

Achieving High, Fairly Shared Quality of Experience

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## MUSLIN: MULTI-SOURCE LIVE STREAMING

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*S. Da Silva, J. Bruneau-Queyreix, M. Lacaud, D. Négru, L. Réveillère*

**Simon Da Silva**



Tuesday June 12, 2018

# Plan

## Background

Context

Problem statement

Our idea

## MUSLIN

Server provisioning

Server advertising

Implementation

## Evaluation

Setup

Results

Conclusion

# Video content consumption evolves...

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## Video content consumption evolves...

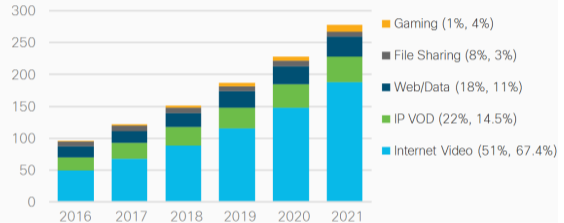


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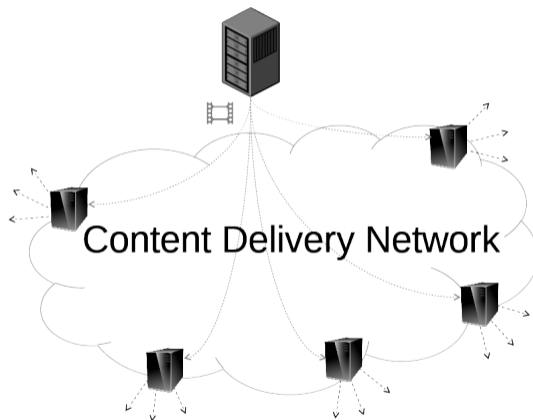


24% CAGR  
2016-2021

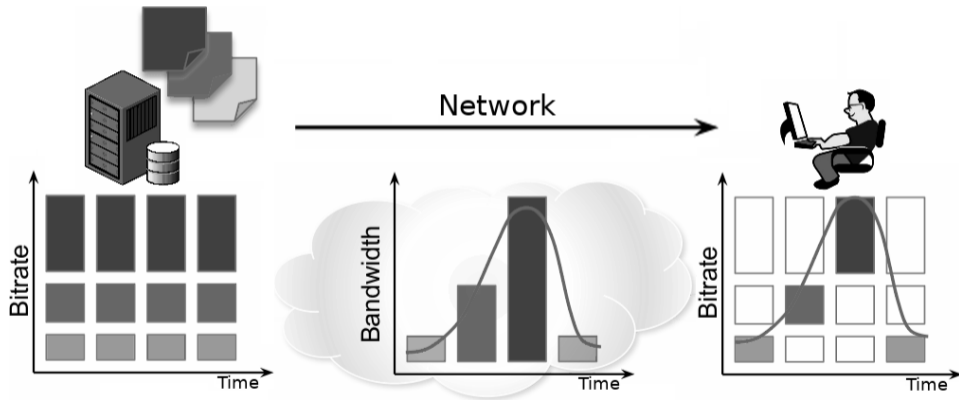
Exabytes  
per month



# Content Delivery Networks (CDN)



# HTTP Adaptive Streaming (HAS)



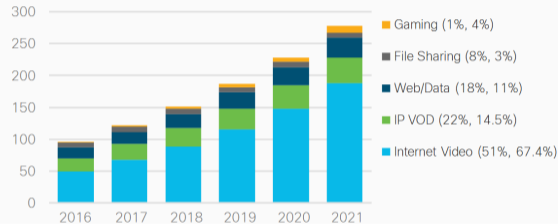


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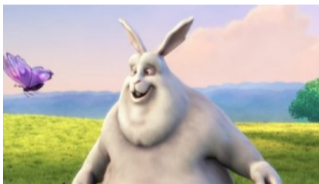
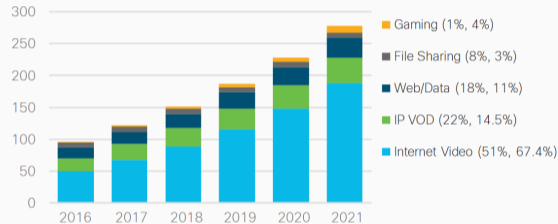


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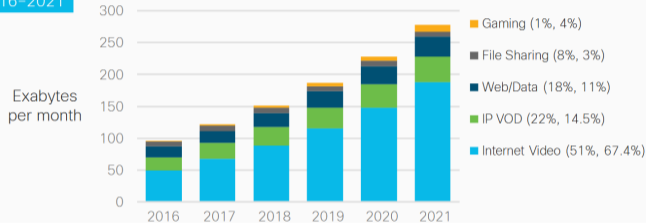
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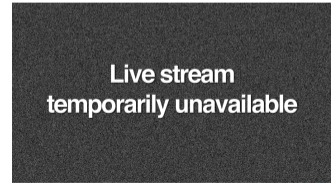
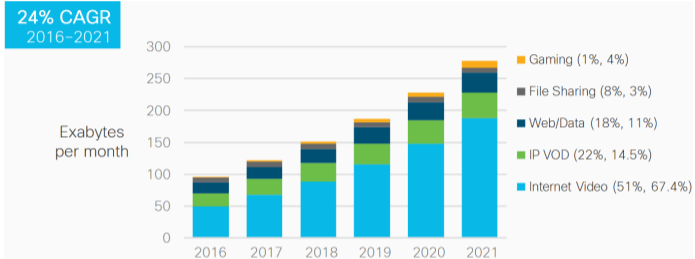
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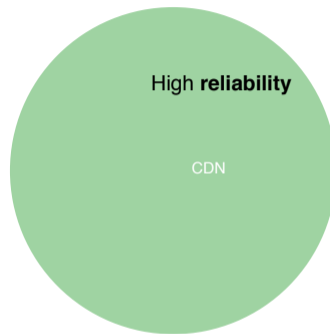


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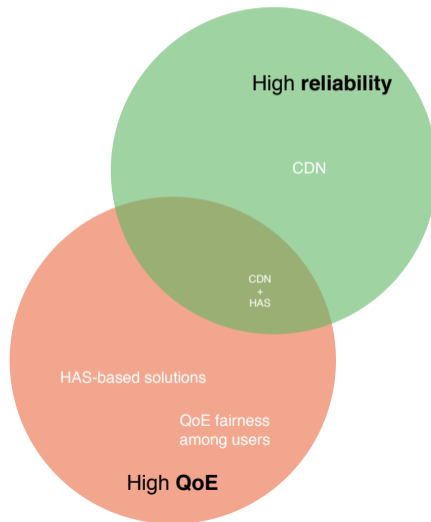


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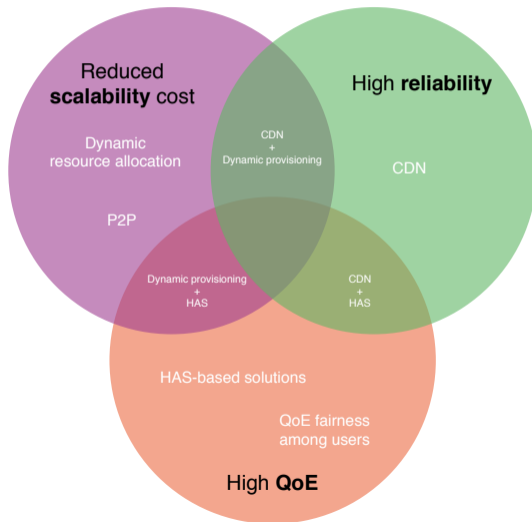
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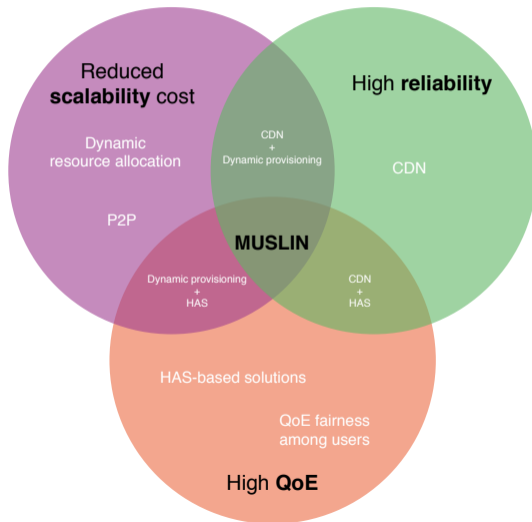


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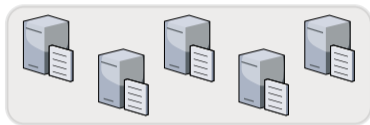




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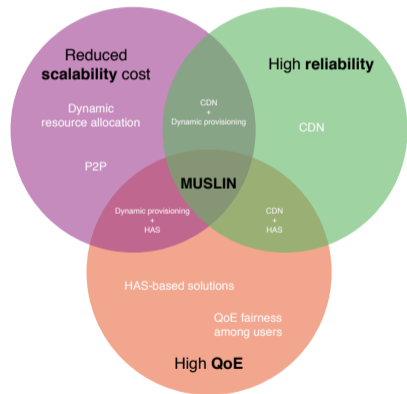


# MUSLIN: Multi-Source Live Streaming

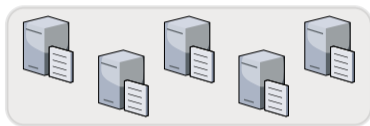


**MUSLIN  
content  
servers**

**MUSLIN  
clients**



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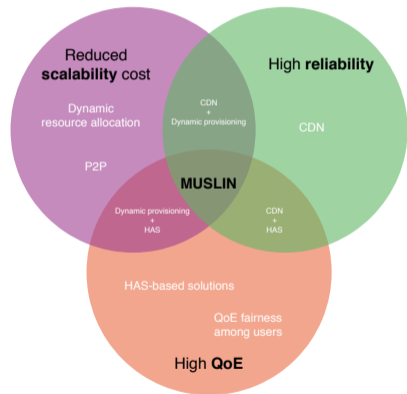
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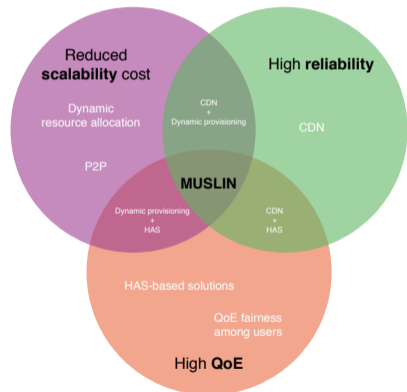
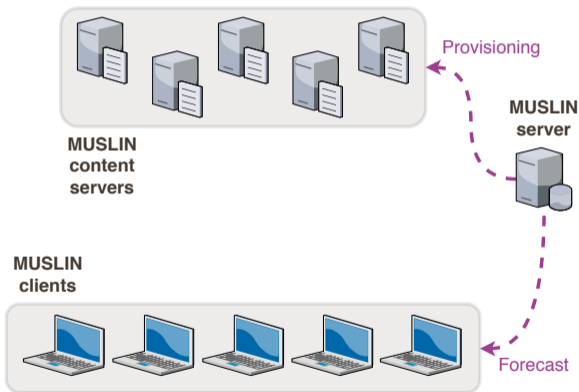
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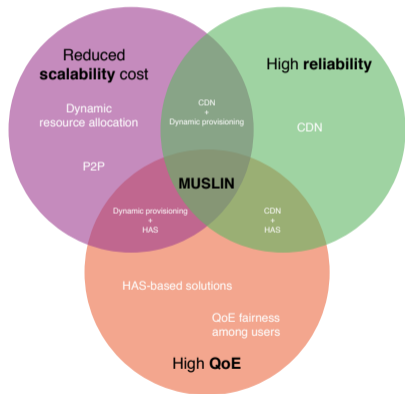
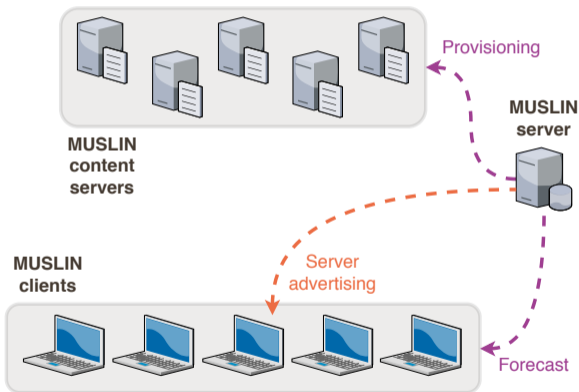
Forecast



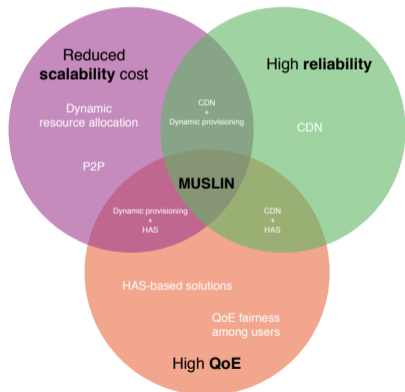
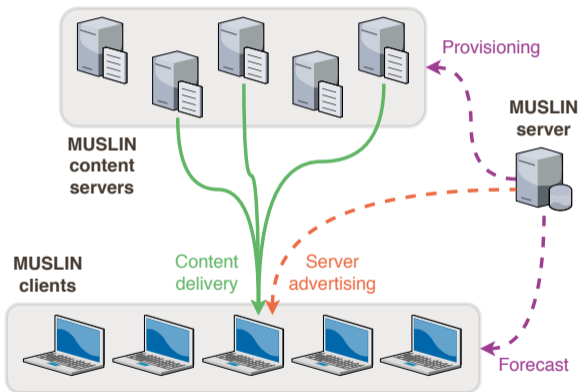
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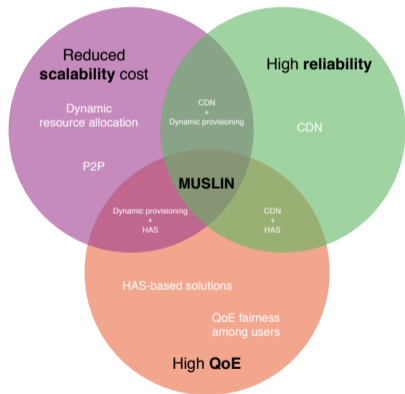
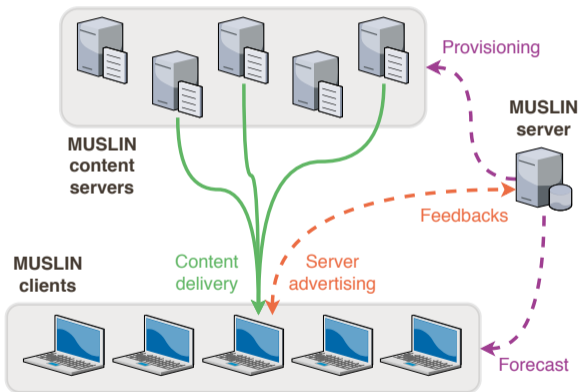
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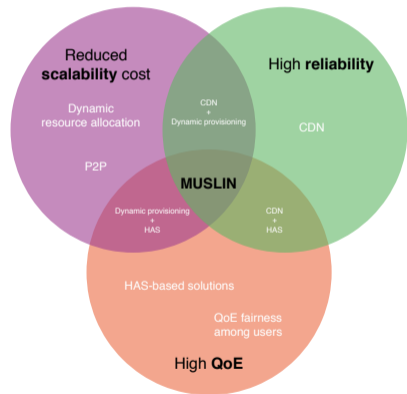
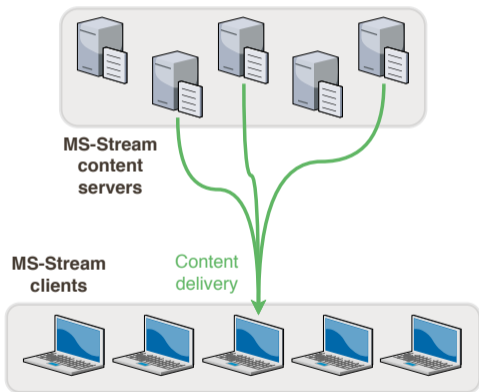
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# Multi-Source Streaming over HTTP

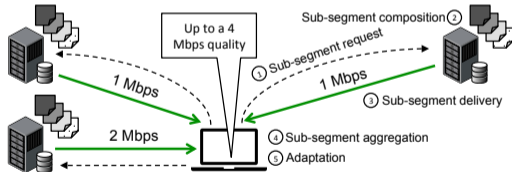




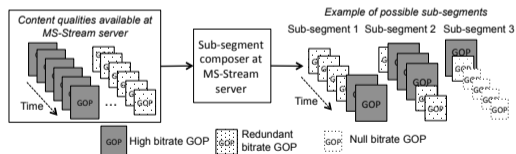
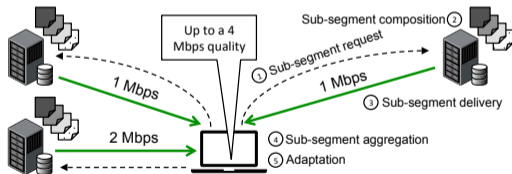
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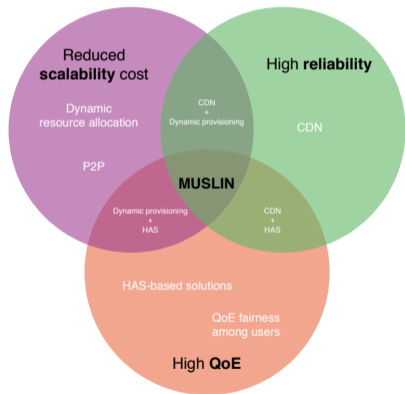
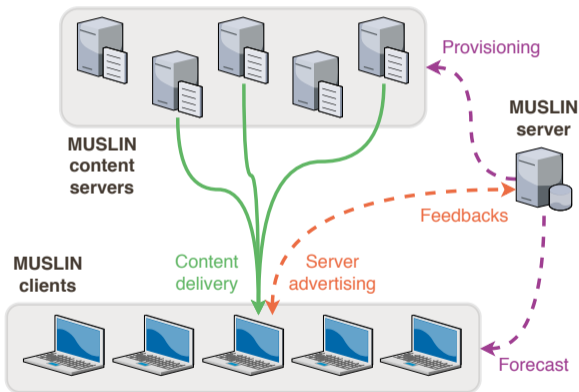
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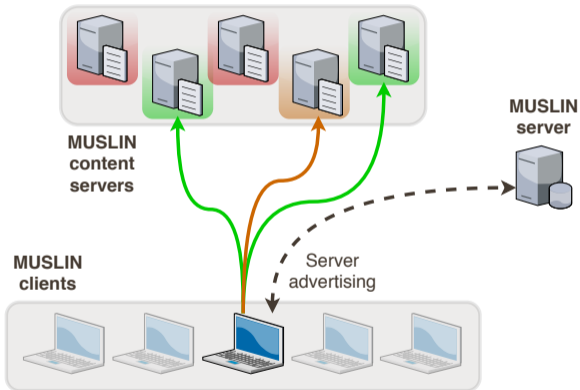
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3. Provisioning decision (Server Ranking Score  $RS_s$ )
  - ▶ Clients location
  - ▶ Server failure rate
  - ▶ Observed bandwidth

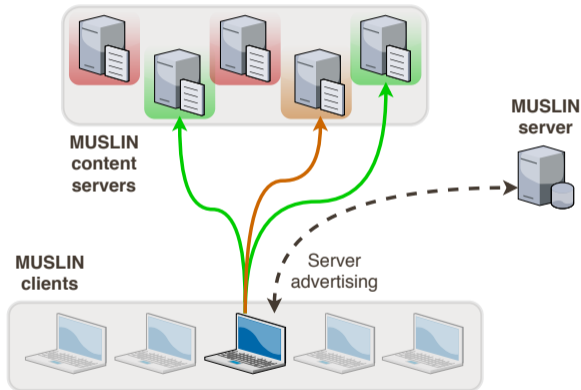


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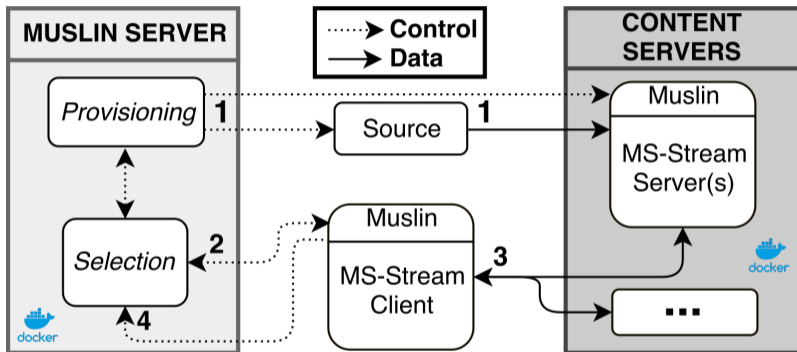


Muslin Ranking Score  $RS_{SC}$ :

- ▶ Server - client distance
- ▶ Server failure rate
- ▶ Observed bandwidth

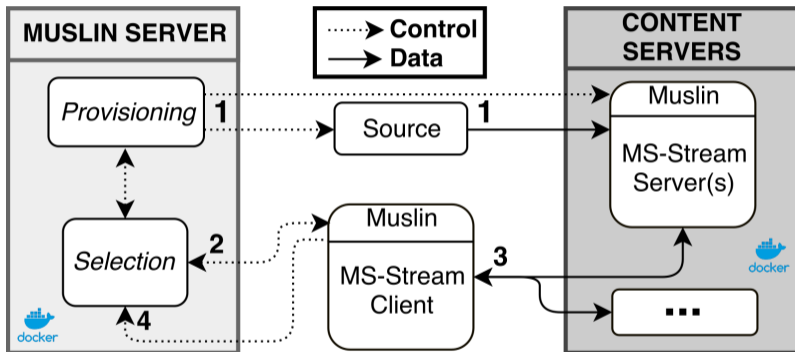
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1 Content replication - 2 Server advertising - 3 Content delivery - 4 Clients feedbacks

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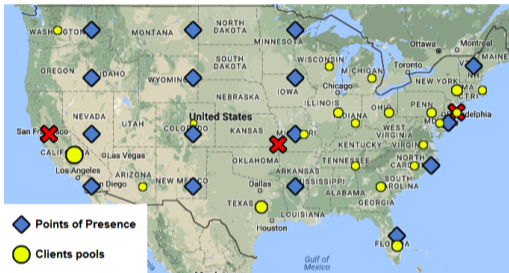
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Feedback request probability:  $Pr = \min(1, N/v_t)$

# Evaluation setup

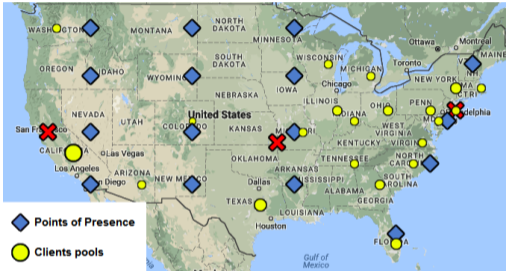
# Evaluation setup

- ▶ 16 Points of Presence (30 Mbps)
- ▶ 21 client pools locations





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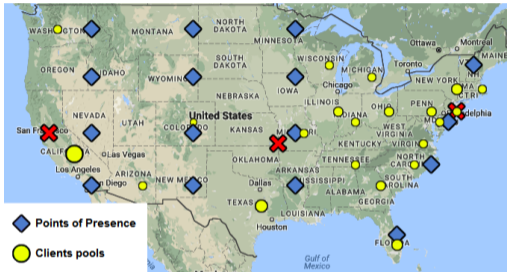


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Table: Evaluated policies

Provisioning and Forecast	Selection	Delivery
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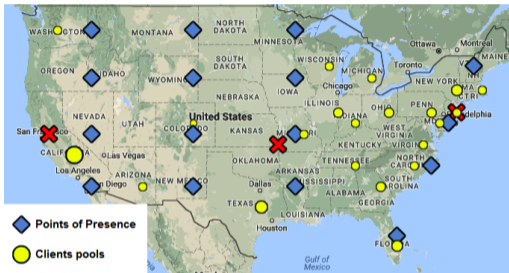


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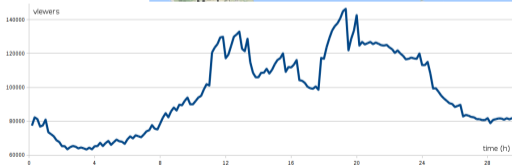
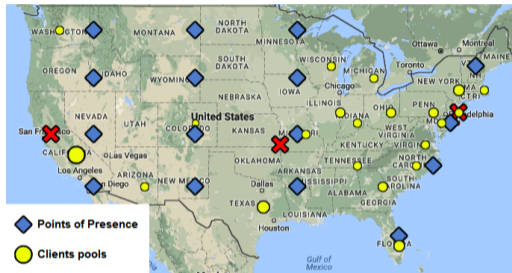


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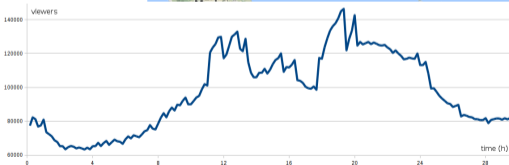
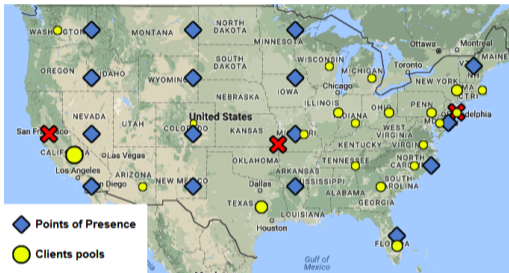


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Actual live audience trace

## Evaluation results

Compared to a best-case CDN setup  
(geographical oracle):

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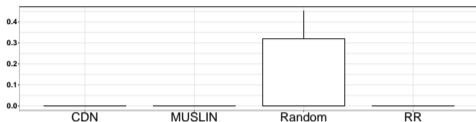


Figure: Rebufferings (per minute)

Compared to a best-case CDN setup (geographical oracle):

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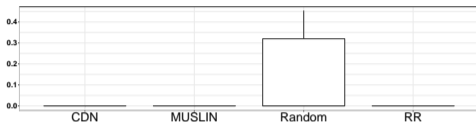


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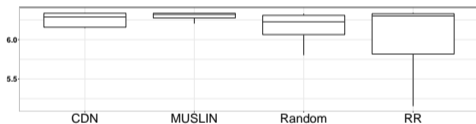


Figure: Displayed bitrate (Mbps)

Compared to a best-case CDN setup (geographical oracle):

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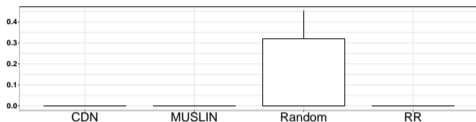


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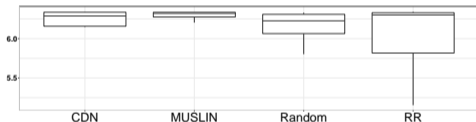


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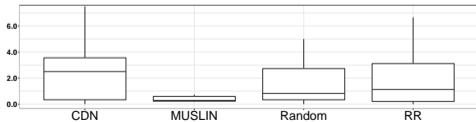


Figure: Quality changes (per minute)

Compared to a best-case CDN setup (geographical oracle):

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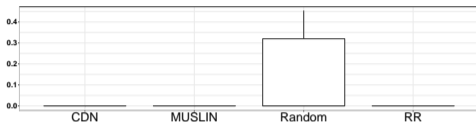


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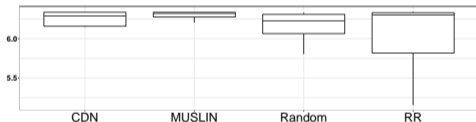


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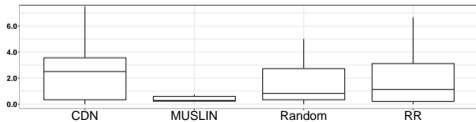


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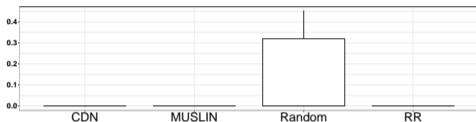


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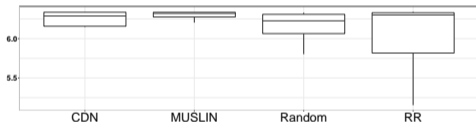


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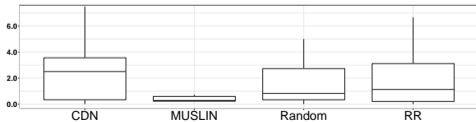


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QoE fairness (F index [1]):

[1] T. Hoßfeld et al.  
Definition of QoE Fairness in Shared Systems.  
IEEE Communications Letters (2017)

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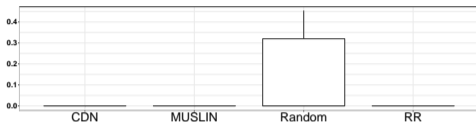


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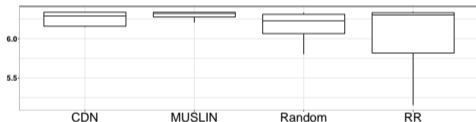


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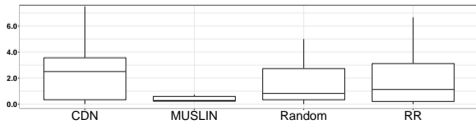


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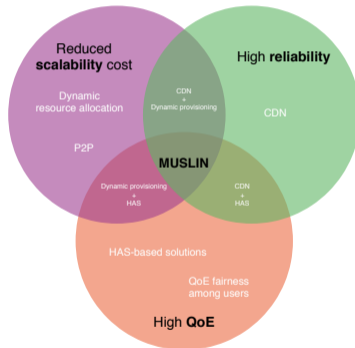
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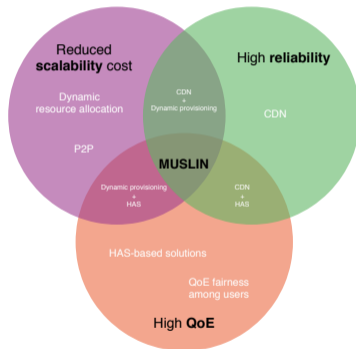
- ▶ + 19.6% bitrate fairness
- ▶ + 52% quality changes fairness
- ▶ + 23.6% rebuffering fairness

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# Conclusion and Future Work

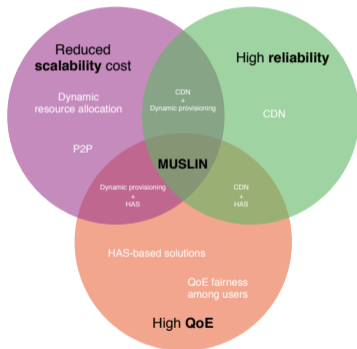


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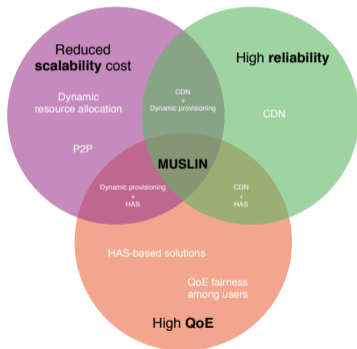
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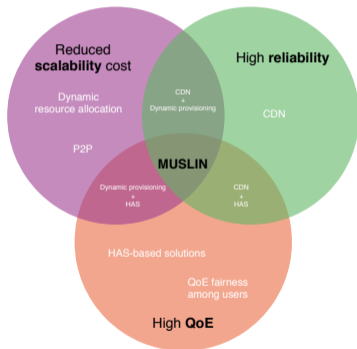
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- ▶ Real-time clients feedbacks

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