WiSE Video: using in-band wireless loss notification to improve rate-controlled video streaming

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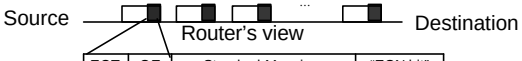
The WiSE Mechanism

Motivation

- **Congestion Control:** Both data and multimedia applications over the Internet are expected to perform congestion control, typically using packet loss as indication of congestion.
- **Problem:** Flows experiencing loss over hybrid wired and wireless paths, cannot distinguish congestion on the wired from corruption on the wireless part. This information is critical for choosing (i) the right reaction to congestion and (ii) error resilience.
- **Previous solutions:** (i) shield wired from wireless using proxies (ii) communicate the cause of loss to the source, using explicit messages or dedicated header bits.

The M-ECN approach

- **Sharma, Katabi, Prabhakar, Pan, SIGCOMM Poster 2003**
- **Multiplexed ECN channel:** routers communicate with end-points by sneaking information into ECN bits of a flow, but without interfering with the ECN signaling functionality.
- Provides an in-band, easy-to-deploy mechanism for network-to-user signaling. Useful for a variety of applications.
- How it works:
  - It marks ECN bits in the IP header.
  - It spreads a message across multiple packets.

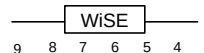


ECT	CE	Standard Meaning	"ECN bit"
0	0	ECN incapable	
1	0	No congestion, nonce=0	ECN = 0
0	1	No congesion, nonce=1	
1	1	Congestion, nonce cleared	ECN = 1

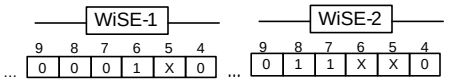
WiSE: Wireless signaling via ECN

- Use the M-ECN approach to signal corruption vs. congestion
- **Examples of marking:**

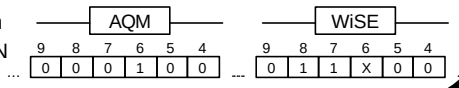
1. Successive corrupted packets



2. Composability of WiSE messages



3. Interaction between WiSE and legacy ECN



WiSE Video

WiSE Components

- WiSE-Agent: encodes messages ("corruption")
- WiSE-Receiver: decodes and sends "ACK/NACK+cause"
- WiSE-Source: takes appropriate action
  - Decrease sending rate only in case of congestion
  - Retransmit lost packets asap

Rate Control Schemes considered

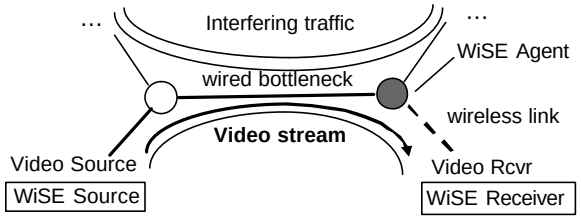
- The exact reaction depends on Rate-Control scheme
  - **Switch Stream Rate Control (SSRC)**
    - Receiver sends feedback
    - Sender switches (at GOP boundaries) to
      - lower rate description during congestion
      - higher rate description otherwise
  - [TFRC]
  - **HTTP streaming**
    - One description stored, sent over TCP

TCP friendly

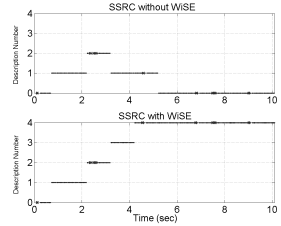
Natural to video

Simulation Setup

- Foreman, 10sec, H.264, GOP=15, QCIF, 30fps, RTP/UDP
- 5 descriptions with rates: 50kbps (0), 78Kbps (1), 116kbps (2), 184kbps (3), 346kbps(4), and quality 27.4-39.1dB
- Network simulations using ns-2
  - video traffic crosses both wired and wireless links
  - interfering web+ftp traffic, shares wired bottleneck



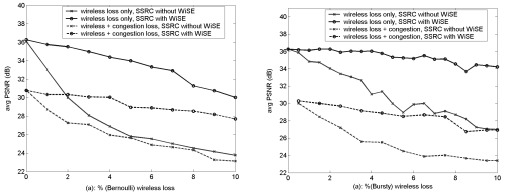
Example



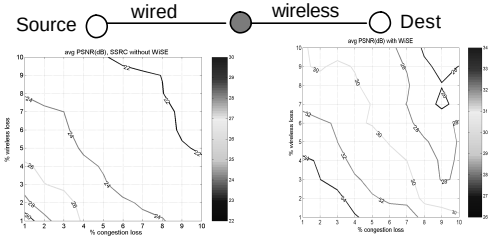
Simulation Results

SSRC with/without WiSE

- WiSE SSRC: decreases rate only in case of congestion loss and retransmits lost packets asap.
- Performance improvement for uniform/bursty wireless loss, 0-10% rates, with/without congestion

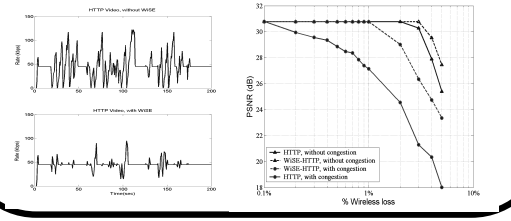


- Improvement for all pairs of (wired, wireless) loss rates



HTTP with/without WiSE

- WiSE HTTP backs-off only when loss is due to congestion
- Performance improvement for 0-10% wireless loss, with/without interfering traffic



Conclusion

- WiSE improves rate-controlled video over hybrid wired & wireless, for a wide range of conditions.
- Strengths: in-band, incrementally deployable.
- Limitations: low rate, delay.

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