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Center for Advanced Technology in Telecommunications

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Media Engineering & Networking

Area Head: Keith Ross

November 21, 2008

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CATT Media Research

- Katherine Isbister
  - New gaming projects at Poly
- Yao Wang
  - Perceptual Quality Assessment for Compressed Video
- Yong Liu
  - Live P2P video: viewing-uploading decoupling
- Keith Ross
  - Live P2P video: layered streaming & incentives

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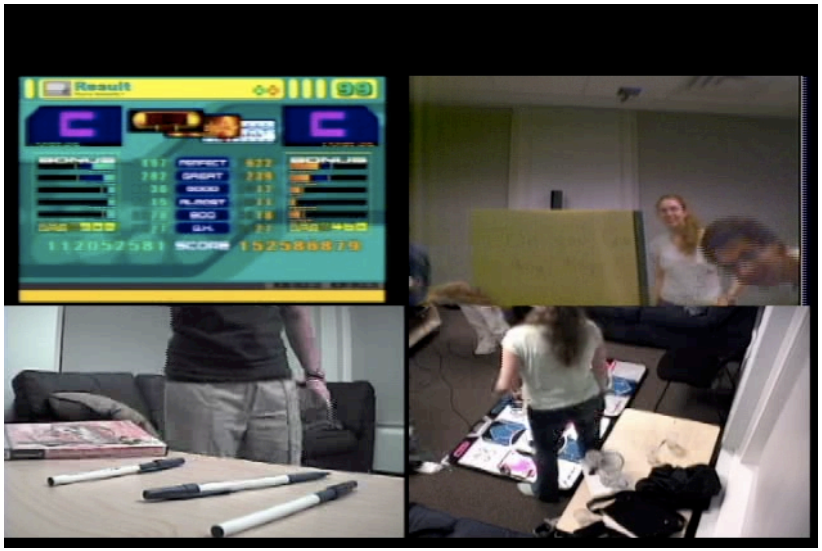
Social Game Lab

- **Gaming research facility**
  - Console games, pc-hookup, large display, video monitoring and digital mixing and recording facilities
- **Internal launch Nov. 15 after all-day 3D Game Engine workshop**



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Social Game Lab

- Allows for rich analysis of game play and user experience

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Gesture and Emotion project

- Analyzing gesture design in commercial games
- Creating a design pattern language
- Innovating new gestural strategies for games and other applications that enhance social and emotional experience

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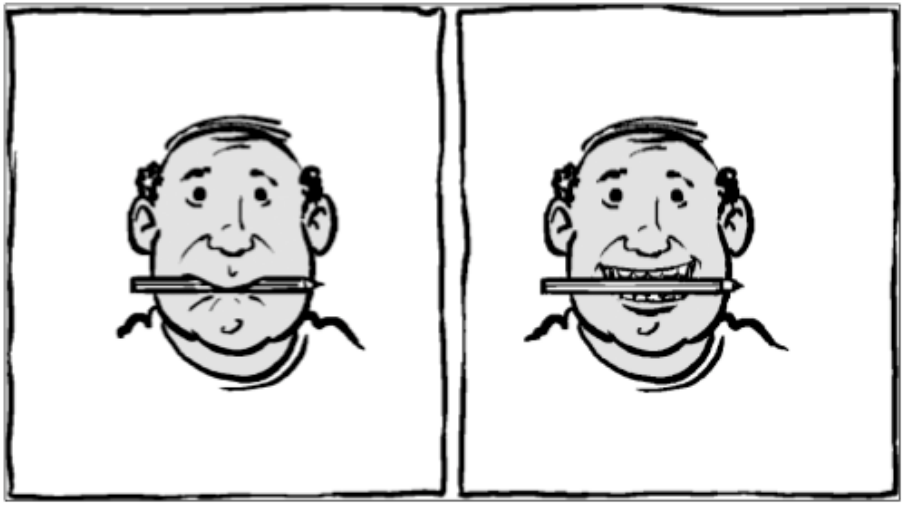
Gesture and Emotion project

- Effects of interest
  - Physical feedback loop
  - Emotional contagion
  - Increasing trust & liking through shared movement & mimicry



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Gesture and Emotion project

- Enhance social & emotional ties in non-game digital environments.

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Games for Learning Institute

- Multi-institution 3-year grant from Microsoft:
  - Research effective design for learning through games.
  - NYU, Columbia, Dartmouth, CUNY, Parsons The New School, Rochester Institute of Technology
- NYU-Poly faculty:
  - Katherine Isbister, Digital Media
  - Carl Skelton, Digital Media
  - Joel Wein, Computer Science
- Games will focus on STEM subjects.

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Motivation

- To deliver video to low-bandwidth users, should we code video at high frame rate, large frame size but low quality per frame, or vice versa?
- To deliver the same video to users with diverse downlink bandwidth, how to meet different users' capability?
  - Code the video into a scalable stream that can be accessed at different spatial, temporal, and amplitude resolutions.
  - Which combination is the best for a particular bandwidth?
- Should maximize the perceptual qualit?
- How to measure the perceptual quality?
- Prior research focuses on videos of fixed frame rate and frame size.
- This work investigates the impact of frame rate and quantization.

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Subjective Quality Assessment

- Testing Sequence Pool
  - Four original video in CIF (352x288) resolutions, 30 frames/sec (fps), each 8 seconds long
  - Each original video is coded following the H.264 scalable video coding (SVC) standard [JSVM912] and decoded at different frame rates (30, 15, 7.5, 2.75 fps) and quality levels (QP=28, 32, 36, 40), yielding 64 test sequences
- 20 viewer ratings for each processed video sequence

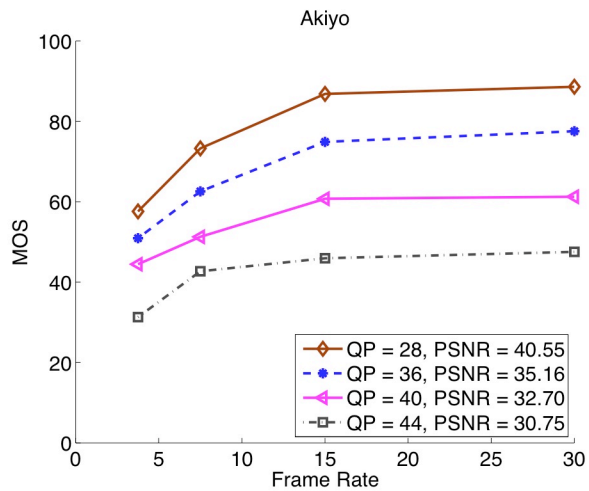
Akiyo

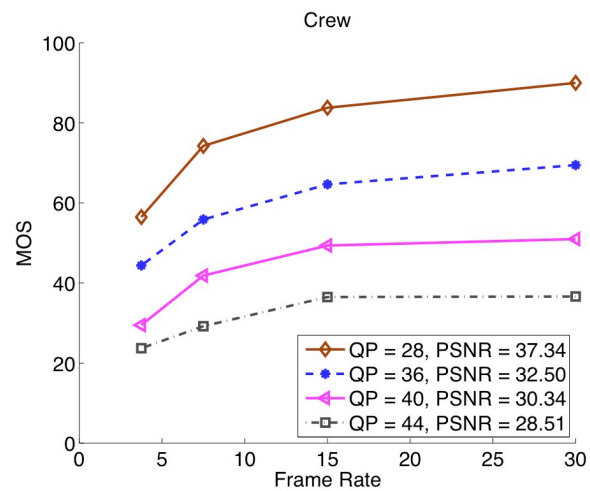
City

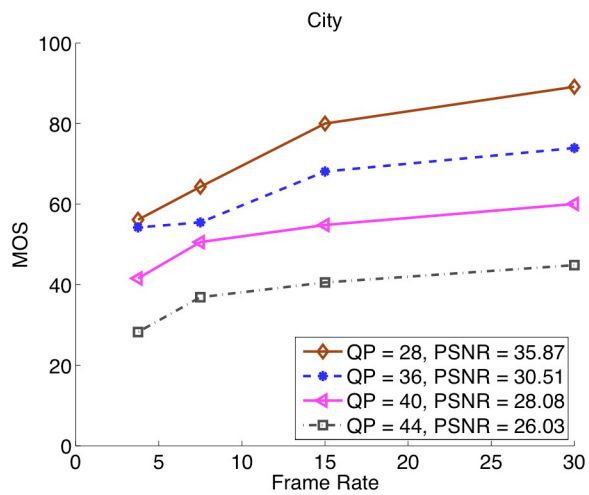
Crew

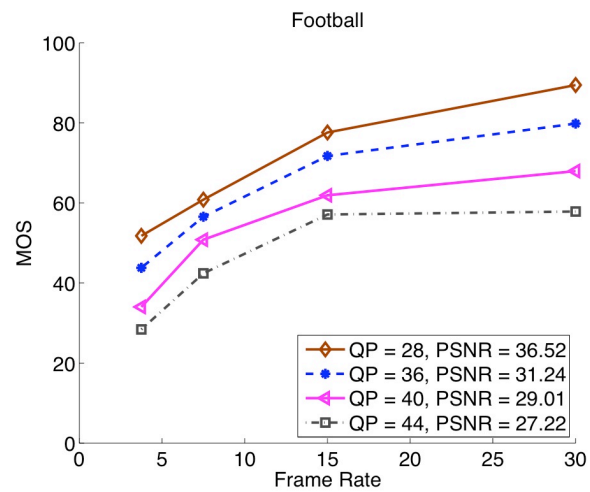
Football

Subjective Quality Test Result









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Proposed Quality Metric

$$VQMTQ(f, PSNR) = Q(PSNR)TCF(f)$$

- Q(PSNR) models the quality at the highest frame rate:

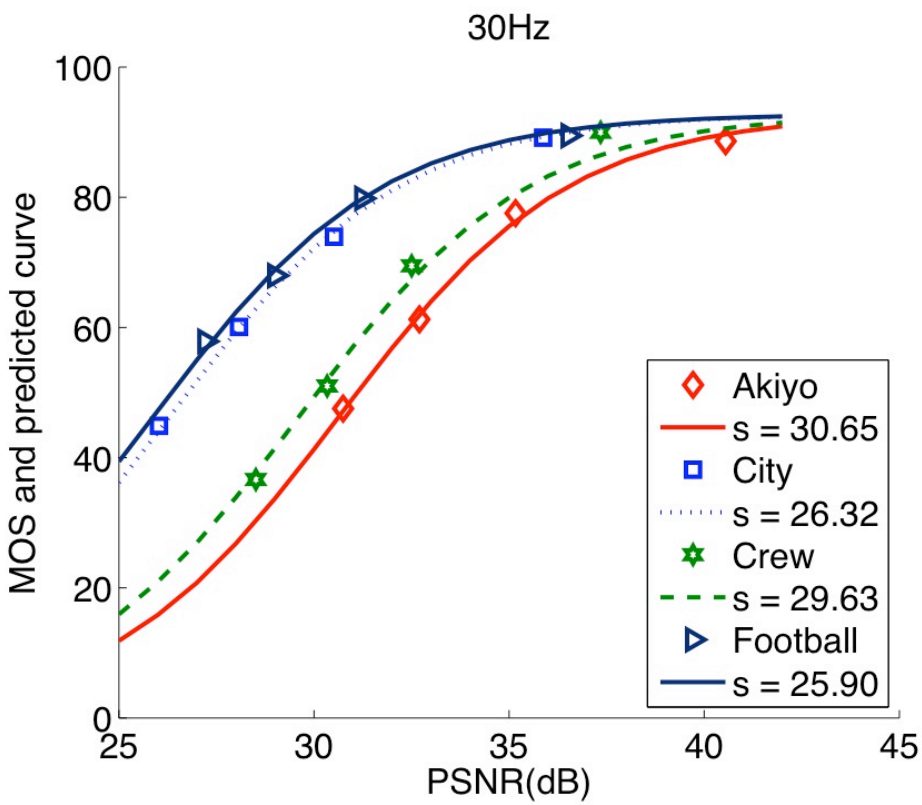
$$Q(PSNR) = \hat{Q}_{\max}\left(1 - \frac{1}{1 + e^{p(PSNR - s)}}\right)$$

- Temporal Correction Factor (TCF) characterizes the quality drop with frame rate reduction:

$$TCF = \frac{1 - e^{-b\frac{f}{f_{\max}}}}{1 - e^{-b}}$$

$$Q(PSNR) = \hat{Q}_{\max}\left(1 - \frac{1}{1 + e^{p(PSNR - s)}}\right)$$

Predicted vs. Measured Quality At the Highest Frame Rate



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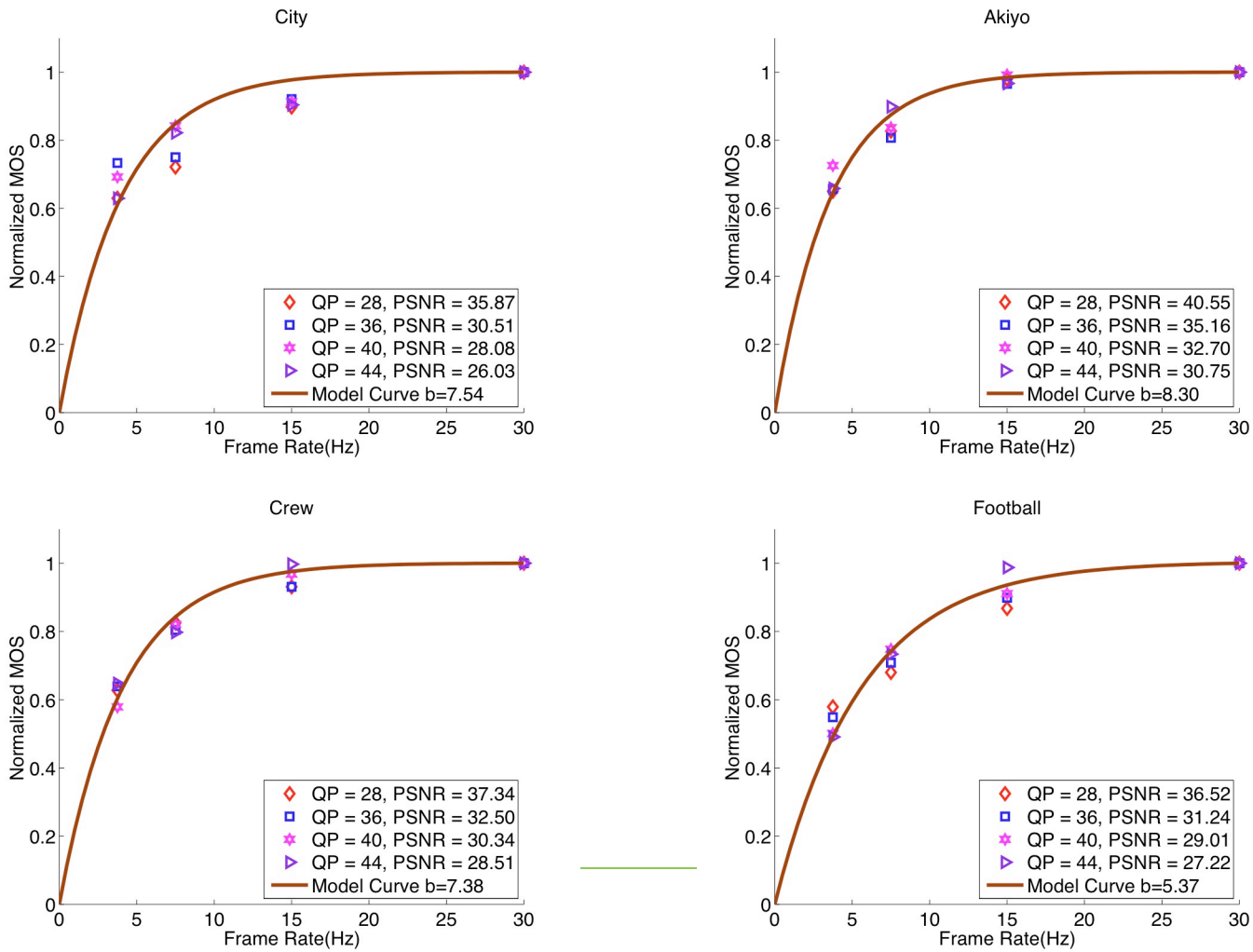
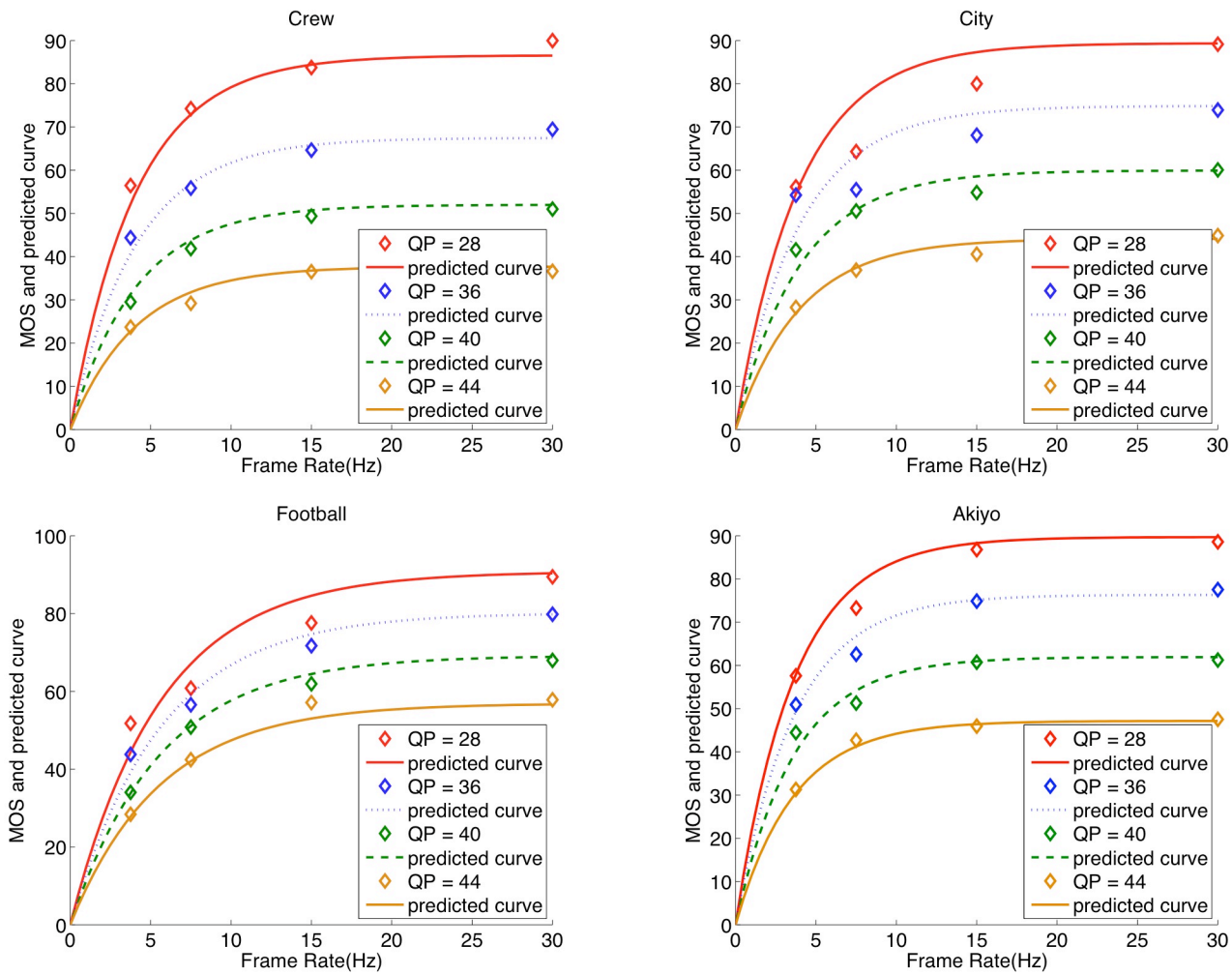
$$TCF = \frac{1 - e^{-b\frac{f}{f_{\max}}}}{1 - e^{-b}}$$

TCF vs. normalized MOS



QualityModel vs. Measured



Conclusion and Future Work

- **Conclusion**
  - Proposed model fits the subjective ratings accurately
  - Degradation of the perceptual quality due to quantization and frame-rate reduction are captured by two functions separately (sigmoidal function and inverted falling exponential).
  - Each function has a single parameter that is video-content dependent.
- **Future Work**
  - Investigate the correlation between model parameters and video content.

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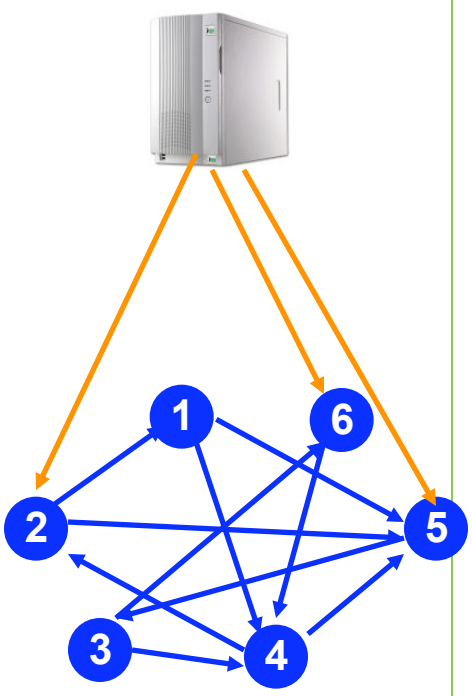
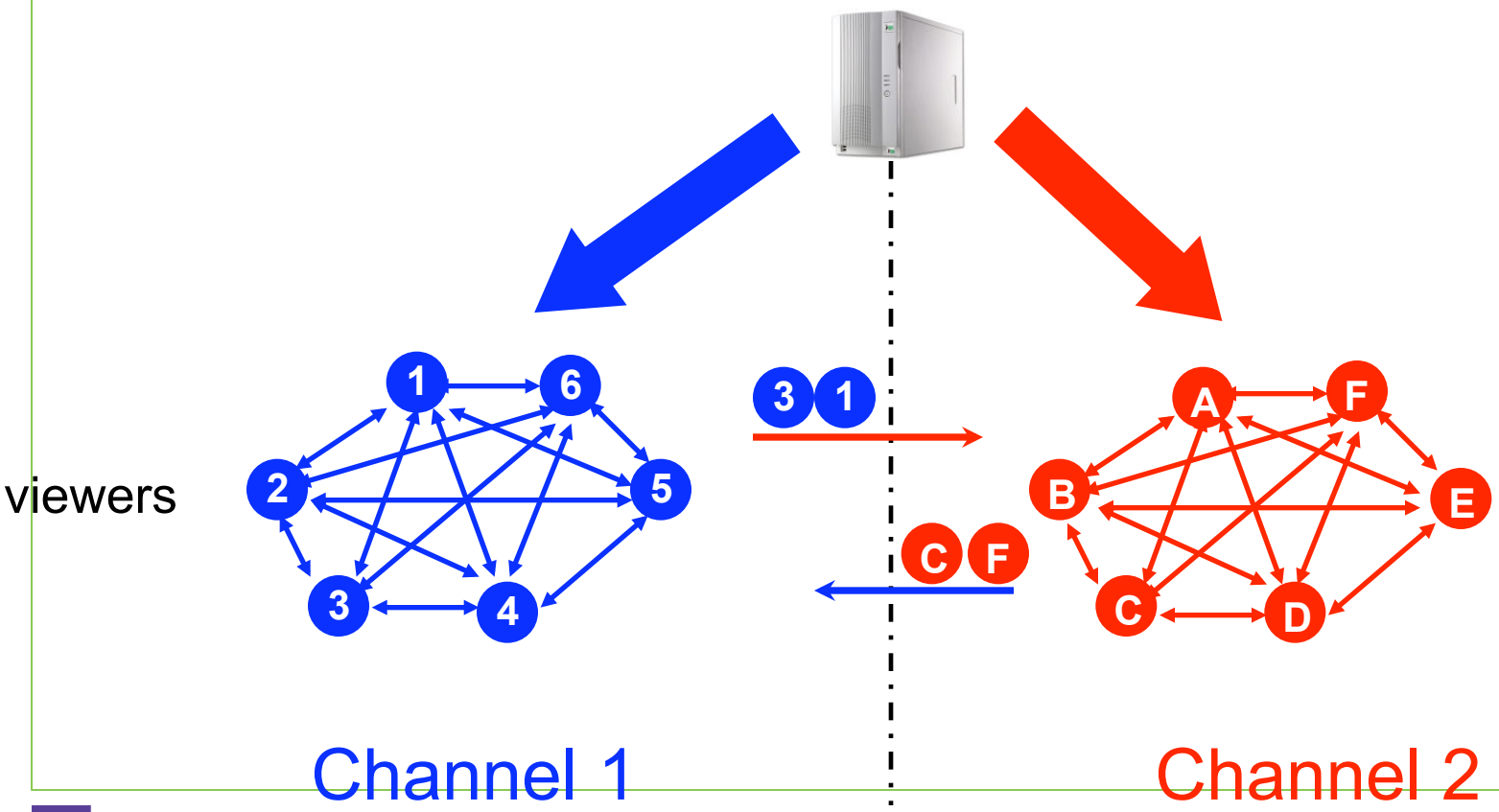
Peer-to-Peer Video Streaming

- Peer-to-Peer Video Streaming
  - peers help each other retrieve video
  - exploit peer uploading/buffering capacity
  - low infrastructure cost
- Large scale deployments on Internet
  - thousands of live/on-demand channels
  - millions of world-wide users daily
- P2P streaming at poly
  - measurement, analysis, design, prototyping, security
  - two demos today



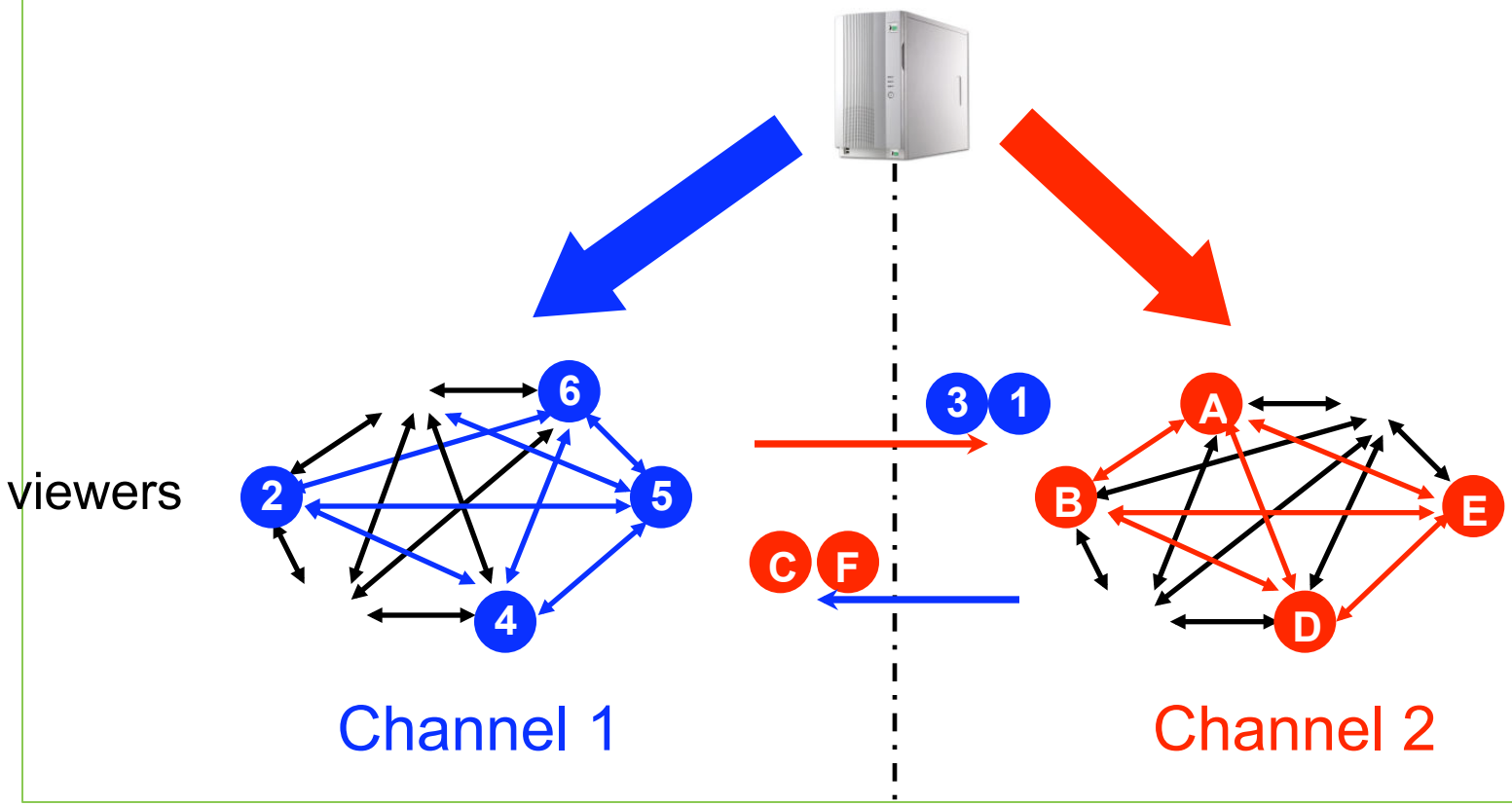
Multi-Channel System: Traditional Isolated Channel Design

<u>P2P Sharing Rule:</u> peers upload to each other only if they watch same channel



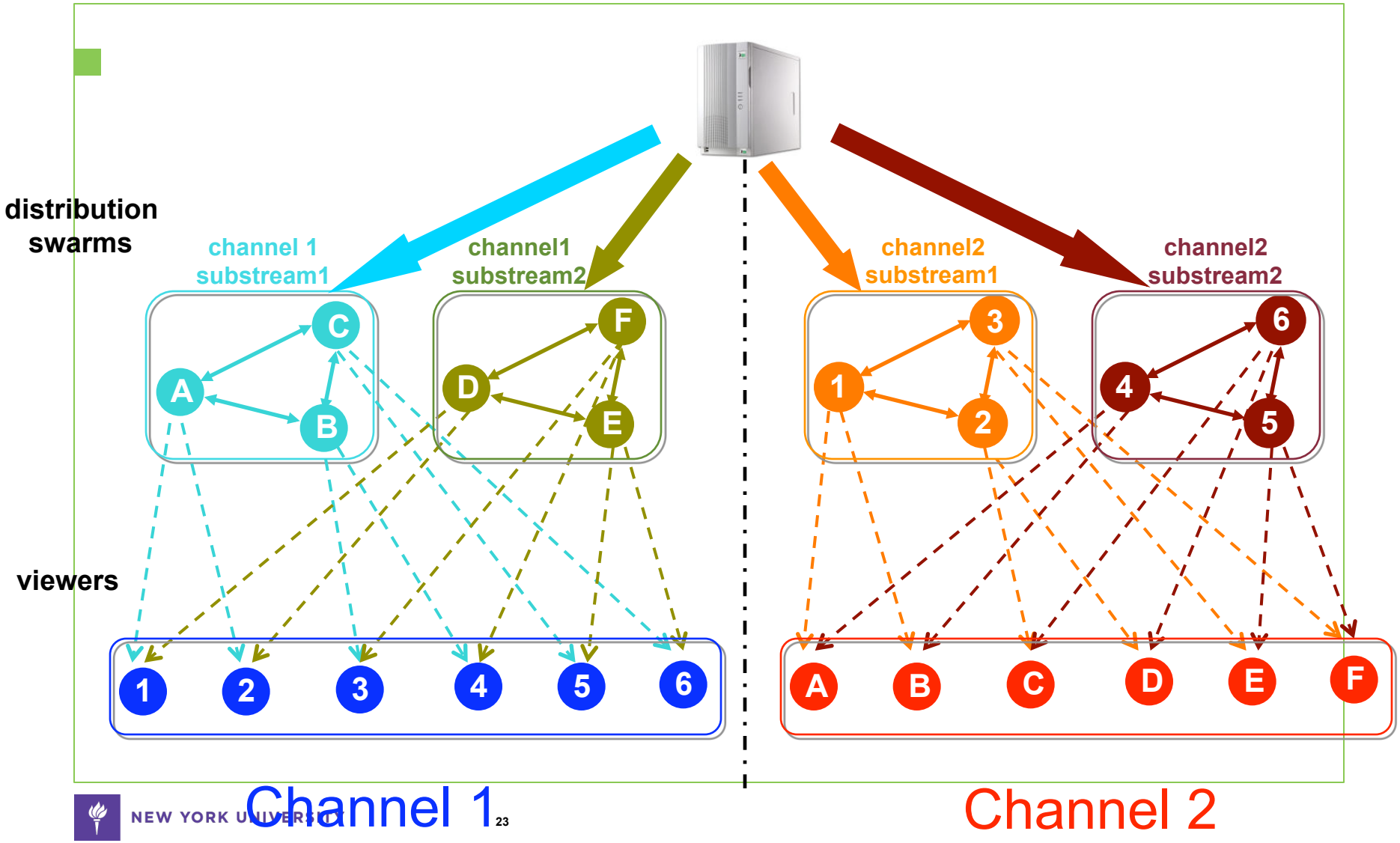
Multi-Channel System: Traditional Isolated Channel Design

<u>Drawback:</u> distribution systems disrupted when peers switch channels

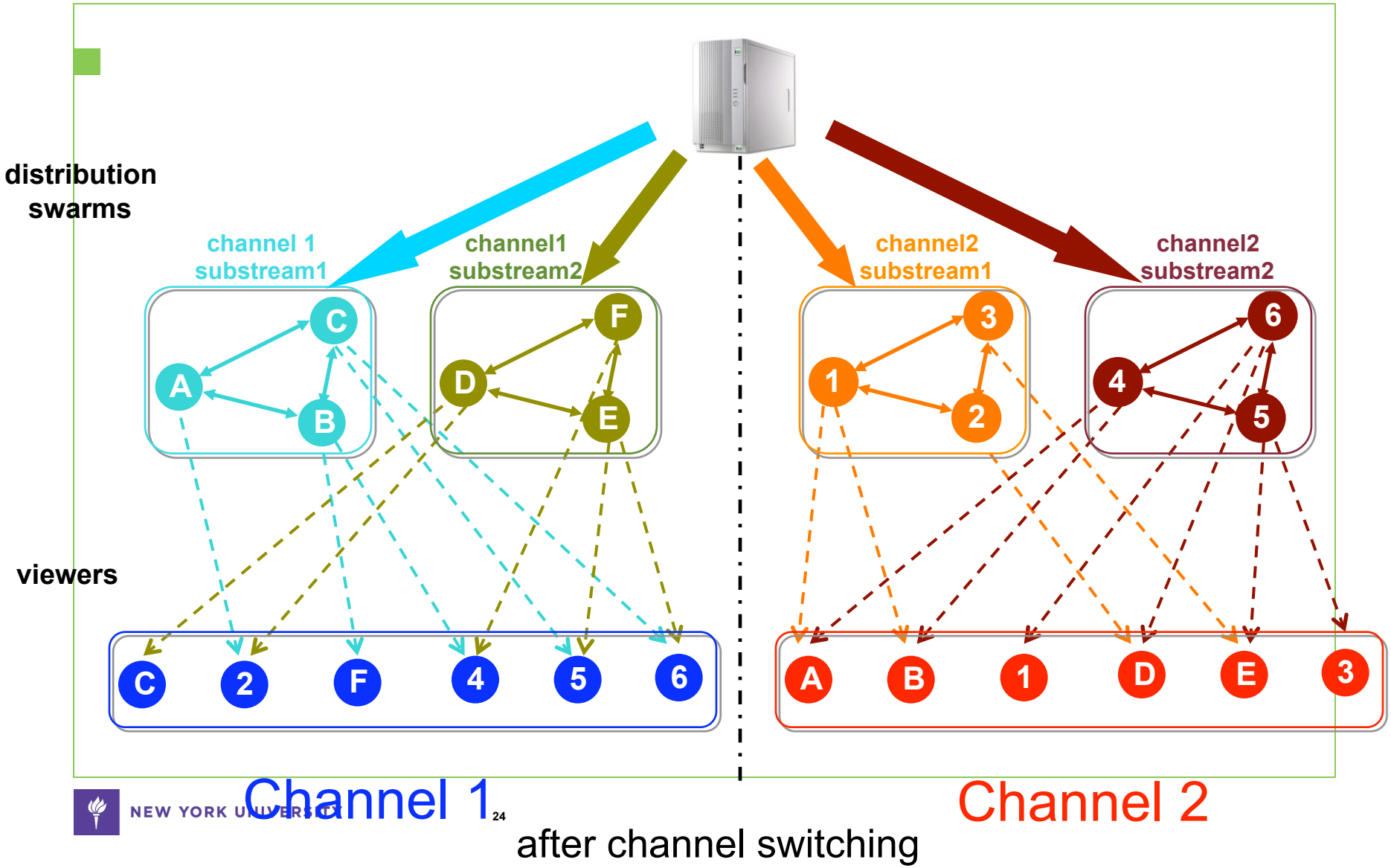


after channel switching

New Design: View-Upload Decoupling



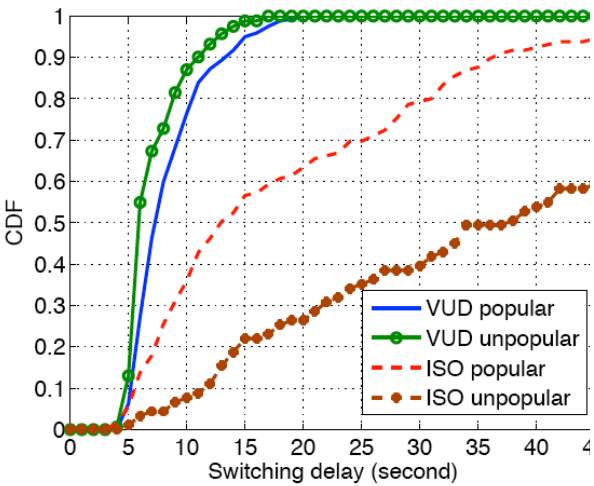
View-Upload Decoupling

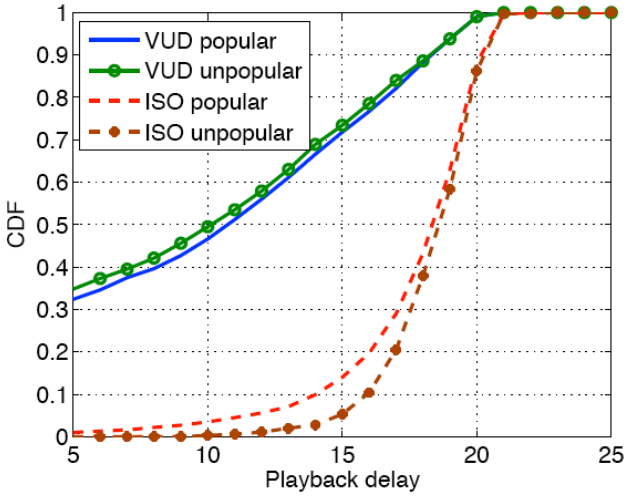


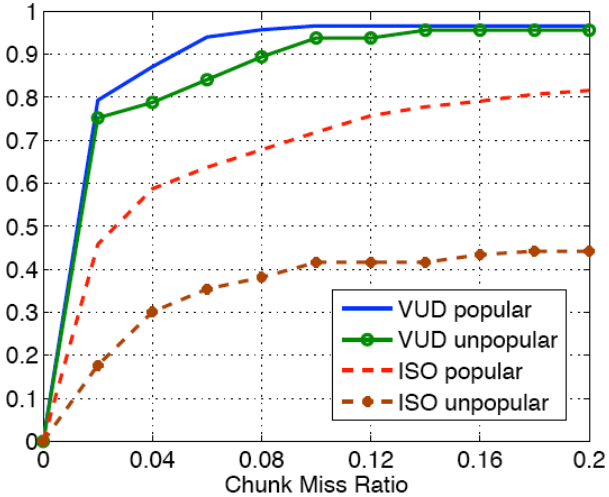
after channel switching

VUD vs. ISO

- Robust against frequently peer channel switching
- Balance bandwidth resource cross channels
  - take care of long-tail channels
- Largely improved streaming delay performance
  - switching delay, playback delay







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"View-Upload Decoupling: A Redesign of Multi-Channel P2P Video Systems"
Di Wu, Chao Liang, Yong Liu and Keith Ross,
Polytechnic Technical Report, August 2008

"Queuing Network Models for Multi-Channel P2P Live Streaming Systems",
Di Wu, Yong Liu and Keith Ross,
Polytechnic Technical Report, August 2008

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Goal: create incentives to contribute

- Incentive principle:
  - The more you upload, the better the video quality.
- Approach:
  - Layered coding
  - Trading layered chunks
- Aggregate bandwidth plentiful:
  - Everyone gets excellent quality
- Aggregate bandwidth scarce:
  - You get want you give

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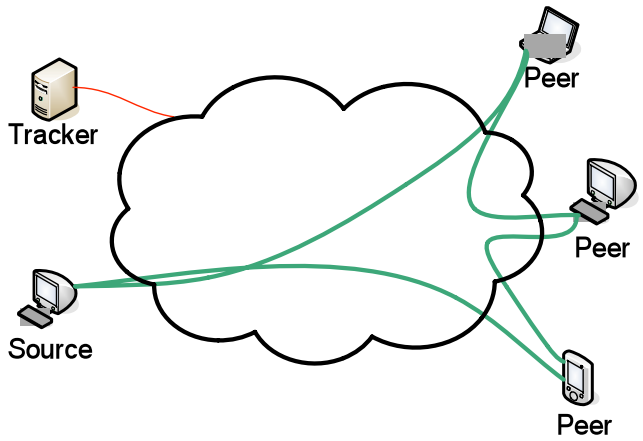
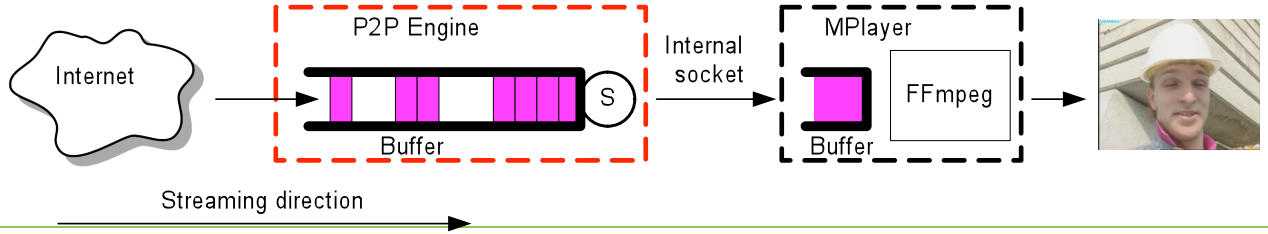
Deployment

- Tracker, server, and client
  - More than 10,000 lines of C++ code
  - Linux platform





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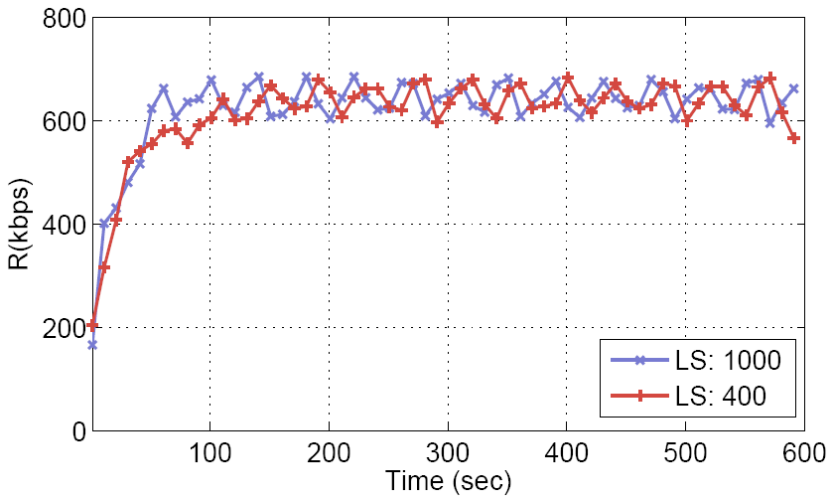
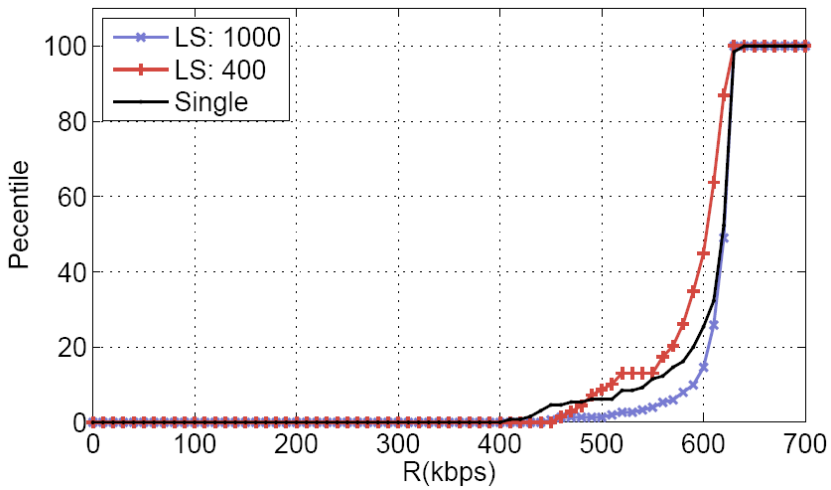
Evaluation: underloaded; no free-riding

- 100+ PlanetLab Nodes;
- Video rate =630kbps (VBR), layers =300, 200, 130





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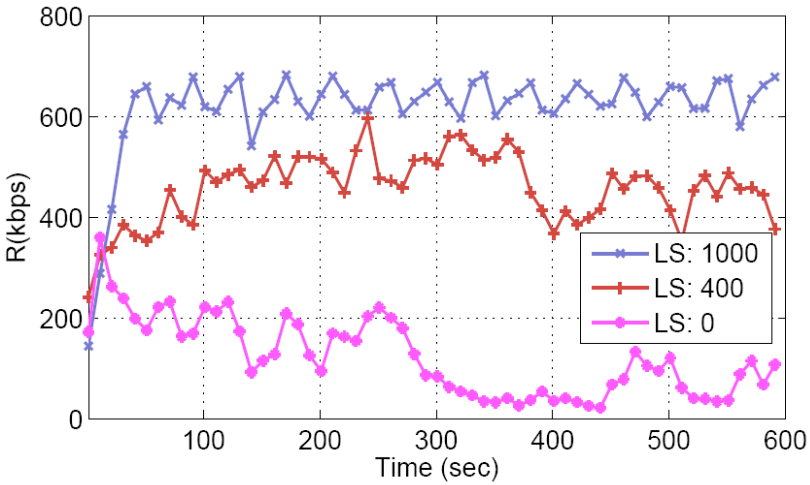
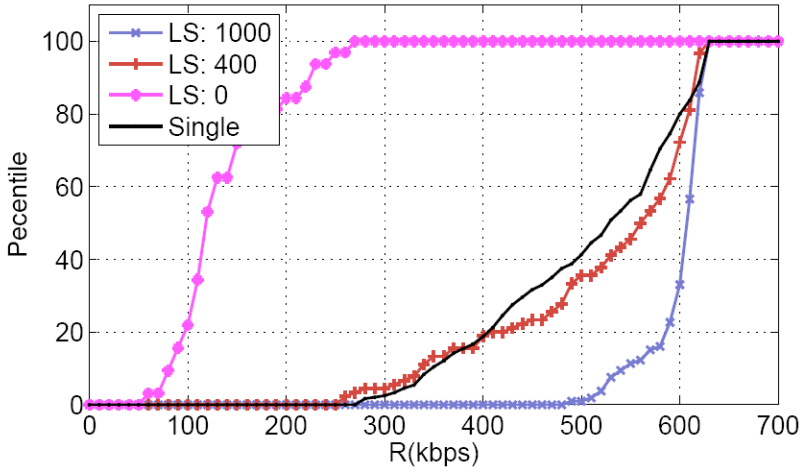
Evaluation: overloaded; 15% free-rider





- Peers that upload more receive better video quality
- Free-riders receive a poor video quality

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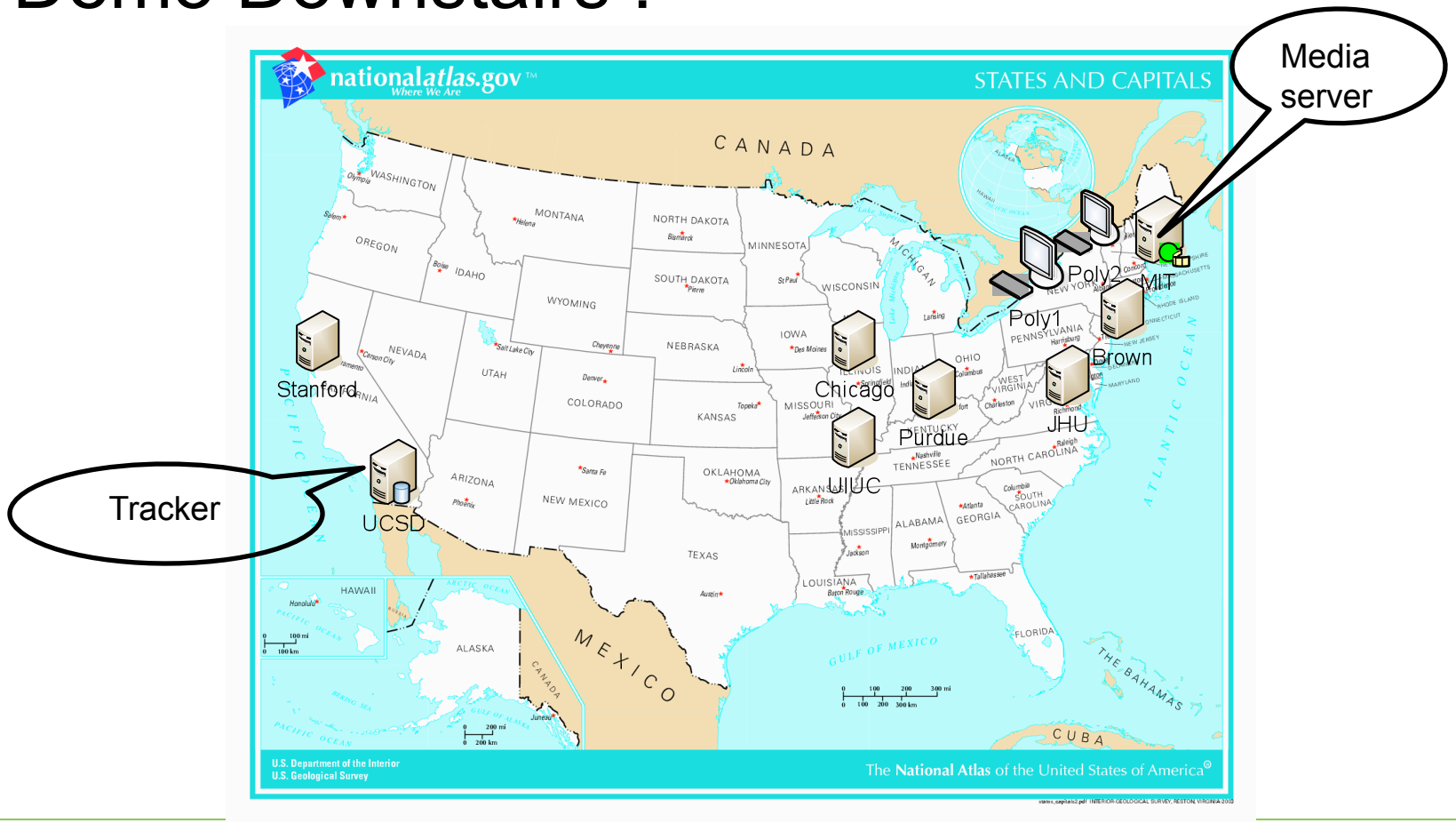
Demo Downstairs !



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Thank You!!!