LAB 7 OVERVIEW AND STREAMING VIDEO AND MPEG-DASH

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UC San Diego

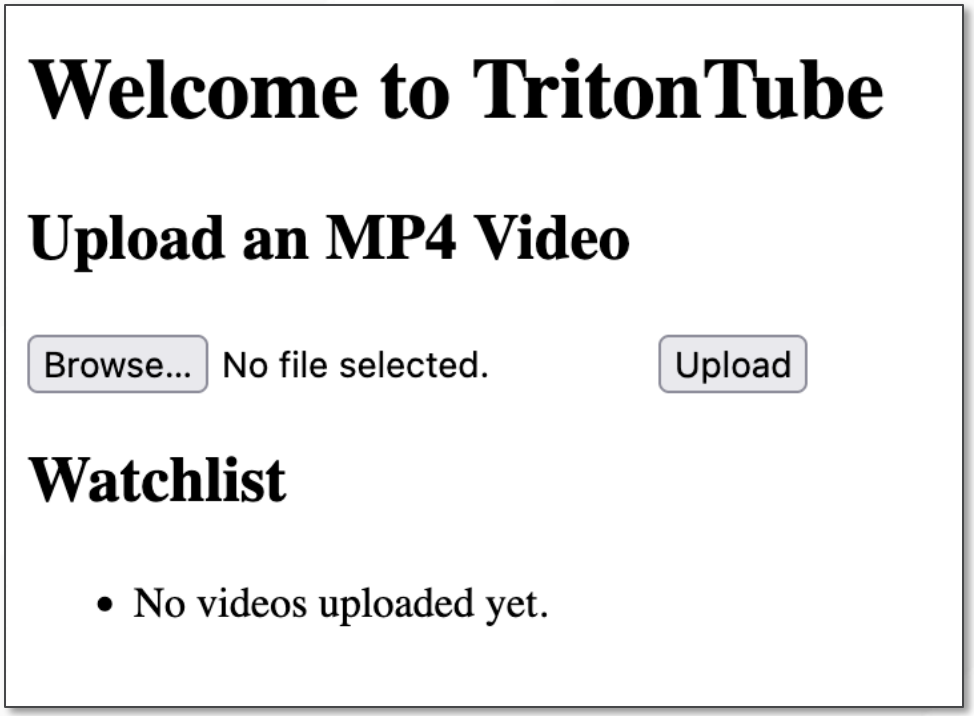
ATTRIBUTION

- These slides incorporate material from:
  - The Blender Foundation (blender.org)
  - https://www.wowza.com/blog/mpeg-dash-dynamic-adaptive-streaming-over-http

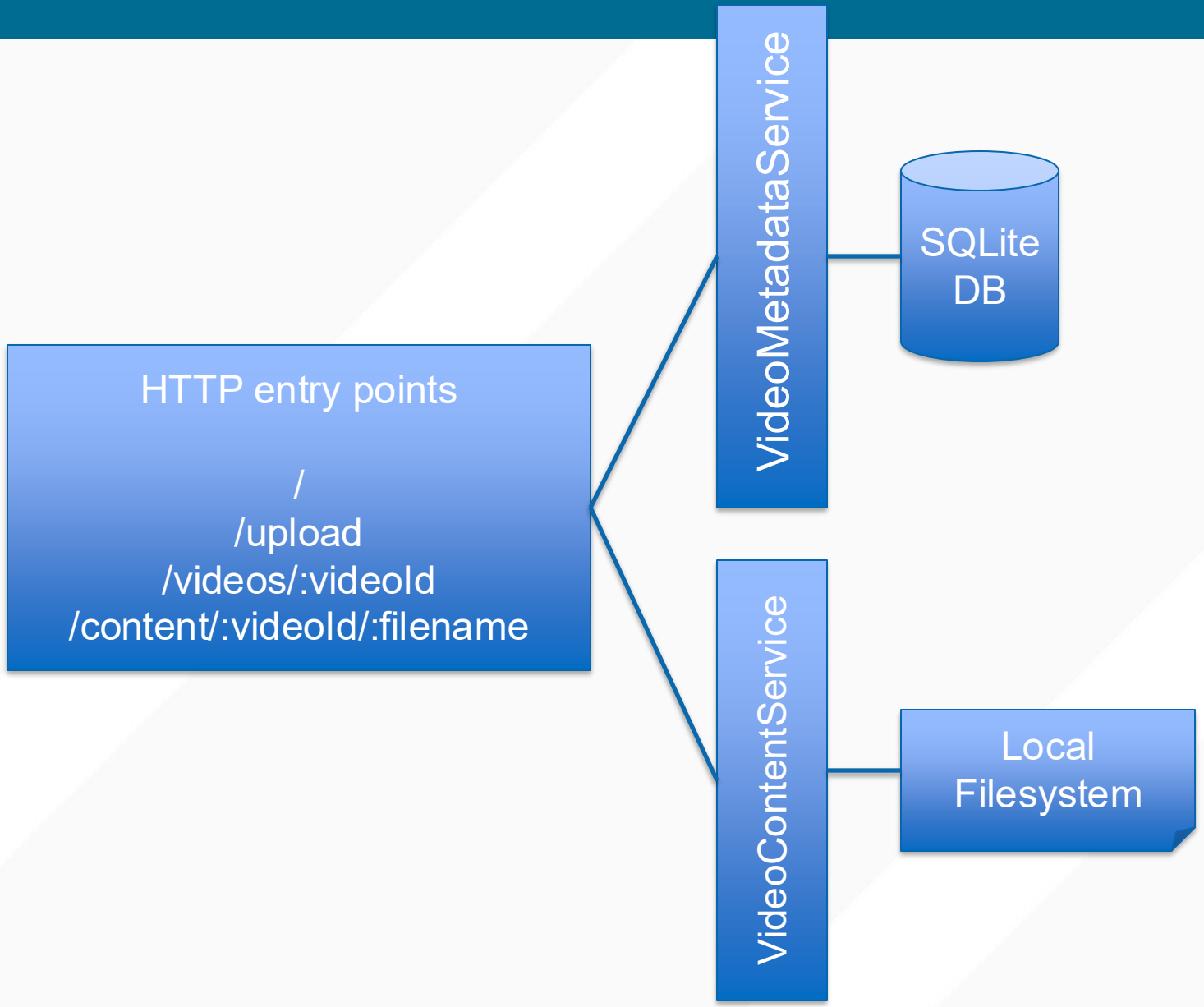
Video streaming outline

- Lab 7 overview
- Example video from Blender.com
- Image and video compression overview
- MPEG-DASH format
- MPEG-DASH demo

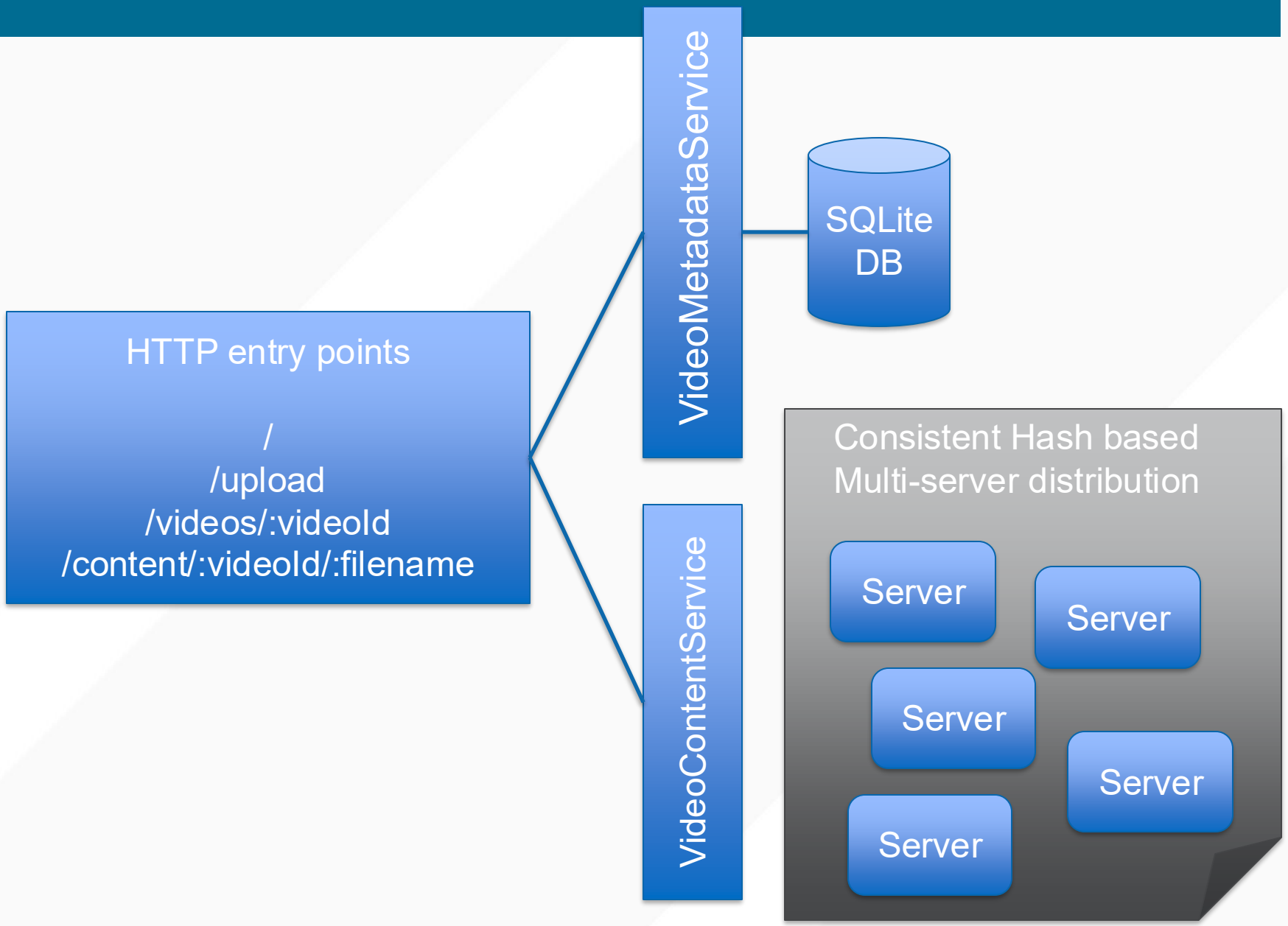
LAB 7 DEMO


Welcome to TritonTube
Upload an MP4 Video
Browse...
No file selected.
Upload
Watchlist
No videos uploaded yet.

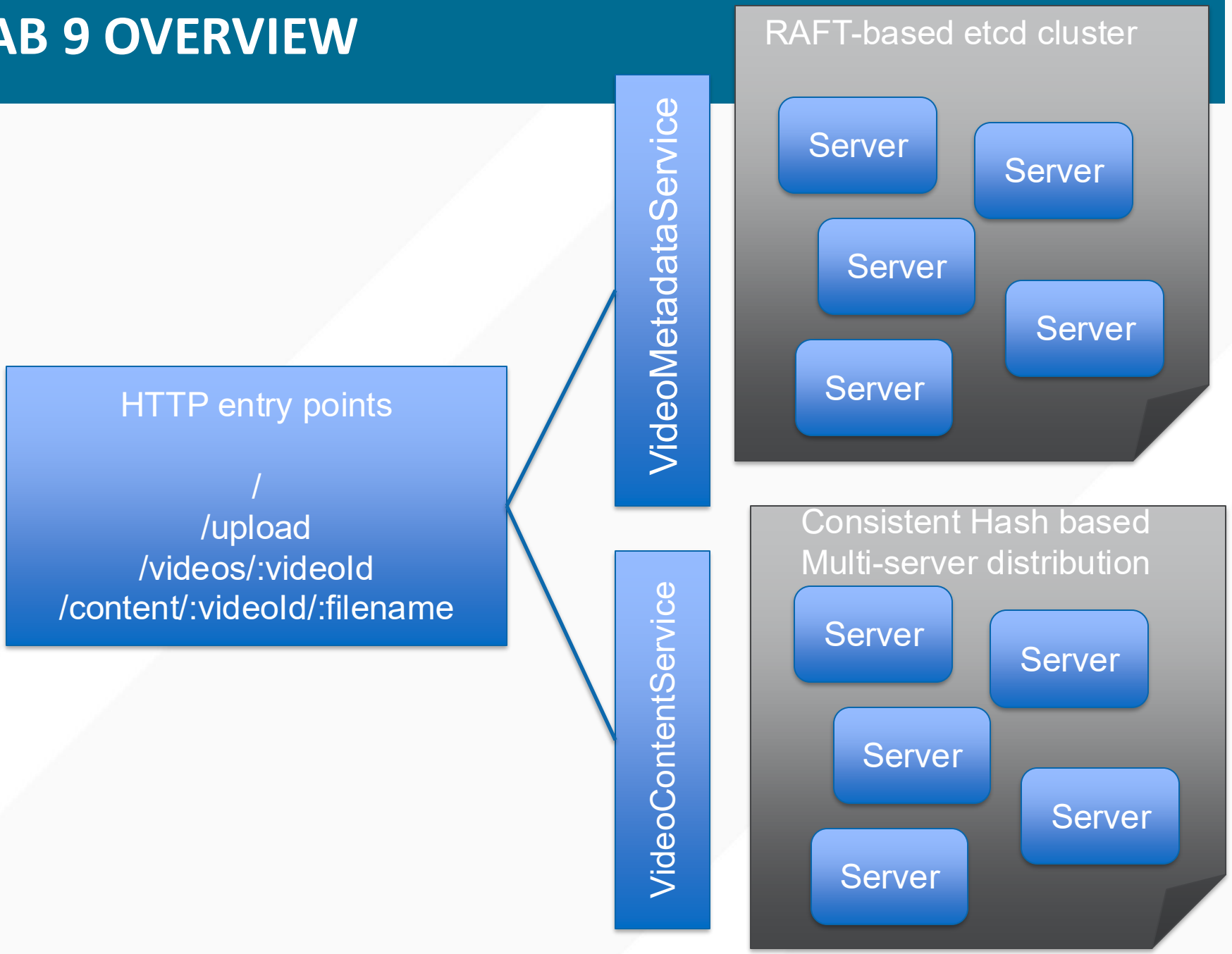
LAB 7 OVERVIEW



LAB 8 OVERVIEW



LAB 9 OVERVIEW



TESTING STRATEGY

- We have released a binary version of the entire project
- You can play around with this and compare your solution with our solution if you have questions
- At end of lab 7, we'll release source code for lab 7 so you can implement labs 8/9 even if you had trouble with lab 7

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LOSSY IMAGE COMPRESSION

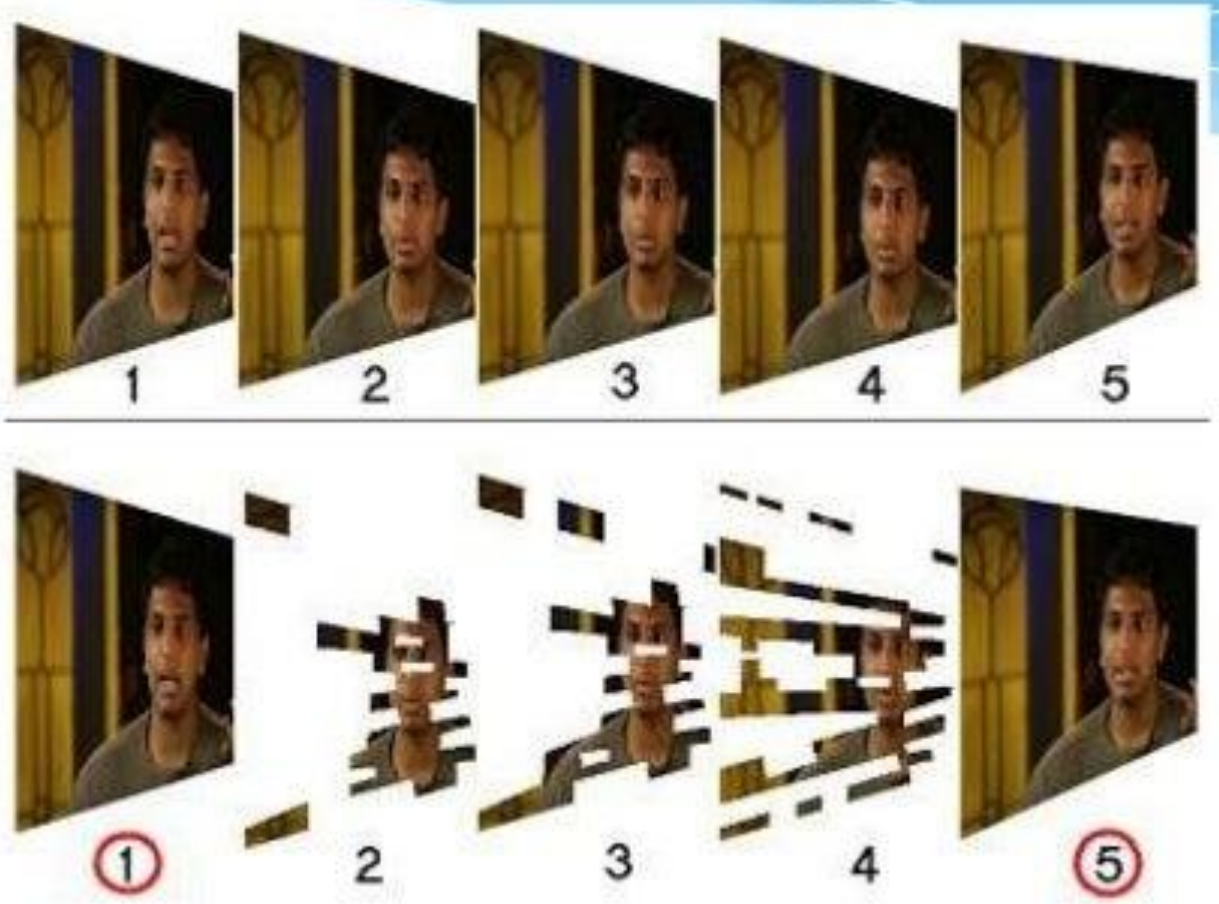
8.9M

68.34K

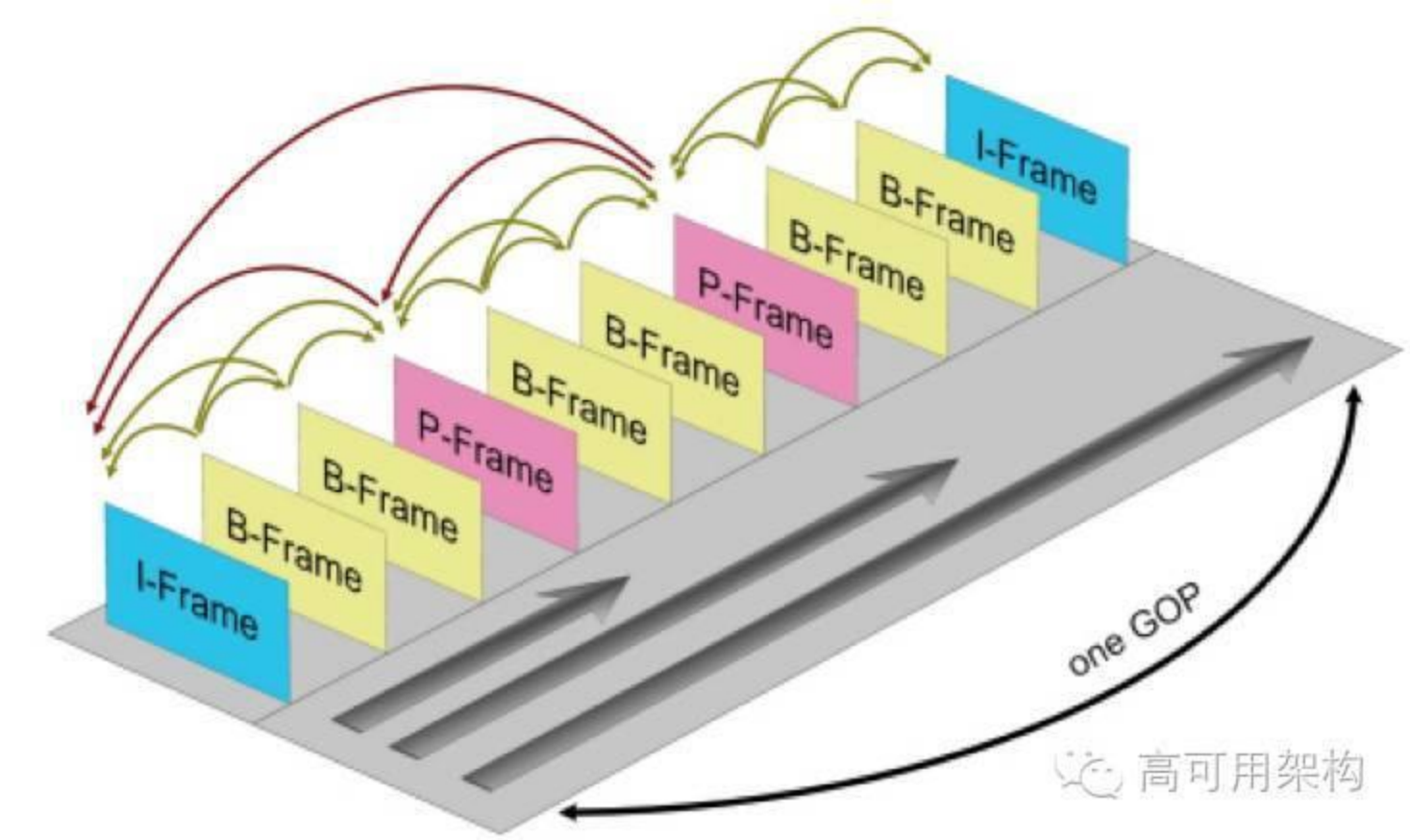
BITRATES


Quality = 100
Quality = 50
Quality = 10
Quality = 5
Less Compression
More Compression

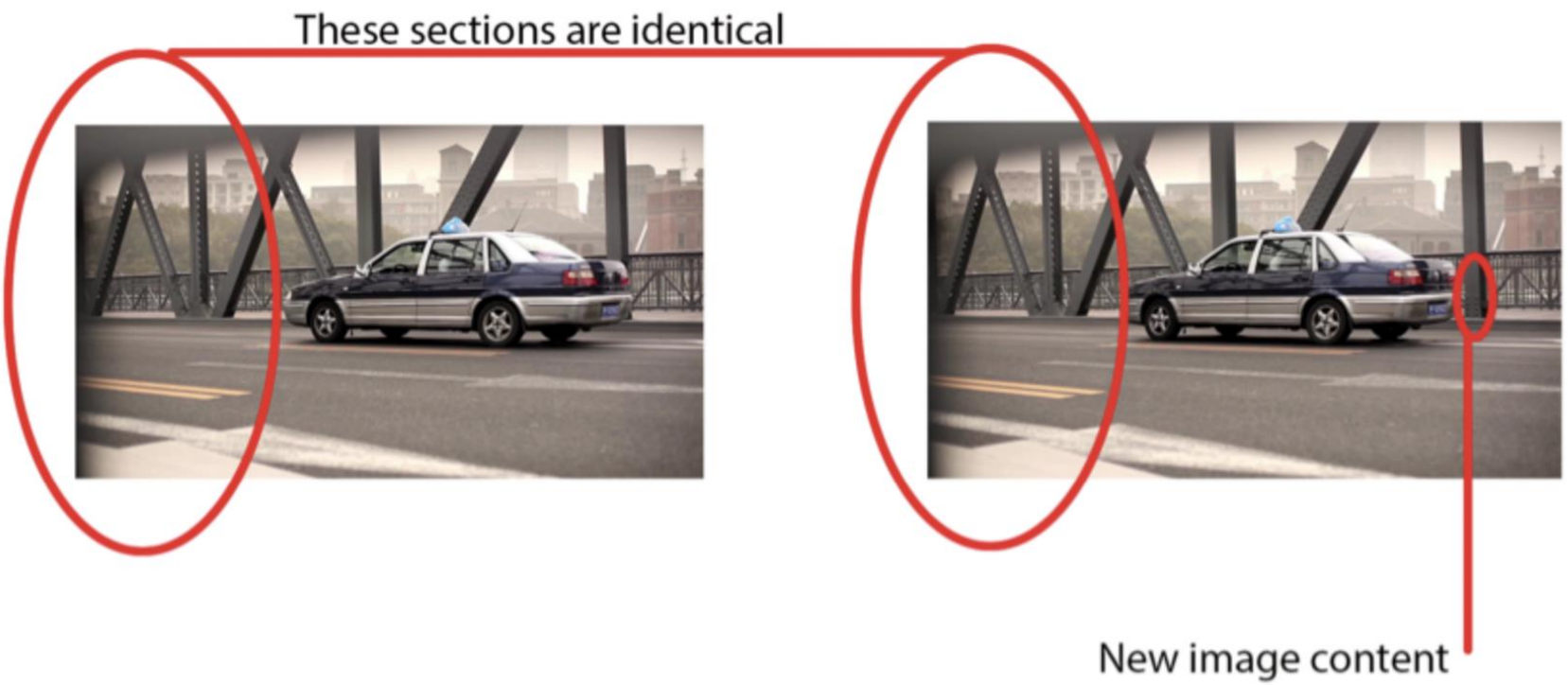
Example



I-FRAMES, B-FRAMES, P-FRAMES, GOPS



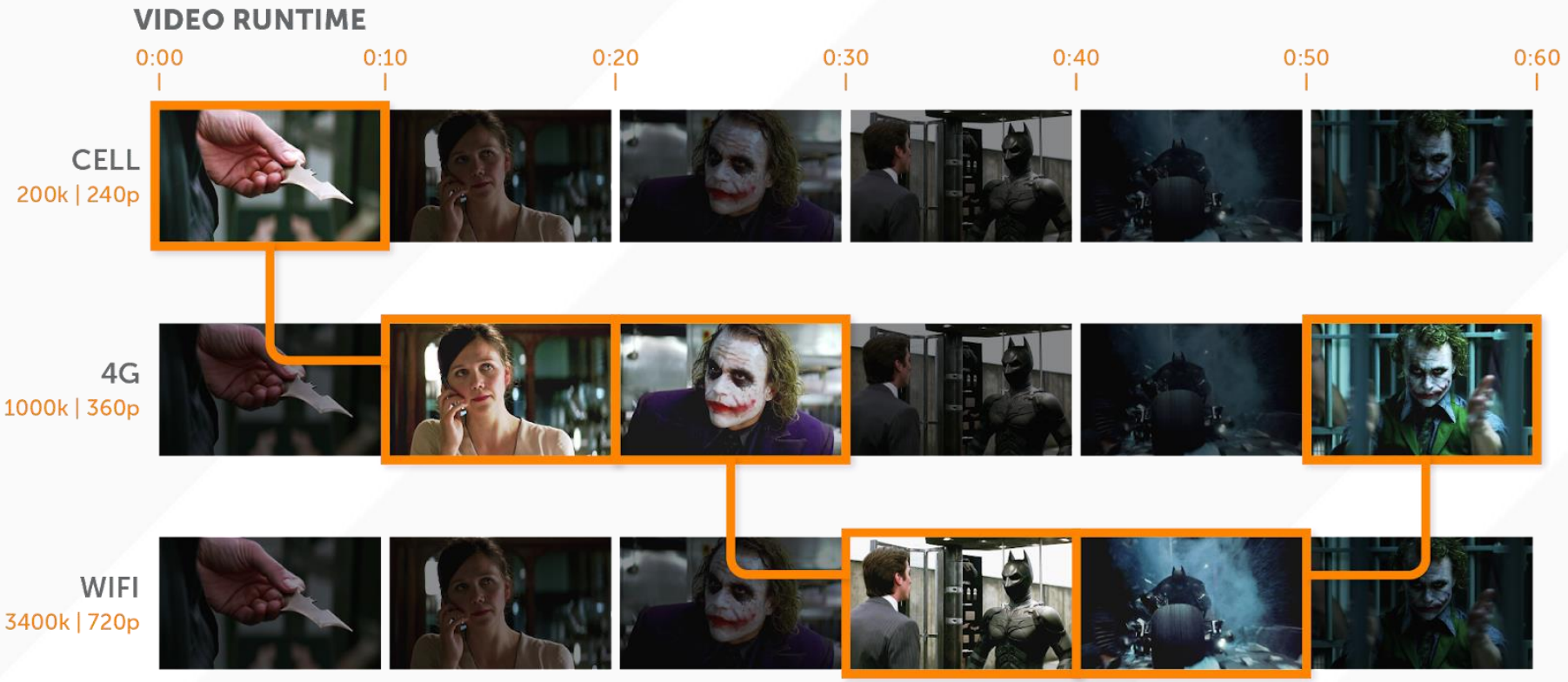
ENCODING PARTS OF EACH IMAGE



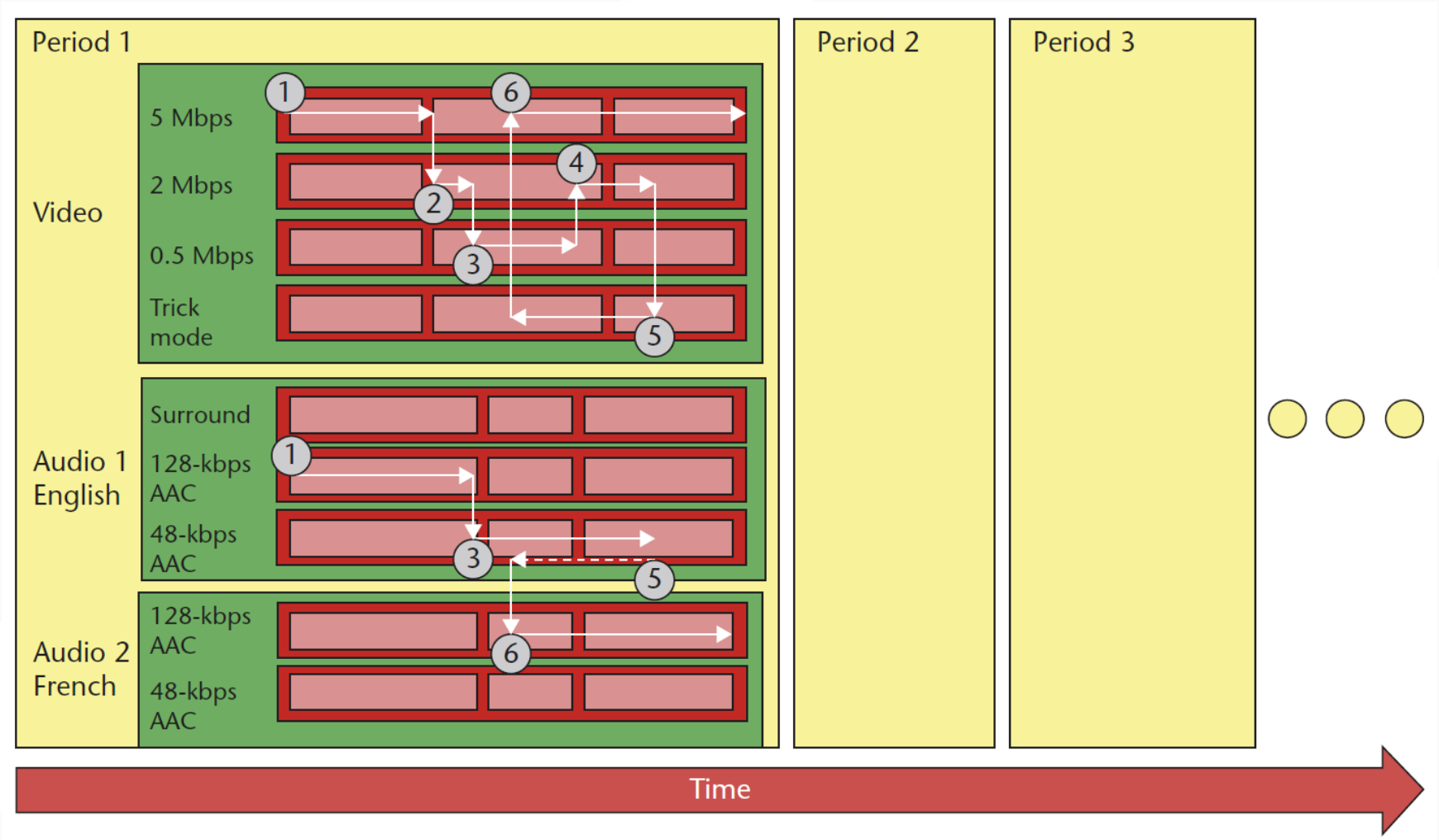
IMAGE/VIDEO TAKEAWAYS…

- Images are typically sent over the network in a compressed format
  - The amount of compression affects image quality as well as #bytes sent over the network (→ bandwidth for real-time delivery)
- A video compression codec takes advantage of temporal and spatial commonalities in video frames to further compress video
- In general, larger file sizes mean more bandwidth = higher quality video
  - When bandwidth is limited, you can either reduce quality or give up real-time streaming (e.g. the video will buffer)
- Adaptive bitrate video streaming maximizes quality while minimizing buffering

ADAPTIVE BITRATE STREAMING



DYNAMIC ADAPTIVE STREAMING EXAMPLE



Video streaming outline

- Example video from Blender.com
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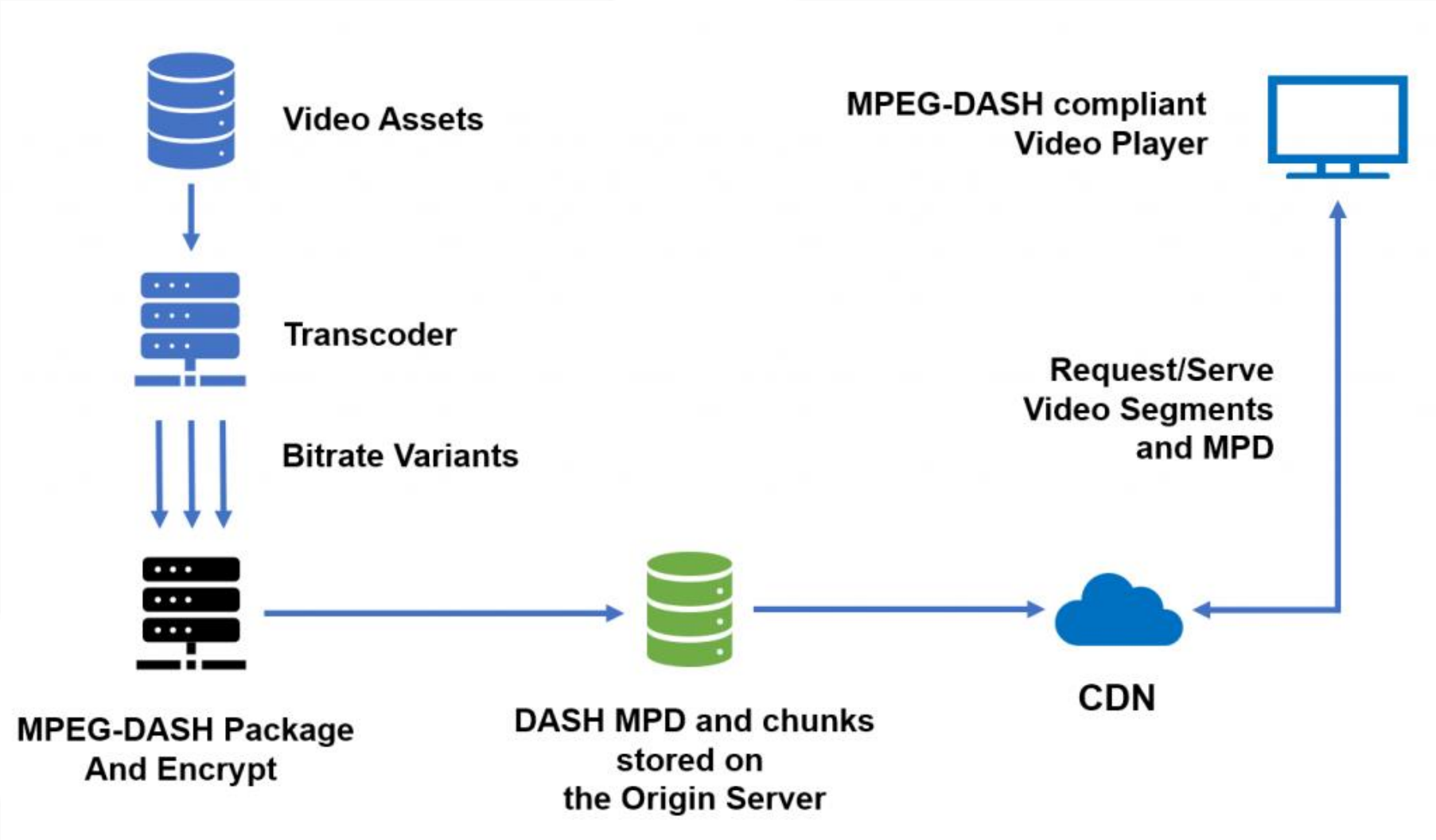
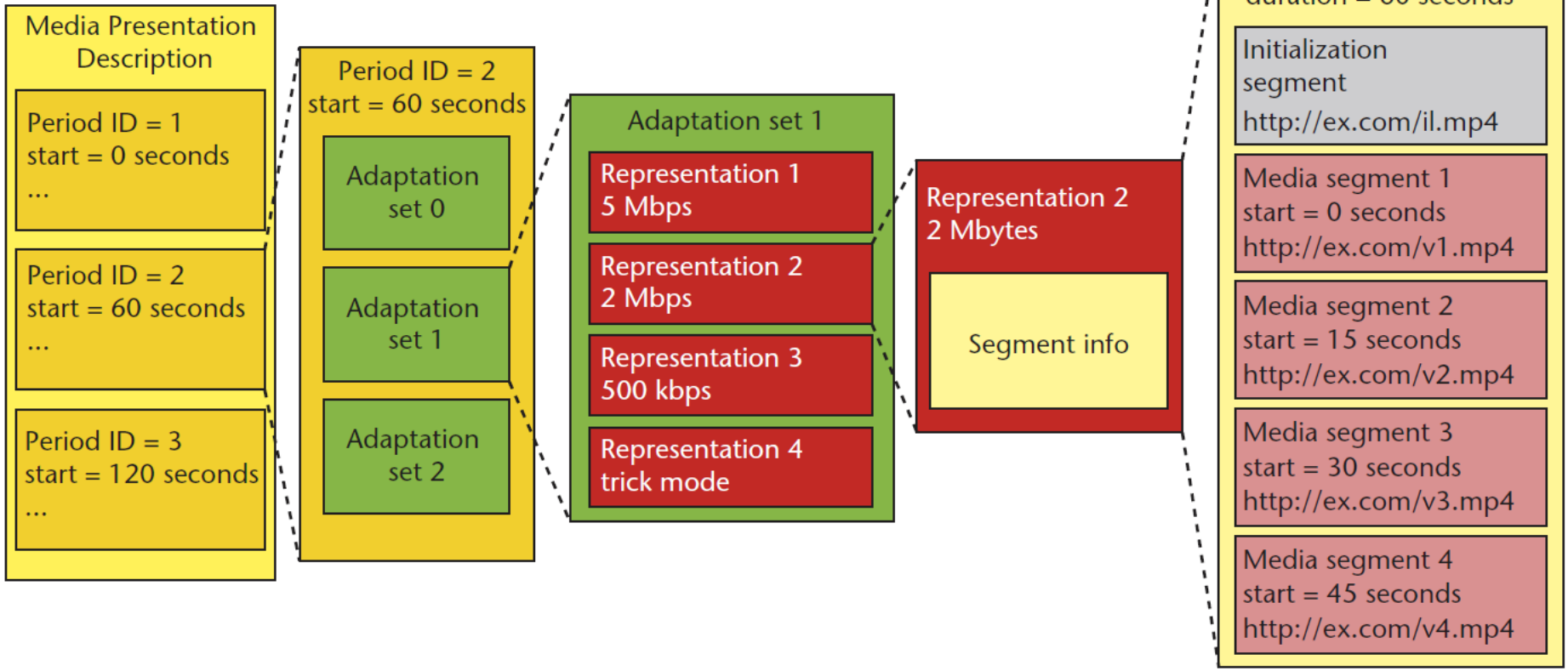
WHAT IS MPEG-DASH?

- Open-source video streaming protocol based on HTTP
- Supports different encodings of video, bitrates, quality levels, and bitrates
- Designed to be hosted on webservers and content distribution networks (a topic for a later lecture) – designed with scale in mind
- Easy to replicate and distribute around the world so content can be closer to end users
- The “smarts” of the algorithm are embedded in the client, not the server (which is passive)
- Many open-source players available to embed in smartphones, apps, browsers, set-top TVs, etc.

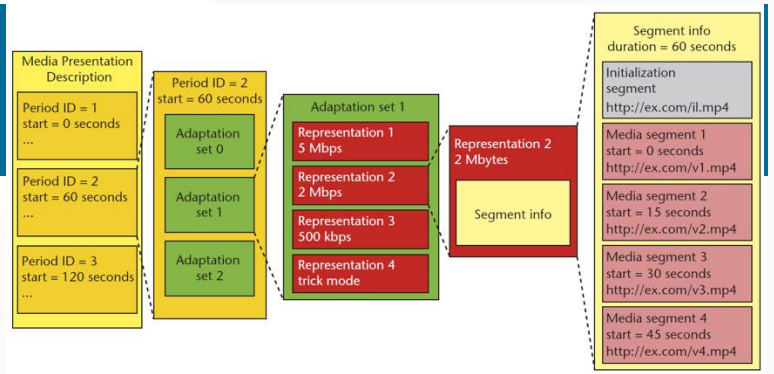
CLIENT AND SERVER OVERVIEW



MPD (MEDIA PRESENTATION DESCRIPTION) FILES

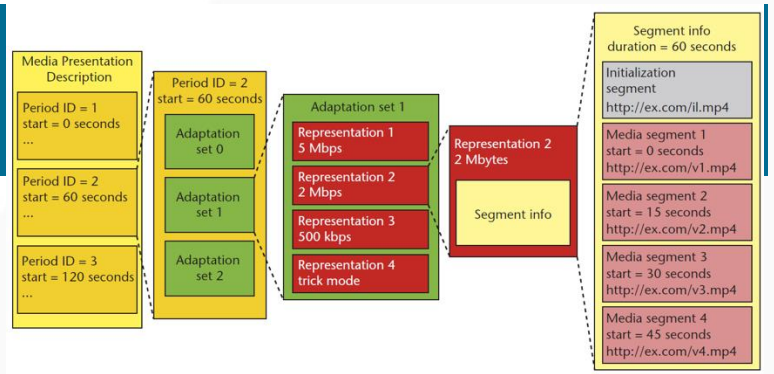


MEDIA PRESENTATION



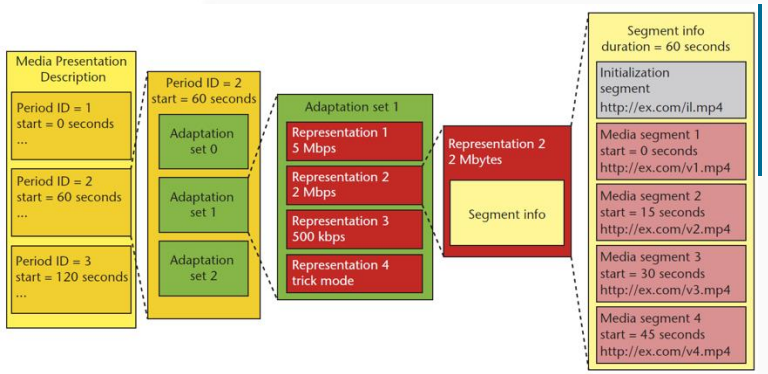
- Contains information about the media in this stream
  - Video, audio, closed-captioning
  - Total length of stream
  - Some parameters such as the maximum length of a segment (defined in a few slides)

PERIODS



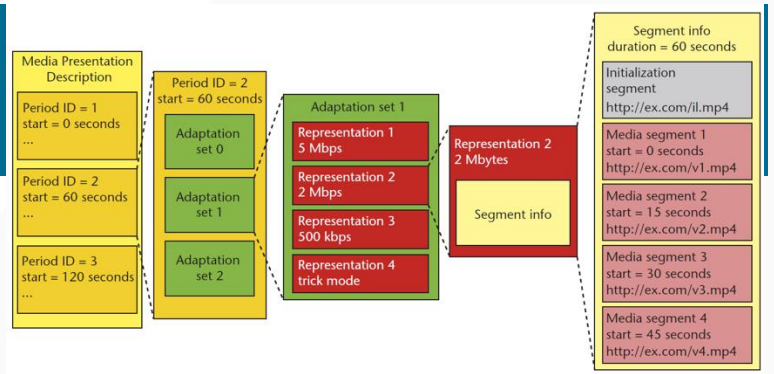
- Breaks the stream into one or more periods, and playback goes seamlessly from one to the next
  - Similar to “chapters” on a DVD/Bluray
- Allows the client to “jump” through the stream with the ‘next chapter’ button on the remote
- Commercials can be automatically spliced in between periods

ADAPTATION SETS



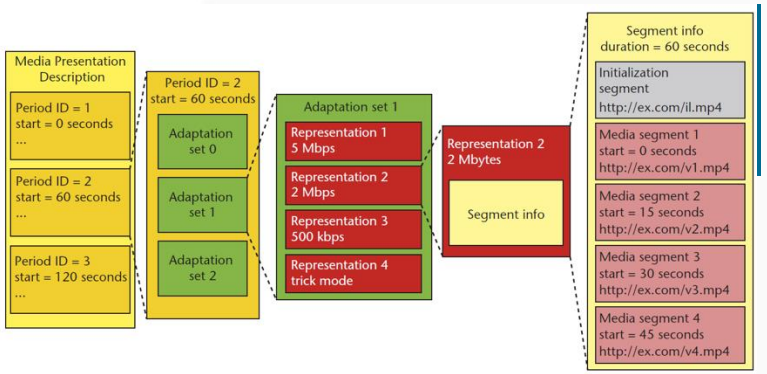
- An adaptation set consists of one or more representations of the content
  - Different resolutions
  - Different bitrates
  - Stereo vs. multi-channel sound
  - Different languages for closed captioning
- The client chooses the best representation to meet user demands, but that choice can change from one segment to the next (and might, especially if the network bandwidth changes)

REPRESENTATION



- A representation is an expression of the content at a particular bitrate associated with a particular average bandwidth
  - E.g. Cell phone vs wifi vs wired internet

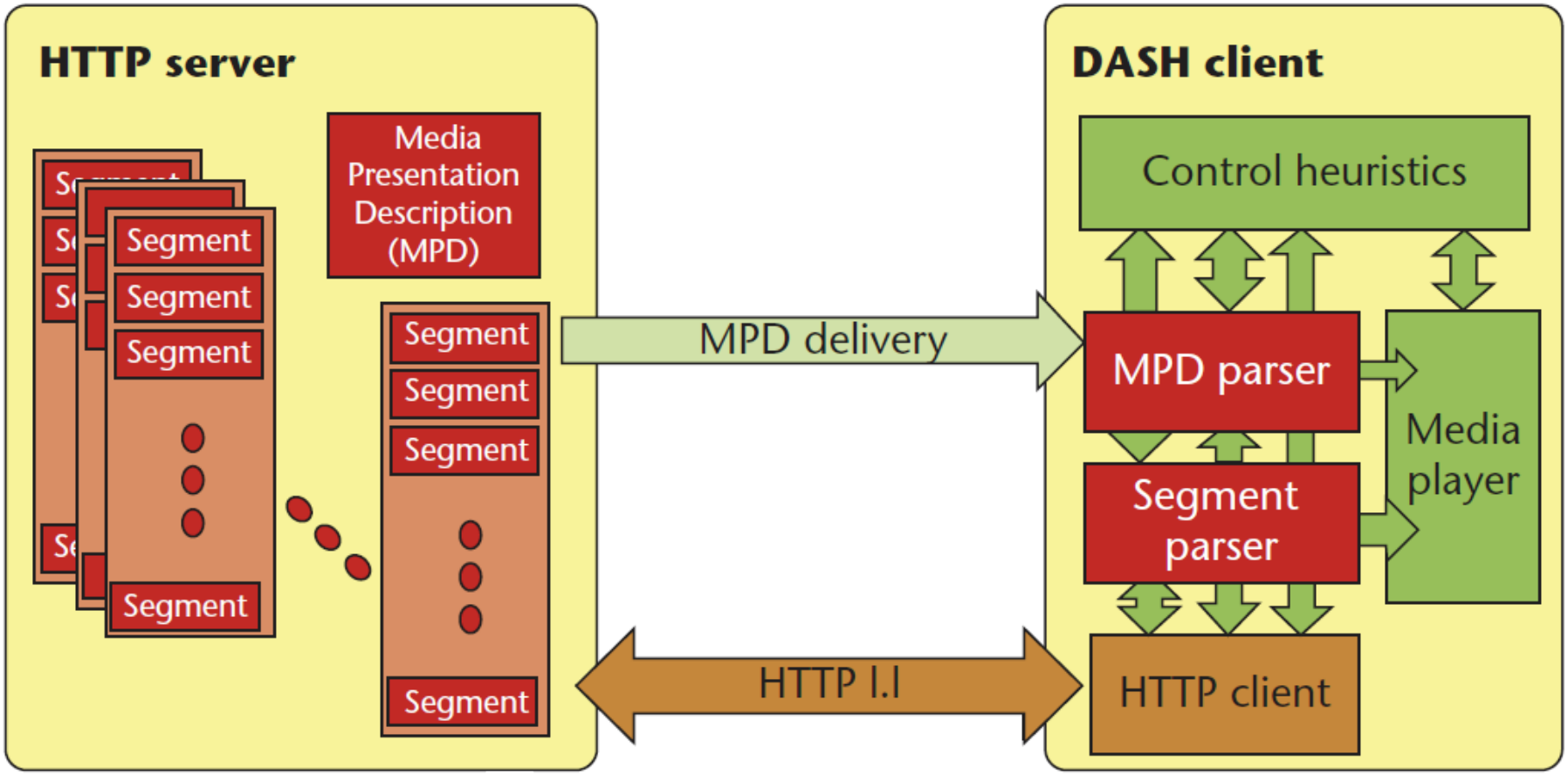
SEGMENT



- A segment contains the HTTP URL required to download a specific chunk of video/audio

```
<SegmentList duration="10">
  <SegmentURL media="seg-m1-C2view-1.mp4"/>
  <SegmentURL media="seg-m1-C2view-2.mp4"/>
  <SegmentURL media="seg-m1-C2view-3.mp4"/>
</SegmentList>
```

MPEG-DASH AND HTTP SERVERS



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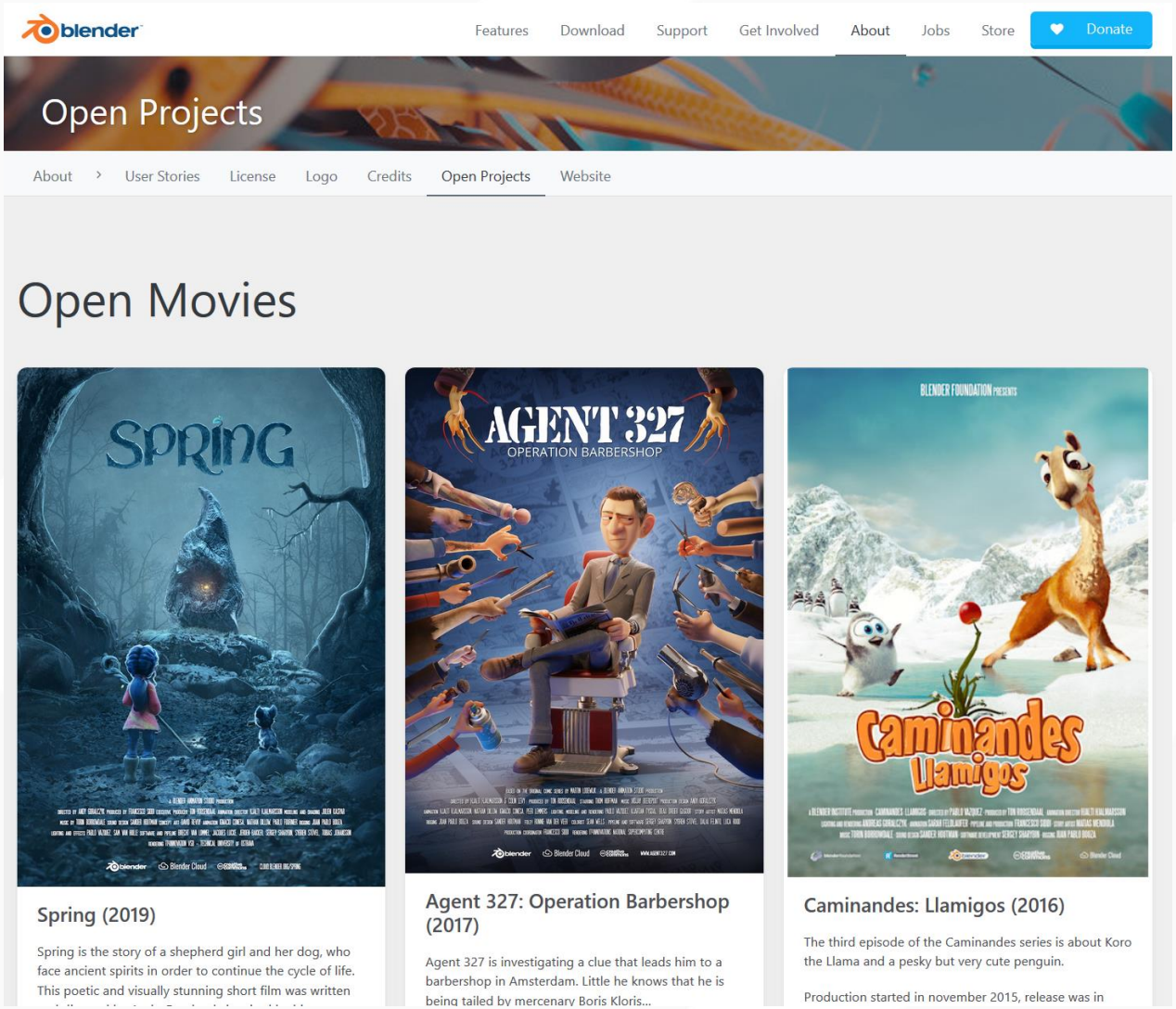
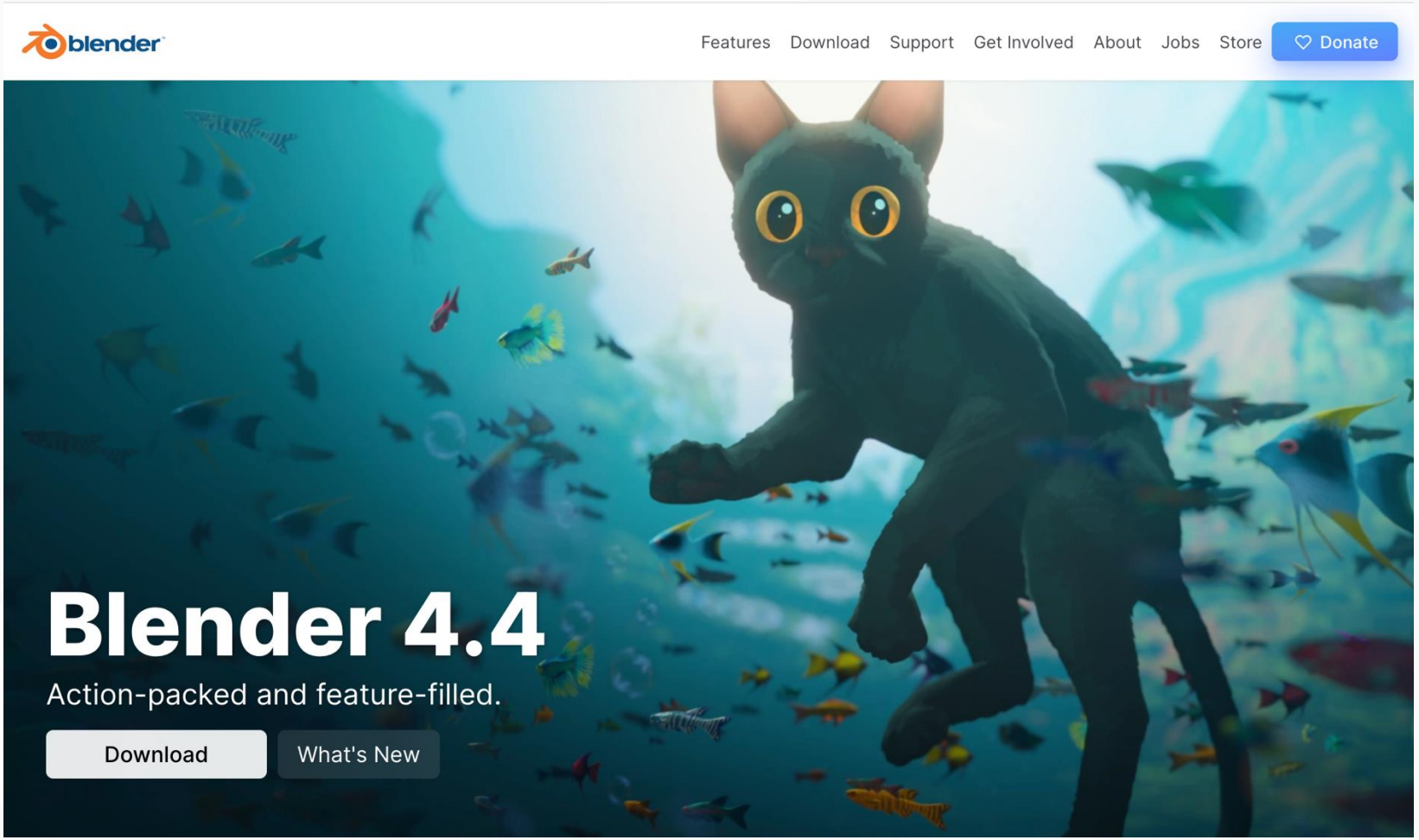
OPEN-SOURCE MOVIES: BLENDER.ORG AND CAMINANDES.COM



2025 OSCAR AWARD WINNING MOVIE: FLOW

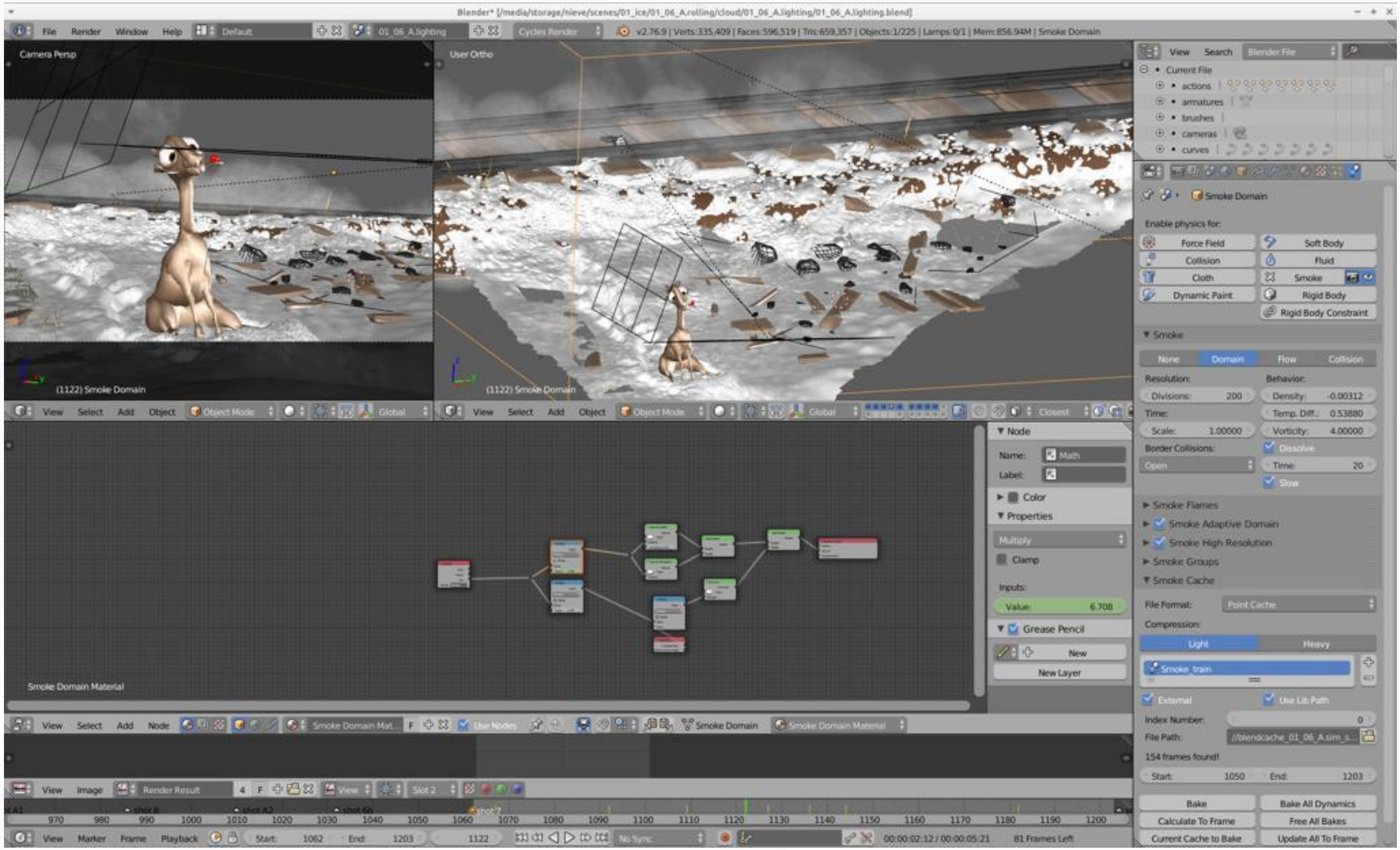


DEMO: CAMINANDES LLAMIGOS (2.5 MINUTES)

DEMO: CAMINANDES LLAMIGOS

OPEN-SOURCE MOVIES

OPEN-SOURCE MOVIES



DEMO

Tracing HTTP requests related to an MPEG-DASH stream

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SQLITE OVERVIEW

LIMITATIONS OF FILES FOR STORING STATE

- Your video server needs to store information about the videos
  - Title
  - Uploaded date/time
  - View count? (not part of our project)
- Could use a file (e.g. videos.txt)
  - Types? How to structure data you want to store?
  - Reading/writing kinda slow O(n)
  - What about multiple goroutines? How to manage concurrency?
  - What if your server crashes while updating the file?
    - Corruption!

DATABASES TO THE RESCUE

What is a database?

- A structured collection of data
- Persisted on disk (or in-memory)
- Managed by a Database Management System (DBMS) or stored in a file (SQLite)

Why learn about them?

- Backbone of virtually every application
- Enable reliable storage, querying, and reporting

KEY BENEFITS OF USING DATABASES

Data Integrity & Consistency

- ACID transactions

Efficient Querying & Indexing

- Fast lookups via B-trees, hashes

Concurrency & Security

- Multiple users, roles, permissions

Scalability & Backup

- Replication, clustering, point-in-time recovery

LOGICAL STRUCTURE – SCHEMAS & TABLES

- **Schema**
  - Namespace grouping tables, views, procedures
- **Table**
  - Two-dimensional grid of rows & columns
  - Each table represents an entity (e.g., users, orders)
- **Row = Record**
  - One instance of the entity
- **Column = Field**
  - Attribute with a defined data type

TABLES

Columns

- Name + Data Type + Constraints (e.g., NOT NULL, UNIQUE)

Rows

- Concrete data entries

Primary Key

- Uniquely identifies each row

Foreign Key

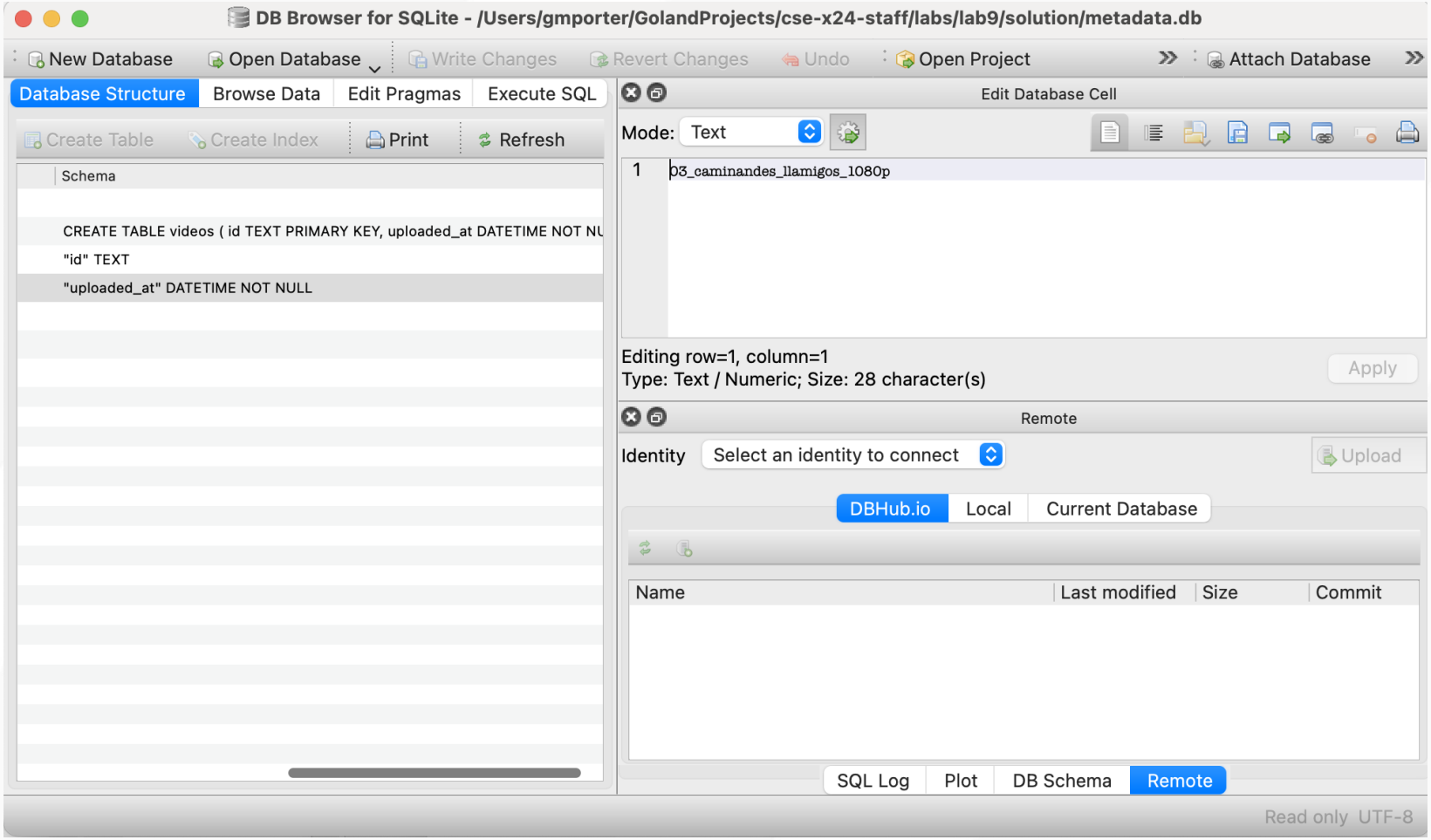
- Links to a primary key in another table

TYPED DATA REPRESENTATION

Category	Examples	Use-Case
Numeric	`INT`, `BIGINT`, `DECIMAL`	Counts, monetary values
Text / String	`VARCHAR`, `TEXT`	Names, descriptions
Date & Time	`DATE`, `TIMESTAMP`	Birthdates, logs
Boolean	`BOOLEAN`, `TINYINT(1)`	Flags (true/false)
Binary / Blob	`BLOB`, `BYTEA`	Images, files, encrypted data

BROWSING SQLITE FILES

- https://sqlitebrowser.org/dl/



SQLITE DEMO

- sql-demo.go

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