Towards a QoE-aware P2P Video-on-Demand System

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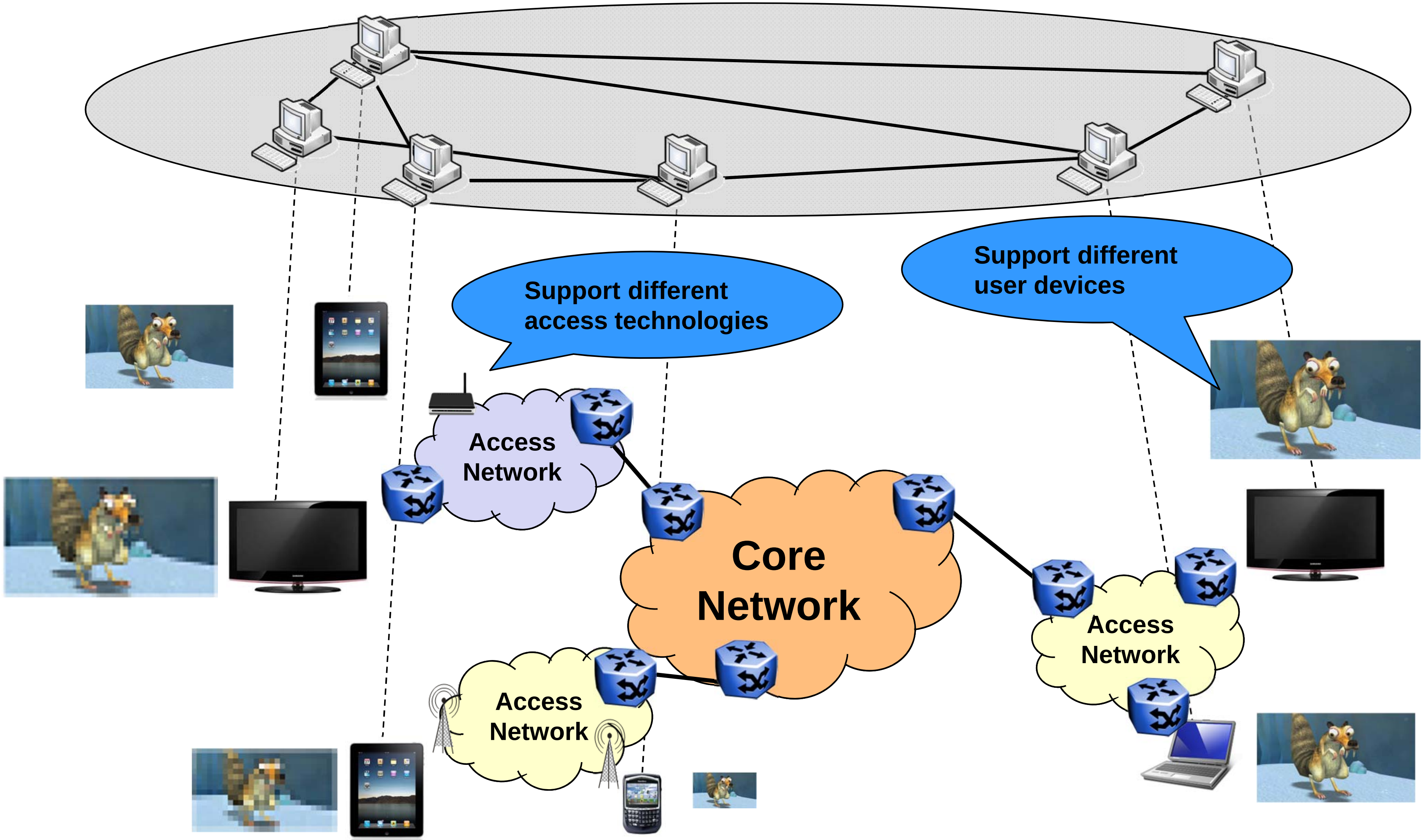
Live Streaming vs. VoD

- P2P Live Streaming: Video content encoded on-the-fly and delivered to all peers nearly simultaneously

- P2P VoD Streaming: Video content already available, different play back positions of the peers

Network Parameters	Impact on Live Streaming (UDP)	Impact on VoD (TCP)
Packet loss	Loss of information, artifacts, stalling, stream starvation	Retransmissions, impact on TCP control loop
Insufficient available bandwidth	Leads to packet loss	Higher startup delay, frequent stalling
Delay	Higher startup delay, less “live” experience	Higher startup delay, possible impact on bandwidth
Jitter	May lead to packet loss (jitter buffer to small; VLC e.g. 300 ms)	Practically none

Motivation – P2P VoD Streaming



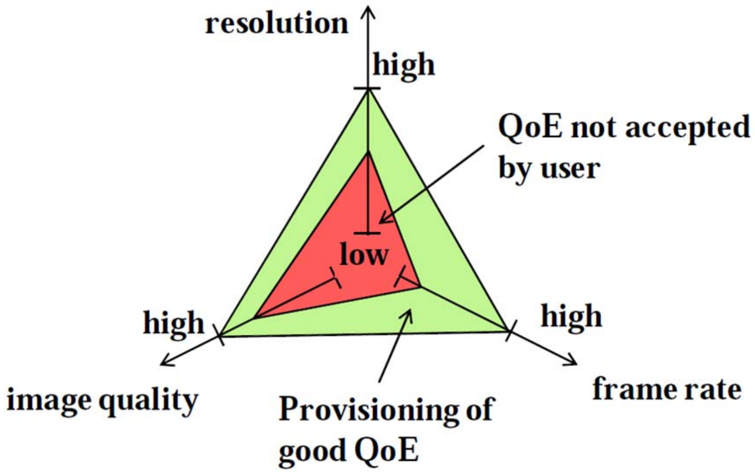
Agenda

- Motivation
- QoE for video transmissions
  - QoE management
  - Impact of QoS on QoE
- P2P VoD System
  - Peer and chunk selection mechanisms
  - Scalable video coding
  - Scenario description and results
- Conclusion

QoE Management

- QoE degradation due to bad network conditions, e.g. bandwidth
  - empty buffers and stalling (TCP)
  - packet loss and artifacts / stream starvation (UDP/RDP)
  - → Negative, uncontrollable impact on the QoE (success related)

- Bandwidth saving feasible by reducing:
  - resolution
  - frame rate
  - image quality
  - → Negative, but controllable impact on QoE (resource related)



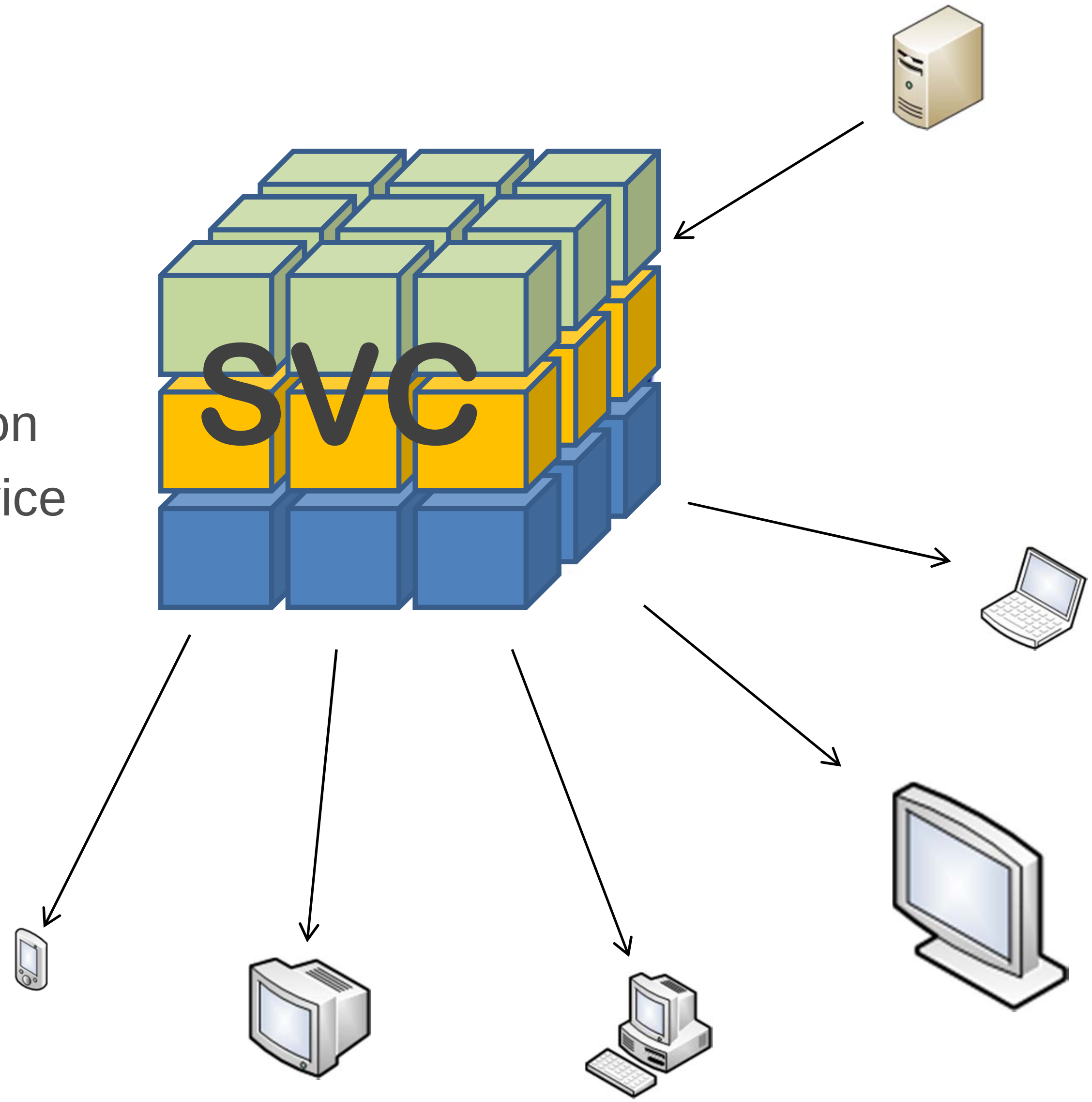
➔ Comparison of the different impact factors on the video QoE

Motivation – Scalable Video Codec

- Many forms of internet connections

- Possible solutions
  - Same file for each device and connection
  - One file for each device and connection
  - One multi-layer file

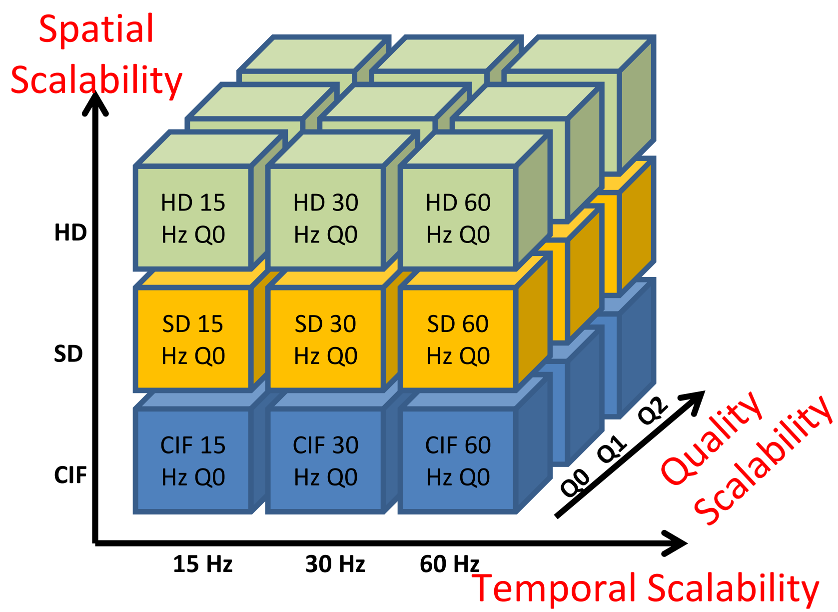
- Scalable video codec
  - Adapted to user‘s requirements



H.264 / SVC

- Extension of H.264/AVC single layer codec

- Encoding in one bit stream with different qualities:
  - resolutions (spatial)
  - frame rates (temporal)
  - image quality (quality)

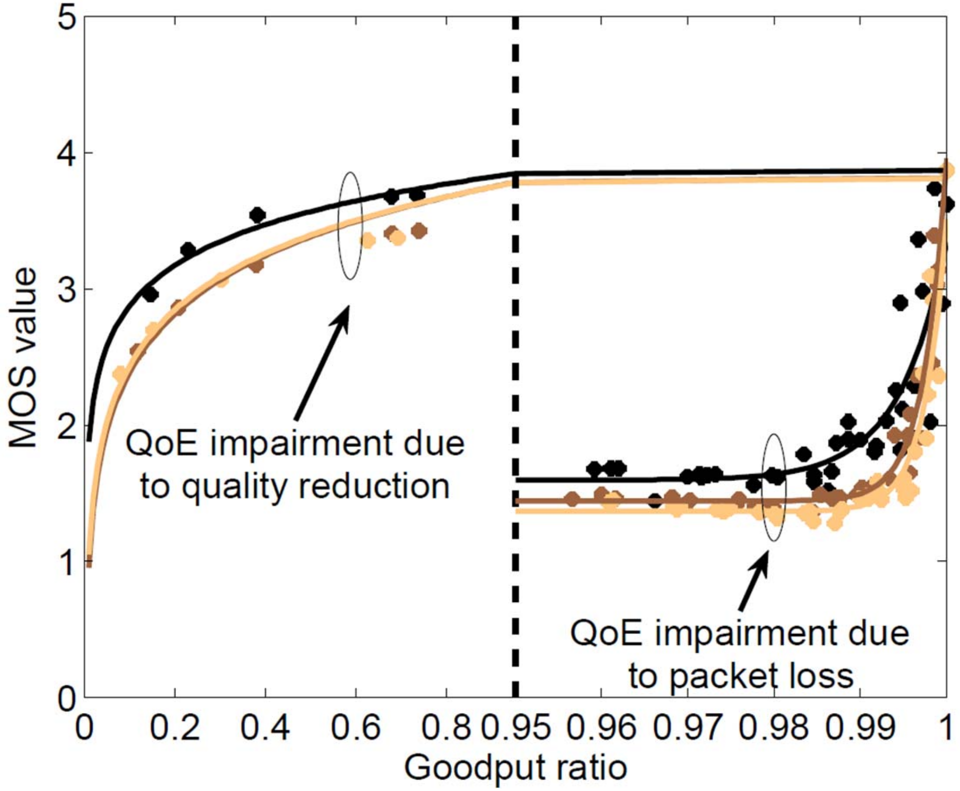


- Enables code adjustments with respect to:
  - user device
  - network conditions

➔ Seamless switch between different layers enables QoE management

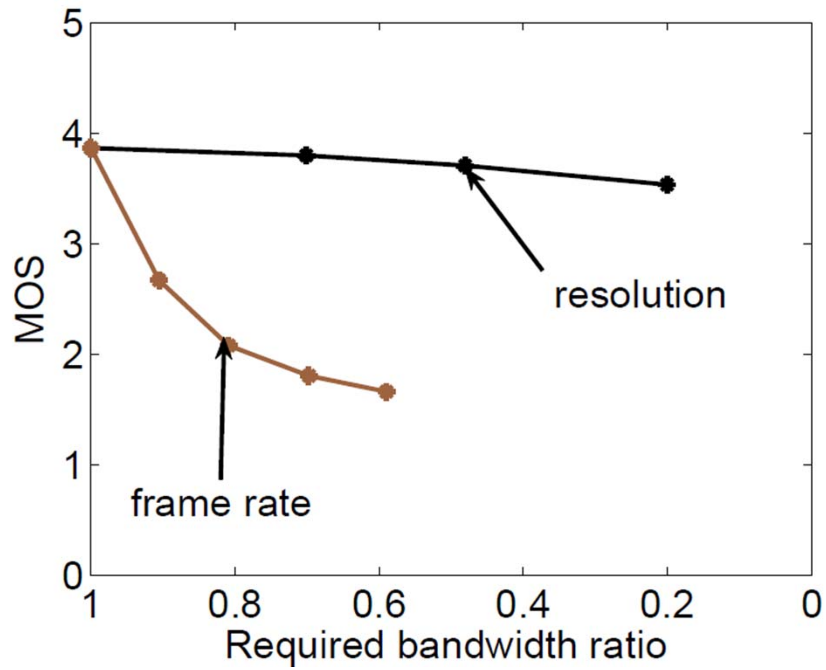
Delivery-Provisioning Hysteresis

- Controlled and uncontrolled video distortion as function of goodput (application perceived throughput)



Frame Rate vs. Resolution

- 720p video clip with 30 fps provided best user perceived quality



➔ Resolution / Image quality reduction outperforms frame rate adaptation in terms of bandwidth savings and video quality

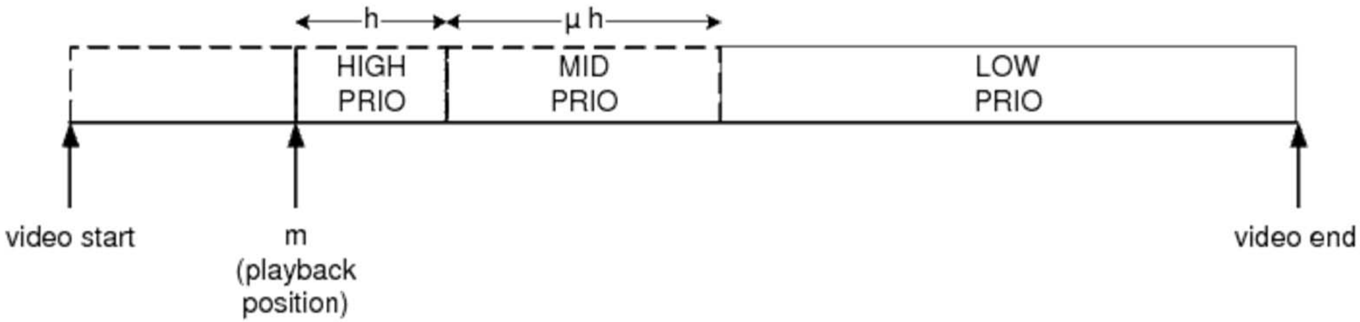
QOE-AWARE P2P-VIDEO-ON-DEMAND SYSTEM USING SVC

P2P-VoD based on Tribler

- P2P VoD System Tribler (P2P-Next)
- BitTorrent extension
  - Designed for file-sharing
- Adapted peer and chunk selection algorithms:
  - Give2Get algorithm replaces Tit4Tat
  - Chunk selection modified w.r.t. time awareness
- Suitable for VoD services
- Our approach: Enhance Tribler to support scalable video coding

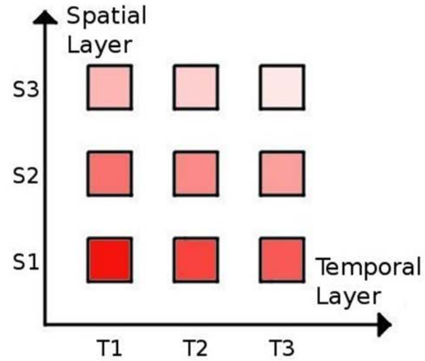
SVC Chunk Selection

- Arrangement in priority windows



- Adaptation of priority window appraoch to SVC

- Lower enhancement layers are favored
- Temporal enhancement layers are prefered to spatial ones



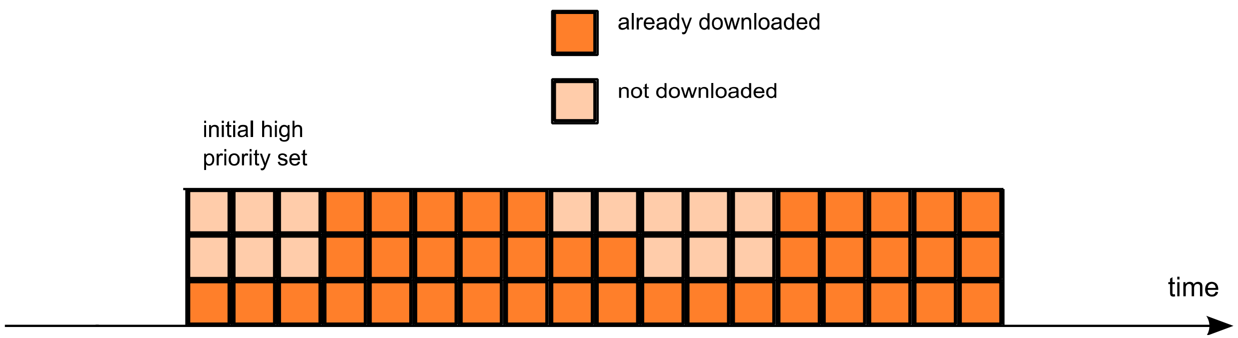
Objective Quality of Experience

- Parameters measured in simulation study
  - Based on Protopeer
- Average number of layers played out
  - One value for temporal, spatial scalability each
- Delay to playout start interval
  - Time interval from peer start event to playout start
- Stalling times
  - Sum of all stall events of one peer
- Length of the inter quality switching time
  - Vector of all time intervals with same quality

Investigation of Different Seeding Strategies

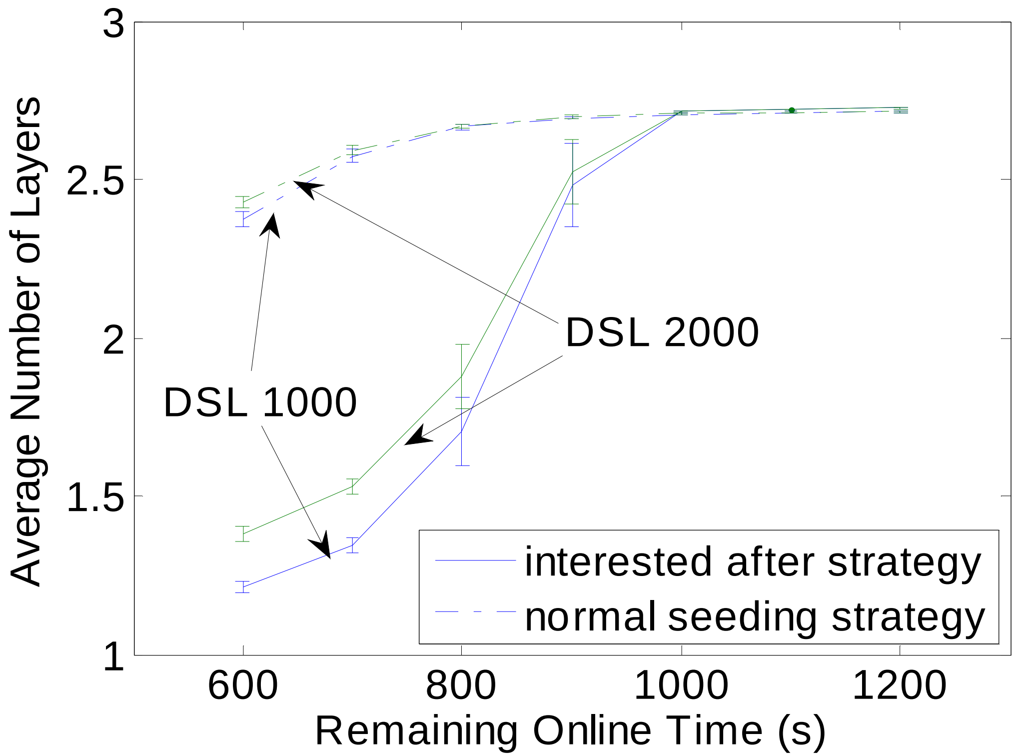
- Scenario setup:
  - Two peer classes: DSL 1000, DSL 2000 with 128 kbps, 192 kbps upload capacity
  - 40 server with 512 kbps upload capacity (each 4 upload slots)

- Comparison of two seeding strategies:
  - Normal seeding strategy: no download after watching the video
  - Interested after strategy: chunks demanded after watching the video



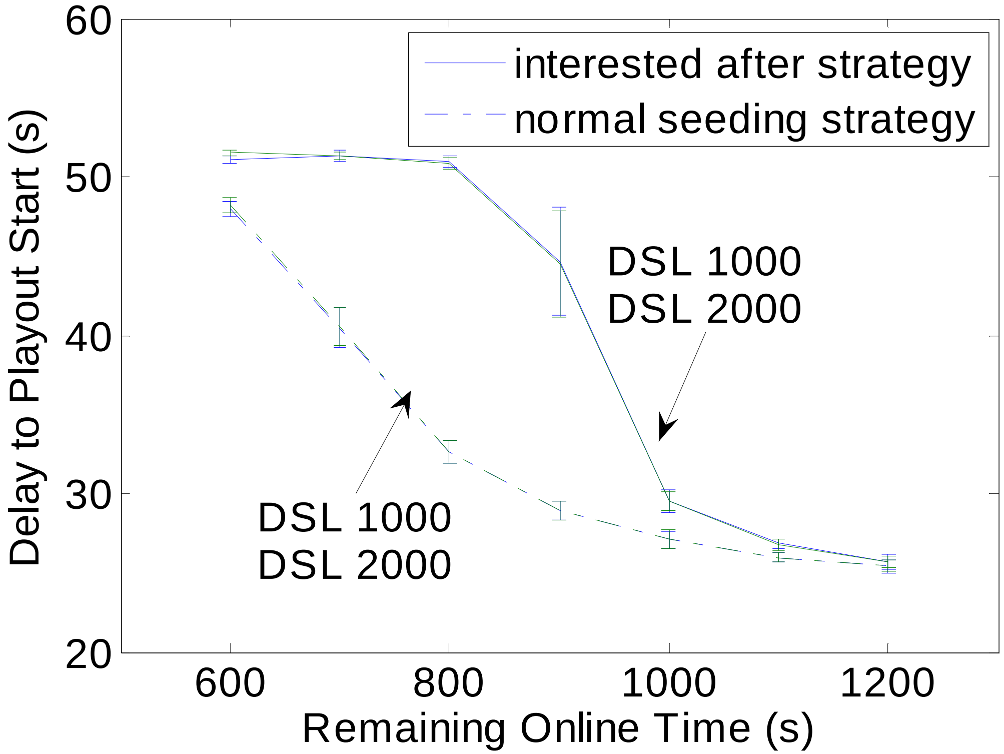
- Investigation with regards to remaining online time

Impact on Playback Quality



- ➔ Normal seeding strategy better at small seeding times
- ➔ More enhancement layers for DSL 2000 peers
- ➔ Increased quality with longer remaining online time

Impact on Initial Delay



- ➔ Reduced delay with increasing remaining online time
- ➔ No difference between peer classes
- ➔ Normal seeding strategy outperforms interested after strategy

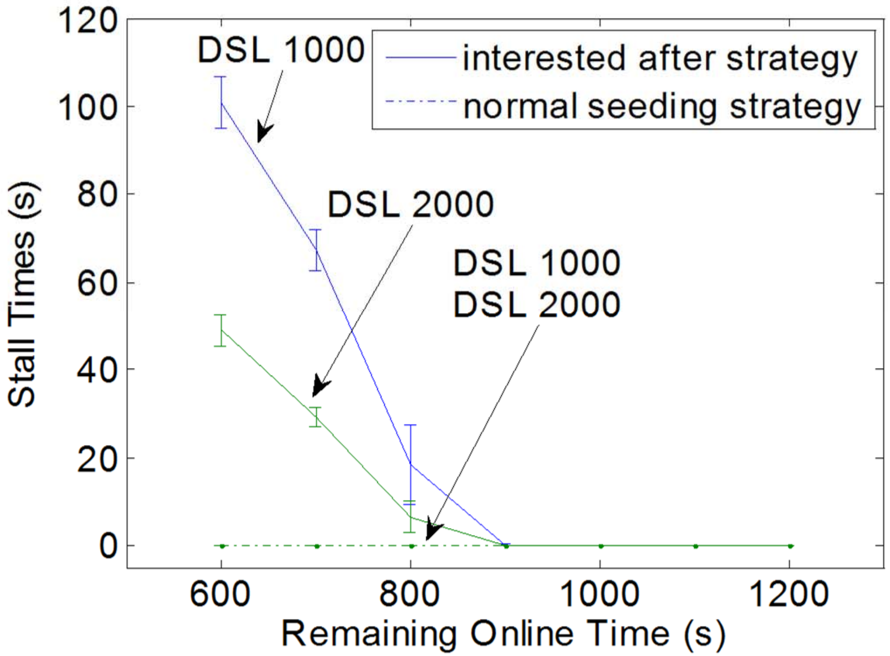
Conclusion

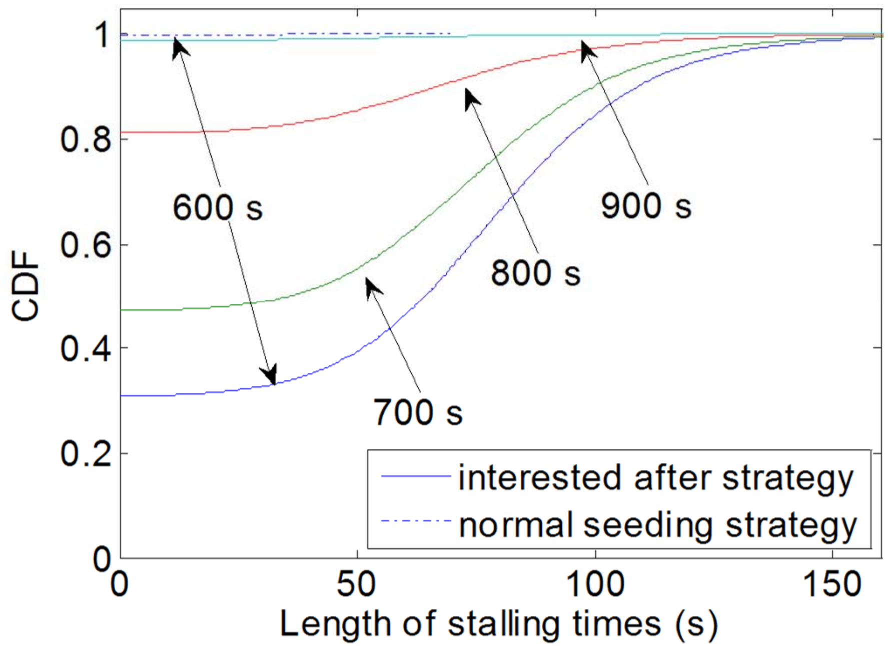
- Influence of network QoS on user perceived quality for video streaming:
  - Controlled quality degradation outperforms uncontrolled degradation
  - Frame rate adaption should be avoided
- Discussion of a QoE-aware P2P VoD system:
  - Enables easy adaptation of user's QoE to provided resources
  - Peers which finished play back should not download further chunks
- Future work:
  - Further investigation of P2P VoD (including measurements)
  - Enhancement of QoE Hysteresis with FEC
  - QoE Model for Stalling
  - Media-aware network element for maximizing QoE for SVC streams

Q&A

Thank you for your attention !

Impact on Stalling





- ➔ No stalling times with normal seeding strategy
- ➔ Remaining online time of 900 s with interested after strategy
- ➔ Smaller stalling times for DSL 2000 peers

Tribler Peer Selection

- Based on G2G algorithm
  - Prefers peers with good uploading behavior
  - Discourages free riders
- Rates every peer before sending data
- Asks grandchildren about peer-behavior