

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.

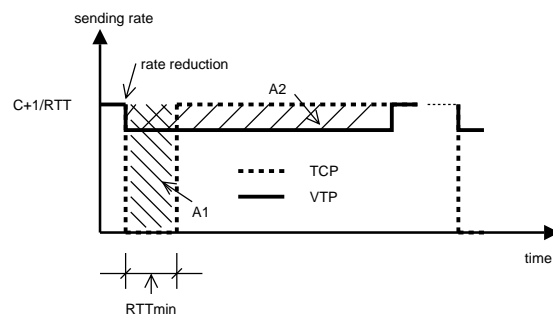
- Goal of this work:
[Compare VTP, TFRC Wireless and MULTFRC in terms of efficiency/adaptivity, fairness and friendliness.](#)

Video Transport Protocol (VTP)

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 \Leftrightarrow likely congested, vice versa.
 - Error-loss does not trigger rate reduction in VTP.

VTP – cont'd



- 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.*](#)

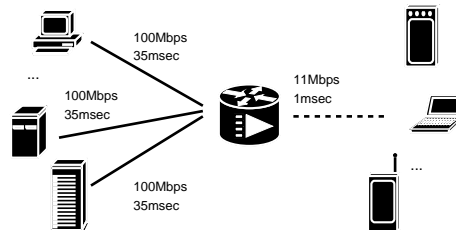
- Similar end-to-end Loss Discrimination as in VTP to differentiate between congestion and random loss.
- Random loss is excluded from packet loss statistics and has little impact on TFRC performance.

MULTFRC

[*M. Chen, A. Zakhor, "Rate control for streaming video over wireless", IEEE Infocom 2004, Hong Kong, China, Mar. 2004.*](#)

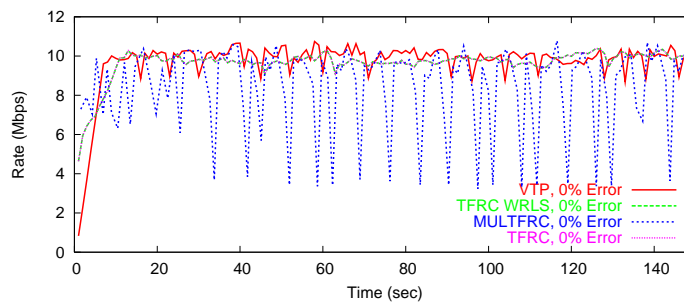
- Multiple TFRC connections are created and used simultaneously when a single connection is inefficient.
- Number of connections adjusted based on RTT measurement:
 - Similar idea as in VTP/TFRC Wireless:
long RTT \Leftrightarrow likely congestion
 - Inversely Increase Additively Decrease (IIAD) algorithm.

Simulation Setup



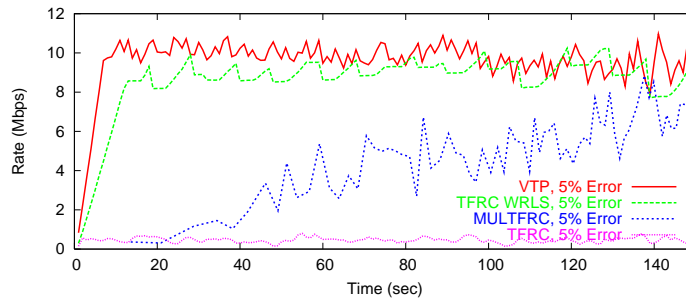
- Wired-cum-wireless scenario:
 - Internet servers connected to base station.
 - Wireless link represents shared medium of WLAN.
 - Loss model is applied at wireless link.

Simulation: Efficiency



- 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



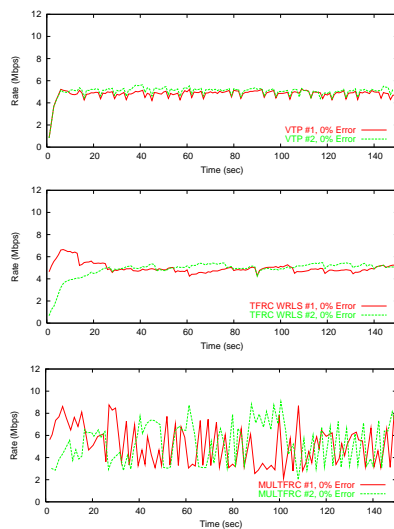
- Single connection test, *5% errors*
 - VTP beats all other protocols.
 - TFRC Wireless performs better than MULTFRC.
 - Original TFRC completely fails.

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Simulation: Fairness



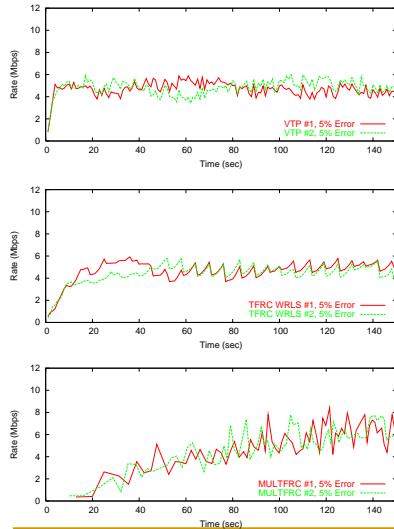
- Two-connection test, *no errors*
 - VTP/TFRC Wireless show good fairness.
 - MULTFRC flows fluctuate drastically.

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Simulation: Fairness – cont'd



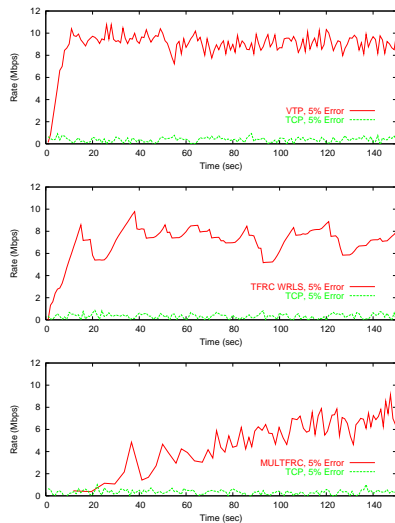
- Two-connection test, **5% errors**
 - VTP/TFRC Wireless are still fair and efficient.
 - MULTFRC has OK fairness but poor efficiency.

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Simulation: Opportunistic Friendliness



- **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.

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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?