

Measurement of the Congestion Responsiveness of RealPlayer Streaming Video Over UDP

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<http://www.cs.wpi.edu/~claypool/papers/h2h/>



The Hungry Wolf - Bandwidth Requirements for Video

- Streaming media growing
 - 350,000 hours of online video broadcast '01
 - Voice is 32-64 Kbps, but video has range of data rates
 - Videoconference 0.1 Mbps (H.261, MPEG-4)
 - VCR 1.2 Mbps (MPEG-1)
 - Broadcast quality 2-4 Mbps (MPEG-2)
 - HDTV quality 25-34 Mbps (MPEG-2)
- Thus, potential for more than network capacity



The Wolf on the Prowl - Transport Protocols for Video

- Streaming video doesn't like TCP
 - Wants rate-based not window-based
 - Can tolerate some loss
 - AIMD causes rate fluctuations
- So, use UDP where application controls
- But UDP has no congestion control
 - Unfair, unfriendly, and even collapse!
- Approaches to have router catch
 - Model video as CBR "firehose" (is it?)



The Wolf Pack - Commercial Video

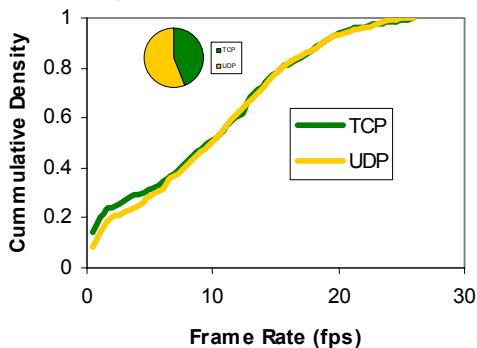
- Commercial products have major impact



- Have been studies characterizing commercial traffic
 - Bandwidth use, frame rate, user use...
- But no work measuring responsiveness, or lack of it, of commercial video products



Specific Motivation

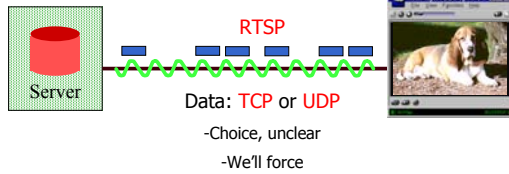


Outline

- Introduction ✓
- Background ←
- Experiments
- Results
- Analysis
- Conclusions



RealVideo Network Characteristics



- SureStream
 - Allows bandwidth scaling
- Buffering
 - Remove jitter



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Methodology

- Select Real Video Clips
- Construct environment for measuring congestion response
- Construct environment to measure ability to scale (SureStream)
- Iteratively plan clips varying network

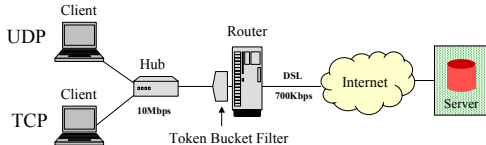


RealVideo Clip Playlist

- If put in controlled environment, may not be representative of clips "in the wild"
- Select large number through search engines (Yahoo, Google ...)
- Randomly choose 100 (79 analyzed)
- Geography results:
 - 76 US, 9 Canada, 8 UK, 6 Italy, 1 Germany
 - North American dominance likely reflected in typical user locality of reference
- Length results:
 - Median 3 minutes, min 20 seconds, max 30 minutes



Responsiveness Measurement Environment



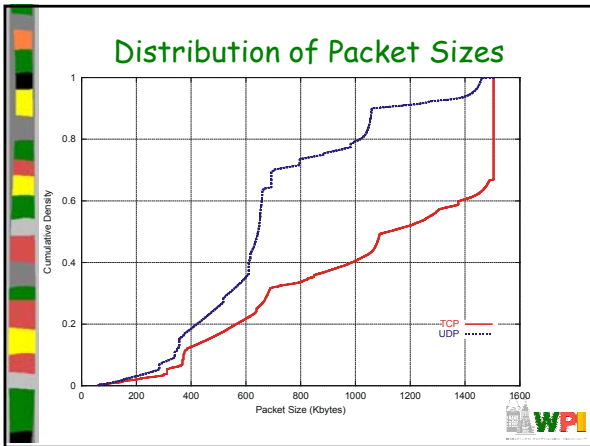
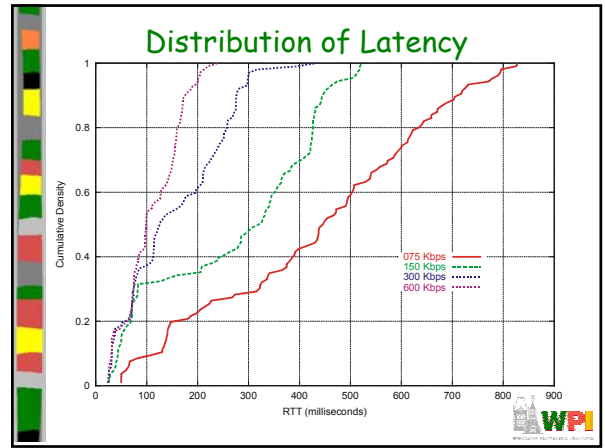
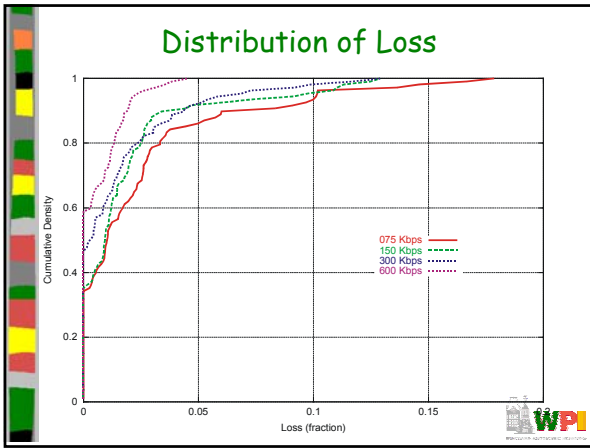
- PIII 700 Mhz, 128 MB RAM, Linux 2.4
- RealPlayer version 8.0.3
- Sniffing via tcpdump
- Loss and round-trip time via ping
- TBF to limit bandwidth
- 2 Measurements for each clip
- (Note, *RealTracer* for *MediaScaling*)



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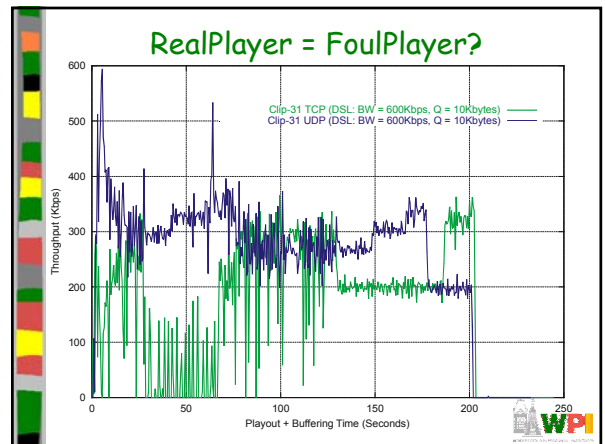
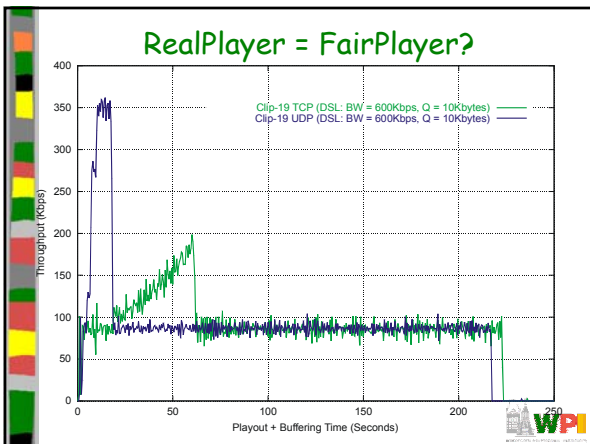
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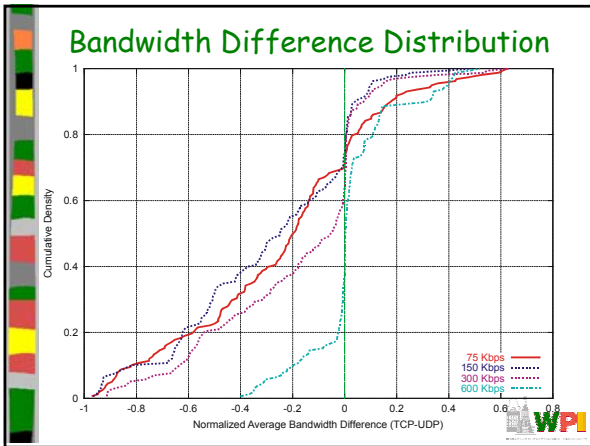
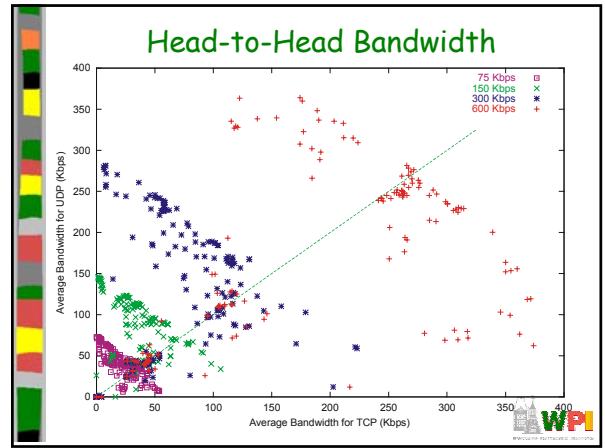
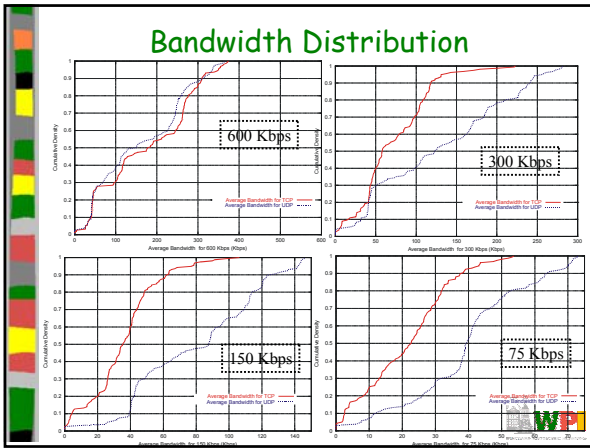




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Mostly TCP-Friendly!

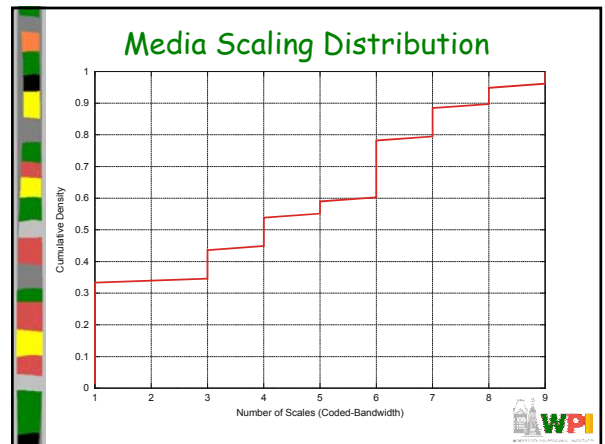
- Remove low bandwidth (36%)
- Then remove unscalable (14%)

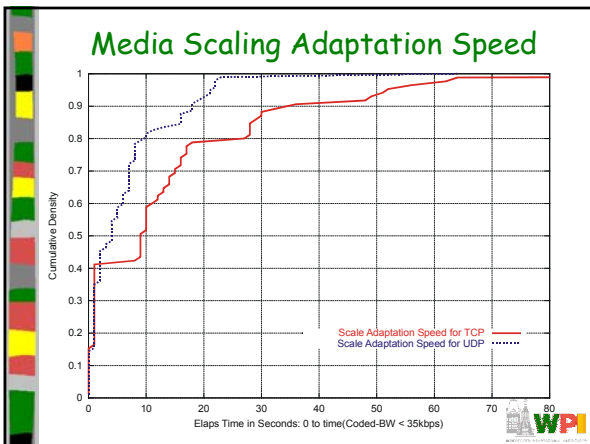
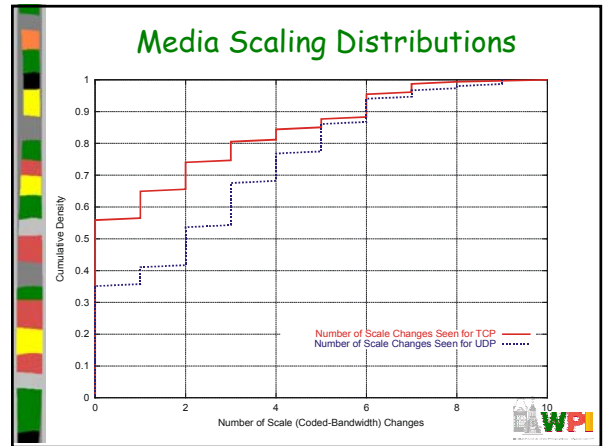
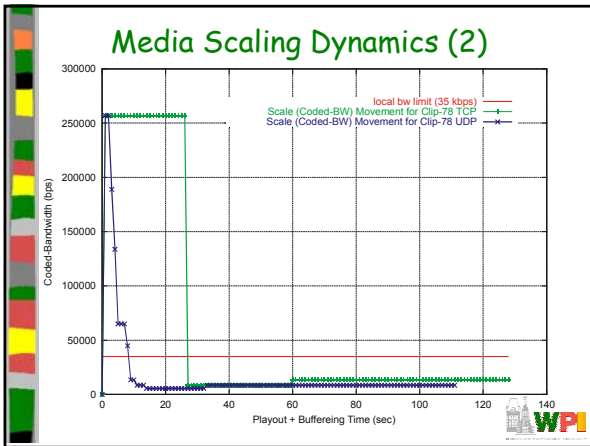
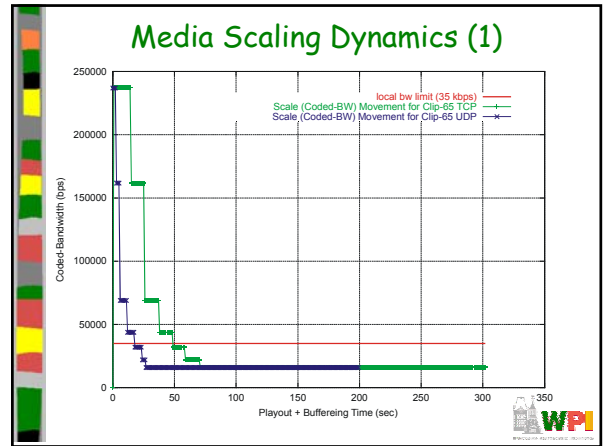
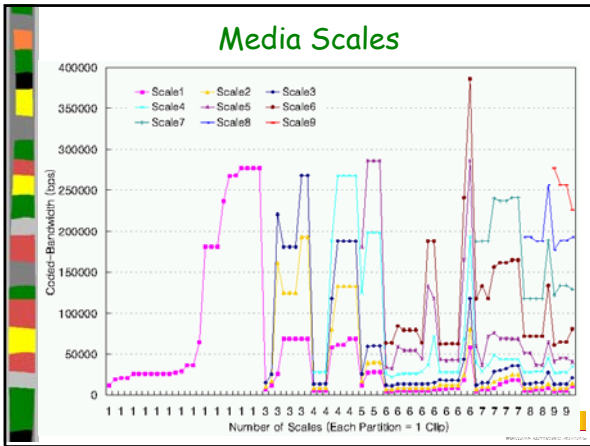
$$T \leq \frac{1.5\sqrt{2/3} \times s}{R \times \sqrt{p}}$$

Bottleneck Bandwidth	Total Unfriendly	$\min > \text{fair}$	$\max < \text{fair}$	Effective Unfriendly
75 Kbps	8/110 (7%)	22	30	8/58 (14%)
150 Kbps	7/110 (6%)	12	42	5/56 (9%)
300 Kbps	9/110 (8%)	12	48	7/50 (14%)
Total	24/330 (7%)	46	120	20/164 (14%)

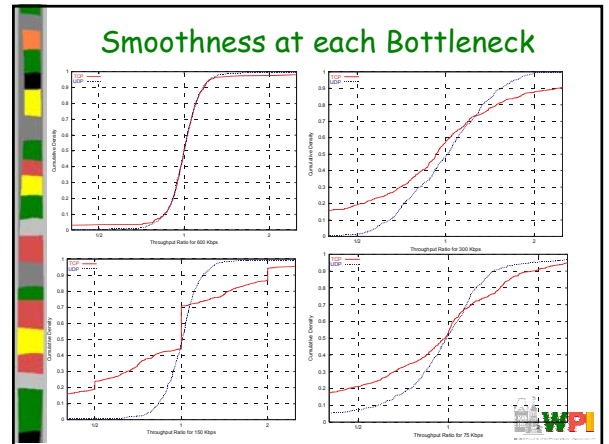
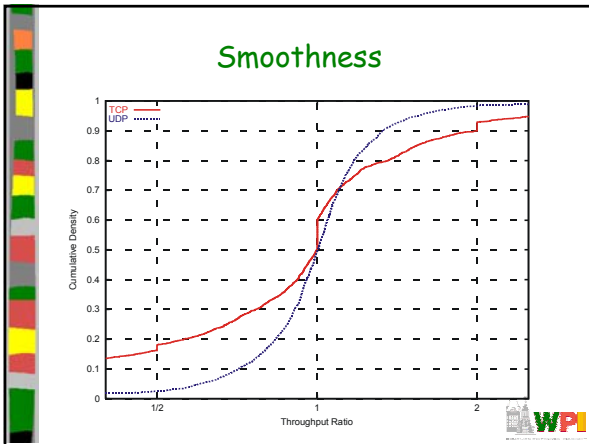
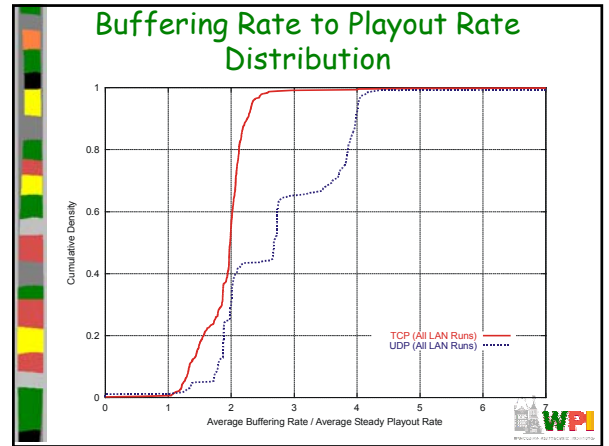
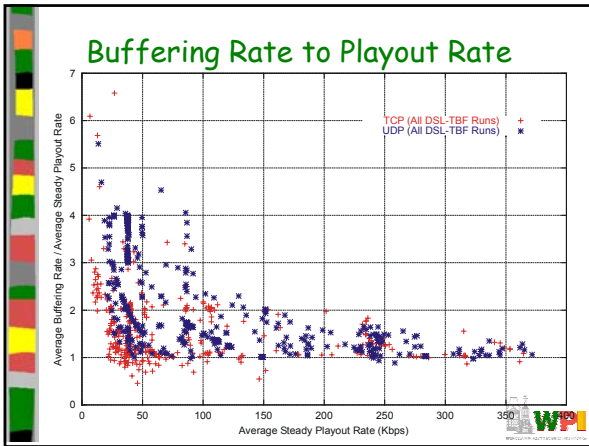
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- ### Discussion of Results
- No concrete incentives to respond to congestion
 - In fact, may be "rewarded" for not
 - However, clearly responds
 - often TCP-Friendly
 - Content providers need to provide chance for scalability
 - But buffering at higher rate is bad for network
 - TCP can be as smooth as UDP
 - So why not TCP? → API is limiting

- ### Conclusions
- Response to congestion important to Internet
 - Measured responsiveness of RealVideo
 - RealVideo over UDP is largely responsive
 - receives typically same bandwidth as TCP
 - often TCP friendly

Future Work?



Future Work

- Other commercial Players
 - Microsoft Media Player
- Live clips (versus pre-recorded clips)
- Perceptual quality of video over TCP versus UDP
- Characterization of clips on Internet
 - So can examine "typical" clips

