Error Control Techniques for Interactive Low-bit Rate Video Transmission over the Internet.

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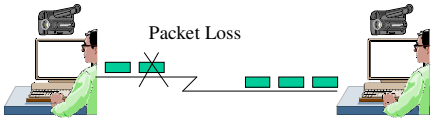
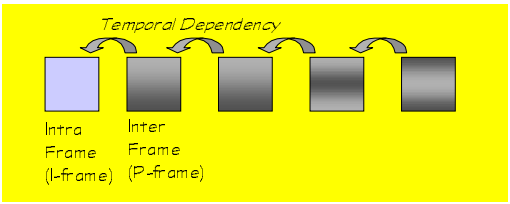
Video Conferencing over Packet-Switching Networks.



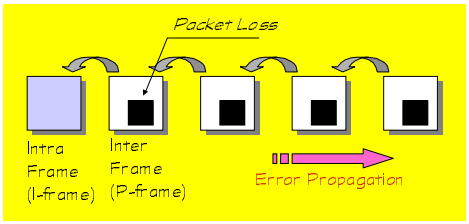
- ¡¡ Compressed video frame is packetized and transmitted.
- ¡¡ Packet loss can occur quite frequently due to congestion
- and user mobility.

Motion Compensated Coding

- Most video codecs use it.
- Each P-frame depends on its previous frames.
- I-frame is periodically transmitted.

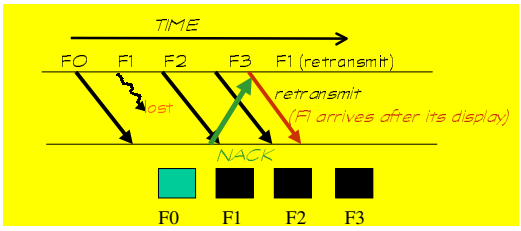


When a packet is lost,....



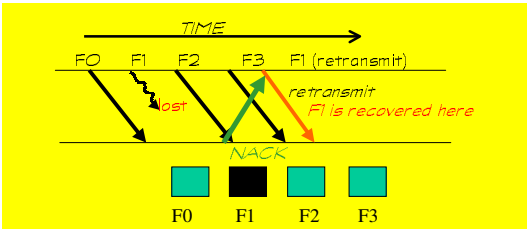
- Conventional Solution : Transmit I-frame more often.
- However, compression efficiency reduces.

Myth: retransmission is not useful for interactive video



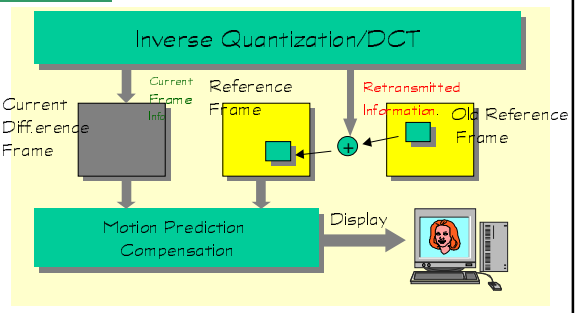
Conventionally, late packets are discarded.

Retransmission stops error propagation.



Don't discard: Use late packets to recover their reference frames

Handling retransmitted 'late' packets in decoder



Error Propagation

Recovery from Error Propagation

Error Recovery Technique

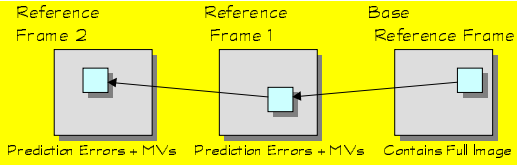
- Recovery from Error Spread using Continuous Update (RESCU)
- Focus on error spread/propagation
- Continuous Update
  - Retransmission (this paper)
  - Forward error correction
- Combined with Layer coding (this paper)

Extending Packet Deadline

1. Add more frame buffers at the decoder.
2. Adjust Temporal Dependency Distance (TDD) of a frame.
   - TDD: frame intervals from that frame to its temporally dependent frame.

Add more reference frame buffers.

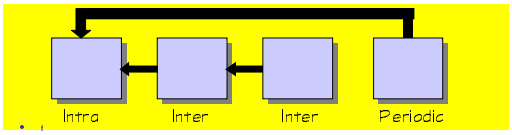
Cascaded Buffering



- Minus: More computation and buffers at the decoder.
- Plus : No change in the codec and picture pattern.

Adjust Temporal Dependency Distance
Periodic TDDs (PTDD)

- Changing Dependency.



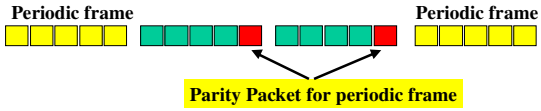
- PTDD can be dynamically adjusted.

+ Reduced Buffers & computations.

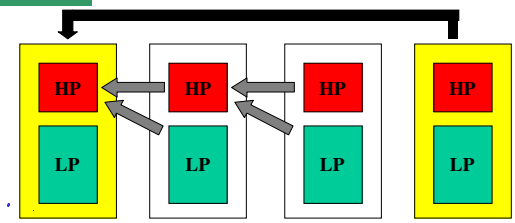
— No protection for non-periodic frame.

Continuous Updates
Retransmission & Forward Error Correction

- Retransmission
  - Retransmit lost packets within PTDD.
  - Retransmission delay requires larger PTDD.
- Forward Error Correction
  - send parity packets over a PTDD period.

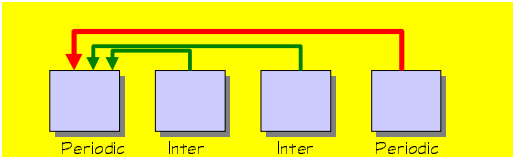


Protecting non-periodic frames
RESCU + Quality Assurance Layering



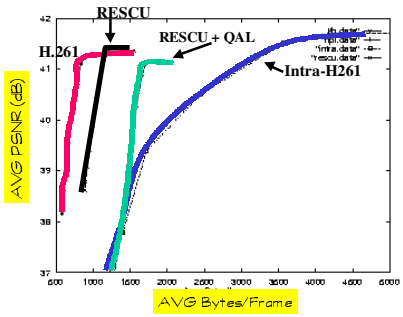
- HP stream is sent with forward error correction.
- RESCU contributes to reducing bit rates.

protecting non-periodic frames
Change temporal dependency

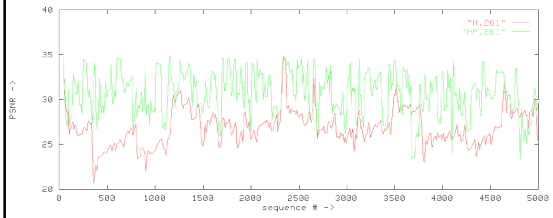


- Errors in non-periodic frames do not propagate.
- As PTDD increases,
  - Compression efficiency decreases.

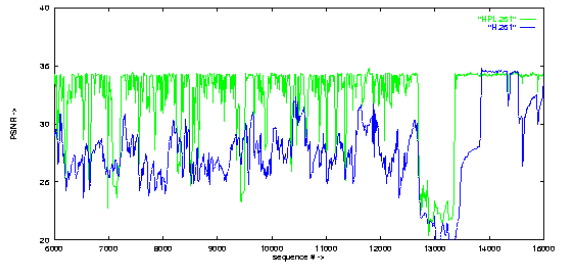
Compression Efficiency
(MPEG-4 Class A, AKIYO)



Error Resilience
(H.261 v.s. RESCU)

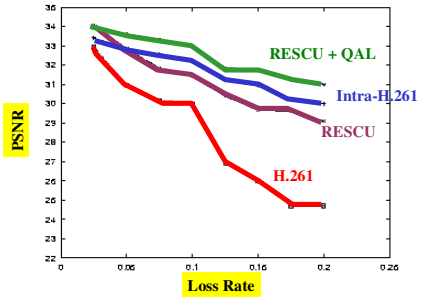


RESCU + QAL



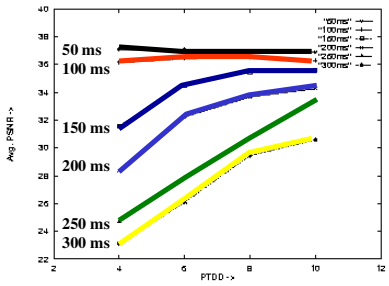
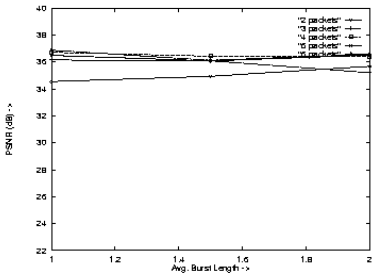
Error Resilience

various loss groups



Conclusions

- RESCU accommodates delays in recovery (retransmission or FEC).
- error resilience for interactive video.
- high compression efficiency.
  - need I-frames less frequently.
- Good for bandwidth-constrained, lossy networks (e.g., mobile wireless networks).
- Much more work to be done.

Error Resilience

Retransmission over various network delays