

Multimedia

Outline
Compression
RTP
Scheduling

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Compression Overview

- Encoding and Compression
 - Huffman codes
- Lossless
 - data received = data sent
 - used for executables, text files, numeric data
- Lossy
 - data received does not != data sent
 - used for images, video, audio

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Lossless Algorithms

- Run Length Encoding (RLE)
 - example: AAABBCDDDD encoding as 3A2B1C4D
 - good for scanned text (8-to-1 compression ratio)
 - can increase size for data with variation (e.g., some images)
- Differential Pulse Code Modulation (DPCM)
 - example AAABBCDDDD encoding as A0001123333
 - change reference symbol if delta becomes too large
 - works better than RLE for many digital images (1.5-to-1)

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Dictionary-Based Methods

- Build dictionary of common terms
 - variable length strings
- Transmit index into dictionary for each term
- Lempel-Ziv (LZ) is the best-known example
- Commonly achieve 2-to-1 ration on text
- Variation of LZ used to compress GIF images
 - first reduce 24-bit color to 8-bit color
 - treat common sequence of pixels as terms in dictionary
 - not uncommon to achieve 10-to-1 compression (x3)

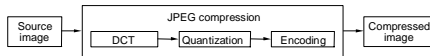
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Image Compression

- JPEG: Joint Photographic Expert Group (ISO/ITU)
- Lossy still-image compression
- Three phase process



- process in 8x8 block chunks (macro-block)
- grayscale: each pixel is three values (YUV)
- DCT: transforms signal from spatial domain into and equivalent signal in the frequency domain (loss-less)
- apply a quantization to the results (lossy)
- RLE-like encoding (loss-less)

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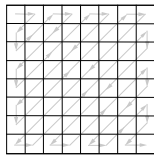
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Quantization and Encoding

- Quantization Table

3	5	7	9	11	13	15	17
5	7	9	11	13	15	17	19
7	9	11	13	15	17	19	21
9	11	13	15	17	19	21	23
11	13	15	17	19	21	23	25
13	15	17	19	21	23	25	27
15	17	19	21	23	25	27	29
17	19	21	23	25	27	29	31

- Encoding Pattern



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MPEG

- Motion Picture Expert Group
- Lossy compression of video
- First approximation: JPEG on each frame
- Also remove inter-frame redundancy

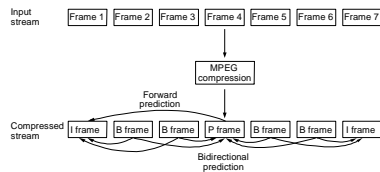
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MPEG (cont)

- Frame types
 - I frames: intrapicture
 - P frames: predicted picture
 - B frames: bidirectional predicted picture



- Example sequence transmitted as I P B B I B B

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MPEG (cont)

- B and P frames
 - coordinate for the macroblock in the frame
 - motion vector relative to previous reference frame (B, P)
 - motion vector relative to subsequent reference frame (B)
 - delta for each pixel in the macro block
- Effectiveness
 - typically 90-to-1
 - as high as 150-to-1
 - 30-to-1 for I frames
 - P and B frames get another 3 to 5x

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MP3

- CD Quality
 - 44.1 kHz sampling rate
 - $2 \times 44.1 \times 1000 \times 16 = 1.41$ Mbps
 - $49/16 \times 1.41$ Mbps = 4.32 Mbps
- Strategy
 - split into some number of frequency bands
 - divide each subband into a sequence of blocks
 - encode each block using DCT + Quantization + Huffman
 - trick: how many bits assigned to each subband

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RTP

- Application-Level Framing
- Data Packets
 - sequence number
 - timestamp (app defines “tick”)
- Control Packets (send periodically)
 - loss rate (fraction of packets received since last report)
 - measured jitter

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Transmitting MPEG

- Adapt the encoding
 - resolution
 - frame rate
 - quantization table
 - GOP mix
- Packetization
- Dealing with loss
- GOP-induced latency

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Layered Video

- Layered encoding
 - e.g., wavelet encoded
- Receiver Layered Multicast (RLM)
 - transmit each layer to a different group address
 - receivers subscribe to the groups they can “afford”
 - Probe to learn if you can afford next higher group/layer
- Smart Packet Dropper (multicast or unicast)
 - select layers to send/drop based on observed congestion
 - observe directly or use RTP feedback

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Real-Time Scheduling

- Priority
- Earliest Deadline First (EDF)
- Rate Monotonic (RM)
- Proportional Share
 - with feedback
 - with adjustments for deadlines

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