Real-time Streaming over Wireless Links: A Comparative Study

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Outline

- Introduction
- Video Transport Protocol (VTP)
- TFRC Wireless
- MULTFRC
- Comparison Results
- Conclusion

Introduction

- Two types of video apps exist on the Internet.
  - Pre-stored video clips, e.g., video-on-demand.
  - Real-time streams, e.g., live broadcast, online gaming.
  - Real-time streaming is more challenging: no large buffering allowed.
- Portable devices getting popular.
  - Many are connected through wireless technologies.
  - High error rates cause frequent (random) packet loss.

Introduction

- Real-time streaming rate control for wireless
  - Video Transport Protocol (VTP)
    - Unique mechanism for smooth and friendly rate control.
    - Loss Discrimination Algorithm (LDA) to differentiate between congestion- and random- packet loss for better efficiency.
  - TFRC extensions aiming wireless scenarios.
    - TFRC Wireless: equipping TFRC with Loss Discrimination.
    - MULTFRC: creating multiple TFRC connections.
- Goal of this work:
  Compare VTP, TFRC Wireless and MULTFRC in terms of efficiency/adaptivity, fairness and friendliness.

Video Transport Protocol (VTP)

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G. Yang, M. Gerla, M. Y. Sanadidi, “Adaptive Video Streaming in Presence of Wireless Errors”, MMNS 2004, San Diego, CA, Oct. 2004

- Unique mechanism for smooth and friendly rate control.
  - VTP continuously monitors the Achieved Rate (AR).
  - AR is a useful measure for setting the appropriate sending rate.
- VTP rate control based on analysis of TCP instantaneous rate.
  - Avoids the drastic rate reduction upon congestion in TCP:
    new-sending-rate = achieved-rate
  - Temporarily holds rate increase until TCP catches up.
- An end-to-end Loss Discrimination Algorithm (LDA) is used to differentiate congestion- and error-loss.
  - RTT-based scheme: long RTT ⇔ likely congested, vice versa.
  - Error-loss does not trigger rate reduction in VTP.

VTP – cont’d

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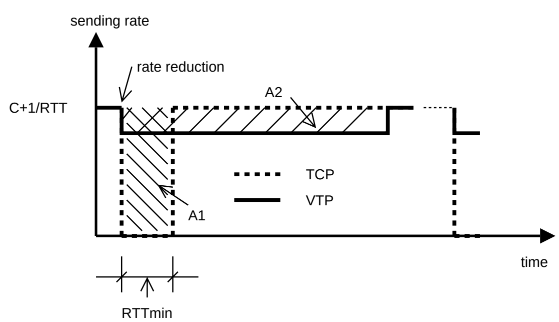

- Illustration on VTP rate control.
  - TCP cuts rate deeply; VTP cuts less but stays at the rate longer.
  - A1 = A2 to assure friendliness.

TFRC Wireless

S. Cen, P. Cosman, G. Voelker, "End-to-end differentiation of congestion and wireless losses", IEEE/ACM Transactions on Networking, 11(5):703-717, Oct. 2003.

- Similar end-to-end Loss Discrimination as in VTP to differentiate between congestion and random loss.
- Random loss is excluded from packet loss statistics and has little impact on TFRC performance.

MULTFRC

M. Chen, A. Zakhor, "Rate control for streaming video over wireless", IEEE Infocom 2004, Hong Kong, China, Mar. 2004.

- Multiple TFRC connections are created and used simultaneously when a single connection is inefficient.
- Number of connections adjusted based on RTT measurement:
  - Similar idea as in VTP/TFRC Wireless: long RTT ⇔ likely congestion
  - Inversely Increase Additively Decrease (IIAD) algorithm.

Simulation Setup

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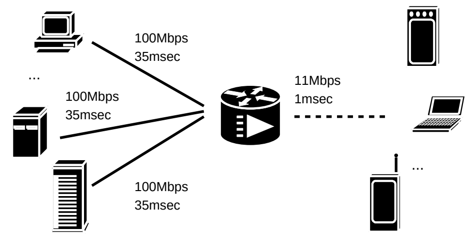

- Wired-cum-wireless scenario:
  - Internet servers connected to base station.
  - Wireless link represents shared medium of WLAN.
  - Loss model is applied at wireless link.

Simulation: Efficiency

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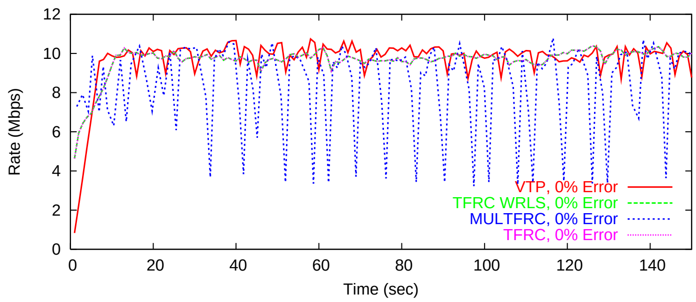
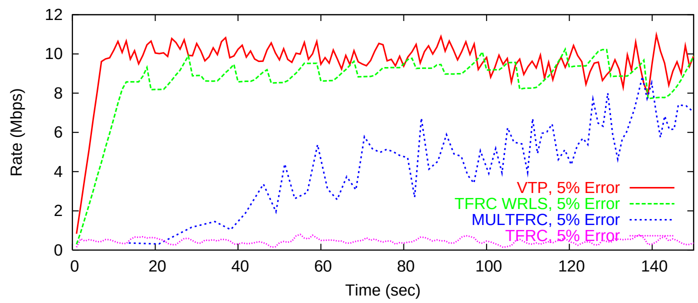


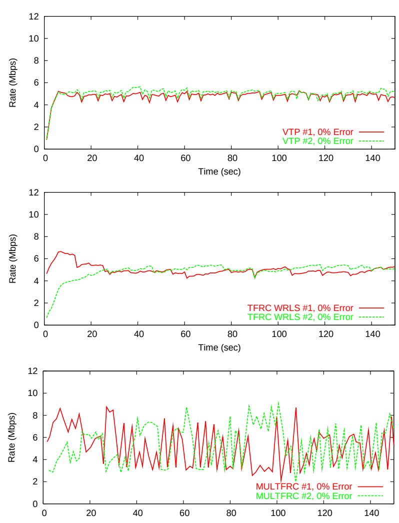
- Single connection test, *no errors*
  - VTP, TFRC Wireless, original TFRC all perform closely.
  - MULTFRC fluctuates due to number of connections flipping between 1 and 2.

Simulation: Efficiency – cont'd



- Single connection test, *5% errors*
  - VTP beats all other protocols.
  - TFRC Wireless performs better than MULTFRC.
  - Original TFRC completely fails.

Simulation: Fairness



- Two-connection test, *no errors*
  - VTP/TFRC Wireless show good fairness.
  - MULTFRC flows fluctuate drastically.

Simulation: Fairness – cont'd

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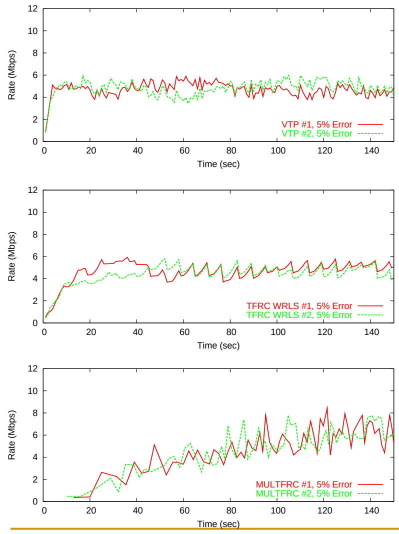

- Two-connection test, *5% errors*
  - VTP/TFRC Wireless are still fair and efficient.
  - MULTFRC has OK fairness but poor efficiency.

Simulation: Opportunistic Friendliness

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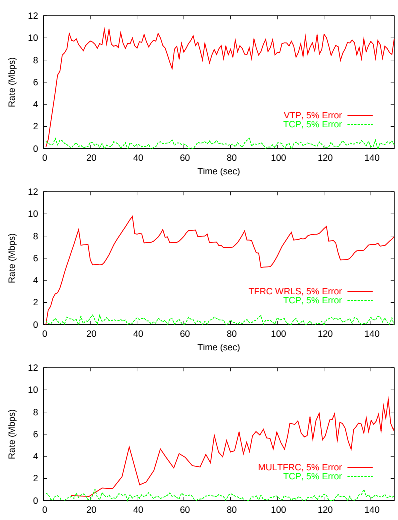

- *No errors (not shown)*
  - All protocols are friendly to legacy TCP.
- *5% errors*
  - TCP is dead by itself.
  - VTP picks up residual bandwidth and keeps smooth rate.
  - TFRC Wireless and MULTFRC demonstrate less efficiency.

Conclusion

- VTP, TFRC Wireless, MULTFRC all show improvement in efficiency.
- VTP provides best smoothness, fairness and friendliness.
- TFRC Wireless is close to VTP in some cases.
- MULTFRC does not work best in our WLAN scenario.

Thank You

Questions?