VAAL, Video Adaptation at Application Layer and Experiments using DCCP

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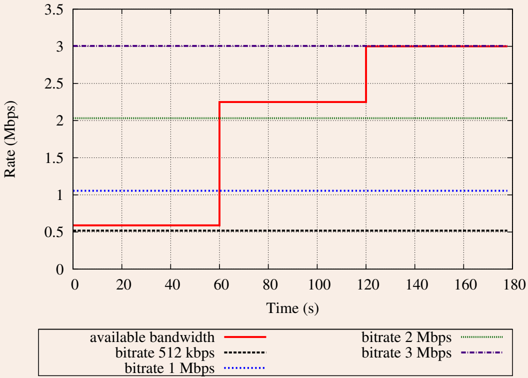
Rate adaptive video control: optimise network usage

Dynamic bandwidth vs static bitrates



The best bitrate

- if bitrate<bw: unoptimised
- if bitrate>bw: lost packets
  - either on network, if no congestion control
  - or at the sender, if congestion control
- bitrate=bw: the best

Rate adaptive video control: improve user experience

Small bandwidth, so small bitrate

High bandwidth, so high bitrate

Demonstration
(look at the change at sec. 15)

Goals of video adaptation

- Improve user experience
- Optimise network resource usage

Plan

State of the art

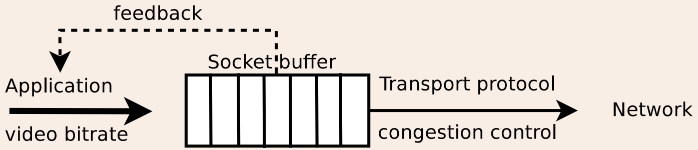
Video adaptation methods based on changed layer

- Low layers changed (unchanged application)
  - for multi-layer encoded video
- Cross-layer (application and transport/network layers changed)
  - iTCP, VTP etc.
- Application layer changed (our VAAL method)

TCP/IP layers
Application
Transport
Network
MAC

Overview of VAAL

VAAL, Video Adaptation at Application Layer



At each moment:

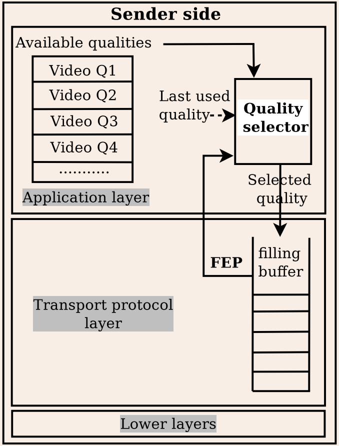
- congestion control takes care of network conditions
- our VAAL algorithm adapts bitrate to network conditions

Details of VAAL

2 phases executed regularly (each 2 sec):

1. Discovery of network conditions
   - compute FEP *(Failed Error Percentage)*
2. Quality selection
   - if FEP=0, increase quality
   - if 0<FEP<5%, maintain quality
   - if 5%≤FEP, decrease quality to q': $q' \leq q(1 - \mathrm{FEP})r$, where q is current quality and $r = 105\%$

VAAL (sender side only)

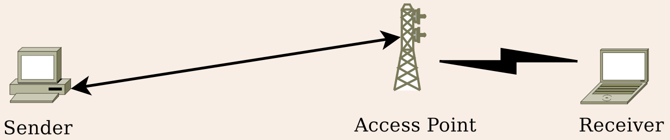


VAAL characteristics

- Easy to implement, since it uses a very simple algorithm
- Only the sender (server) is modified
- Only the application layer is modified
- Can either choose among several available qualities (video on demand), or change the quantisation parameter (videoconference)
- Needs a transport protocol with congestion control
  - network-friendly

Network and transport protocols used in experiments

Network topology

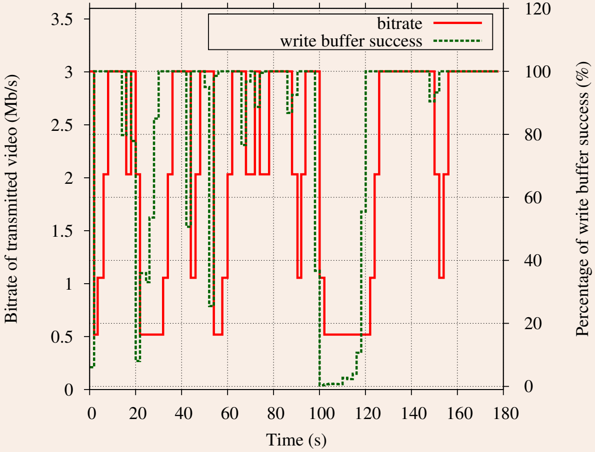


Transport protocol: DCCP (Datagram Congestion Control Protocol)

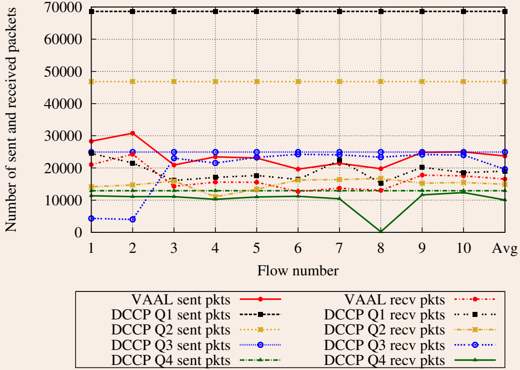
- New protocol more adapted to multimedia transmissions:
  - unreliable, but with congestion control
  - can use various congestion control algorithms, such as:
    - TFRC
    - TCP-like
  - allow the sender to find out the received packets

Checking if adaptation works

Quality variation for 5 flows in competition, flow 1

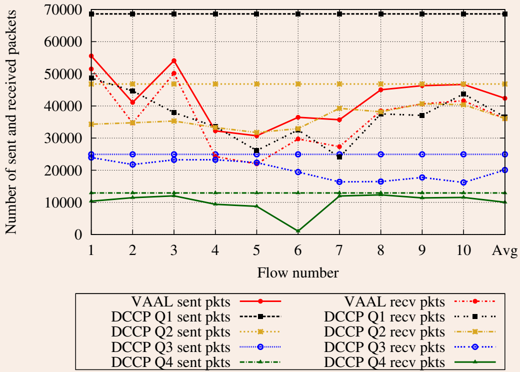


Number of sent and recv packets, 10 flows without gap



Static bitrate leads to either low bitrate, or many network losses (or similar results in lucky cases)

Number of sent and recv packets, 10 flows with 30 sec. gap



VAAL (esp. flows 4 to 7) adapts bitrate to available bandwidth
VAAL has the greatest received/sent packet ratio

Contributions

- One of the rare papers which *analyse* video content adaptation
- The first one which uses DCCP in real experiments in wireless networks
- A new method, called VAAL, using buffer filling
  - simple to deploy (only app-level at sender is modified)
  - works with any transport protocol with congestion control

Conclusions

- By adapting the video bitrate to network bandwidth, VAAL improves network usage (reduces under/over-utilisation) compared to classical static bitrate

Perspectives

- Avoid zigzag quality changing (e.g. using a history)
- Present video quality metrics (PSNR)

Network information

Parameter name	*Parameter value*
Packet size	1024 Bytes
Sender wired card	100Mb/s
Receiver wireless card	802.11b/g
OSes	Ubuntu 64bits, 2.6.31
DCCP	Included in the kernel
Access point	LINKSYS, wireless-G
Wireless bandwidth	54Mb/s
Distance (AP $\leftrightarrow$ receiver)	50cm

On the value of 5% chosen for local losses

"This refers to end-to-end IP packet-loss rate in video. Considering the packet loss in a terminal-jitter buffer and the packet loss in networks is extremely important. The value should be less than 10 [%]."
(ITU-T, Opinion model for video-telephony applications, ITU Recommendation G.1070, Apr. 2007)

About the simplicity of VAAL adaptation algorithm

```
for each period of time
  err = 0
  pkts = 0
  while (period not ended)
    pkts++
    write video packet
    if (write error)
       err++
    sleep
  errorRate = err/pkts
  if (errorRate == 0)
    increase bitrate
  else if (errorRate < 5%)
    maintain bitrate
  else
    decrease bitrate
```