Lecture10 – Audio Compression and Resource Management

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Admin

- Classes
  - Wed – No PSU classes – Veteran's Day
- Programming Assignment 2
  - Due 11/18/2015
  - Binary vs. ASCII output file
- Rest of Quarter (Tentatively)
  - HW 5 – Assign 11/16 – Due 11/23
  - HW 6 – Assign 11/23 – Due 12/2

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PA2

•) Output ASCII

DCT

2 5 3
7 4
6

2 5 7 6 14

8 coefficients

•) DCT

$F(u,v) = \sum C_u C_v \cos(\quad)u\pi \cos(\quad)v\pi$

$C_v = \begin{cases} \frac{1}{\sqrt{2}} & v=0 \\ 1 & v>0 \end{cases}$

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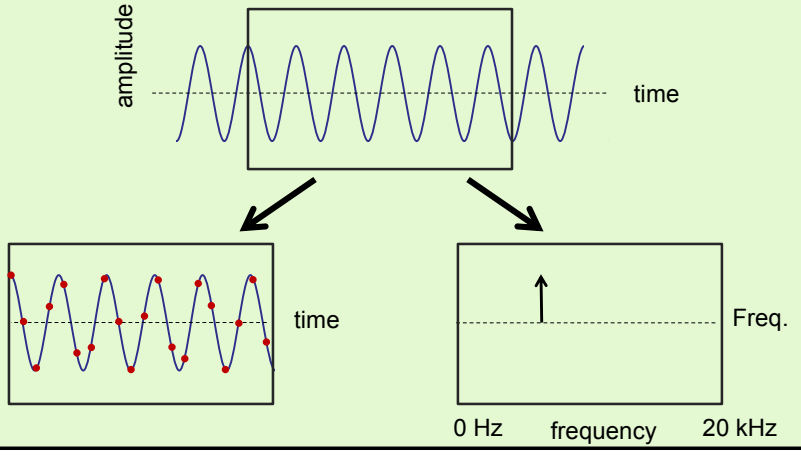
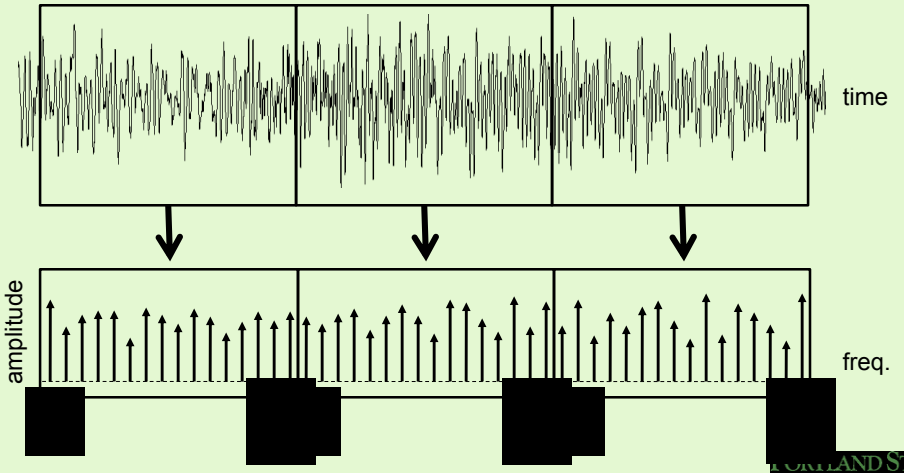
MPEG Audio Refresh

- Sound can sometimes be represented more compactly



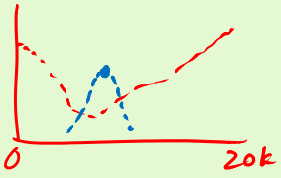
MPEG Audio Background

- Generalizing to audio



Three Limitations of Human Hearing

Threshold of Quiet



Frequency Masking = —

Temporal Masking pre

MPEG Audio – Critical bands

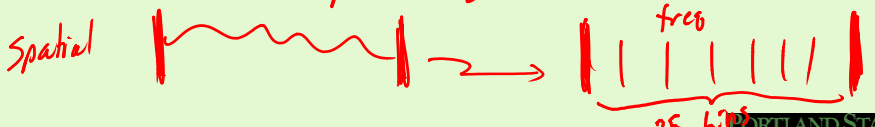
Human ability to distinguish pitch not very good

lower freq < 1000 Hz

higher freq - ability to distinguish pitch ~4000 Hz

IF several tones are nearby, the human ear combines into a single pulsating pitch

Entire human hearing range can be made up of 25 critical bands



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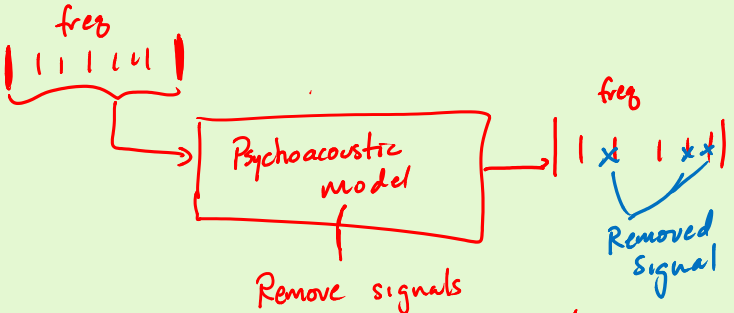
MPEG Audio – Psychoacoustic Models

Models limitations of human hearing



Remove signals that humans (in general cannot hear)

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MPEG Audio Compression

↳ specifies format of compliant compressed stream

do not specify how encoder works

-) Uses freq domain transform
-) Psychoacoustic model to remove irrelevant parts of signal
-) Entropy encoding of remaining signal

Resulting compression:

2.7 - 24:1 compression ratio

~10:1 128 kbps MP3

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MPEG Audio Options

Don't memorize

- Sampling rates: 32 kHz, 44.1 kHz, 48 kHz
- Four different channel modes:
  - Monophonic
  - Dual monophonic
  - Stereo
  - Joint stereo
- Compressed bit rates
  - Predefined from 32-224 kbps
  - "Free" mode — variable-bit-rate
- Layers – simplicity vs. compression

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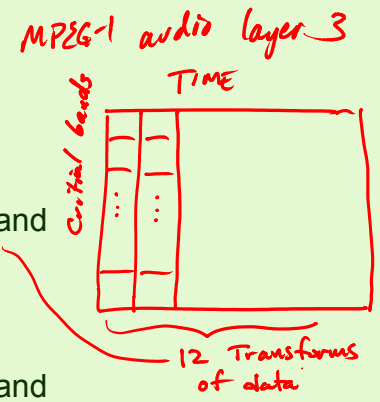
MPEG Audio Layers

- Layer 1
  - Uses 384 audio samples
  - 12 samples from each subband
- Layer 2
  - Uses 1152 samples
  - 36 samples from each subband
- Layer 3
  - Filters with modified DCT
  - Refinements: non-uniform quantization, scale-factor bands, entropy encoding of data values



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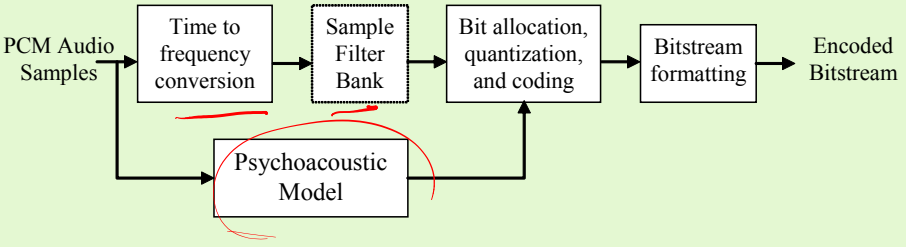
MPEG Audio Compression



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MPEG Audio Summary

- Major Components
  - Frequency domain transform
  - Remove signals that are *perceptually irrelevant*
    - *Threshold of quiet*
    - *Frequency masking*
    - *Temporal masking*
  - Entropy encoding

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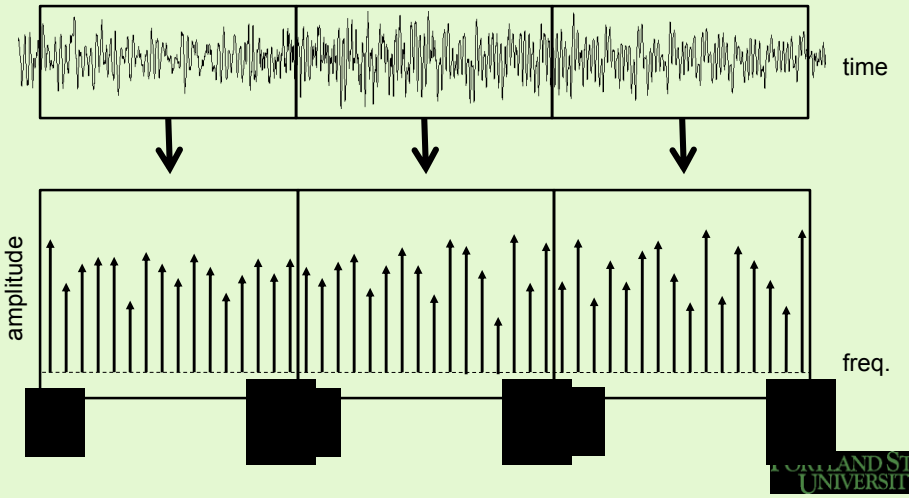
MPEG Audio Summary

- Frequency domain transform



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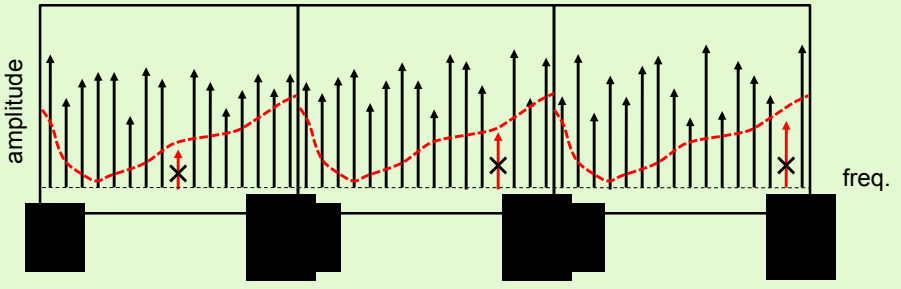
MPEG Audio Summary

- Remove signals that cannot be heard
  Threshold of Quiet



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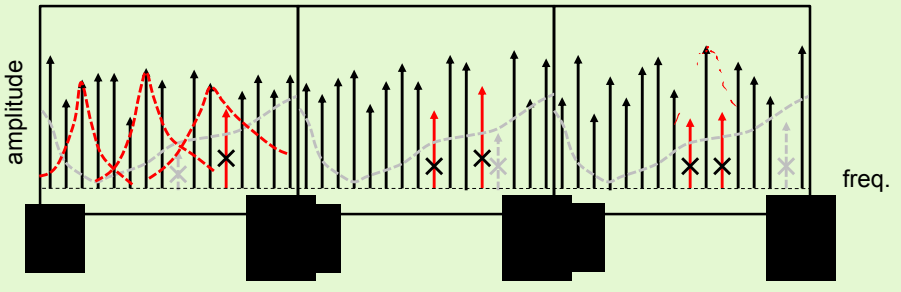
MPEG Audio Summary

- Remove signals that cannot be heard
  Frequency Masking



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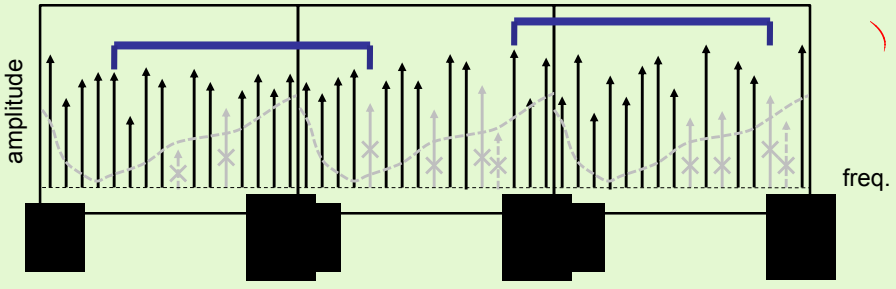
MPEG Audio Summary

- Remove signals that cannot be heard
  Temporal Masking



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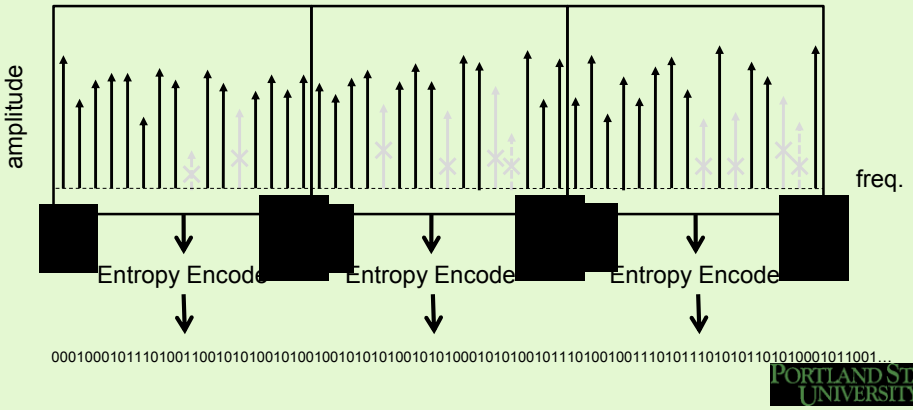
MPEG Audio Summary

- Entropy Encoding
  - Employ standard *Lossless* compression on remaining signal



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Resource Management

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Resource Management

Resource - system capability required

active resource → processing
dynamic over time

passive resource → disk
relatively static

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Resource Management

QoS = Quality of Service

Performance requirements of system - contract

Networking perspective

QoS parameters - things we are trying to achieve

- Throughput - bw over time
- Delay
- Jitter → variation in delay
- Reliability

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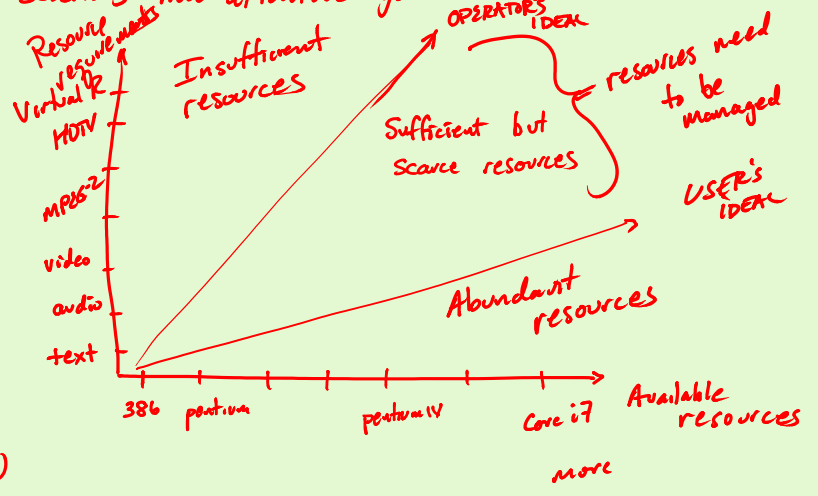
Window of Insufficient Resources

↳ describes how attentive you need to be to deliver QoS



CPU

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Phases of Resource Management

Quality of service calculation
- create "resource centric" parameters
- Are there enough resources?
  - NO → STOP

Resource reservation - set aside resources

Resource scheduling
- Actual processing
- May have policing

optomistic vs Pessimistic scheduling
- how much slack do you leave in system

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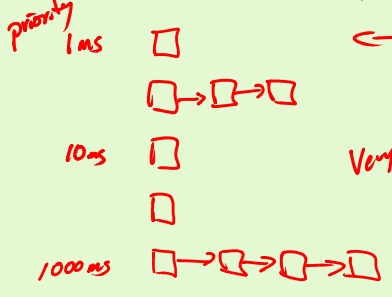
Operating Systems - processes

Process - memory + compute power

O.S. - responsible for running the processes

Scheduler

Canonical O.S. scheduler is a round-robin, priority-based, feedback scheduler



← interactive

Very hard to ensure Real-time

← compute bound jobs

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Multimedia Operating Systems

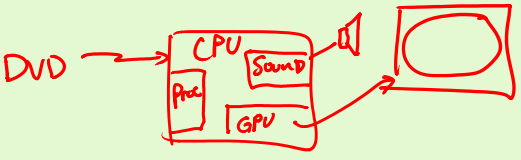
Difficulty for MM is:

-) Continuity over time
-) Timing is important

  Video needs to be paced

  Audio + video need to be synchronized

  < 100 - 150ms off



Real Time System Basics

Real-time (RT) process is a process that delivers the results of processing in a given time span

ex: missile tracking, nuclear reactor shutdown

RT systems implies

-) correctness of results (finish)
-) timing of results – not too fast as well

Deadlines

Deadline - last acceptable time for presenting result

Three types:

Hard RT: No deadline can be missed
implies missed deadline is catastrophic

Soft RT: missed deadline is not catastrophic
not too many deadlines missed
not missed by much

Non-RT: don't have deadlines (email)

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Characteristics of RT / MM Systems

SOFT RT

Video jitter is more acceptable than audio jitter

Always favor audio

Multimedia is periodic
Video typically 30 fps
Audio - sampling rate

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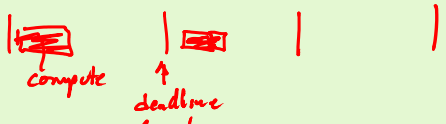
RT Scheduler Types

Assumptions

- Hard deadlines are periodic
- Tasks complete before next request occurs



- Tasks are independent
- Run-time is constant for each task

Two types of schedulers:

- Static - fixed priorities – rate monotonic scheduling
- dynamic priority - deadline driven scheduling

Terminology

$\tau_1, \tau_2 \ldots \tau_m \Rightarrow$ m periodic tasks

$T_1 \ldots T_m \Rightarrow$ request periods

$C_1 \ldots C_m \Rightarrow$ run time of each task