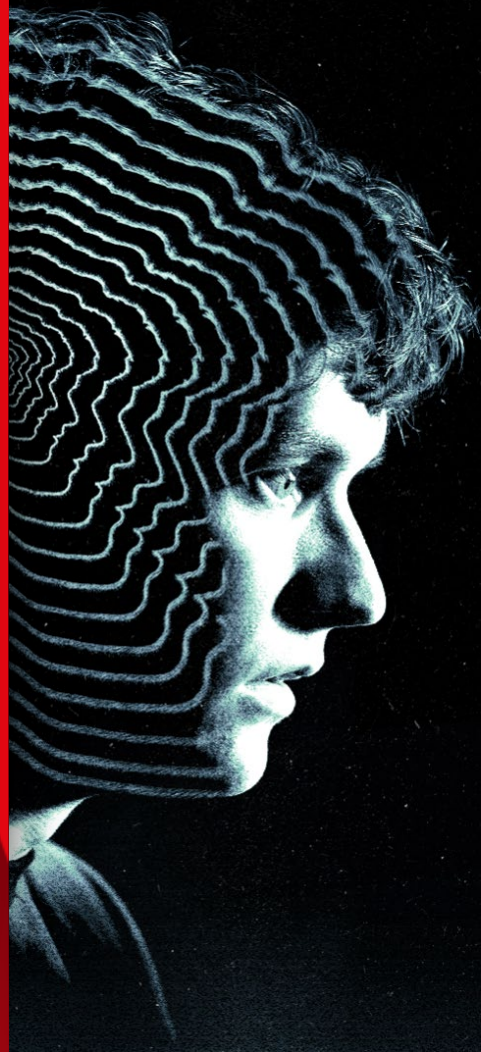


Interactive Storytelling

Choose What Happens Next

Andy Schuler
Manager, Video Engineering

NETFLIX



Bringing **Great Stories**
to life in a
High Quality and
Seamless Experience



**Entertainment
+ Technology**
means we
can innovate
storytelling.

A woman with long brown hair is lying on her back on a light-colored sofa, watching a television. Her arms are raised behind her head, and she appears to be in a relaxed state. The television screen shows a blurred image of a person. The room has a warm, dimly lit atmosphere with curtains visible in the background.

Users “lean back”
when watching TV.

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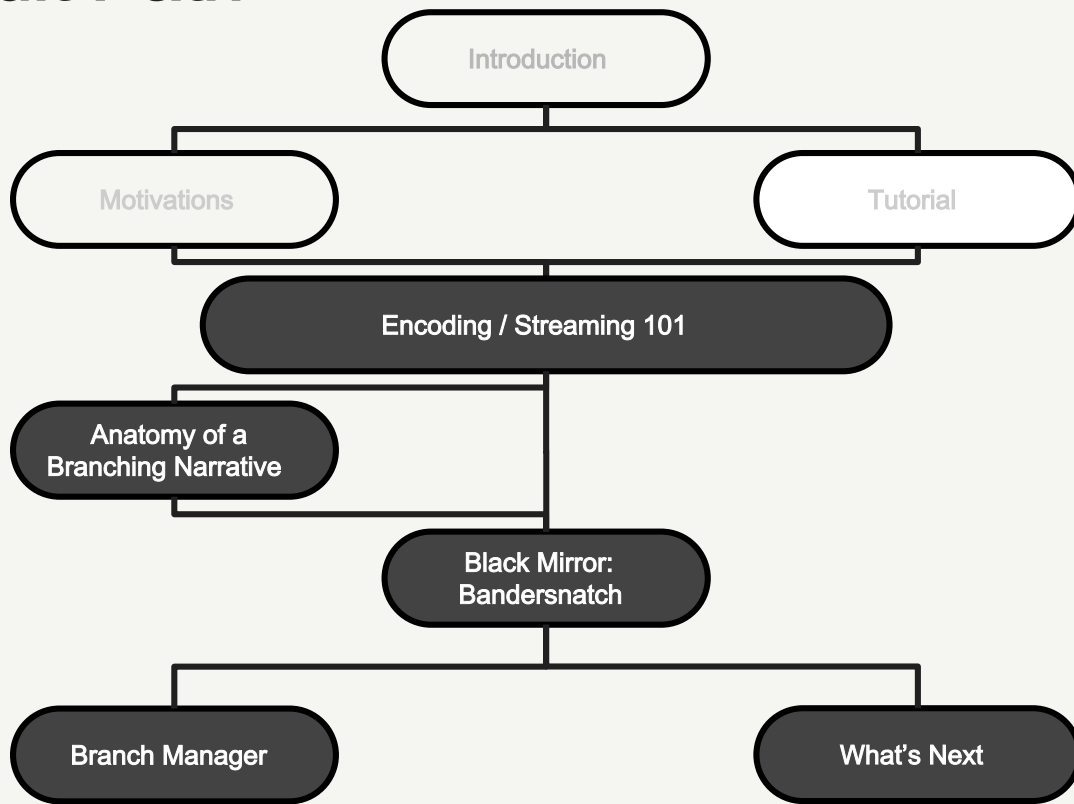
Using tutorials
help them **lean in.**

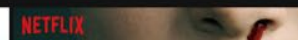
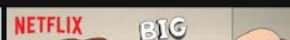



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The Default Path







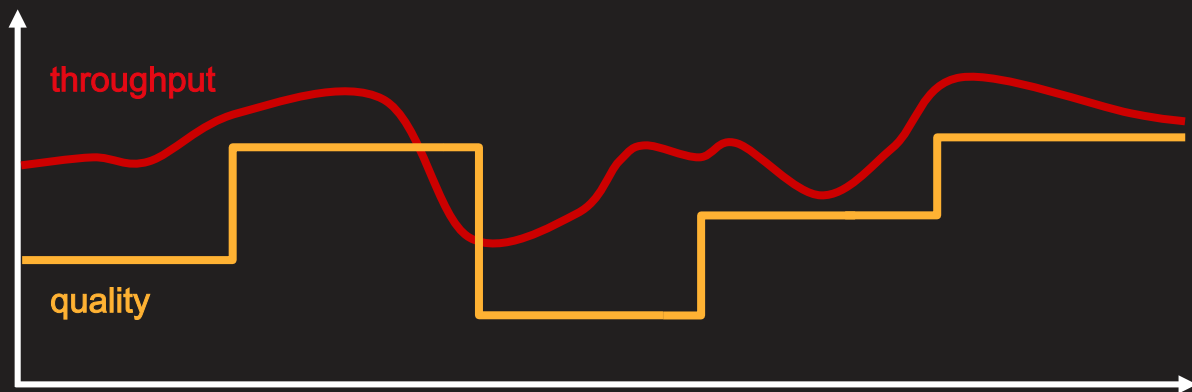
New playback
tech seamlessly
transitions.

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Buffering is
the **enemy**.



Adapt Video Quality Dynamically



Adapt video quality dynamically by creating multiple mp4 files

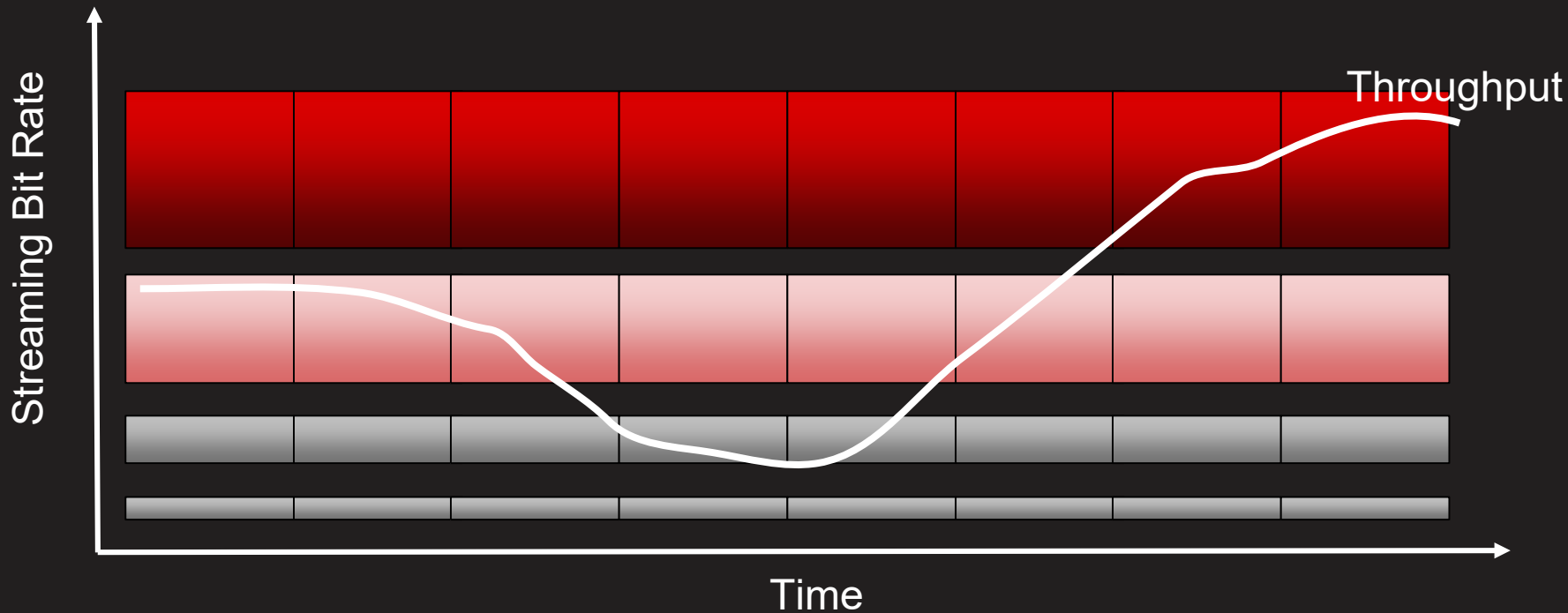


bandersnatch - 420Kbps .mp4

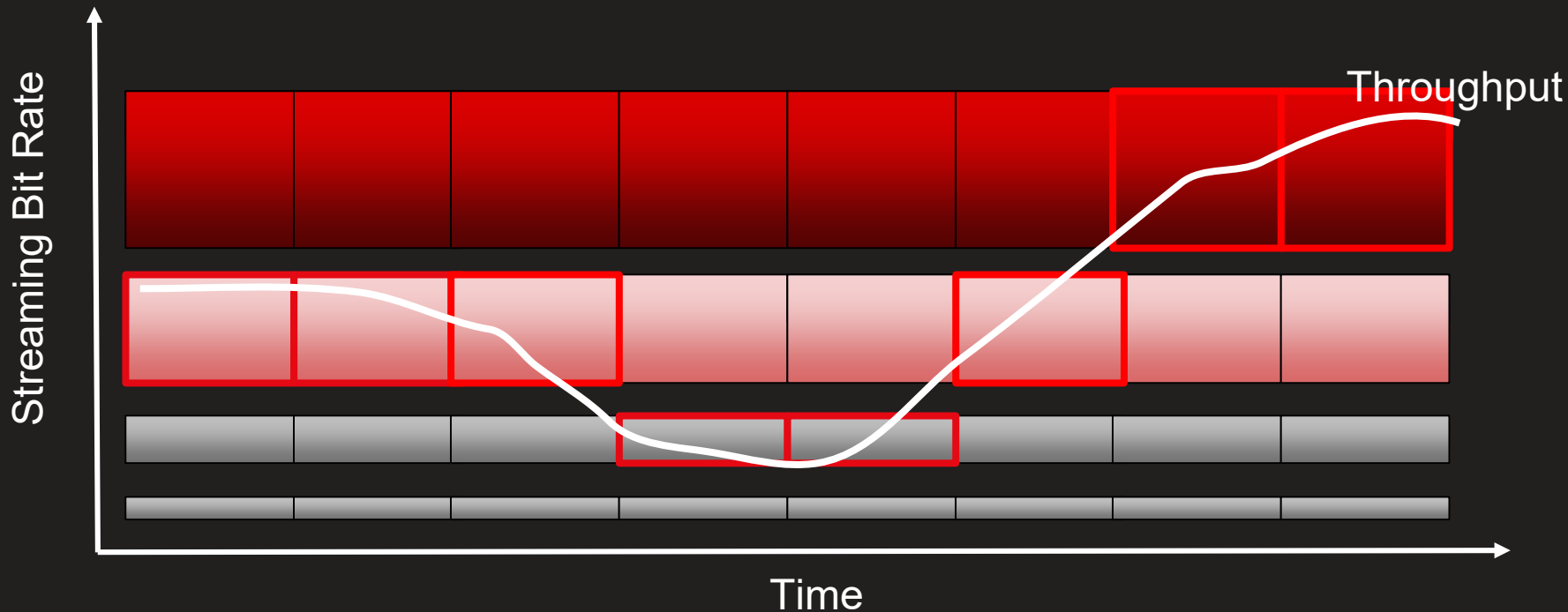


bandersnatch - 1870Kbps .mp4

Adaptive Bitrate Switching

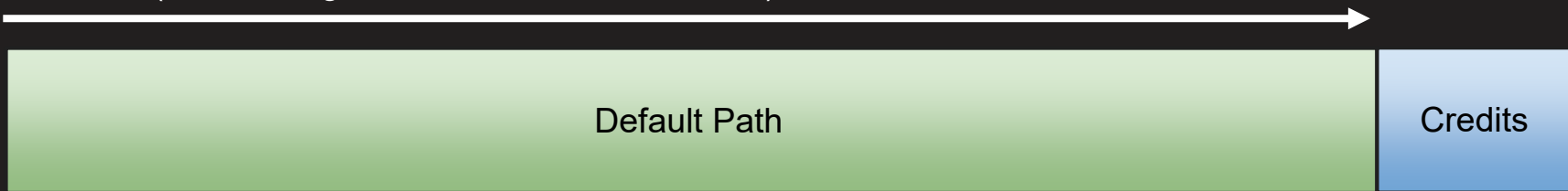


Adaptive Bitrate Switching



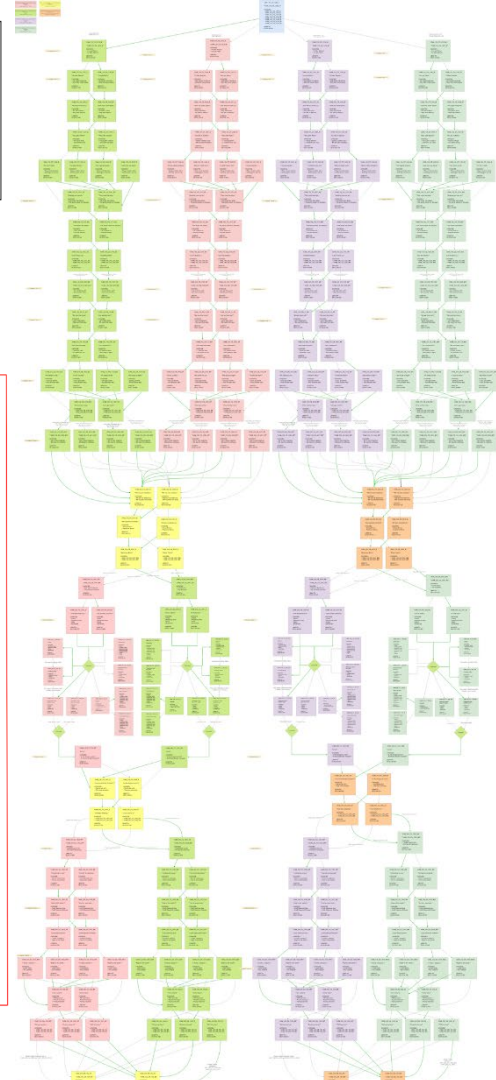
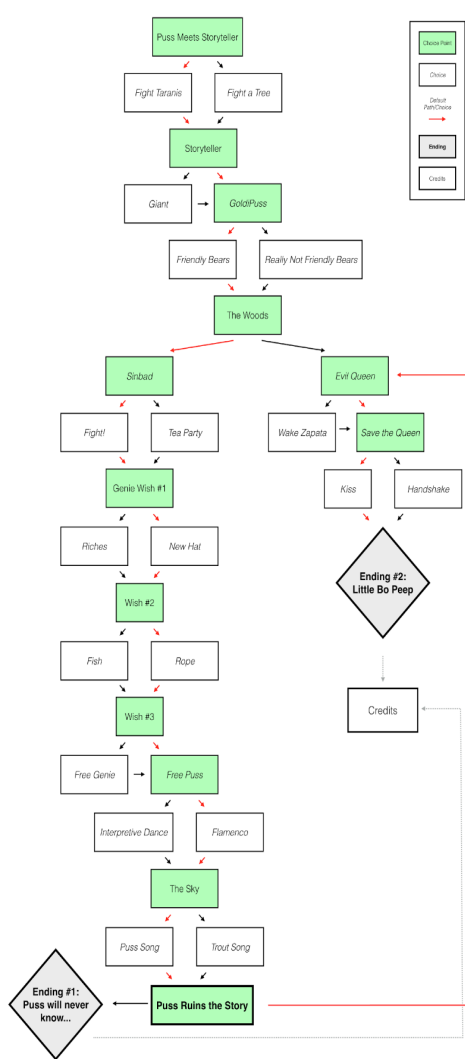
Media File Composition (Linear Playback)

Standard (Linear Progression from Start to Credits)



A man with a beard and glasses, wearing a patterned blazer, is gesturing with his hands while talking to another man in a blue shirt. The background shows vertical blinds and a window.

**When do you talk
about interactive?**





DESTROY COMPUTER

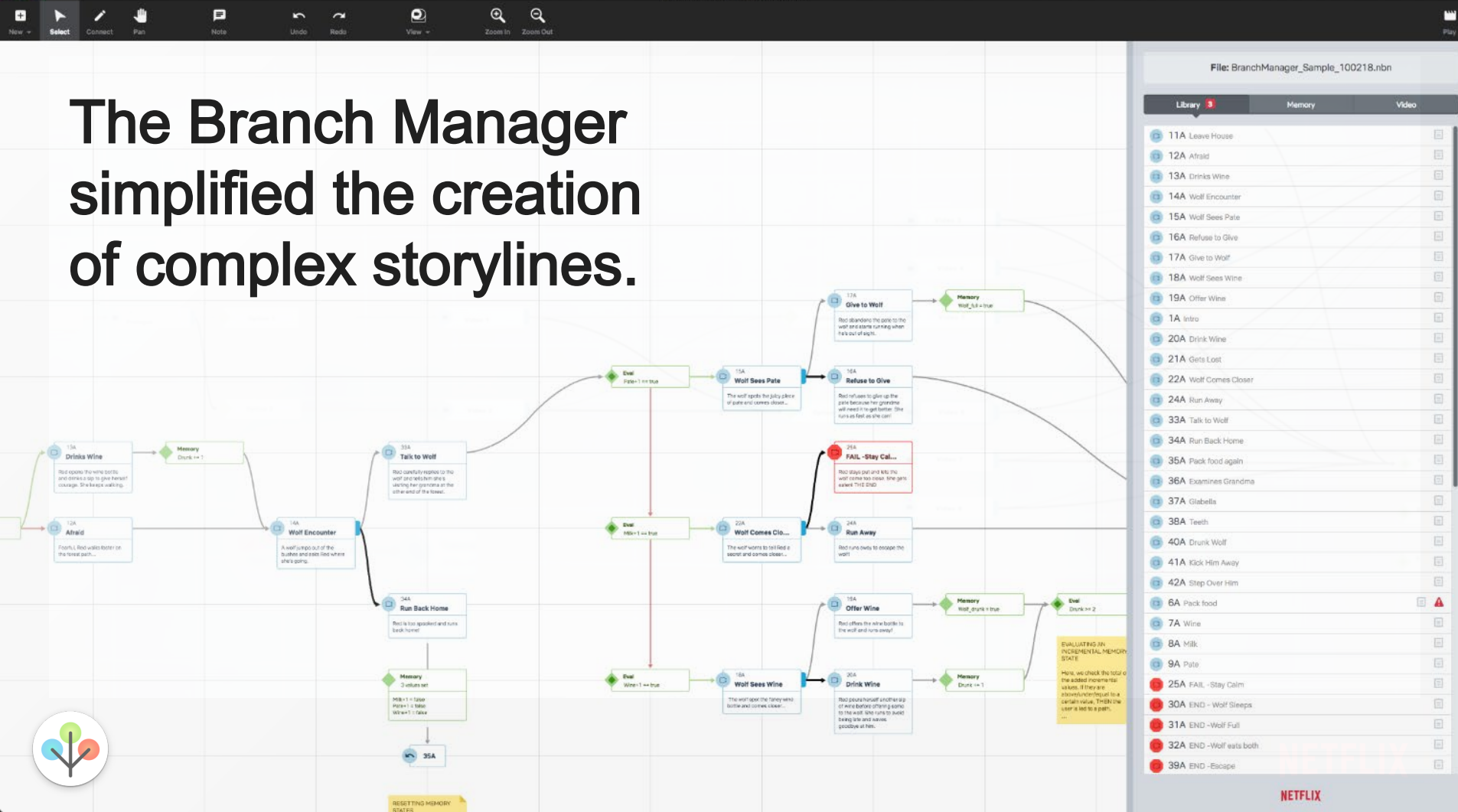
VISIT THERAPIST

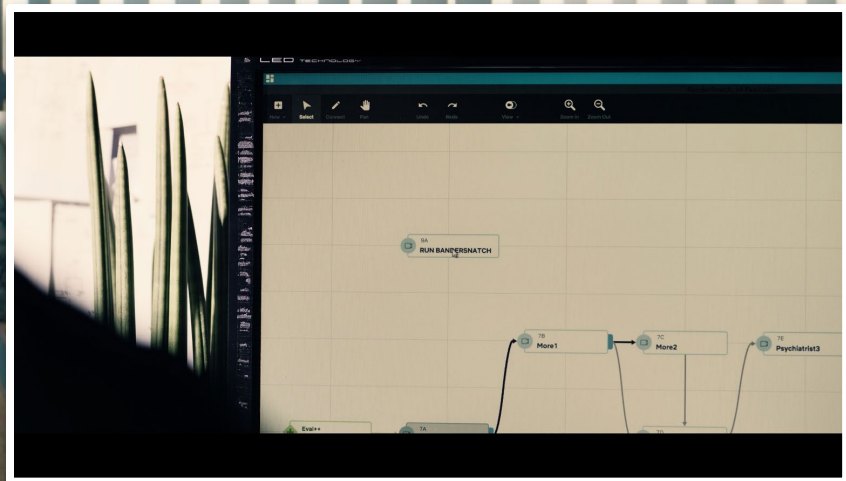


Anatomy of a Branching Narrative

- Title is constructed as a series of Interactive Segments
- A Choice Point occurs at the end of certain Segments wherein
 - a) the user makes a selection, or
 - b) timeout occurs
- In case of a timeout, a default selection is made.
- A Choice Point may initiate the start of a new segment, set some state within a user's session, or both.
- Playback across segments should appear seamless
- Loops are ok.

The Branch Manager simplified the creation of complex storylines.





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Choice Map XML

In addition to the aligned sources, Netflix requires a metadata XML file that contains a list of segments and how each maps to the others. The Choice Map XML is made up of a series of segment elements, each containing an id attribute, a description child element and a choices child element.

```
<?xml version="1.0" encoding="UTF-8"?>
<choiceMap xmlns="http://www.netflix.com/schemas/choicemap/v4">
  <header>
    <title>Puss in Book: Trapped in an
Epic Tale</title>
    <framerate>24000 1001</framerate>
  </header>
  <segment id="He_Meets_a_Storyteller"
initial="true">
    <description>He Meets a
Storyteller</description>
    <start>00:00:00:00</start>
    <end>00:01:45:01</end>
    <choices>
      <choice
id="Fight_a_Spider" default="true"/>
      <choice
id="Fight_a_Tree"/>
    </choices>
  </segment>
  <segment id="Fight_a_Spider">
    <description>Fight a
Spider</description>
    <start>00:01:48:00</start>
    <end>00:03:03:03</end>
    <next id="Storyteller"/>
  </segment>
  <segment id="Fight_a_Tree">
    <description>Fight a
Tree</description>
    <start>00:03:06:00</start>
    <end>00:04:14:15</end>
    <next id="Storyteller"/>
  </segment>
  <segment id="Storyteller">
```

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The Aligned Single Source Model

(Or How I Learned to
Stop Worrying and Love
Giant Chickens)



You have a limited time to choose!

Chicken-sized zombies

Zombie-sized chickens



The Delivery Spec

Each unique segment must be padded to end at 2 - second intervals, with at least 2 seconds of black between segments. In order to achieve this, all segments will need 2 to 4 seconds of black as padding.

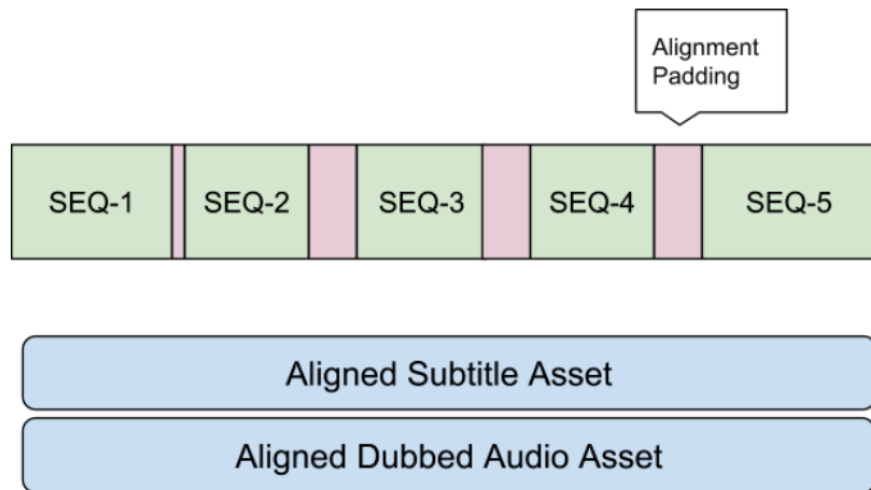
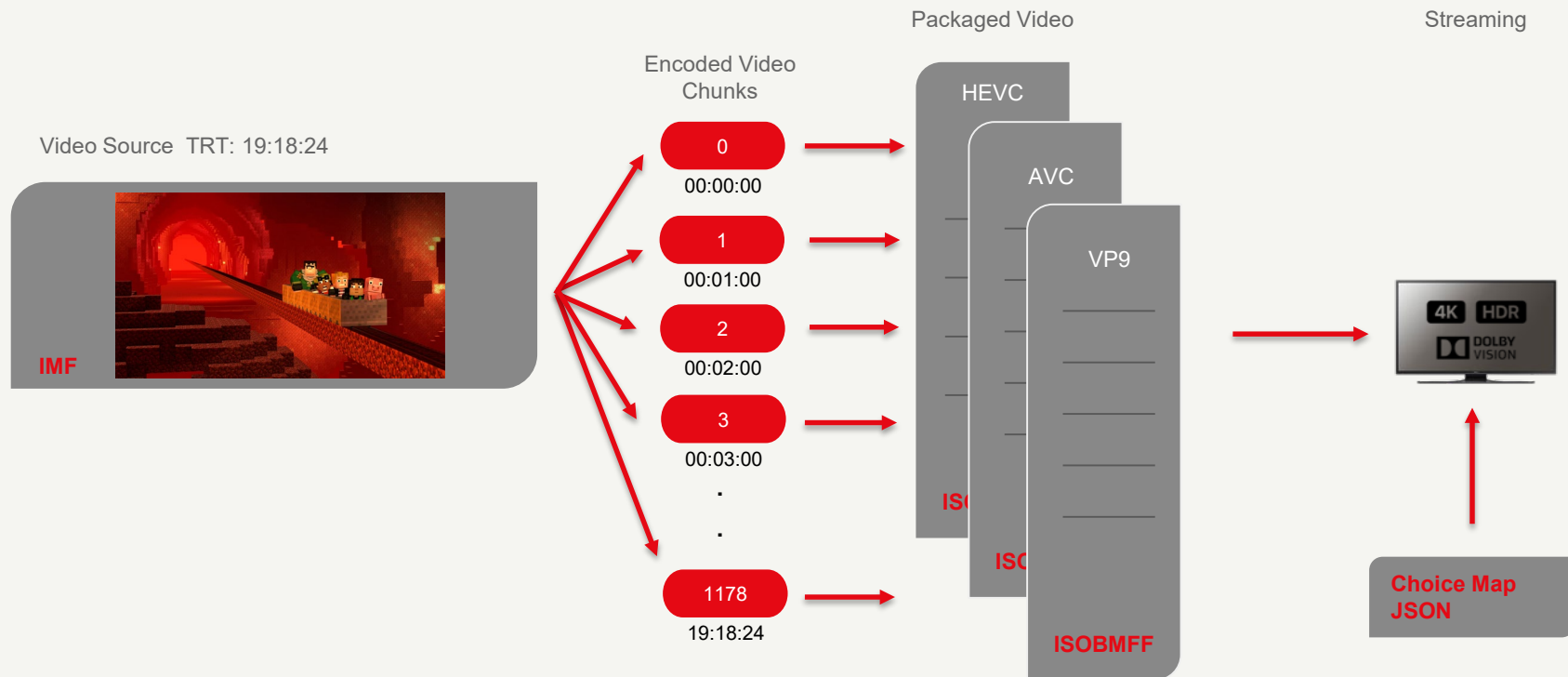


Figure: Possible layout of an aligned Single-Source asset with padding to ensure proper GOP alignment.

Minecraft: Story Mode, Episode 4





A **NETFLIX** INTERACTIVE FILM

BLACK MIRROR BANDERSNATCH

▶ Play

More Info

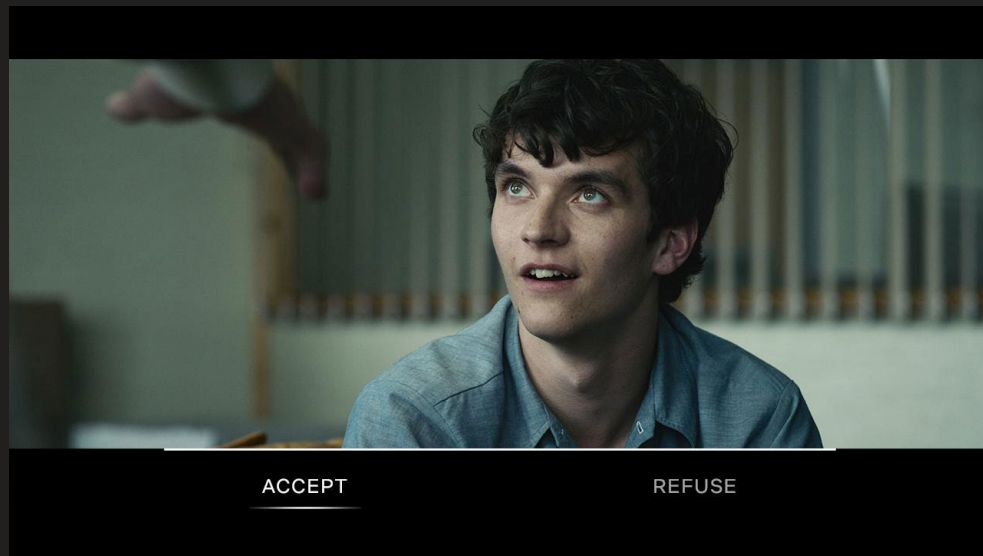
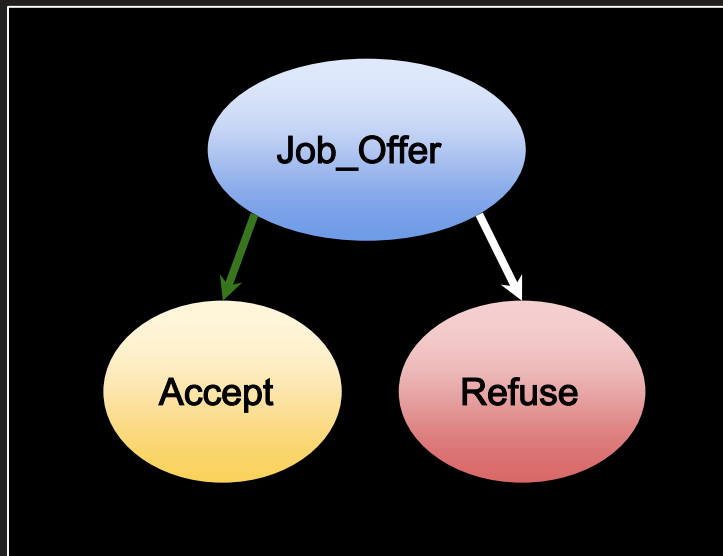


TV-MA

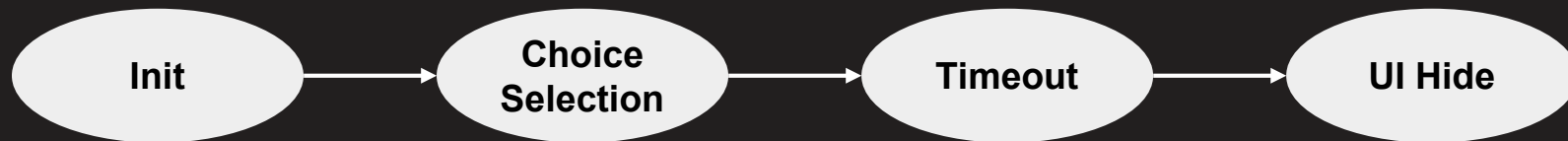
Ultra HD 4K



Branching Narrative



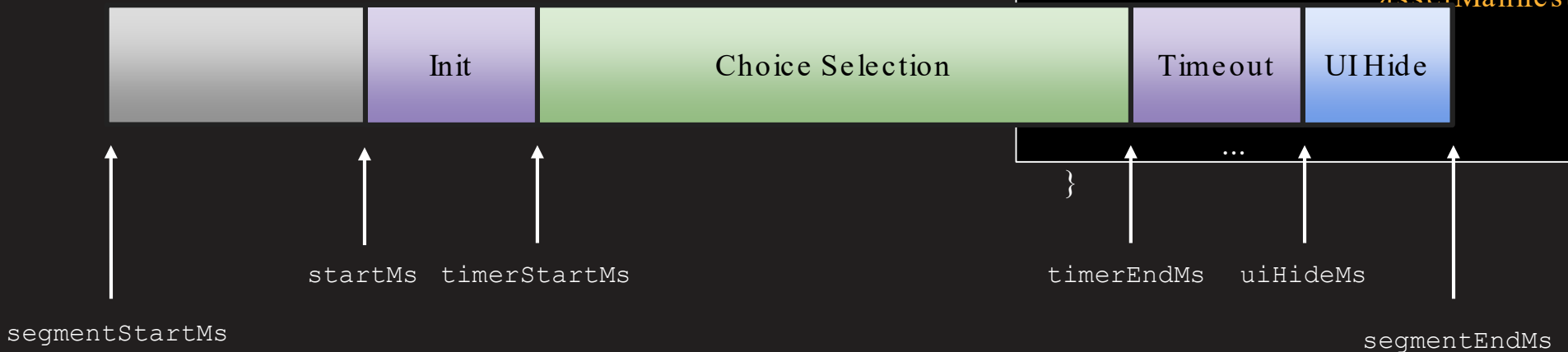
Lifecycle of a Choice Point



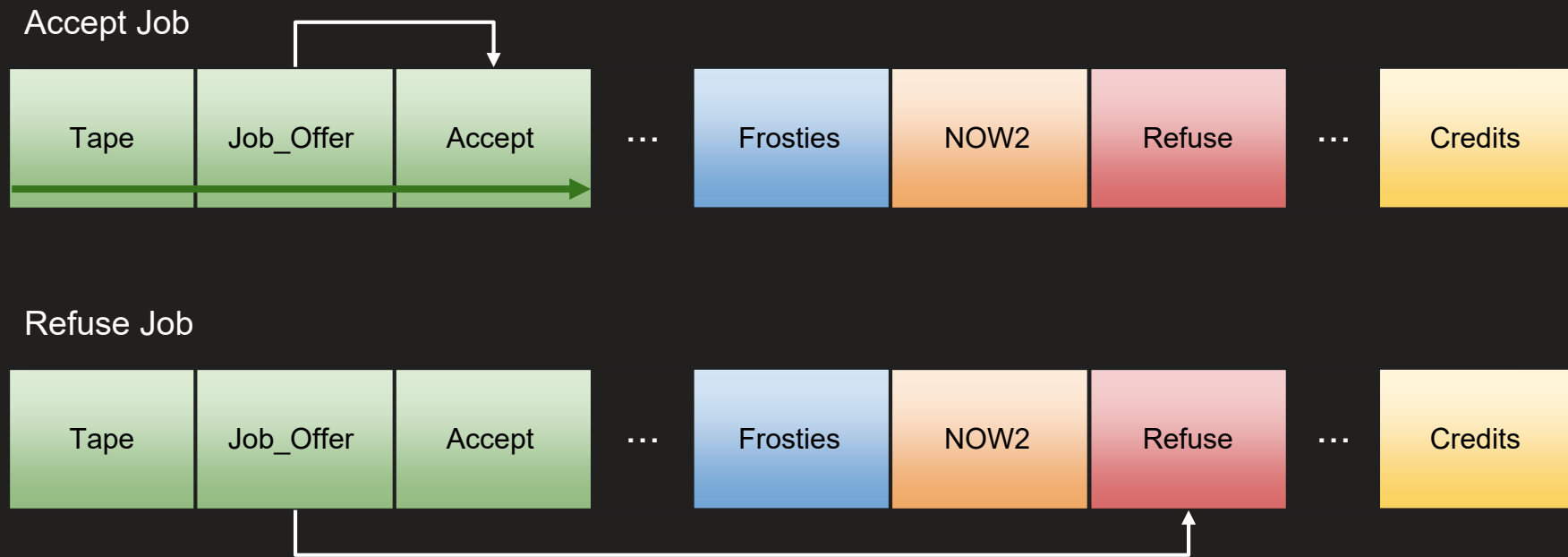
Mapping the Phases to a Segment

```
{  
  startMs:463640,  
  timerStartMs:467360,  
  timerEndMs:477360,  
  uiHideMs:479360,  
  endMs:481360,  
  type:'scene:cs_bs',  
  layout: {  
    assetManifest
```

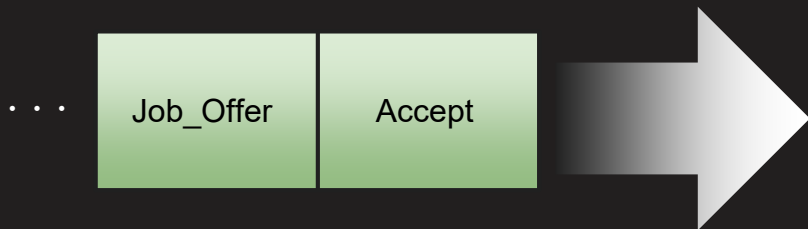
Job_Offer Segment



Media File Composition (Bandersnatch)

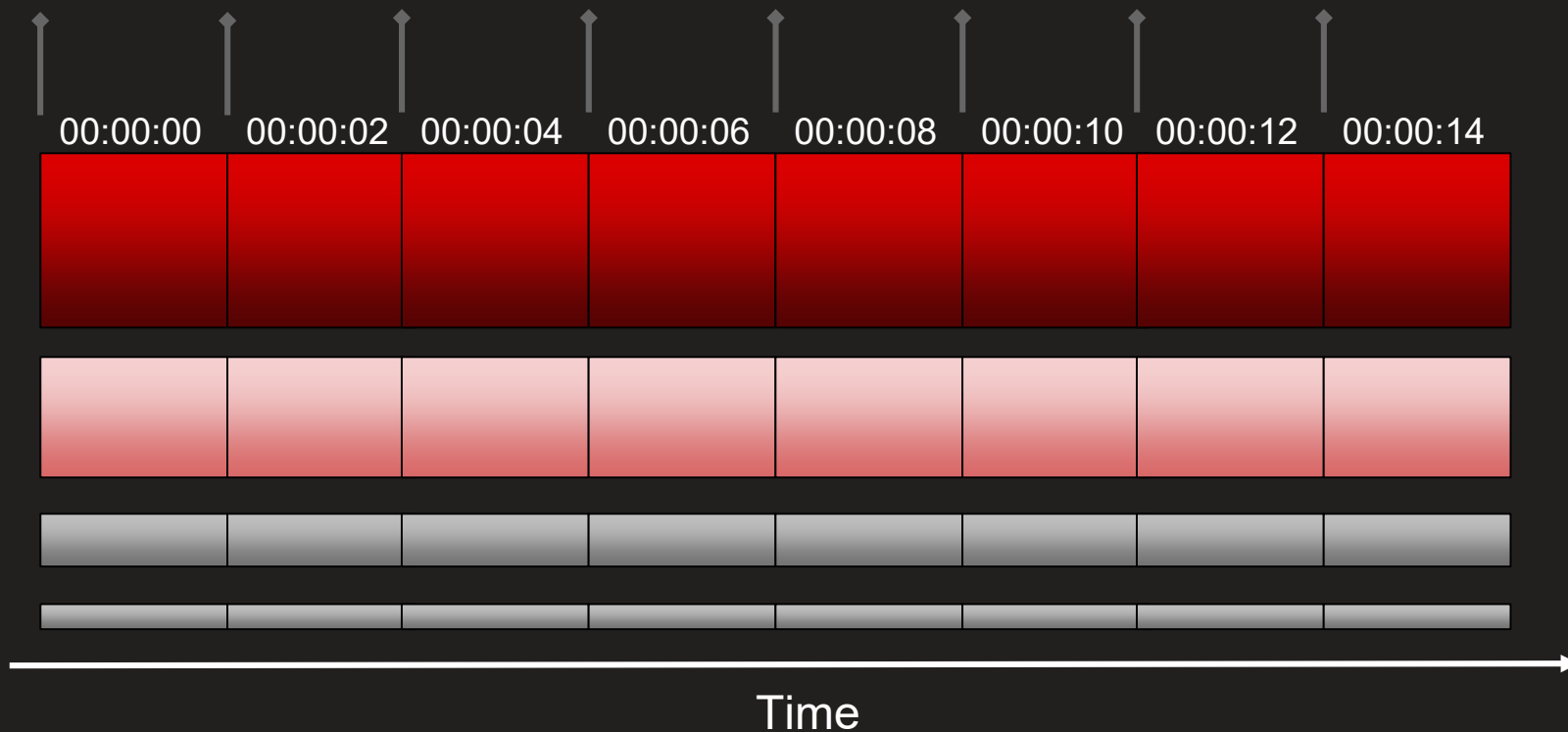


Choice Map

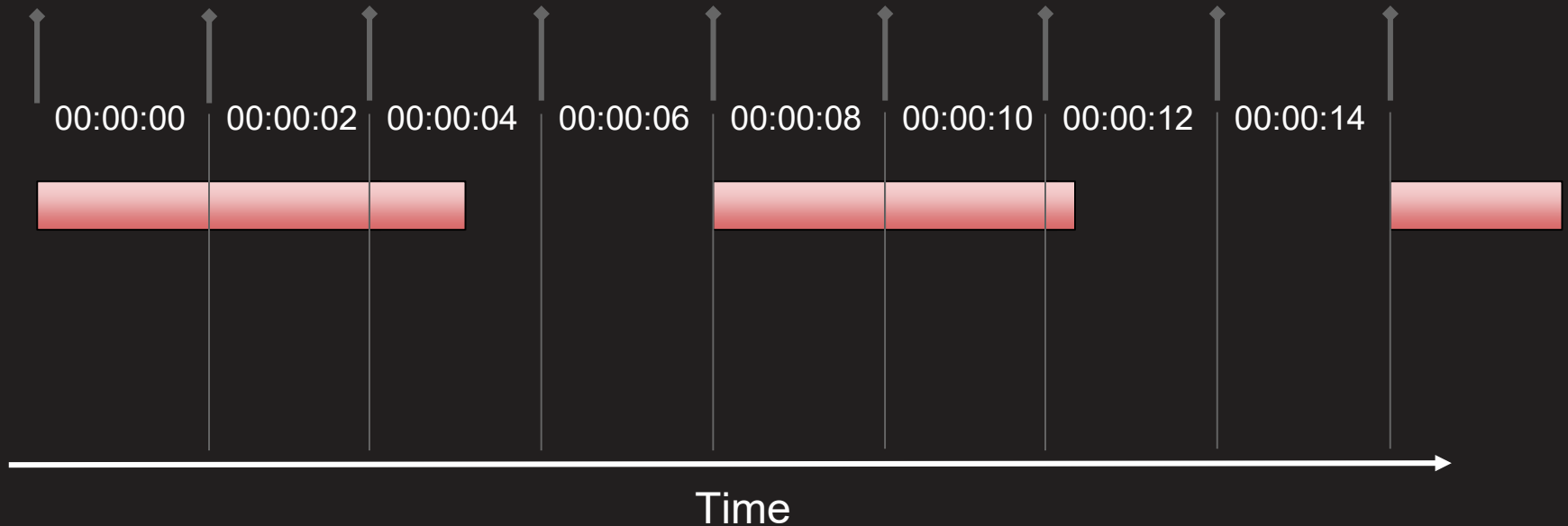


```
{
  "segments": {
    ...
    "Job_Offer": {
      "startTimeMs": 207240,
      "endTimeMs": 481360,
      "next": {
        "Accept": {...},
        "Accept_Again": {...},
        "Refuse_Now2": {...},
        "Refuse_TT": {...}
      },
      "defaultNext": "Accept"
    },
    ...
  }
}
```

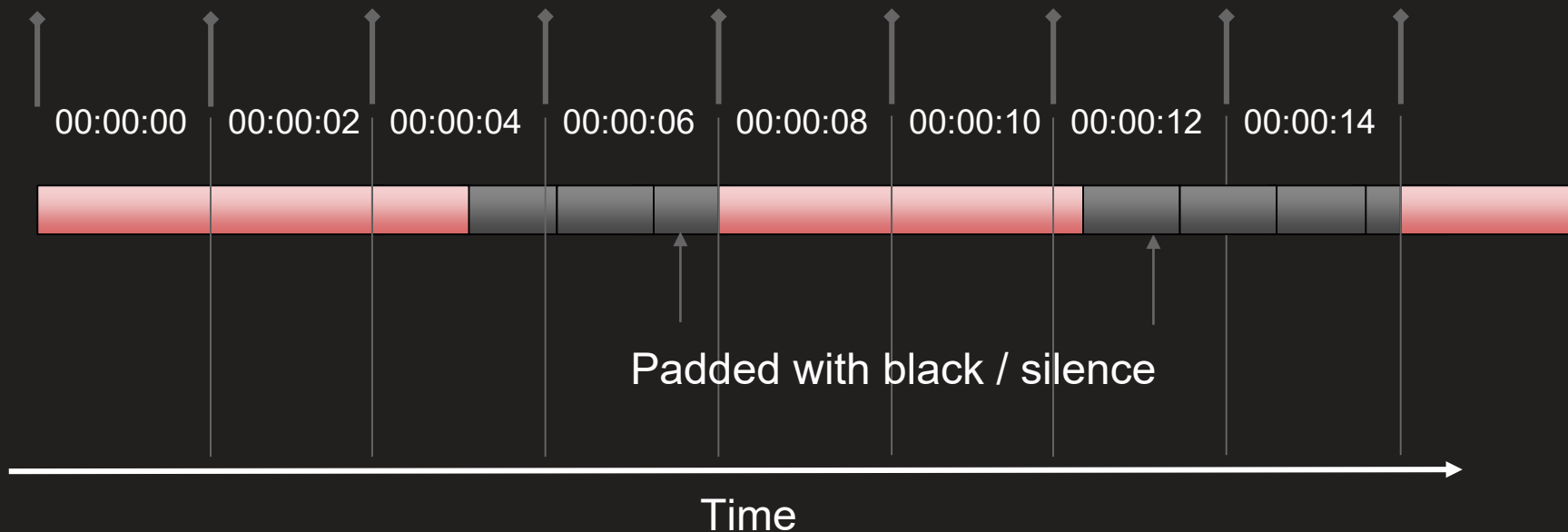
2-second GOP boundaries



Aligning Interactive Segments on 2 - second boundaries



Aligning Interactive Segments on 2 - second boundaries



Media Source Extensions Byte Stream Format Registry

W3C Working Group Note 04 October 2016



This version:

<https://www.w3.org/TR/2016/NOTE-mse-byte-stream-format-registry-20161004/>

Latest published version:

<https://www.w3.org/TR/mse-byte-stream-format-registry/>

Latest editor's draft:

<https://w3c.github.io/media-source/byte-stream-format-registry.html>

<https://www.w3.org/TR/mse-byte-stream-format-registry/>

4. Registry

MIME type/subtype	Public Specification(s)	Generate Timestamps Flag
audio/webm video/webm	WebM Byte Stream Format [MSE-FORMAT-WEBM]	false
audio/mp4 video/mp4	ISO BMFF Byte Stream Format [MSE-FORMAT-ISOBMFF]	true
audio/mp2t video/mp2t	MPEG-2 Transport Stream Byte Stream Format [MSE-FORMAT-MP2T]	false
audio/mpeg audio/aac	MPEG Audio Byte Stream Format [MSE-FORMAT-MPEG-AUDIO]	true

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~~ISO BMFF~~ Byte Stream Format

W3C Working Group Note 04 October 2016



This version:

<https://www.w3.org/TR/2016/NOTE-isobmff-20161004/>

Latest published version:

<https://www.w3.org/TR/mse-byte-stream-format-isobmff/>

Latest editor's draft:

<https://w3c.github.io/media-source-isobmff-byte-stream-format.html>

<https://www.w3.org/TR/mse-byte-stream-format-isobmff/>

“Initialization Segment”

ftyp

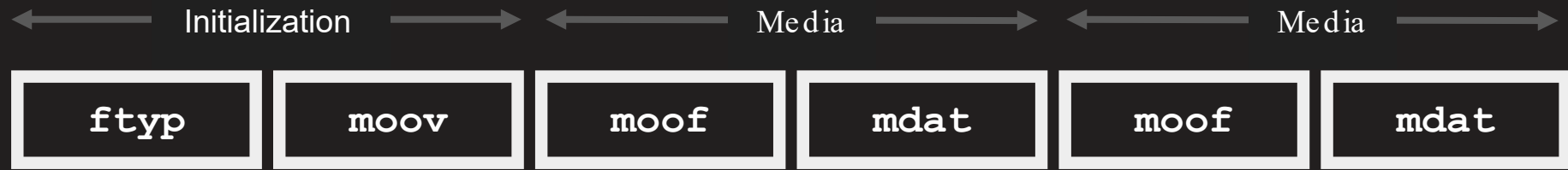
moov

“Media Segment”

moof

mdat

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Codec

Resolution

Colorspace

Codec initialization

Timestamps

Audio or video frames



That's just a
fragmented
MP4 file!

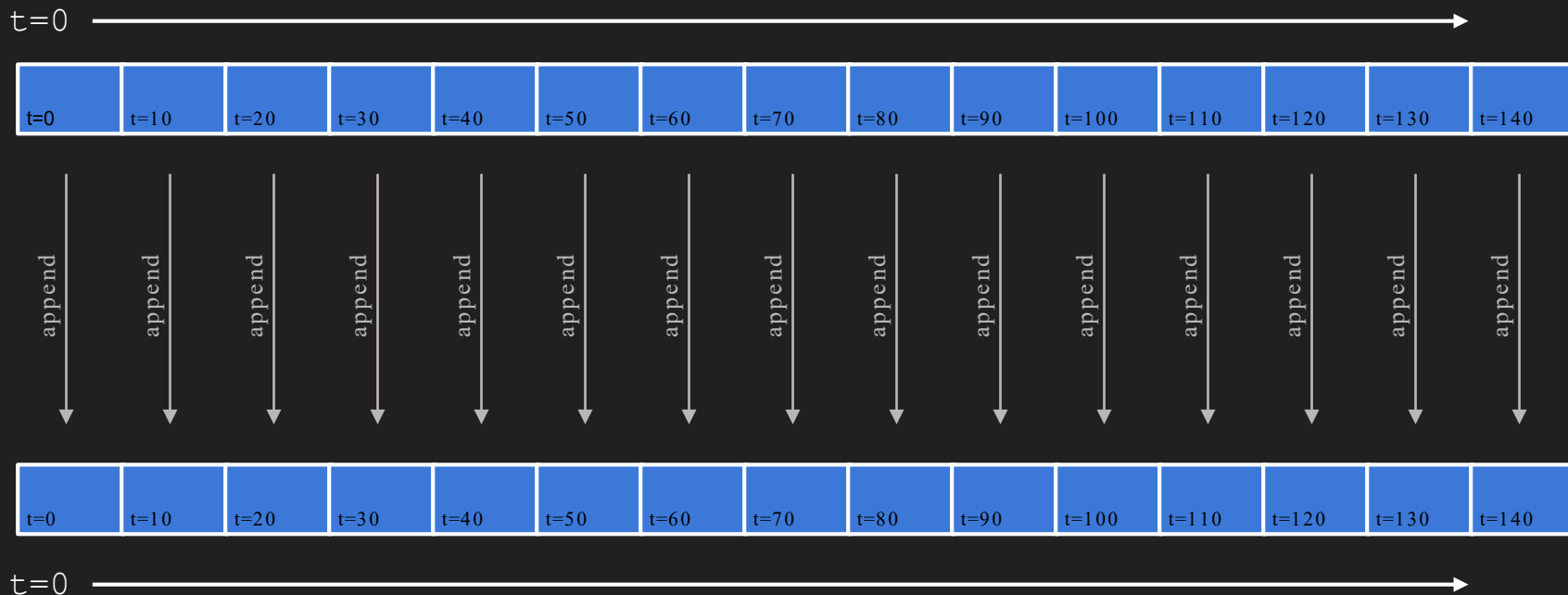
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A 3D rendered image of a heavy metal chain broken in the middle. The two ends of the chain are separated, and a cloud of sharp, metallic shrapnel is exploding outwards from the point of breakage. The scene is set against a solid black background.

**Playback
Timestamps**

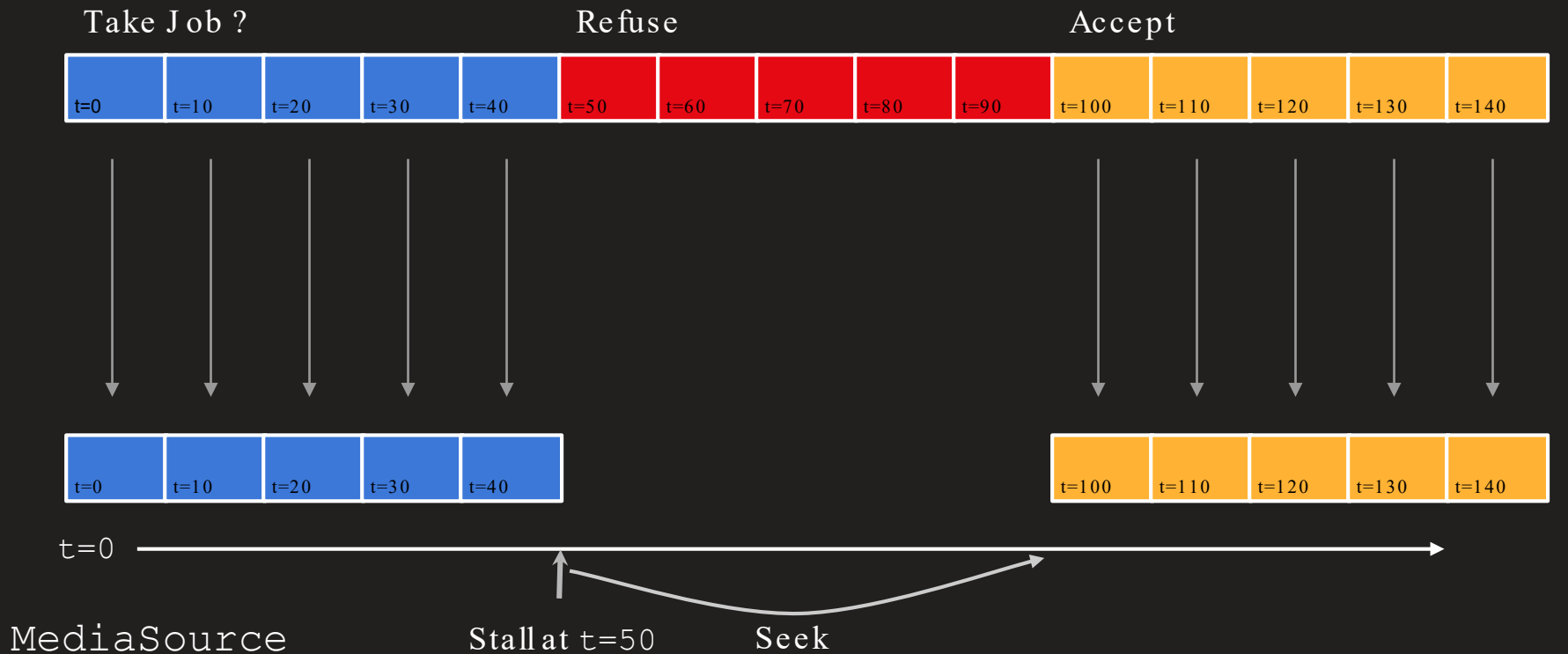
**Content
Timestamps**

Media file

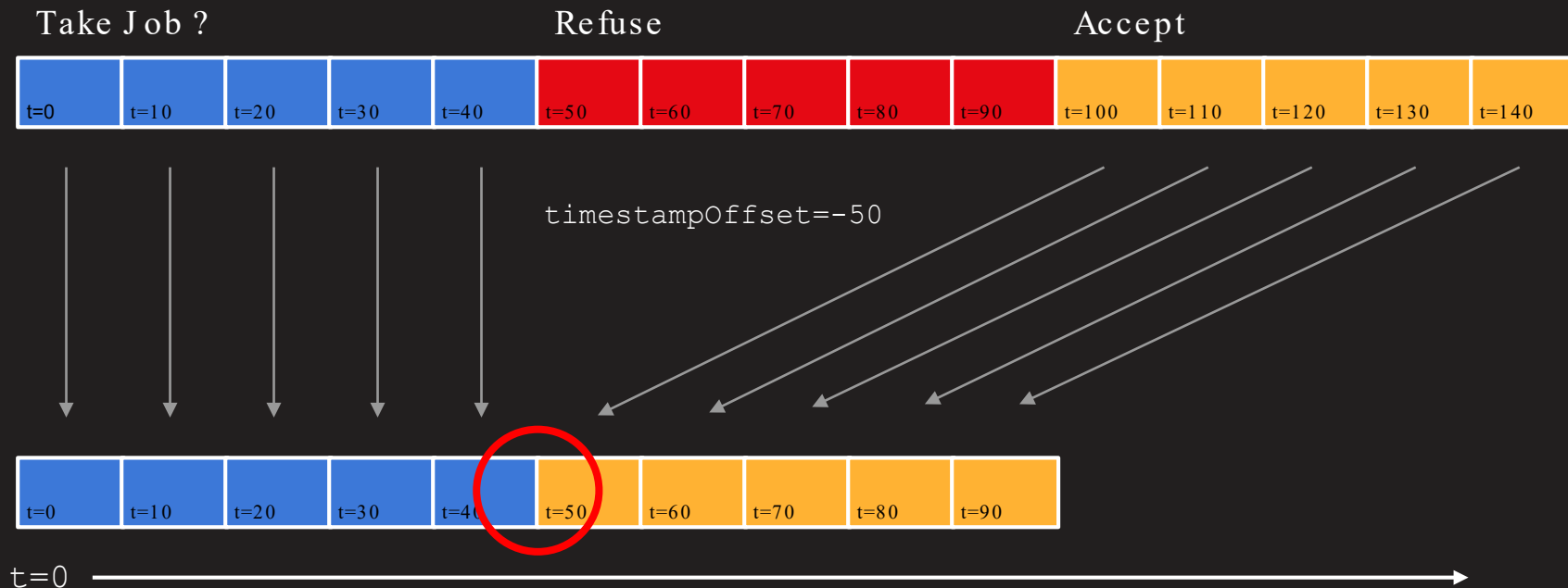


MediaSource

Media file



Media file



MediaSource

Video

40ms



...



Audio

32ms



...



...



Annotated IMF Model

In an Annotated IMF Master, video must be its native frame rate, with SMPTE non-drop-frame timecode, and each unique segment must be denoted with an 'FPCI' IMF Marker - this stands for Fixed Point Candidate Insertion. The marker must be annotated with exact SequenceID for this segment in the Sequence Overview spreadsheet.

Files delivered to Netflix

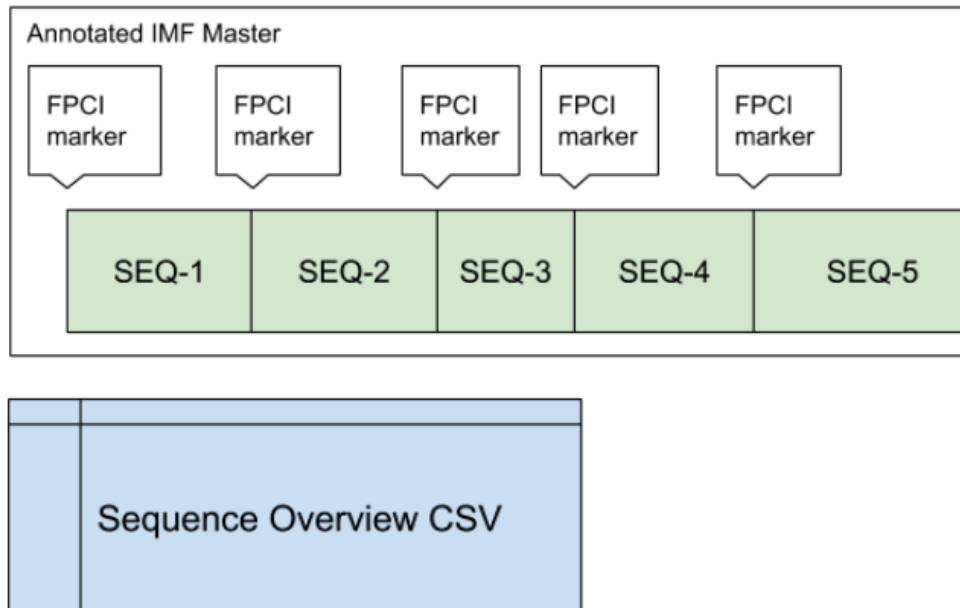
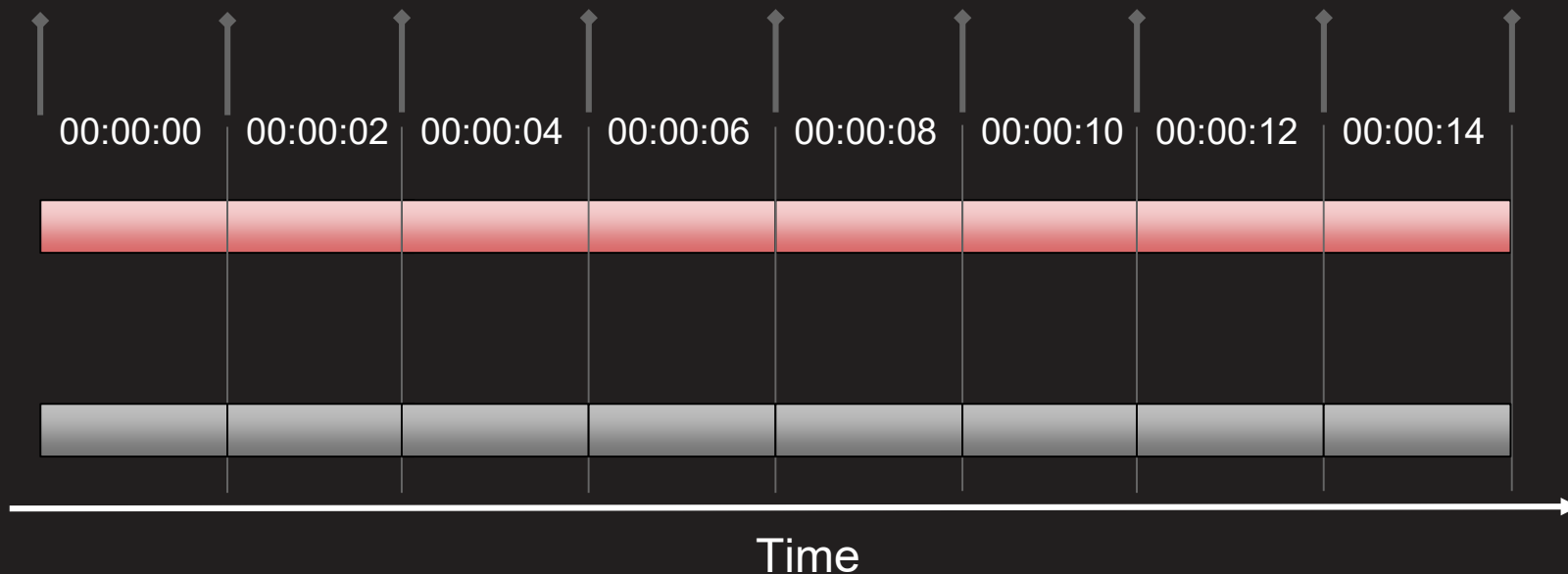
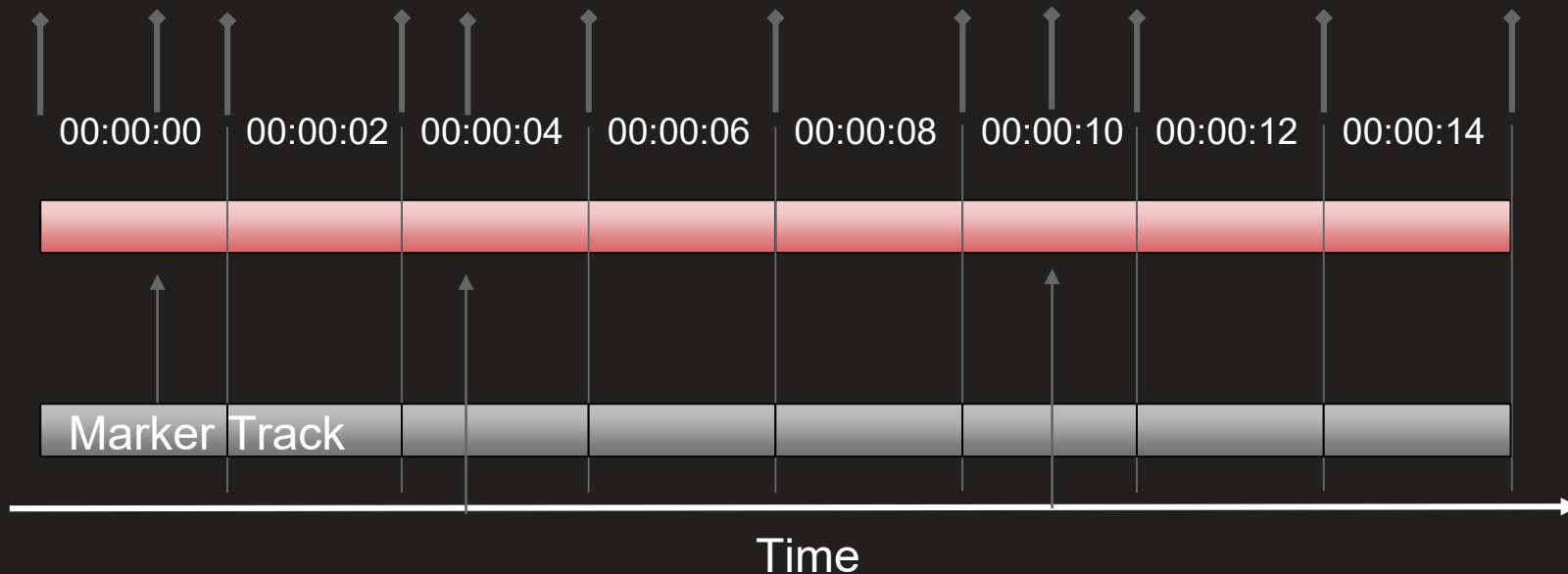


Figure: Overview of deliverables

Annotated IMF w/ Arbitrary Segment Boundaries



Annotated IMF w/ Arbitrary Segment Boundaries



Toward Segment -based Delivery

- Necessary to scale beyond a handful of titles
- Ties logically to the creative design process
- Great use-case for IMF
 - Per-segment CPLs?
 - Can auto-generate Aligned CPL to decouple with client implementations
- Interest within SMPTE to standardize?



tester_hbs@netflix.com

Do you understand?



YES

NO

Thank you