Practical, Real-time Centralized Control for CDN-based Live Video Delivery

Matt Mukerjee, David Naylor, Junchen Jiang, Dongsu Han, Srini Seshan, Hui Zhang
Why Video Delivery?

• Huge demand
• Pressure for higher and higher quality
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• Huge demand
  • ~60% of global internet traffic\(^1\)
  • Expected to reach 80-90% by 2019\(^1\)

• Pressure for higher and higher quality

\(^1\)Cisco Visual Networking Index: Forecast and Methodology, 2014 - 2019
Simple Solution?

Was this filmed on a potato???

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Send everyone terrible quality video!
Very few bits over the network!
Why Video Delivery?

- Huge demand
  - ~60% of global internet traffic\(^1\)
  - Expected to reach 80-90% by 2019\(^1\)
- Pressure for higher and higher quality
  - “Quality of Experience”\(^2\) ≈ bitrate, buffering ratio, join time, ...

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\(^1\)Cisco Visual Networking Index: Forecast and Methodology, 2014 - 2019
\(^2\)Developing a Predictive Model of Quality of Experience for Internet Video. SIGCOMM '13.
Why Video Delivery?

• Huge demand
  • Exponential growth (double in 5 years\(^1\))
• Pressure for higher and higher quality

\(^1\)Cisco Visual Networking Index: Forecast and Methodology, 2014 - 2019
Why Video Delivery?

Hard problem (fun problem?)

60%+ of Internet traffic, growing exponentially

This is fine.
Why Video Delivery?

Hard problem (fun problem?)

Do this all in real-time???

Live video delivery
Live Video Delivery

Video Delivery Network (VDN)
in
“Practical, Real-time Centralized Control for CDN-based Live Video Delivery”

SIGCOMM ‘15
Live vs. Video-on-Demand (VoD)

VoD caches close to clients
Live delivers from sources
Live Video is Becoming Wildly Popular

• Commercial sports streams
  • **Single** World Cup stream = 40% global Internet traffic\(^1\)

• User-generated streams (e.g., Twitch)
  • Users watch **150b min of live video per month**\(^2\)
  • Amazon buys Twitch for ~$1 Billion

\(^1\)Sandvine. Global Internet Phenomenon Report: 1H 2015

\(^2\)Twitch. [http://twitch.tv](http://twitch.tv)
What’s Broken Today?

DNS as point of control: can’t be hammered on, so entries for large video aggregates, 30 second update propagation.
Problems with DNS-based CDN Live Video Delivery

• Coarse control granularity
  • lower quality
  • higher delivery cost
• Slow updates
  • longer failure recovery
  • slower client joins
Our Contributions

• We design a video delivery network ($\text{VDN}$) to efficiently manage quality and cost, with high responsiveness
VDN at a High Level

- **DISCOVERY**
- **CONTROL**
- **CENTRAL CONTROLLER**
- **LOCAL AGENT**
- **HTTP Server**
- **DATA PLANE**

**TOPOLOGY AND VIDEO INFO**

**DISTRIBUTION TREES**

**HYBRID CONTROL**

- **CENTRALIZED**
- **DISTRIBUTED**
Results Overview

Quality
- CDN: 1.0x
- VDN: 1.7x

Delivery Cost (per request)
- CDN: 2.0x
- VDN: 1.0x

Join time
- Centralized: 7.0s
- VDN: 0.2s

Simulation using Conviva traces, modeling user-generated content
Simulation using Conviva traces, modeling large sports events
Emulation using small EC2 testbed
Summary

• Video delivery is hard
  • demand volume and need for quality
• Live video is even harder!
  • little to no caching
  • single source, millions of destinations
  • real-time
• VDN— a system for live video delivery
  • Centralized control = quality + cost
  • Distributed control = joins + failures
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