

# Is the Round-trip Time Correlated with the Number of Packets in Flight?

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# Motivation

- Some Congestion Avoidance Techniques implicitly use the correlation between RTT and the number of packets in flight.
  - TCP-Vegas
  - Z. Wang and J. Crowcroft "A New Congestion Control Scheme: Slow Start and Search (Tri-S)"
  - Raj Jain "A Delay-based Approach for Congestion Avoidance in Interconnected Heterogeneous Computer Networks"
  - S. Biaz and N. H. Vaidya. "Distinguishing Congestion Losses from Wireless Transmission Losses"



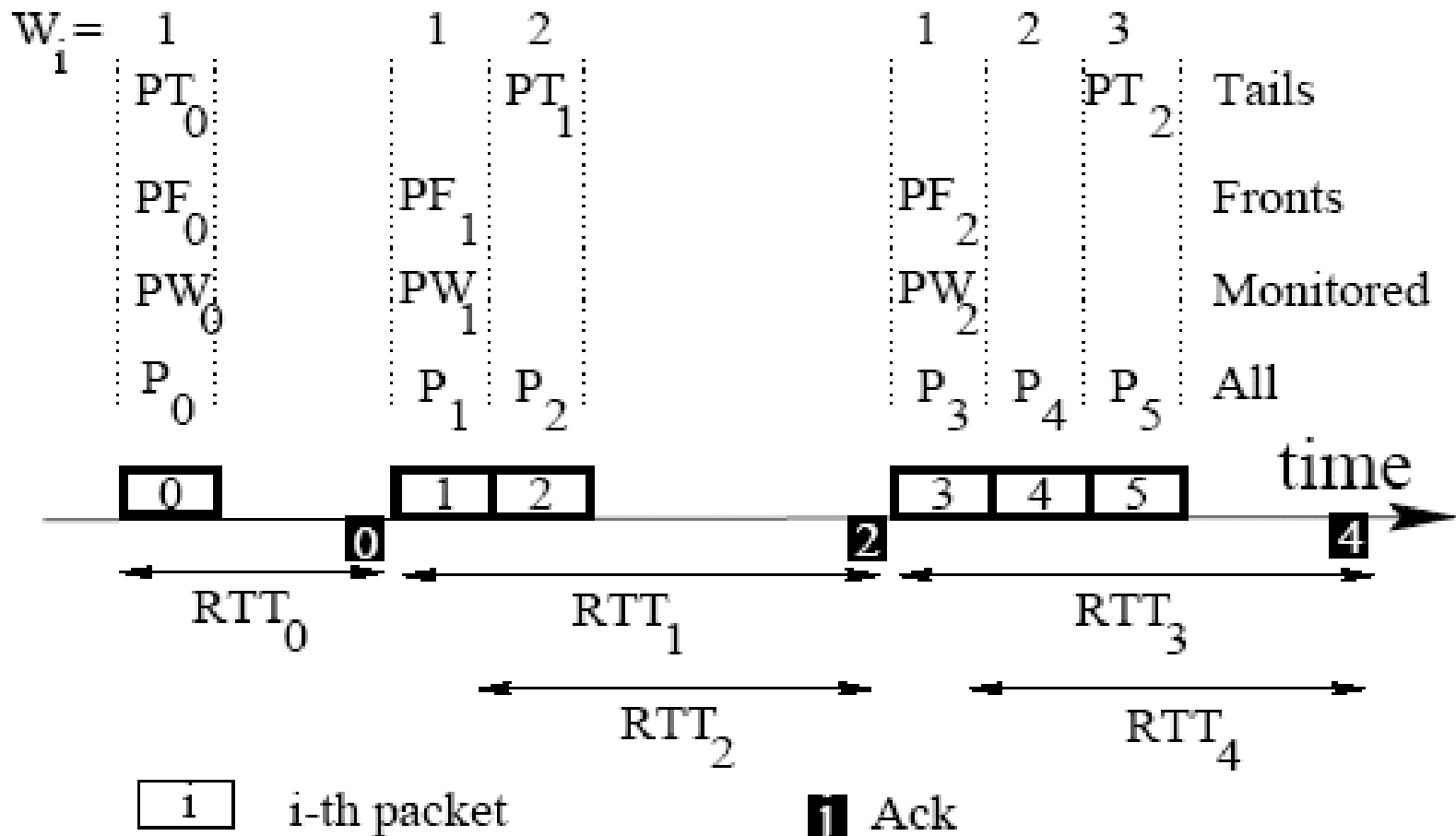
# What can we do

- Sample coefficient of correlation

$$\rho(C_l, x_i, y_i) = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

- $X_i$ : RTT
- $Y_i$ : the number of packets in flight

# Notations and Terms

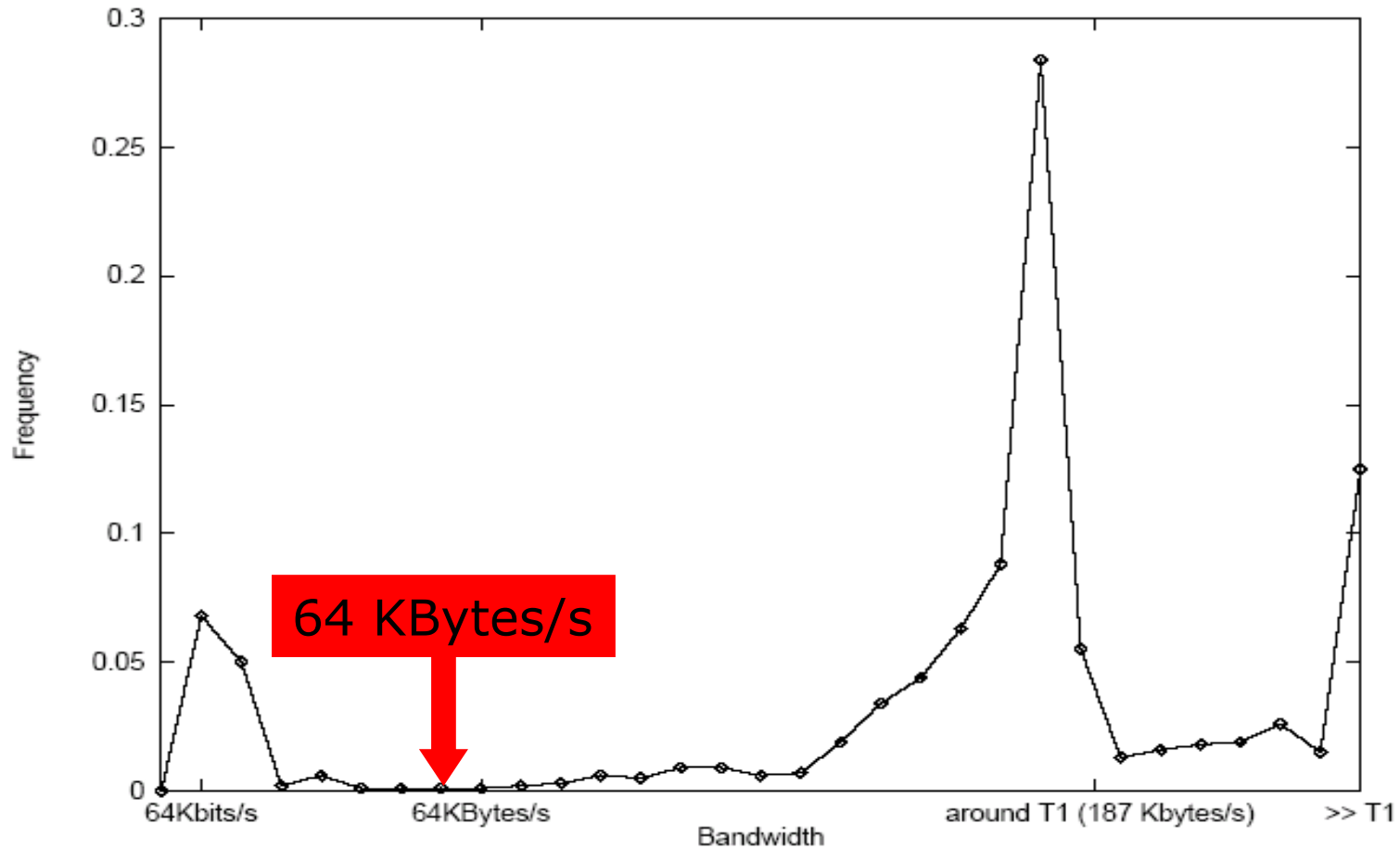


# Data Collection

- Data is based on Dr. Vern Paxson's PhD thesis "Measurements and Analysis of End-to-End Internet Dynamics"
- *Tcpdump* traces collected over 37 sites, 14,218 TCP connections span 737 paths

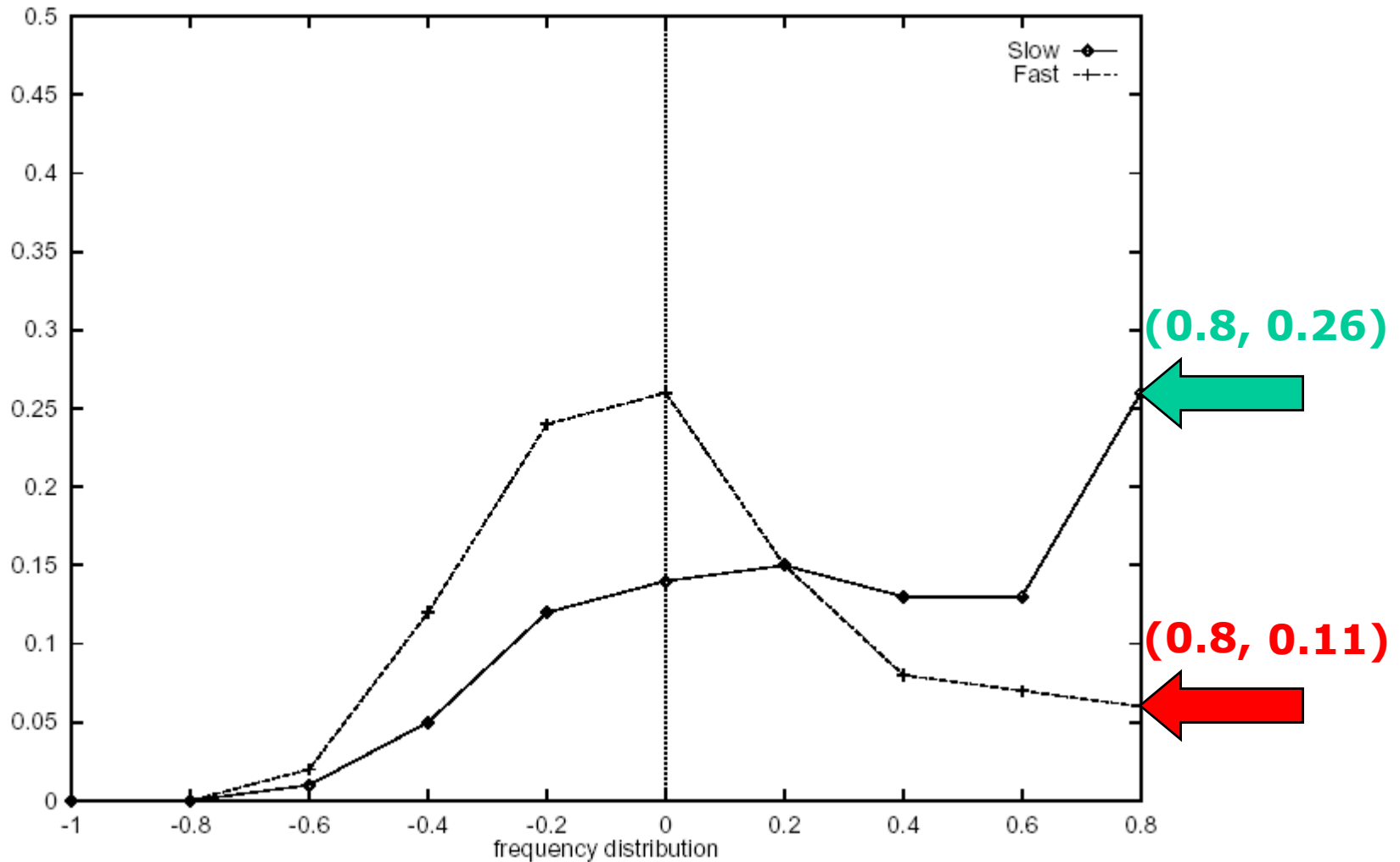


# Slow Path & Fast Path



Frequency Distribution of Connections by Bottleneck Link Speed (Dr. Paxson)

# Correlation between RTT and W

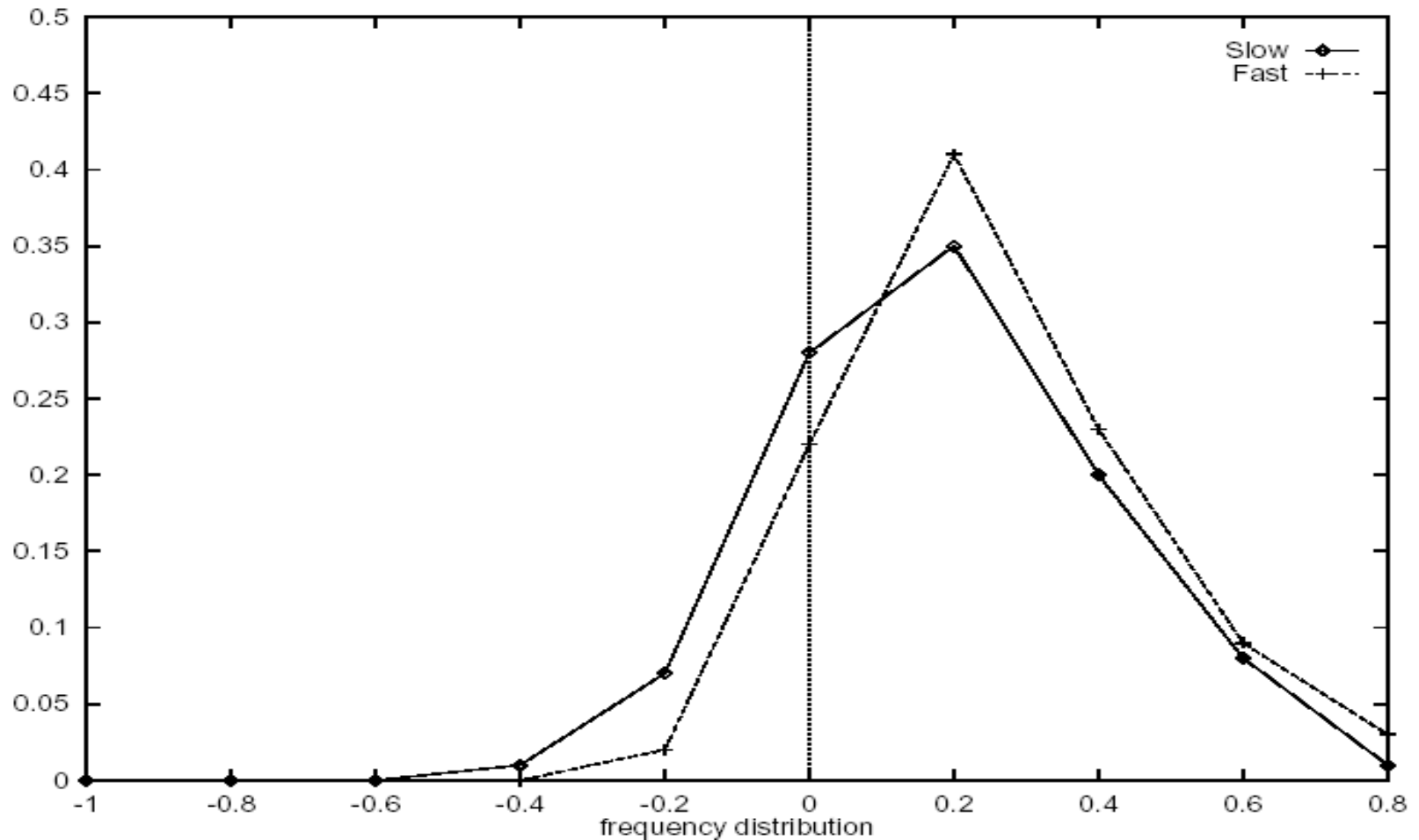


$$\rho(C_l, x_i, y_i) = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

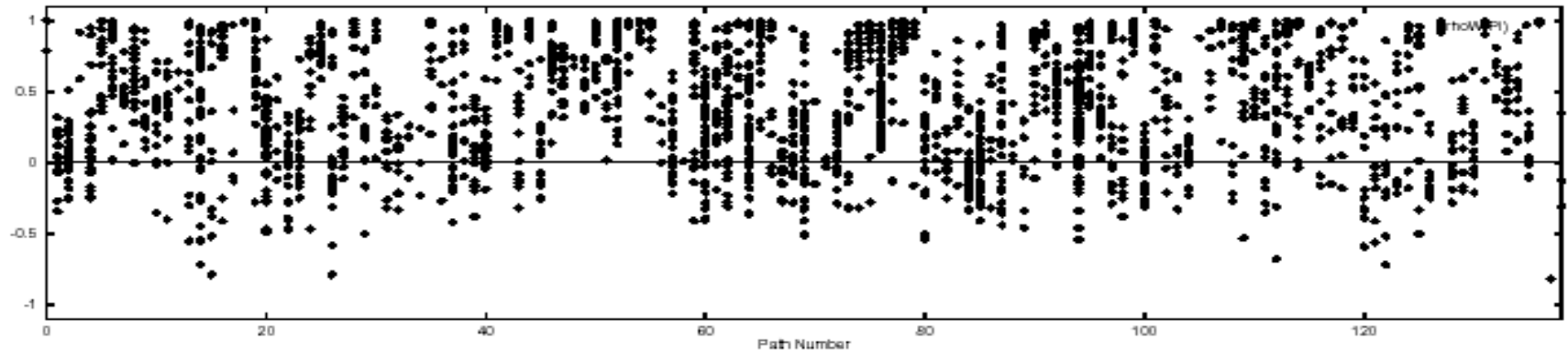
$$\rho_{w_v}(C_l, \frac{\delta RTT_i}{|\delta RTT_i|}, \frac{\delta W_i}{|\delta W_i|})$$



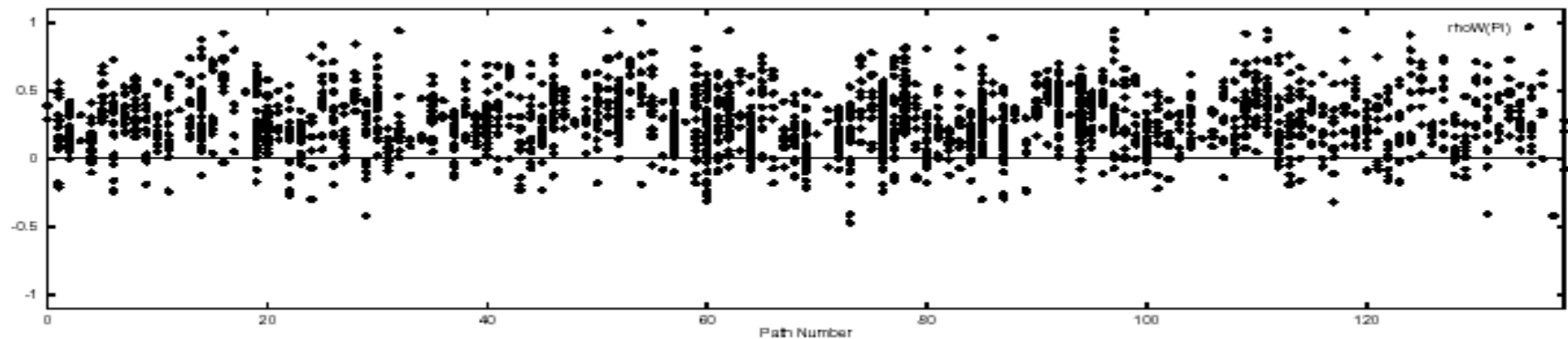
# Correlation in Direction of Change



# Coefficient of Correlation on a Path?



Coefficient of correlation for RTT and W for slow path



Coefficient of correlation for direction of change for slow path

# Conclusion and Future Work

- No strong correlation between the variation of RTT and the variations of congestion window size.
- Most of TCP connections have positive correlation in the direction of change of RTT and  $W$ .
- Updating data collections



# Resources

<http://www.crhc.uiuc.edu/~nhv/old.papers/mobile-computing/99-006.ps.Z>

<http://www.eng.auburn.edu/users/sbiaz/tech99-006.ps>

