Cloud Transcoder: *Bridging the Format and Resolution Gap between Internet Videos and Mobile Devices*

Zhenhua Li, Yan Huang (team leader), Gang Liu, Fuchen Wang, Zhi-Li Zhang and Yafei Dai

Tencent Research and Peking University

Abstract

Despite its increasing popularity, Internet video streaming to mobile devices faces many challenging issues. One such issue is the format and resolution "gap" between Internet videos and mobile devices: many videos available on the Internet are often encoded in formats not supported by users' mobile devices, or in resolutions not best suited for streaming over cellular/WiFi networks. Hence video transcoding to specific devices (and to be streamed over cellular/WiFi networks) is needed. To this end, we propose and implement "Cloud Transcoder" which utilizes an intermediate cloud platform to bridge the format/resolution gap by performing video transcoding in the cloud. Specifically, Cloud Transcoder only requires the user to upload a video request (i.e., a URL link to the video available on the public Internet as well as the user-specified transcoding parameters) rather than the video content. After getting the video request, Cloud Transcoder downloads the original video from the Internet, transcodes it on the user's demand, and delivers the transcoded video back to the user. Therefore, the mobile device only consumes energy in the last step but with much less energy consumption than downloading the original video from the Internet, due to faster delivery of transcoded video from the Cloud Transcoder cloud platform. Running logs of our real-deployed system validate the efficacy of Cloud Transcoder.

Motivation

Mobile device:

- *more and more popular, much more than PCs*
- *small and diverse screens*
- *low battery power*
- *embedded CPU*

Mobile streaming traffic:

- *only iPad accounts to 10% Internet traffic*
- *most headed for video streaming*

Today's Internet videos:

- *mostly PC oriented*
- *single format*
- *very limited resolutions*

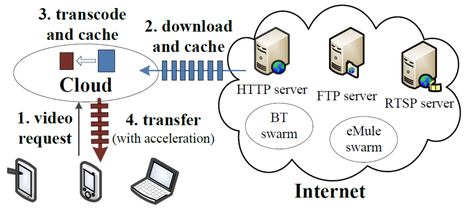
Flash videos: 240p, 360p, 480p (usually)

Existing solutions:

- *local transcoding*
- *PC assistant*
- *traditional cloud-based transcoding*
- *all unsatisfactory*

Cloud Transcoder

Using an intermediate cloud platform to bridge the format/resolution gap by performing video transcoding in the cloud



Looks simple and straightforward, while works effectively!

The user only uploads a video request

< video link; format, resolution, ... >

HTTP/FTP/RTSP link
BT/eMule/Magnet link

User-specified transcoding parameters

The cloud caches both original videos and transcoded videos, and transfers transcoded videos back to users with a high data rate

- via the intra-cloud data transfer accelerations

Mobile user only consumes energy in the last step

- fast retrieving the transcoded video from the cloud

Cloud Transcoder provides **energy-efficient on-demand** video transcoding service to mobile users

- via its special and practical designs
- trying to minimize the user-side energy consumption

energy saving

Potential drawbacks

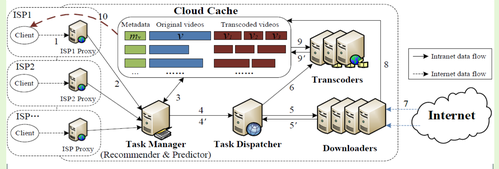
- Cloud Transcoder moves all the video download and transcoding works from its users to the cloud
- critical problem: how to handle the resulting *download bandwidth pressure and transcoding computation pressure on the cloud*
- Our solutions:

- implicit data reuse among users via cloud cache
- explicit transcoding recommendation and prediction
- simple but effective: (1) download task cache hit ratio → 87%, (2) transcode task cache hit ratio → 66%

Commercial System —— QQXuanfeng Transcoder

System Architecture:

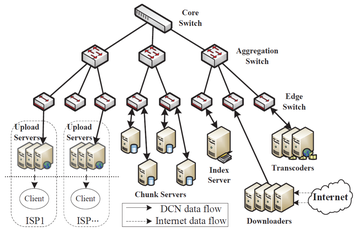
- deployed since May 2011, keep scaling
- 244 commodity servers deployed in 10 ISPs in China
- serving ~8600 requests from ~4000 users per day
- 96% original videos are long videos (> 100 MB)



Hardware Composition (May 2011):

Building Block	Number of servers	CPU (4 cores)	Memory	Storage	Bandwidth
ISP Proxy	6	Intel Xeon X3430 @2.4 GHz	8 GB	250 GB	1 Gbps (Intranet), 0.3 Gbps (Internet)
Task Manager	4	Intel Xeon X3210 @2.13 GHz	8 GB	250 GB	1 Gbps (Intranet)
Task Dispatcher	3	Intel Xeon X3210 @2.13 GHz	8 GB	460 GB	1 Gbps (Intranet)
Downloaders	20	Intel Xeon X3430 @2.4 GHz	8 GB	460 GB	1 Gbps (Intranet), ~0.325 Gbps (Internet)
Transcoders	15	Intel Xeon X3430 @2.4 GHz	8 GB	460 GB	1 Gbps (Intranet)
Cloud Cache	170 chunk servers, 23 upload servers, and 3 index servers	Intel Xeon 5130 @2.0 GHz	8 GB	4 TB (chunk server), 250 GB (upload server)	1 Gbps (Intranet), ~0.3 Gbps (Internet)

Cloud Cache:

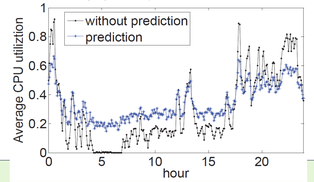


ISPs we support:

1. Telecom
2. Unicom
3. Mobile
4. CERNET
5. Tietong
6. GWBN
7. TBN
8. OCN
9. Teletron
10. Gehua

Transcoding Prediction:

- When the *CPU utilization of the transcoders stays* below a certain threshold (50%) during a certain period (one hour)
- Task Manager starts to predict which videos are likely to be requested for transcoding into which formats and resolutions
- based on the video popularity information



Performance Evaluation

Commercial software (http://xf.qq.com)

Dataset: complete running log in 23 days (Oct. 1-23, 2011)

- 197,400 video transcoding tasks involving 76,293 unique videos
- 85% video links are P2P links
- most popular transcoding parameters: (1) MP4-1024*768 (iPad), (2) MP4-640*480 (iPhone & Android), (3) 3GP-352*288 (Android)

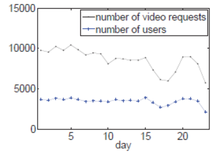


Figure 6: Daily statistics.

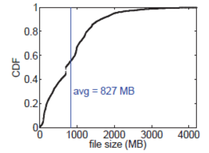


Figure 7: Original file size.

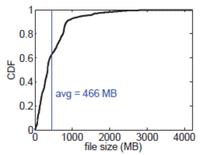


Figure 8: Transcoded file size.

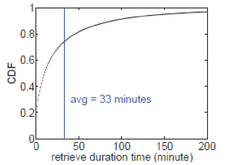


Figure 9: Retrieve duration.

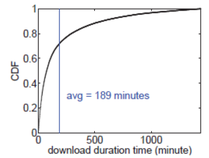


Figure 10: Download duration.

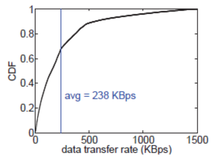


Figure 11: Data transfer rate.

User-side Energy Consumption

Data transfer rate (≈KBps)	50	100	200	300
iPhone battery consumption (%)	8.7	8.9	9.0	9.2
iPad2 battery consumption (%)	4.5	4.8	5.0	5.1

Future Work

Cloud Transcoder: a novel prototype system

- still at its startup stage
- tend to adopt straightforward and solid designs
- still considerable optimization space
- Other cloud transcoding services: mobile web browsers

Related Works

Our Cloud Transcoder paper

- Zhenhua Li, Yan Huang, Gang Liu, Fuchen Wang, Zhi-Li Zhang, and Yafei Dai. Cloud Transcoder: Bridging the Format and Resolution Gap between Internet Videos and Mobile Devices. The 22nd SIGMM Workshop on Network and Operating Systems Support for Digital Audio and Video (***NOSSDAV'12***), Jun. 7-8, 2012, Toronto, Canada. (EI, accept ratio: 17/47 = 36%) [ppt][demo video]

Our Cloud Download paper

- Yan Huang, Zhenhua Li, Gang Liu, and Yafei Dai. Cloud Download: Using Cloud Utilities to Achieve High-quality Content Distribution for Unpopular Videos. The ACM International Conference on Multimedia (***ACM-MM'11***, Nov. 28 - Dec. 1, 2011, Scottsdale, Arizona, USA. (EI, long paper accept ratio: 58/341 = 17%) [ppt] [poster]

Our Open-P2SP paper

- Zhenhua Li, Yan Huang, Gang Liu, Fuchen Wang, Yunhao Liu, Zhi-Li Zhang, and Yafei Dai. **Challenges, Designs and Performances of Large-scale Open-P2SP Content Distribution**. In Minor Revision process of *IEEE Transactions on Parallel and Distributed Systems* (***TPDS***), 2012. (SCI, Impact factor: 1.992)

Contact

Tencent (Shenzhen, Shanghai, Beijing, Chengdu) is one of the biggest Internet companies in China, whose business involves IM, Web portal, (Micro)Blog, Video Streaming, etc. http://www.tencent.com.

Peking University (Beijing, Shenzhen) is one of the oldest and best comprehensive universities in China, which is founded in 1898.

Zhenhua Li, *Peking University* lzh@net.pku.edu.cn
Yan Huang, *Tencent Research* galehuang@tencent.com
Gang Liu, *Tencent Research* sinbadliu@tencent.com
Fuchen Wang, *Tencent Research* future@tencent.com
Zhi-Li Zhang, *University of Minnesota* zhzhang@cs.umn.edu
Yafei Dai, *Peking University* dyf@net.pku.edu.cn