A Multi-Path Error Control Mechanism for Interactive Video in Mobile Wireless Networks

Ahmed Abd El Al, Tarek Saadawi, Myung Lee

Dept. of Electrical Engineering

The City University of New York

Outline

- Motivations
- Current approaches for error resilient wireless video
- Adaptive multi-path retransmission
- Simulation results
- Conclusions

Motivations

- Increasing interest in video communications over mobile wireless networks.
- High error rate on wireless channels.
- Design of wireless communication systems is complicated by the rapidly changing quality of the radio channel.
- Video transmission requires significantly small error rates.
- Delay constraints posed on interactive video.

Approaches for Error Resilient Wireless Video

- Reduce the time between intra-coded frames.
- Forward Error Correction (FEC).
- Retransmission based schemes.
- Layered coding.
- Multiple Description Coding (MDC).

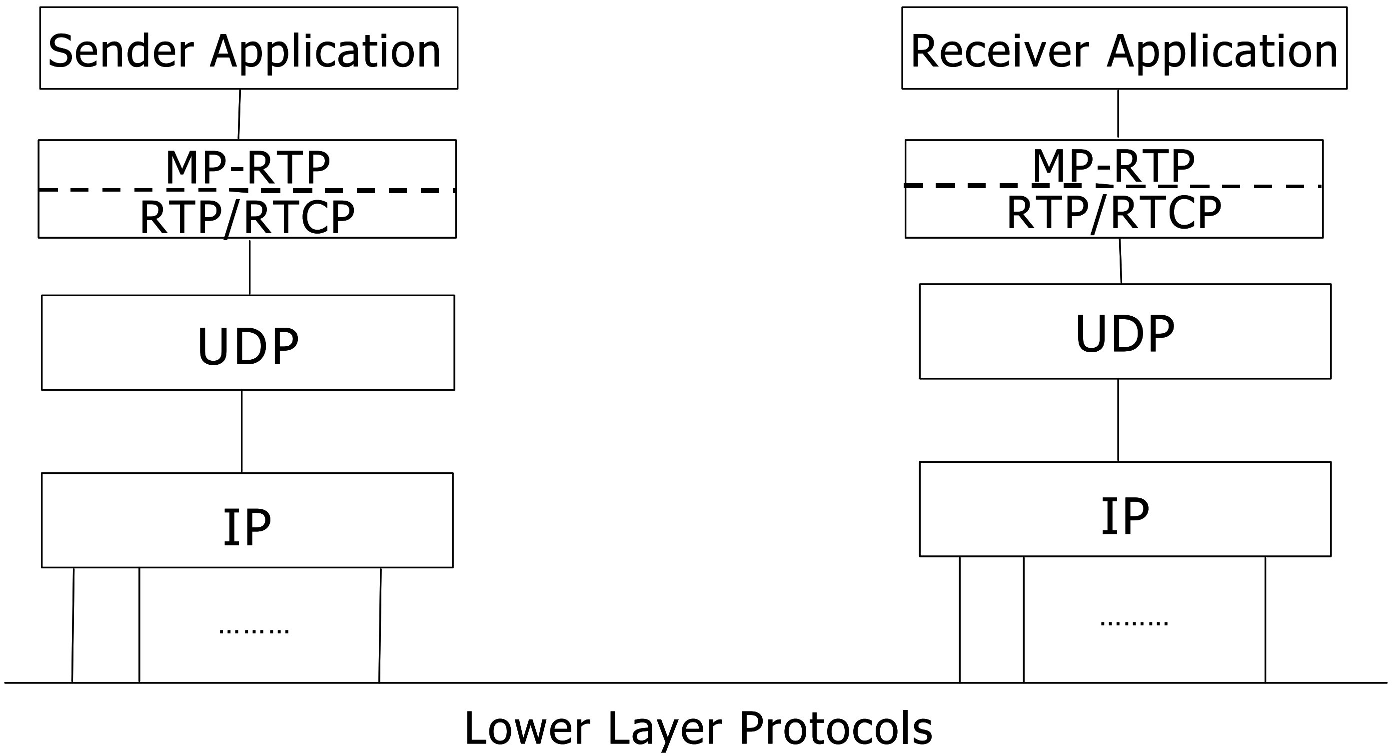
Proposed Solution

- Extends retransmission-based error control to provide adaptive end-to-end unequal error protection for video data.
- Upper layer application assigns different reliability levels and lifetime to video frames.
- Multiple copies of loss sensitive data are retransmitted simultaneously on multiple paths.
- Retransmission paths are selected based on an estimate of One Way Delay (*OWD)* of the path, as well the frames lifetime.

Path Diversity in Wireless Networks

- Single hop networks
- Multi hop networks

System Architecture



Multi-Path RTP (MP-RTP)

V	P	RR	Payload Type=RR	Length
SSRC of packet sender (Receiver ID)				
SSRC_1 (SSRC of first source)				
fraction lost	cumulative number of packet lost			
extended highest sequence number received				
interarrival jitter				
last SR (LSR)				
delay since last SR (DLSR)				
missing sequence number				

Extended RTCP-RR

Path Monitoring

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

Version	Padding	Payload Type=HB	Length
time stamp			

Heartbeat

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

Version	Padding	Payload Type=HB-ACK	Length
time stamp			

Heartbeat Acknowledgement

Retransmission Algorithm

if (lost packet belongs to low priority frame j)

if ($T_c + min(OWD_i) < T_L(j)$)   where path i e {1, N}

Retransmit on path i

else

for all paths i

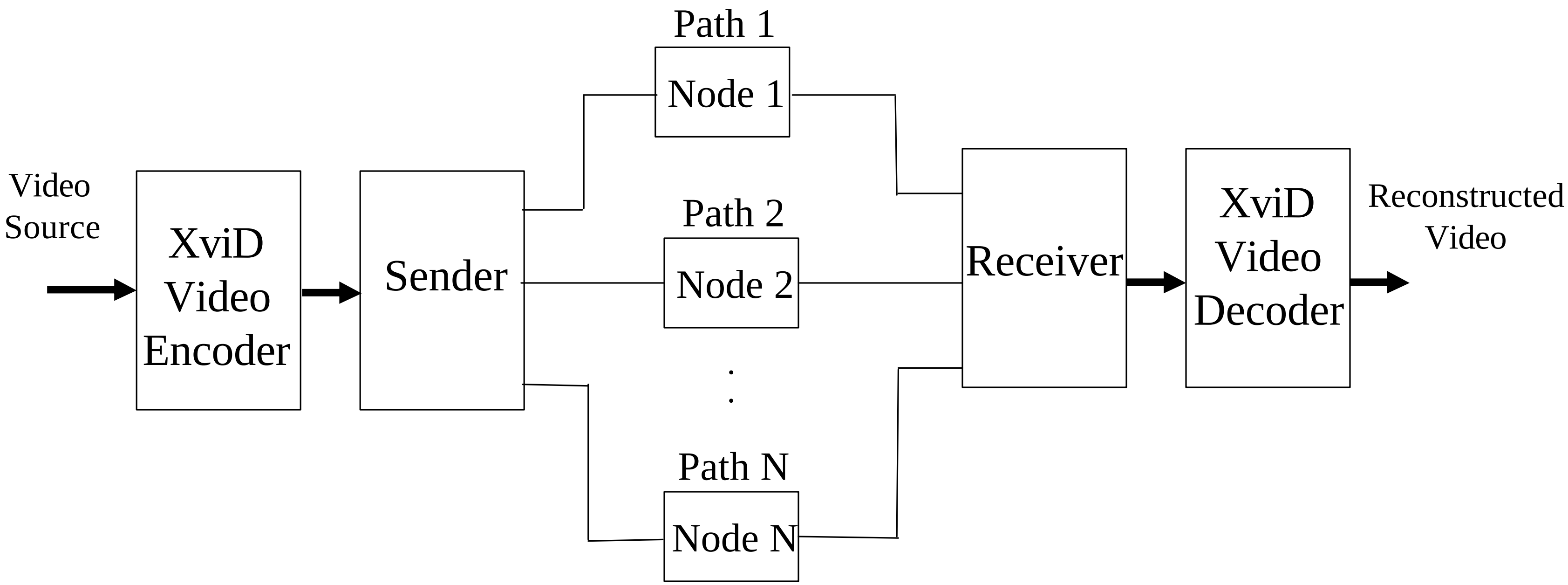
if ($T_c + OWD_i < T_L(j)$)

Retransmit on path i

if (packet cannot be retransmitted)

Notify upper layer for error tracking

Simulation Setup

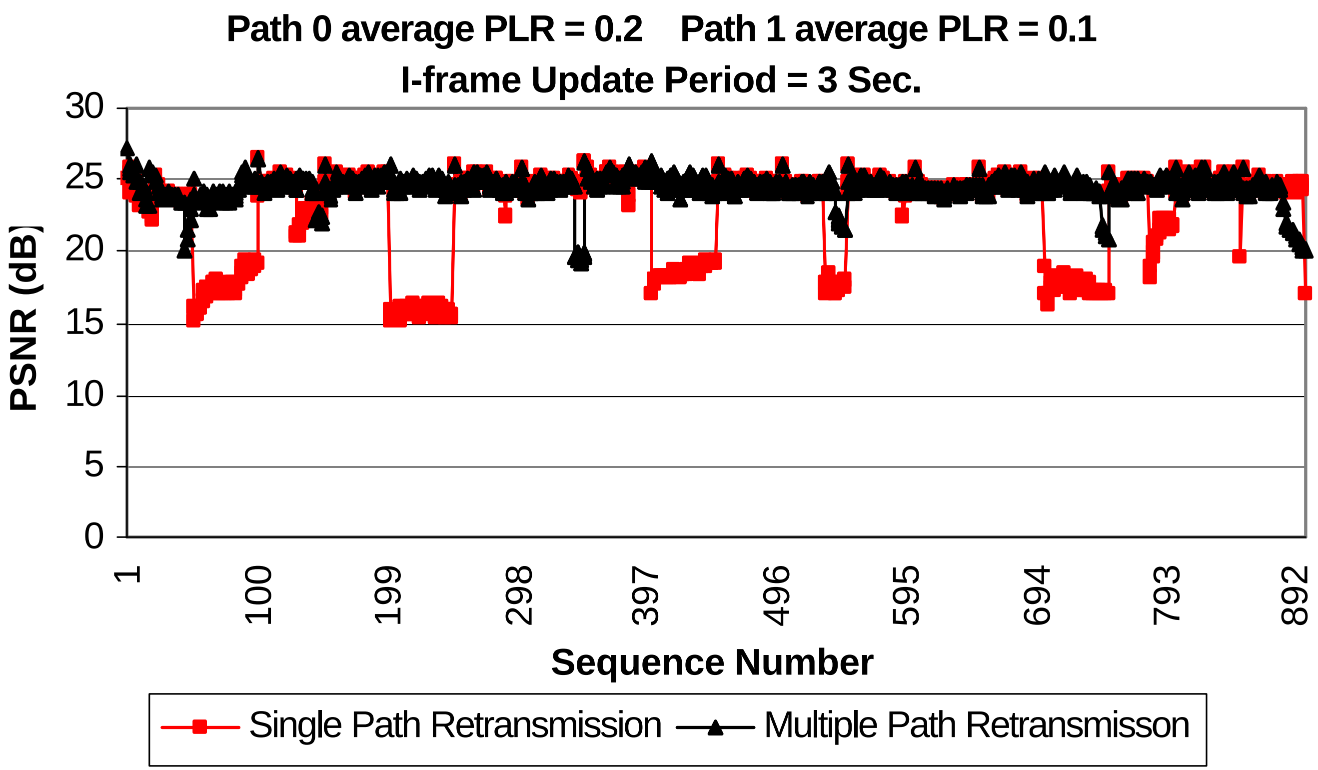


- Nodes 1-N are reconfigurable to represent different levels of packet loss and delay.
- A two-state Markov model to simulate channel loss behavior with burst errors.

Simulation Parameters

Mean channel delay	30 msec.
Channel rate	2 Mbps
MTU	400 Bytes
Heartbeat interval	150 msec.
Switching threshold	300 msec.
Video sequence length	900 frames
Frame dimensions	176 x 144 pixels/frame
Frame rate	15 frames/sec.
Coding rate	200 Kbps
Initial playout delay	100 msec.

Video Quality with Multi-path Retransmission



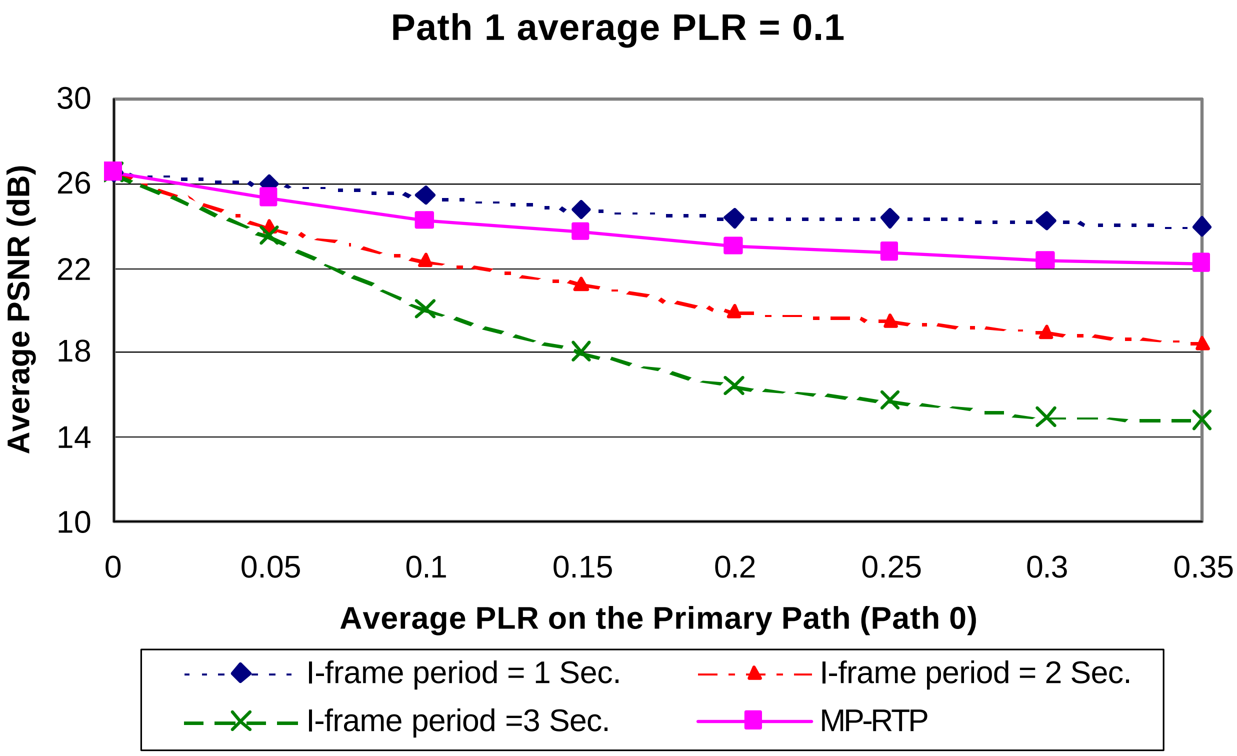
Visual Quality

Single path Retransmission

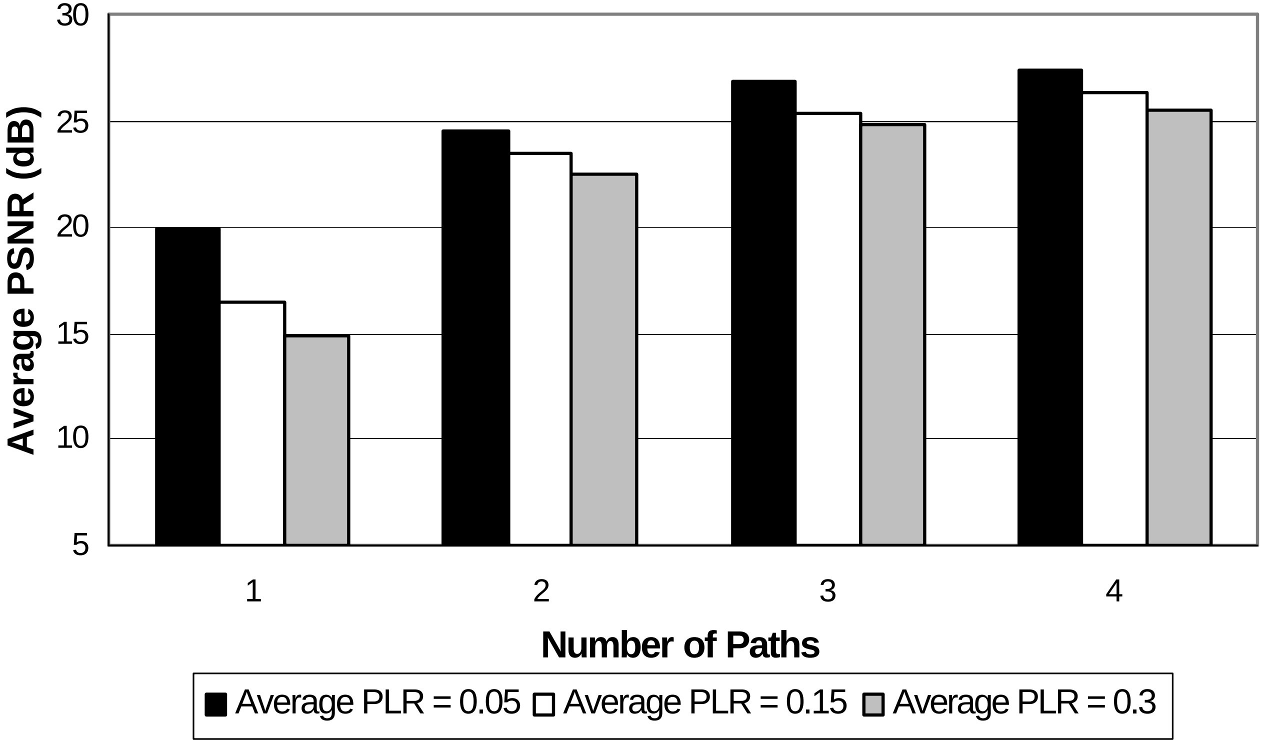
Multi path Retransmission

Frame # 200

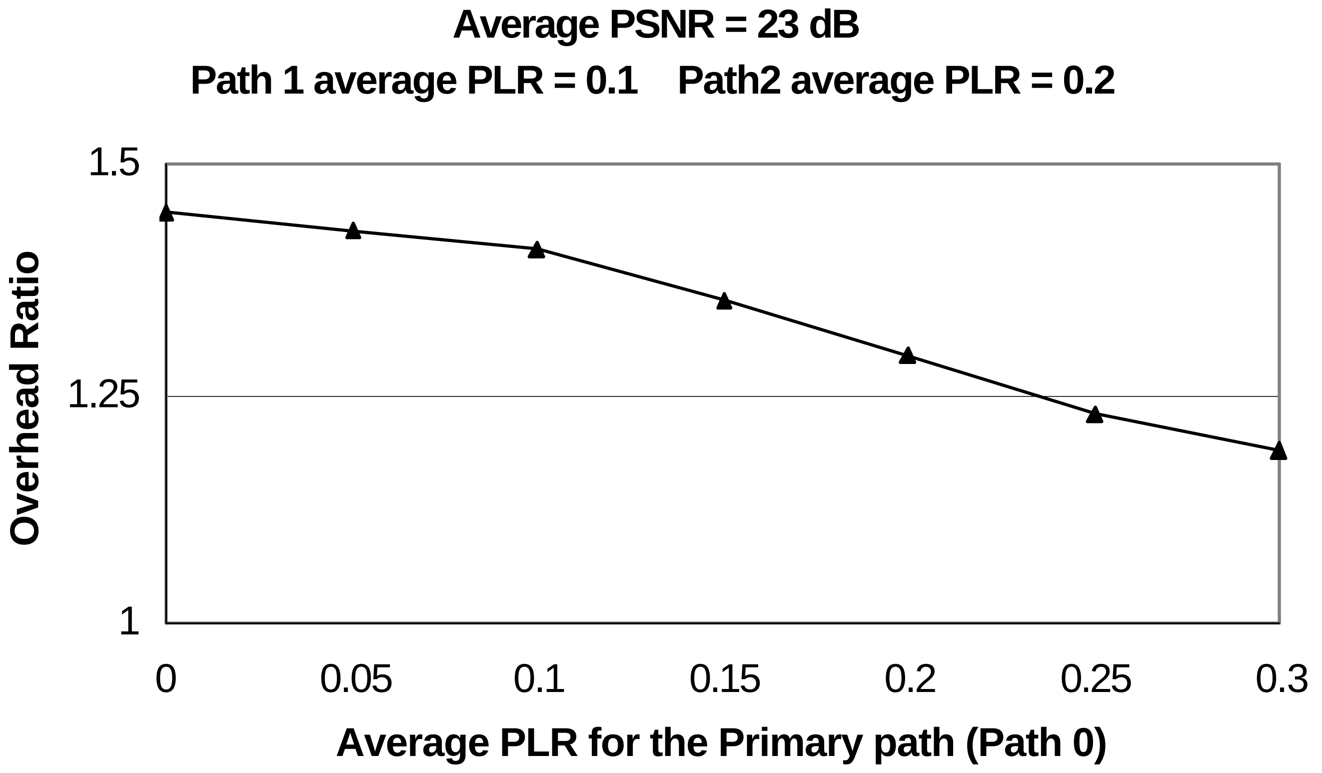
Effect of Packet Loss Rate on Video Quality



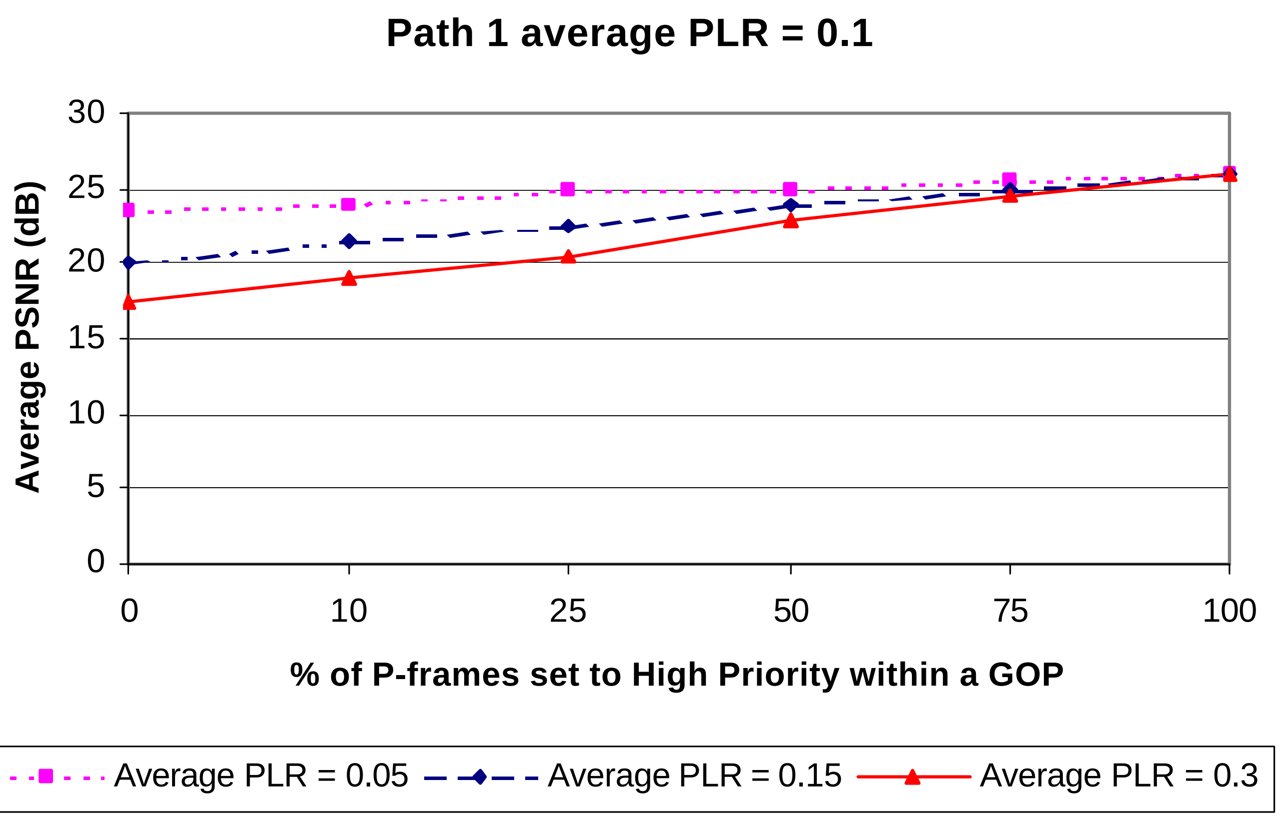
Effect of Changing the Number of Paths



Redundant Retransmission Overhead



Effect of Changing reliability Levels for P- frames



Conclusions

- Video encoded using motion compensation requires higher protection for reference frames that dependent frames.
- We propose an end-to-end unequal error protection to data within the video stream through redundant retransmissions.
- The mechanism factors in the importance of the packets as well as the end-to-end latency constraints to minimize the overhead and maximize the quality at the receiver.
- The mechanism maintains the video quality under different loss rates, with less overhead.