45. Video Distribution System

Real-life examples

- Youtube
- Netflix
- Vimeo

Requirements clarification

Functional requirements

- Upload video: Users can upload videos.
- Watch video: Users can watch videos.
- Search video: Users can search videos.
- Comment video: Users can leave comments to videos, also like or dislike.

Non-functional requirements

- High reliability (Any video uploaded should not be lost).
- High availability.
- High consistency is desirable (It should be ok for a user doesn’t see a video for a while).

Estimation

Traffic estimation

- Our system will be read-heavy.
- Read-write ratio (View-upload ratio) is 200 : 1 (Assumed)
- Users
  - 1.5 billion users. (Assumed)

    - 150 million daily active users. (Assumed)
    - 1% of users are creators, every week will publish one new video. (Assumed)
    - Each user watches 3 videos per day. (Assumed)
- Number of read actions and write actions per week
    - Number of writes (upload) per week = 1.5 billion x 1% = 15 million
    - Number of reads (watch) per week = 15 millions x 200 = 3 billion
- Frequency of read actions and write actions per second (QPS)
    - Frequency of writes per second = 15 millions / (7 days x 24 hours x 3600 seconds) = 24 videos/s
    - Frequency of reads per second = 24 videos/s x 200 = 4800 videos/s

Storage estimation

- **Types**
    - Data: Yes
    - File: Yes
- **Capacity**
    - Size of each video: 500 MB (Assumed)
    - Total capacity needed in week = Number of writes (upload) per week x Size of one record = 15 million x 500 MB = 7152 TB

Bandwidth estimation

- Size of each video: 500 MB (Assumed)
- Write bandwidth = Frequency of writes per second x Size of one record = 24 videos/s x 500 MB = 11 GB/s
- Read bandwidth = Frequency of reads per second x Size of one record = 4800 videos/s x 6 MB/s (1080p) = 28 GB/s

System interface definition

Interface 1

- **uploadVideo(api_key, video_title, video_description, video_content)**
- **Function**
  - Upload a video
- **Parameters**
  - api_key (string): The API developer key of a registered account.
  - video_title (string): The title of the video.
  - video_description (string): The description of the video.
  - video_content (stream): The content stream of the video.

Interface 2

- **streamVideo(api_key, video_id, offset, codec, resolution)**
- **Function**
  - Watch a video
- **Parameters**
  - api_key (string): The API developer key of a registered account.
  - video_id (string): The ID of the video.
  - offset (number): A playing time in seconds from the beginning of the video.
  - codec: The encoding format of the video.
  - resolution: The resolution of the video.

Data model definition

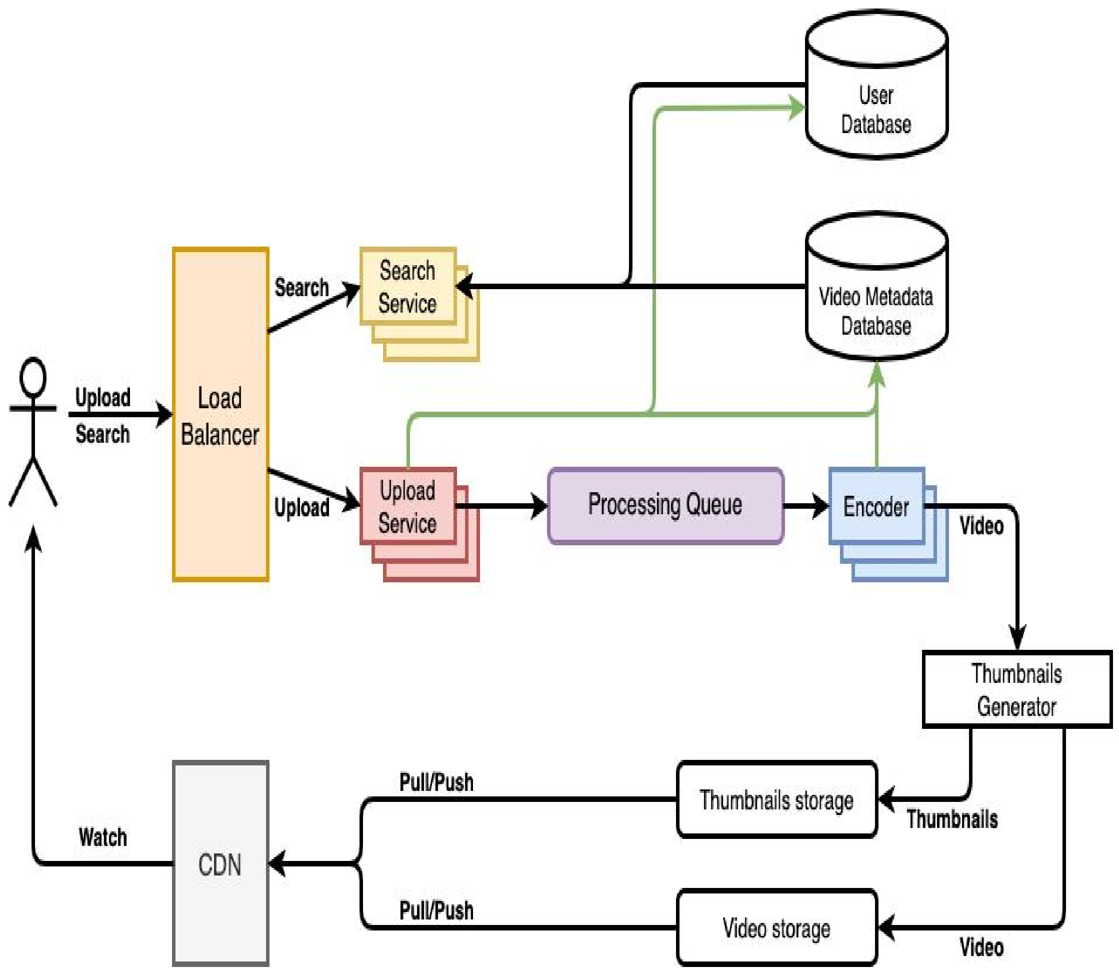
Schema

- Table 1: VideoMetadata
- Table 2: Comment
- Table 3: User

Data storage

- Database
- File storage (to store video and thumbnails)
- HDFS
- GlusterFS
- Amazon S3

High-level design



Upload Service

Handle upload requests

Create a encoding task and push it into the processing queue.

Processing Queue

- Store all the encoding tasks.
- Decouple uploading works and encoding works
- It can act as a buffer if the encoder is unavailable or overloaded.

Encoder

- Encode each uploaded video into multiple formats.

Thumbnails generator

- Generate a few thumbnails for each video.

Video Storage

- Store video contents.

Thumbnails Storage

- Store thumbnails.

Video Metadata Database

- Store all the information about videos like title, file path in the system, uploading user, total views, likes, dislikes, comments.

User Database

- Store user's information.

Key points

- Use queue to decouple upload works with encoding works.
- Use proper storage for storing videos and thumbnails.
    - Object storages
    - CDN
- Read traffic for thumbnails will be huge compared to videos
    - Users will be watching one video at a time, but they might be looking at a page with 20 thumbnails of other videos.