# Understanding video streaming algorithms in the wild Maximilian Grüner



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Photo: ETH Zürich / Gian Marco Castelberg







#### Melissa Licciardello



#### Ankit Singla





### Introduction





# Introduction Setup



#### Introduction

### •Setup

### •Experiments



- Introduction
- •Setup
- •Experiments
- Limitations and future work



- Introduction
- •Setup
- •Experiments
- Limitations and future work
- •(Some) Takeaways



# Streaming in industry

#### Share of global internet traffic %



Categories

[Sandvine 2019]



# Streaming in industry

#### Share of global internet traffic %



[<u>Sandvine</u> 2019]



# Streaming in industry



Share of global internet traffic %

#### 23.8 % Various, 23.1 % Netflix, 12.7 % YouTube, 4.2 % Twitch...



### Streaming in academia



Year



### Streaming in academia



#### Year



























Provider

Description

#### Alexa Rank



7

Provider	Description
YouTube	Broad coverage

#### Alexa Rank

2, Global



7

Provider	Description
YouTube	Broad coverage
ZDF	German Public Service

#### Alexa Rank

2, Global

47, Germany



7

Provider	Description
YouTube	Broad coverage
ZDF	German Public Service
Pornhub	Pornographic video sharing we

#### Alexa Rank

2, Global 47, Germany

46, Global

ebsite



7

Provider	Description	Alexa Rank
YouTube	Broad coverage	2, Global
ZDF	German Public Service	47, Germany
Pornhub	Pornographic video sharing website	46, Global
Arte	French-German,cultural	270,France
Fandom	Gaming, pop-culture	91, Global
SRF	Swiss Public Service	45, Switzerland
TubiTV	Movies and series of all genres	1330, USA
Twitch	Live and VoD streaming service, gaming	39, Global
Vimeo	Artistic content	188, Global
XVideos	Pornographic video sharing website	67, Global



#### Providers X Net-traces X Videos X Length



### Providers X Net-traces X Videos X Length

9750 minutes ~ 7 days of streaming time





Request/Response

#### Browser







Request/Response

























### Looking at a measurement



200	300	400

Time [s]



### Looking at a measurement



Time [s]



### Looking at a measurement



Time [s]


# Looking at a measurement



Time [s]



# Measurement setup



# Measurement setup







### Stream A





### Stream A



### Stream B













### Stream B















### Stream B



















### Stream B













### Stream B













Providers



Providers



Providers







Time [s]

Provider

Fandom nul fune up in Arte un upe deo 20t Set witch



Time [s]

Provider



Time [s]





Time [s]

Provider















#### 30 40 50 60

% Played





# Convergence







# Convergence



% Played





# Convergence









Buffer [s]











Buffer [s]





Buffer [s]





Buffer [s]



## Risk tolerance



## 60 80 100

% Played



# Risk tolerance



% Played



# Risk tolerance



% Played



#### Bandwidth

#### **Buffer State**

### Playback


**Buffer State** 





**Buffer State** 









**Buffer State** 









**Buffer State** 











**Buffer State** 











**Buffer State** 







**Buffer State** 



Playback



### Redownload





### Risk tolerance



% Played

























#### Time [s]





#### Time [s]





















# Downloads after change





# Downloads after change







Time [s]





Time [s]





#### Time [s]























Played



#### Static Image



Played



#### Static Image





Played

#### Action Scene





#### Static Image





Played

#### Action Scene



#### Static Image



#### [Videos from YouTube]



Static Image





Played

Resolution

Buffer

#### Action Scene



#### Static Image



#### [Videos from YouTube]



Static Image





Played

Resolution

Buffer



#### Action Scene



#### Static Image



#### [Videos from YouTube]


Static Image





Played

Resolution

Buffer





### Action Scene



### Static Image





Static Image





Played

Resolution

Buffer





### Action Scene



### Static Image







Static Image





Played

Resolution

Buffer





### Action Scene



### Static Image









Static Image





Played

Resolution

Buffer







### **Action Scene**

### Static Image









Static Image





Played

Resolution

Buffer







### **Action Scene**

### Static Image











### ) 40 60 80 Top [x%] VMAF chunks









# Twitch Rate - Twitch Vimeo MPC - Vimeo 40 60 80

Top [x%] VMAF chunks







• Latency





- Latency
- Geography





- Latency
- Geography
- Mobile vs. desktop space





- Latency
- Geography
- Mobile vs. desktop space
- Optimisation at the provider







### I. Prioritisation of stable streaming



# Prioritisation of stable streaming Buffer goal differs



- I. Prioritisation of stable streaming
- 2. Buffer goal differs
- 3. Bandwidth is not fully used



- I. Prioritisation of stable streaming
- 2. Buffer goal differs
- 3. Bandwidth is not fully used
- 4. Indication for optimisation



### Understanding video streaming algorithms in the wild

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https://github.com/magruener/understanding-video-streaming-in-the-wild

a construction of the

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Photo: ETH Zürich / Gian Marco Castelberg



