cost":24,
    "user":"user_31",
    "campaign": "campaign_1",
    "ip":"ip_64",
    "action": "blocked"
}
```

- Query: We want to keep a running total of impressions per domain
- Design the producer and consumer
- Hints:
  - Think about how to aggregate stats for each domain



Solution: Processing Clickstream Data

- Discuss various solutions

Next: Slack

Quiz: Design a Messaging System Like Slack

- Here is a sample payload

```
{
    "timestamp" : "...",
    "from" : "user1",
    "to" : "user2",
    "message": "Hi, wanna grab lunch today?"
}
```

- Design Producer and Consumer
- Discuss data formats (keys, values)

Solution: Design a Messaging System Like Slack

- Discuss various solutions

Next: Netflix

Quiz: Design a Netflix Resume Feature

- You can watch Netflix on one-device (say TV), pause, and pick it up on another device (say iPad), exactly where you left off
- Implement this feature using Kafka
- Discuss what data you will send to Netflix to achieve this
  - How about keys?
  - How often to send data?

Solution: Discuss Netflix Resume Solution

Next: Fitbit

Quiz: Design a FitBit Badge Feature

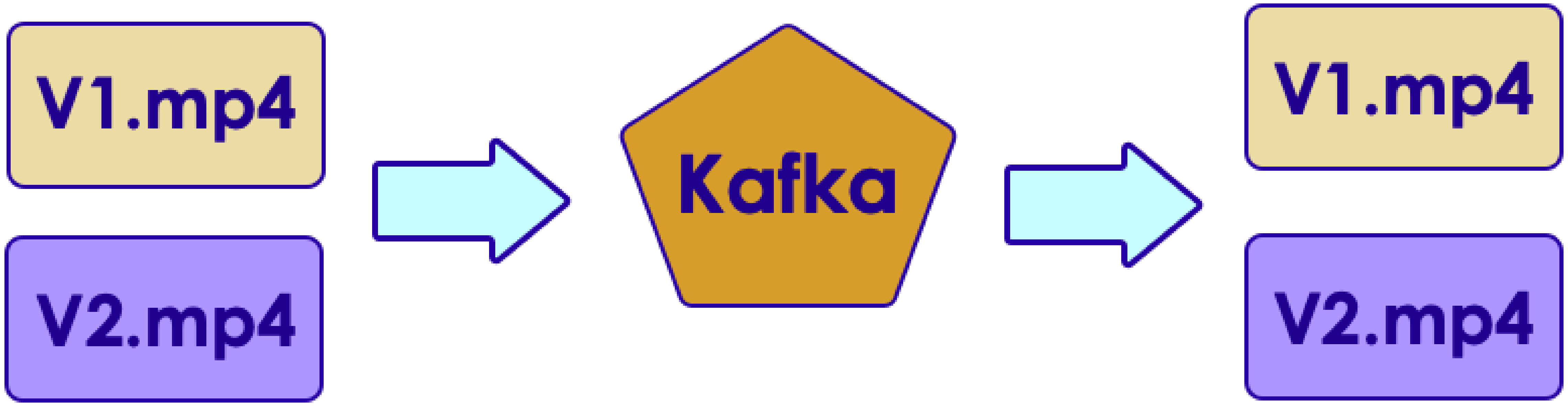
- Fitbit device tracks a person's movement (i.e. steps)
- People set target goals (10,000 steps / day)
- When the target goal is achieved (say 10,000 steps per day) we want to send a 'Well done !' email
- Also we want to announce 'daily competition winners' - a group of people competing together
    - We will send push notification to every one's phone at the end of day (say 11pm) to announce the winner for the day

Solution: Discuss Fitbit Design

Next: Large Video Files

Quiz: Sending Large Video Files Through Kafka

- We have video files that are of size from 100s of MB in size to few Gigs.
- We want to send these files using Kafka
- And assemble the files on the other end



Solution: Sending Large Video Files Through Kafka

- Chop the file into smaller chunks and send them with SAME key (so all chunks of one file will be written to ONE partition, and a consumer can re-construct the file on the other end)
- **Questions for class**
  - What can we use for key?
  - How do we make sure the files aren't corrupted?
- **Instructor:**
  - Draw out the payload send order

Next: Too Many Partitions

Quiz: Too Many Partitions Making Kafka Cluster Unstable

- We have a **created** topic with 1000 partitions
- And we have been sending data to the topic. All partitions have data
- But this is proving to be too many partitions for our little kafka cluster.
- We want to cut down the number of partitions to 100
- How can we accomplish this?Remember, number of partitions can not be reduced!
- **Answer next slide**

Solution: Reducing Number of Partitions

Next: IOT to Kafka

Quiz: How to Capture Events From an IOT device and push it to Kafka?

- Imagine we have IOT devices sending data 'home'
- These devices are outside our firewall!
- Capture the data in Kafka
- Design a system do this
- We want to award badges to users who accomplish certain milestonese.g. Fitbit send "well done" when a user completes 10,000 steps a day
  - These awards are sent via email & mobile app push notifications
- **Answer next slide**

Solution: IOT Data Capture

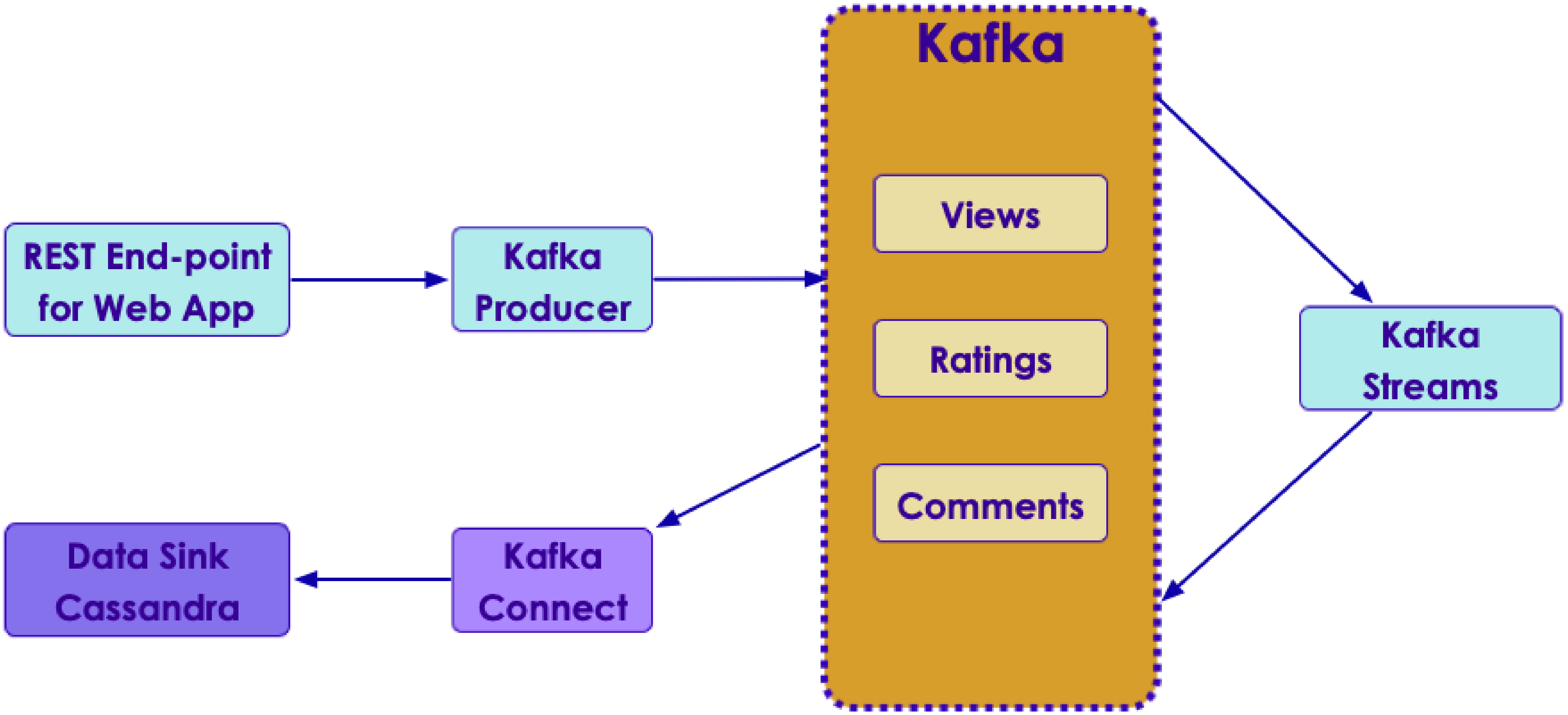
- Kafka REST

Next: YouTube

MyVideos / YouTube

- Allows users to upload videos
- Users can view, rate and comment on videos
- Rating is an integer 1 to 5
- Comment is text up to 1K bytes
- Need to handle millions of concurrent users
- Need to store all **views** , **ratings** , **comments** in some kind of database
- Assume some "processing" on ratings/comments will be required
- Lab:
  - Design a system to handle these requirements

MyVideos Design: Our Solution



Lab: MyVideos Cluster setup

- *Overview:*
  - Setup a Kafka cluster for MyVideos
    - Use instances of your group to form the cluster
  - Create the MyVideos topics
    - Think about replicas, partitions
- **Builds on previous labs:** None
- **Approximate time:** 30 minutes

MyVideos: Topics and Messages

- Producer
  - Receives all events - views, ratings, comments as they occur
  - It will send messages to Kafka topic(s)
  - For lab, assume we will generate the messages
- Design Kafka topics and message formats

MyVideos: Topics and Messages: Our Solution

- Topics
  - View
  - Rating
  - Comment
- Messages - AVRO data format
  - View: user_id, video_id, time_of_view, time_spent
  - Rating: user_id, video_id, time_of_rating, rating
  - Comment: user_id, video_id, time_of_comment, comment

MyVideos: Messages Schema

- Create Avro schemas
- Reference: http://avro.apache.org/docs/current/spec.html

MyVideos: View Schema: Our Solution

```
{"namespace": "com.example.videos",
  "type": "record",
  "name": "View",
  "fields": [
     {"name": "user_id", "type": "int"},
     {"name": "video_id", "type": "string"},
     {"name": "time_of_view", "type": { "type": "string", "logicalType": "timestamp
millis" }},
     {"name": "time_spent", "type": "int"}

  ]
}
```

MyVideos: View JSON: Our Solution

```
Example JSON data for Views:
{
  "user_id": 123,
  "video_id": "VID45128-1",
  "time_of_view": "2019-01-02T12:30:01",
  "time_spent_in_secs": 3.5
}
```

- Create schema at https://www.jsonschema.net/

MyVideos: Rating Schema: Our Solution

```
{"namespace": "com.example.videos",
 "type": "record",
 "name": "Rating",
 "fields": [
     {"name": "user_id", "type": "int"},
     {"name": "video_id", "type": "string"},
     {"name": "time_of_rating", "type":
     { "type": "string", "logicalType": "timestamp-millis" }},
     {"name": "rating", "type": "int"}
  ]
}
```

MyVideos: Rating JSON: Our Solution

```
Example JSON data for Views:
{
  "user_id": 123,
  "video_id": "VID45128-1",
  "time_of_rating": "2019-01-02T12:30:01",
  "rating": 4
}
```

- Create schema at https://www.jsonschema.net/

MyVideos: Comment Schema: Our Solution

```
{"namespace": "com.example.videos",
 "type": "record",
 "name": "Comment",
 "fields": [
     {"name": "user_id", "type": "int"},
     {"name": "video_id", "type": "string"},
     {"name": "time_of_rating", "type":
     { "type": "string", "logicalType": "timestamp-millis" }},
     {"name": "comment", "type": "string"
  ]
}
```

Lab: MyVideos Producers

- **Overview:**
  - Create Producers for the Rating topics
    - Think about the various settings, optimizations
- Bonus: Create producers for the other topics as well!
- **Approximate time:** 60-90 minutes

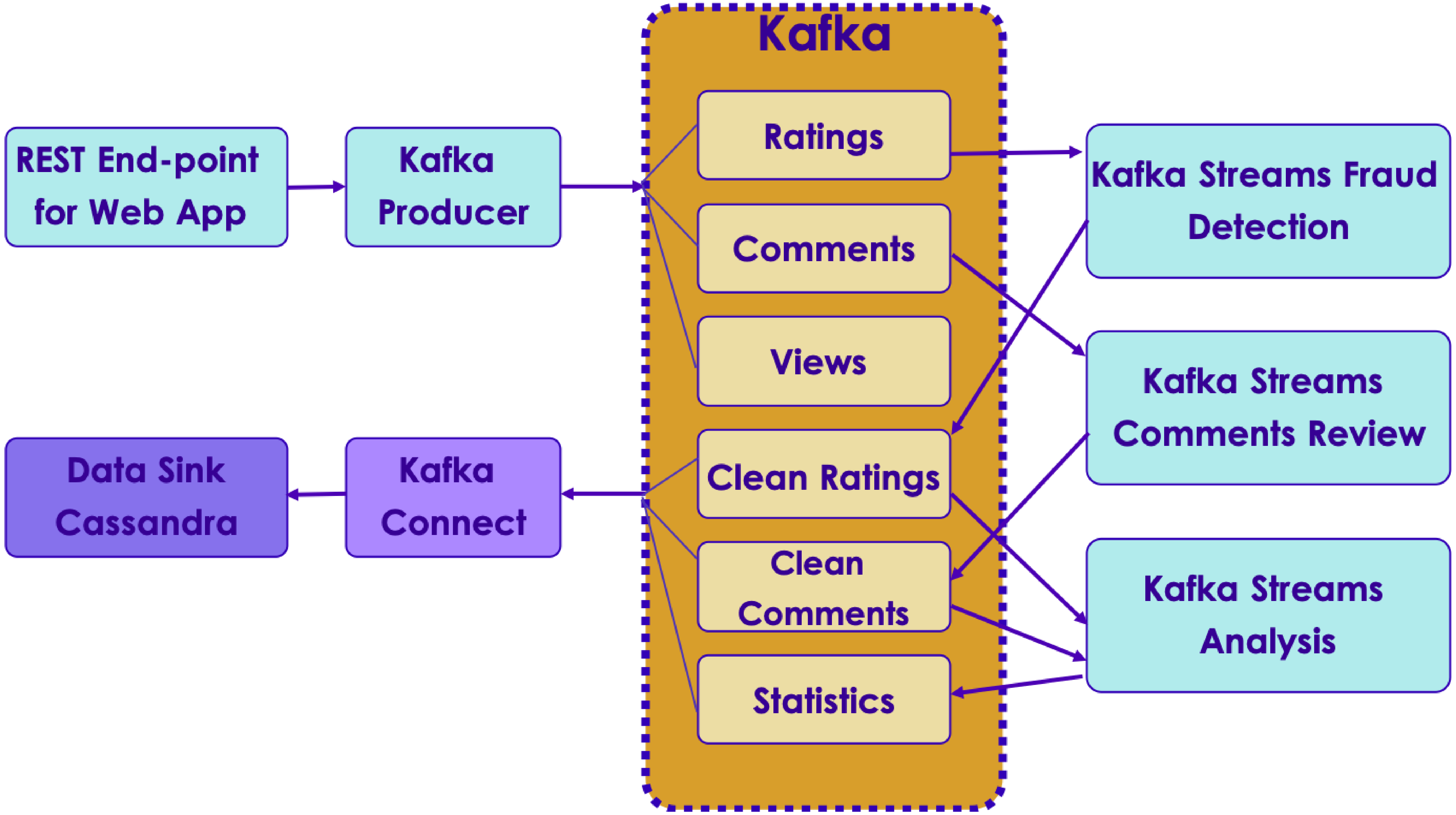
Lab: MyVideos Producers

- **Overview:**
  - Create Producers for the Rating topics
    - Think about the various settings, optimizations
- Bonus: Create producers for the other topics as well!
- **Approximate time:** 60-90 minutes

MyVideos: Stream Processing

- Check ratings and comments for fraud and unacceptable content
  - Assume we have a separate Java class/library that can do this
- We want real-time summary statistics such as number of views, ratings, comments per hour
  - Number of views per minute for the last hour
  - Count of ratings = 5 received per minute
  - Number of comments per minute
- Modify your design to handle these requirements

MyVideos Design: Our Solution



MyVideos: Stream Processing

- We want real-time summary statistics such as:
  - Number of views per minute
  - Count of highest rating (i.e. 5) received per minute
- How would you implement this?

MyVideos: Statistics: Our Solution

- Add a new Consumer app "statistics"
    - Process 'view' and 'rating' topics using Kstreams:
        - Create hopping windows of one minute
- Reference: https://kafka.apache.org/20/documentation/streams/developer-guide/dsl-api.html#streams-developer-guide-dsl-windowing

Lab: MyVideos Consumers

- **Overview:**
  - Implement Statistics app
    - Consume Rating events
    - Create Statistics topic
- **Approximate time:** 1 hour

MyVideos: Bonus: User Devices

- A user has multiple devices (TV, tablet, phone, computer)
- We want to track devices used to view videos
  - How many videos are viewed using which devices
- Device attributes:
  - device_id (something unique)
  - Device Type (phone/tv/tablet/set-top)
  - Device belongs to ONE user
- Modify your design to handle devices

MyVideos: User Devices: Our Solution

- Add following fields to "View" schema:
  - device_id, device_type
- Add a new Consumer app
  - Process 'view' topic using Kstreams:
    - Group messages by device_type and count them

Review and Q&A

- Let's go over what we have covered so far
- Any questions?