Better Behaved, Better Performing Multimedia Networking

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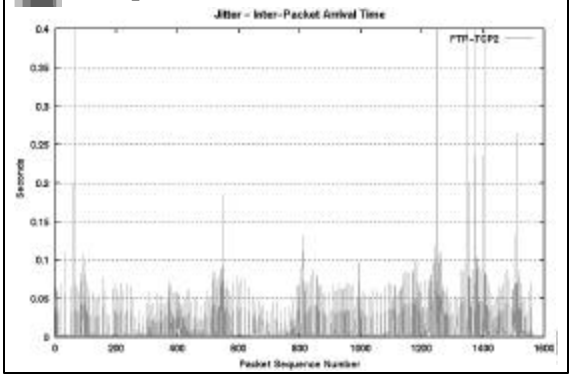
Outline

- Motivation
- Approach
- Experiments
- Results
- Conclusion
- Future Work

TCP on the Internet

- The Internet is predominantly designed for TCP traffic.
  - Best effort (no timing constraints)
  - Reliable delivery
- TCP is unsuitable for Multimedia applications
  - Window-based causes fluctuations in sending rate

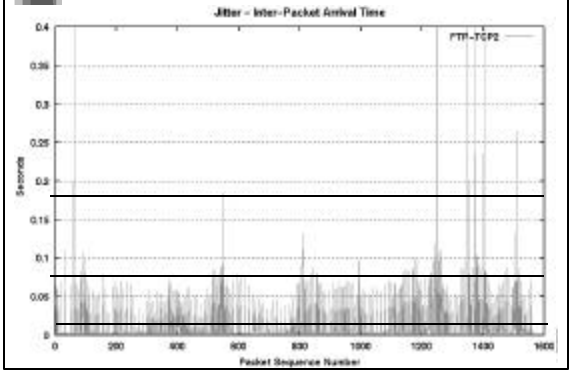
Example of TCP



UDP on the Internet

- So … multimedia applications use UDP
- Can send at application specific rate
- Does not have full retransmission
- But … UDP is unresponsive to congestion!

Example of UDP



Approach

- Model the TCP congestion control strategy for UDP flows
  - Exponential decrease in data rate when congestion is encountered
  - Linear increase in data rate in the absence of congestion [Jacobson et al. 1988]
- But make rate-based
- Build protocols (and application) using approach
  - MM_APP and MPEG_APP
- Experiments using simulator
- Analyze results

Modeling TCP Congestion Control Issues

- Multimedia scaling
  - to enable the variations in the data rate
- Congestion detection mechanism
  - when to reduce the data rate

Multimedia Scaling

- Directly associate transmission rates to scale values
- MPEG_APP : based on MPEG-I encoding [Walpole et al. 1997] (from trace file)

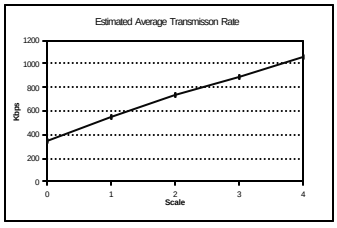
Maximum Frame Rate (Scale 4) = 30 frame/sec		
Scale	Transmission Policy (Pattern 1)	Estimated Average Trans. Rate (Kbps)
4	I B B P B B P B B I	1056
3	I B P B P B I	896
2	I P P I	736
1	I P I	544
0	I I	352

Congestion Detection

- Frame loss is the indicator for congestion
- A frame is assumed lost when:
  - the receiver gets a frame whose sequence number is greater than the expected sequence number.
  - the receiver does not get any frame within a timeout interval.

Operation

- In case of congestion reduce scale value by half (exponential decrease)
- In the absence of congestion increase the scale value by one (linear increase)



Groupwork

- Think of everything you know about TCP
- What are some ‘features’ missing in the above approach?
- What other implementation issues might be present?

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- *Experiments*
  - (NS)
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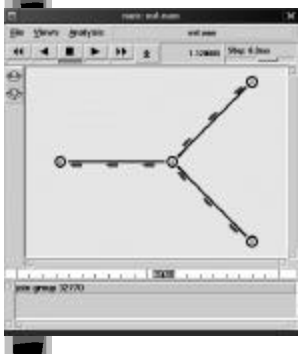
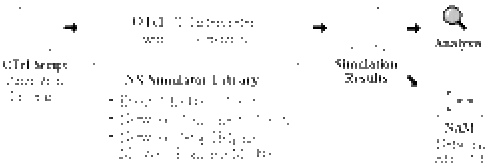
NS



- WAN Simulator developed at UC Berkeley
  - NSF supported
- IP, (TCP,UDP), (FTP, Telnet), Router Queue
- Topology!

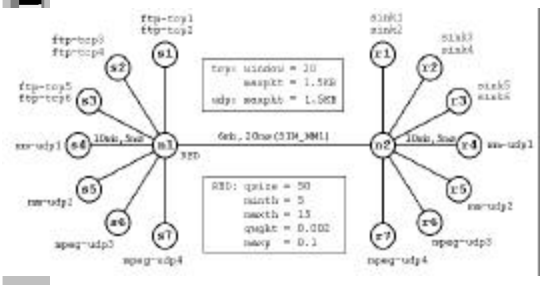
NS Input



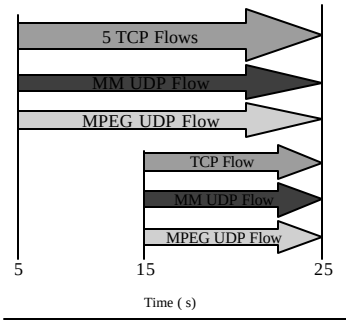
NS Output

```
#! /bin/tcsh -f
cat out.tr | grep " 2 3 cbr " | grep ^r | column 1 10 | \
  awk '{dif = $2 - old2; \
  if(dif==0) dif = 1;
  if(dif > 0) {\
    printf("%d\t%f\n", $2,
      ($1 - old1) / dif);
      old1 = $1; old2 = $2}
  }' \
> jitter.txt
```

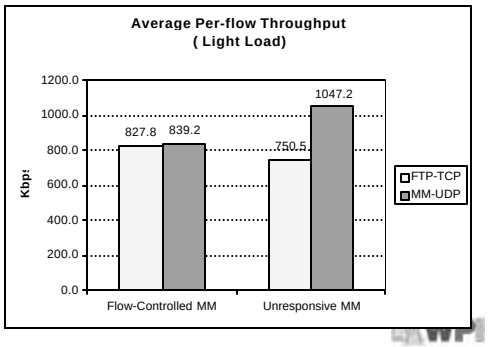
Experiments



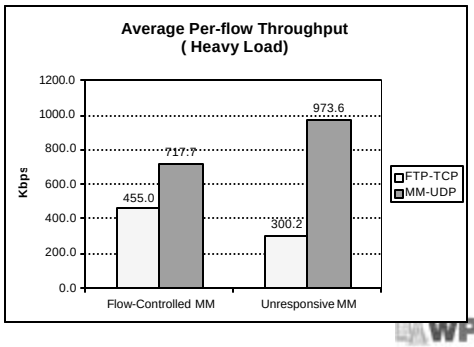
Simulation



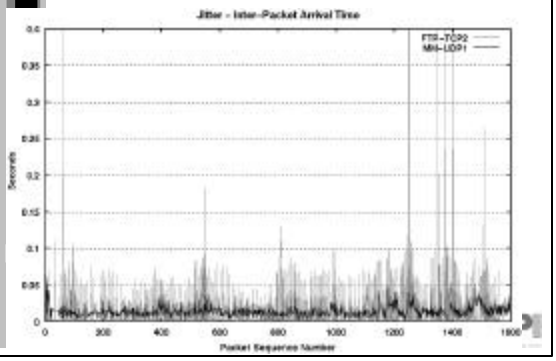
Results



Results



Simulation Results



Conclusions

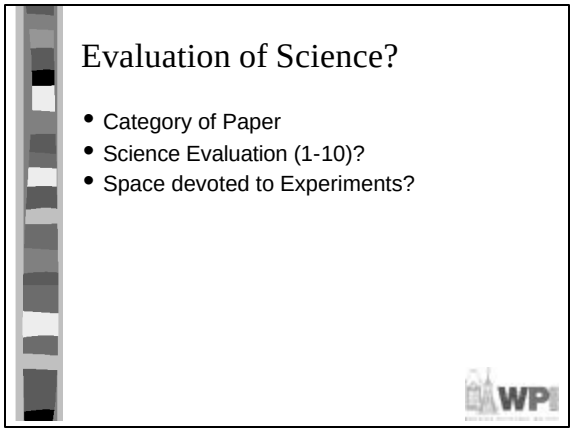
- "TCP-like" multimedia protocol built upon UDP
  - Responsive to congestion
  - Rate-based for better Multimedia Quality
  - MPEG-1 streaming application
- Quantitative comparison of TCP, UDP and responsive UDP
- Implementation in NS
  - Source code can be downloaded

Work in Progress

- Additional software design
  - Separate application from protocol
    - + Easier to add other applications
- Parameters
  - Number of scale values
  - Additive amount
  - Multiplicative decrease amount
- Tests comparing with other multimedia protocols
  - TFRC

Future Work

- Content-based multimedia scaling
- Experiments with other media formats
- Evaluation of perceptual quality by user studies
- Quantitative analysis of data loss (ratio of packets sent and packets lost)
- "TCP Friendly" Evaluation


Evaluation of Science?
• Category of Paper
• Science Evaluation (1-10)?
• Space devoted to Experiments?
WPI