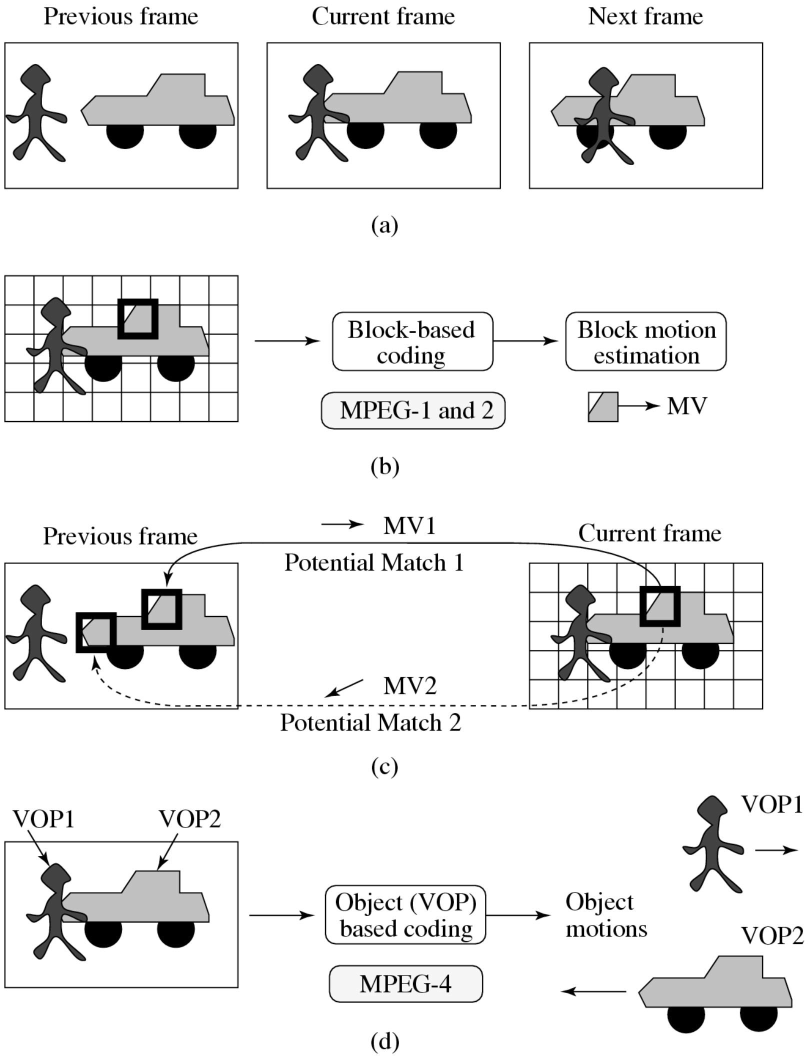
Bluray (http://www.blu-ray.com/faq)

- MPEG-2 - enhanced for HD, also used for playback of DVDs and HDTV recordings
- MPEG-4 AVC - part of the MPEG-4 standard also known as H.264 (High Profile and Main Profile)
- SMPTE VC-1 - standard based on Microsoft's Windows Media Video (WMV) technology
- Video bitrate - 40.0Mbps (vs ~10 Mbps for DVD)

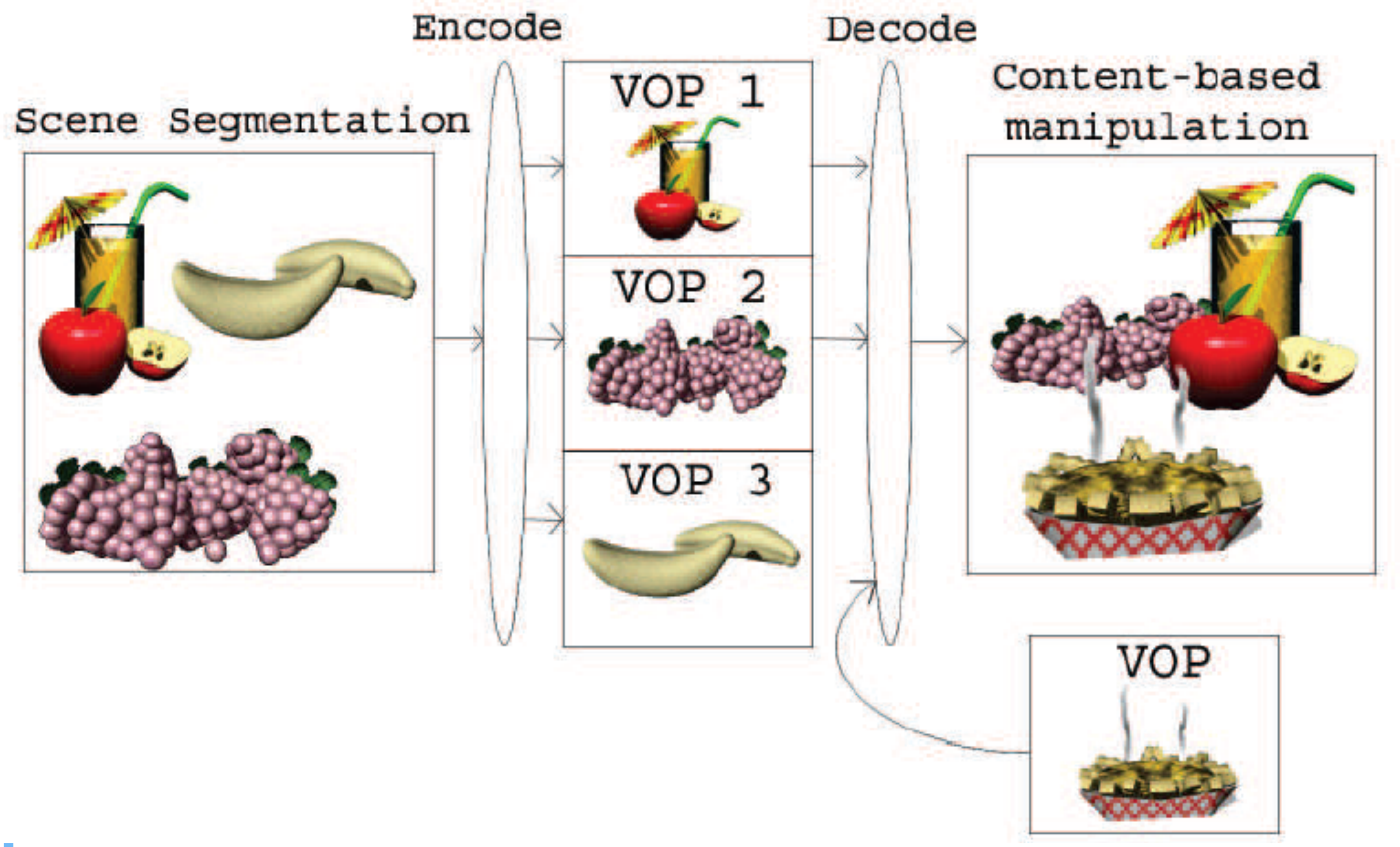
MPEG-4

- MPEG-4 adopts a **object-based coding**:
  - Offering higher compression ratio, also beneficial for digital video composition, manipulation, indexing, and retrieval
  - The bit-rate for MPEG-4 video now covers a large range between 5 kbps to 10 Mbps
  - More interactive than MPEG-1 and MPEG-2

Comparison between Block-based Coding and Object-based Coding



Composition and manipulation of object



Overview of MPEG-4

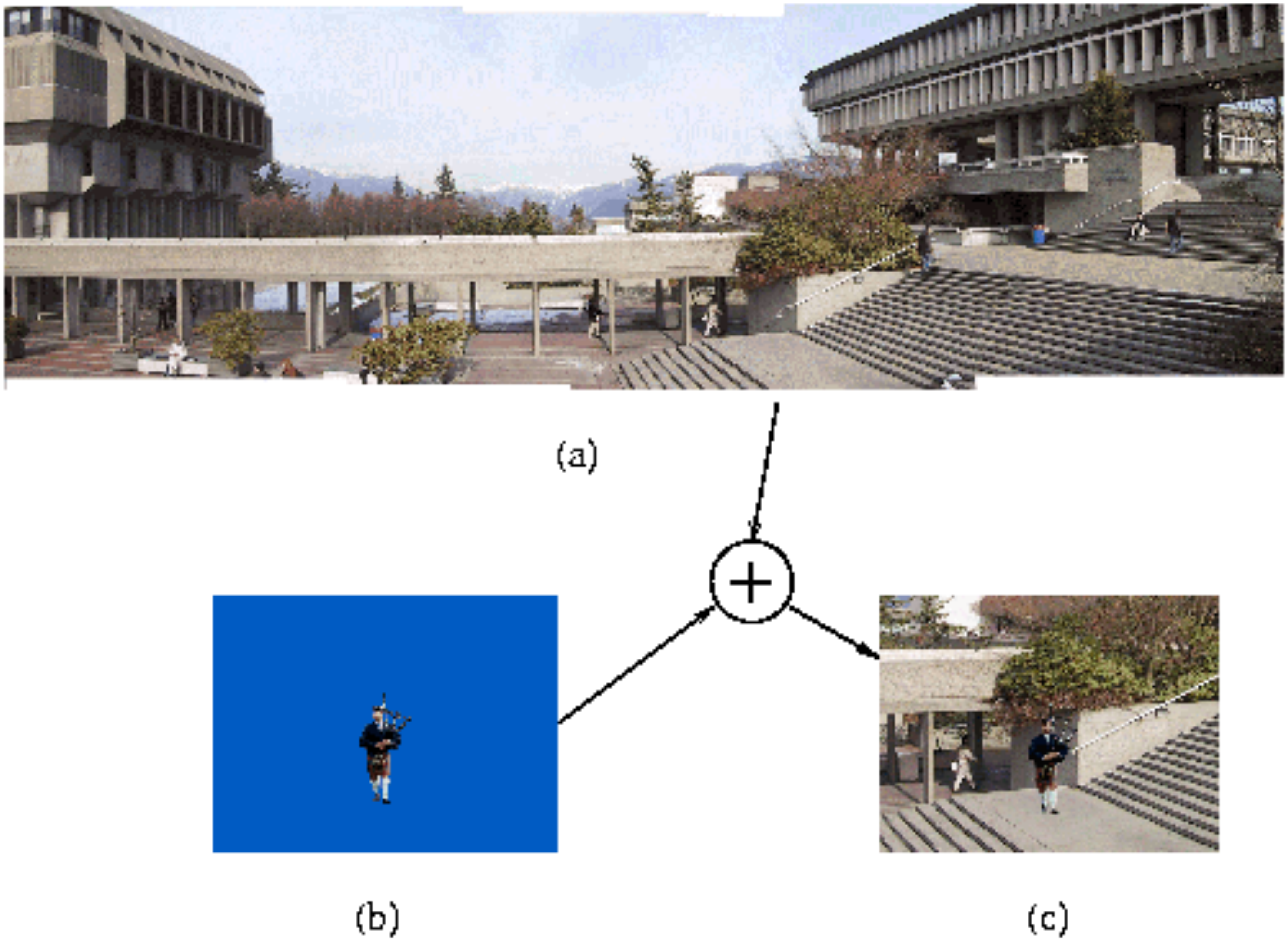
1. Video-object Sequence (VS)—delivers the complete MPEG-4 visual scene, which may contain 2-D or 3-D natural or synthetic objects
2. Video Object (VO) — a object in the scene, which can be of arbitrary shape corresponding to an object or background of the scene
3. Video Object Layer (VOL) — facilitates a way to support (multi-layered) scalable coding. A VO can have multiple VOLs under scalable coding, or have a single VOL under non-scalable coding
4. Group of Video Object Planes (GOV) — groups Video Object Planes together (optional level)
5. Video Object Plane (VOP) — a snapshot of a VO at a particular moment

Object oriented

- VOP – I-VOP, B-VOP, P-VOP
- Objects can be arbitrary shape – need to encode the shape and the texture (object)
  - Need to treat MB inside object different than boundary blocks (padding, different DCT etc)

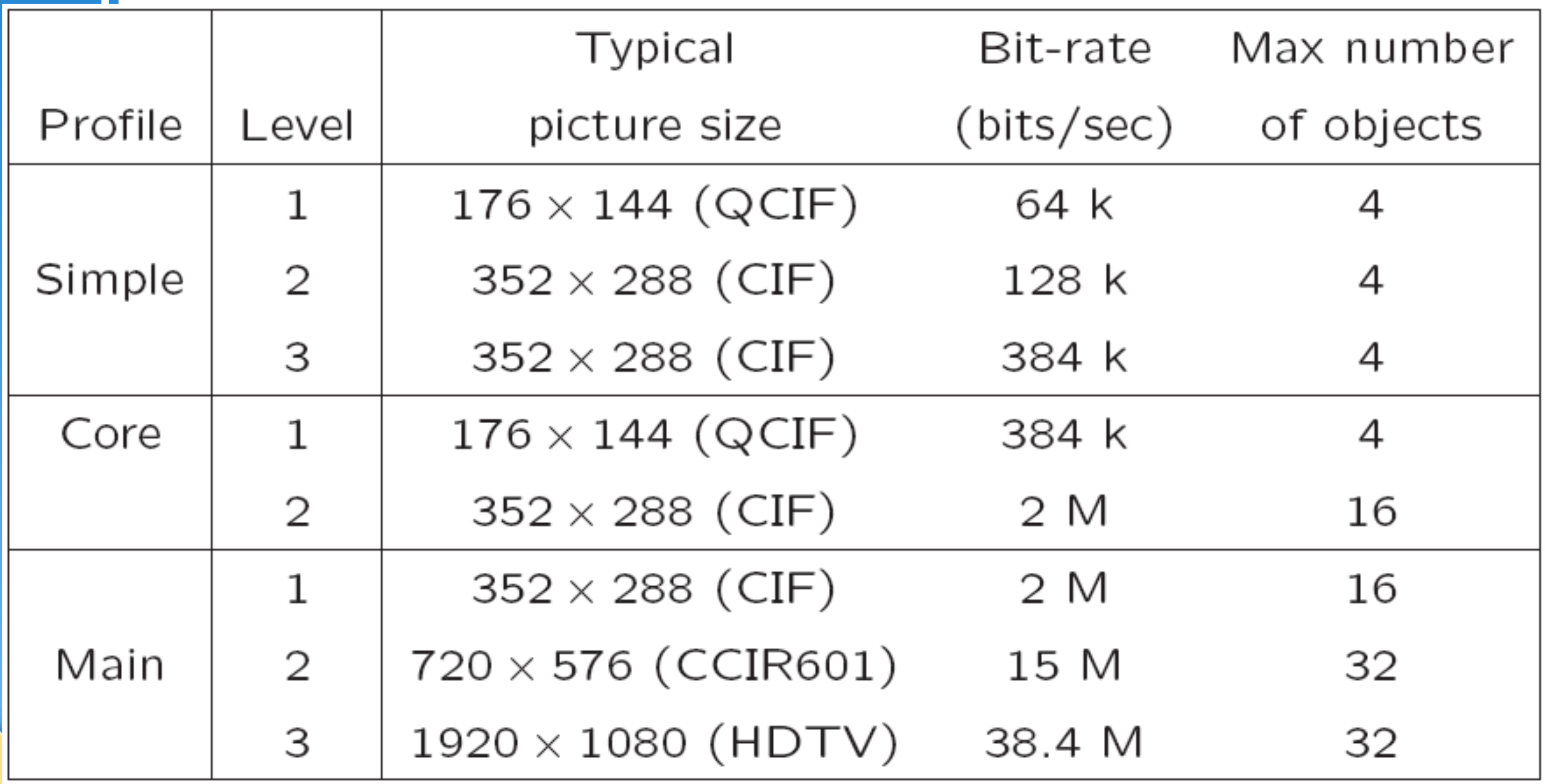
Sprite Coding

- A **sprite** is a graphic image that can freely move around within a larger graphic image or a set of images
- To separate the foreground object from the background, we introduce the notion of a **sprite panorama**: a still image that describes the static background over a sequence of video frames
  - The large sprite panoramic image can be encoded and sent to the decoder only once at the beginning of the video sequence
  - When the decoder receives separately coded foreground objects and parameters describing the camera movements thus far, it can reconstruct the scene in an efficient manner


(a)
+
(b)
(c)

Global Motion Compensation (GMC)

- "Global" – overall change due to camera motions (pan, tilt, rotation and zoom)
  - Without GMC this will cause a large number of significant motion vectors
- There are four major components within the GMC algorithm:
  - Global motion estimation
  - Warping and blending
  - Motion trajectory coding
  - Choice of LMC (Local Motion Compensation) or GMC.

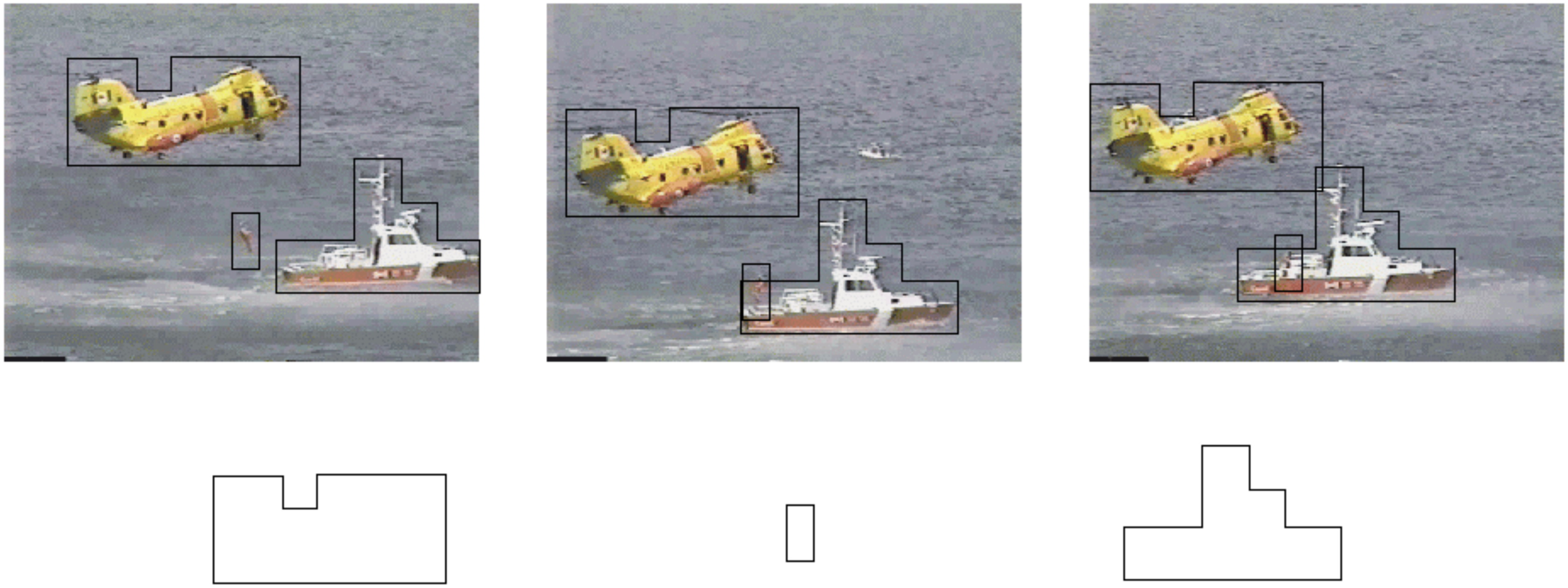


Profile	Level	Typical picture size	Bit-rate (bits/sec)	Max number of objects
Simple	1	176 × 144 (QCIF)	64 k	4
	2	352 × 288 (CIF)	128 k	4
	3	352 × 288 (CIF)	384 k	4
Core	1	176 × 144 (QCIF)	384 k	4
	2	352 × 288 (CIF)	2 M	16
Main	1	352 × 288 (CIF)	2 M	16
	2	720 × 576 (CCIR601)	15 M	32
	3	1920 × 1080 (HDTV)	38.4 M	32

MPEG-7

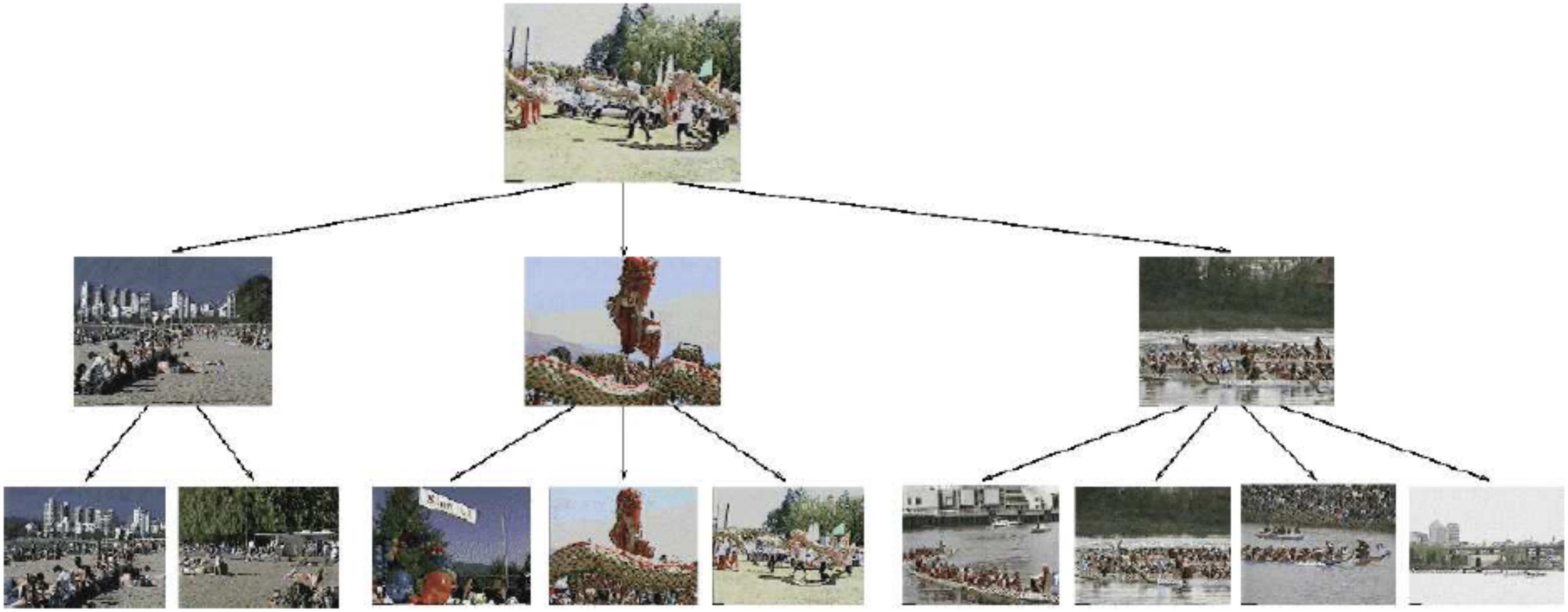
- The main objective of MPEG-7 is to serve the need of audio-visual content-based retrieval (or audiovisual object retrieval) in applications such as digital libraries

MPEG-7 video segment



Moving Region: Helicopter Moving Region: Person Moving Region: Boat

A video summary

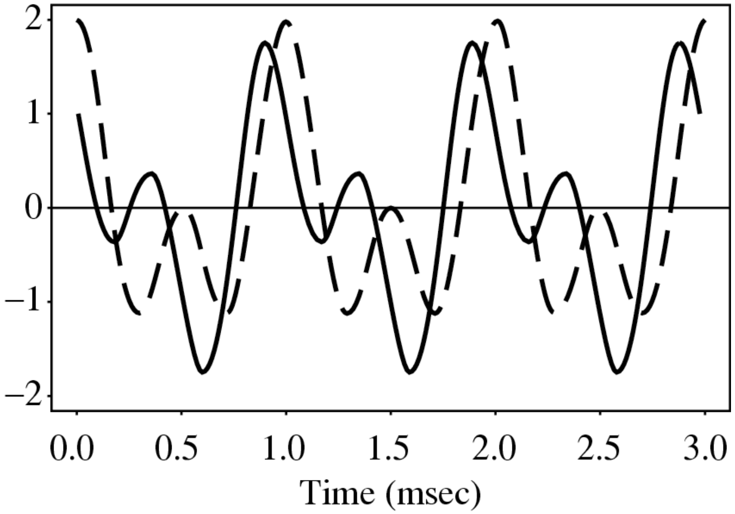


Chapter 13: VOCODER

- Voice only coder use aspects of human hearing
  - E.g. Formant Vocoder - voice is not equal represented in all frequencies because of vocal cord
  - They can produce good quality sound in 1,000 bps
- concerned with modeling speech so that the salient features are captured in as few bits as possible
  - use either a model of the speech waveform in time (LPC (Linear Predictive Coding) vocoding
  - break down the signal into frequency components and model these (channel vocoders and formant vocoders)
- Simulations are improving but still recognizable (automated phone calls)

Phase insensitivity

- A complete reconstituting of speech waveform is really unnecessary, perceptually: all that is needed is for the amount of energy at any time to be about right, and the signal will sound about right.



- Solid line: Superposition of two cosines, with a phase shift. Dashed line: No phase shift. wave is different, yet the sound is the same, perceptually

Linear Predictive Coding (LPC)

- **LPC vocoders** extract salient features of speech directly from the waveform, rather than transforming the signal to the frequency domain
- **LPC Features**:
  - uses a time-varying model of vocal tract sound generated from a given excitation
  - transmits only a set of parameters modeling the shape and excitation of the vocal tract, not actual signals or differences → small bit-rate

Chapter 14: MPEG Audio

- Psychoacoustics
  - Frequency: Remove audio that are masked anyway
    - A lower tone can effectively mask (make us unable to hear) a higher tone
    - The reverse is not true – a higher tone does not mask a lower tone well
    - The greater the power in the masking tone, the wider is its influence – the broader the range of frequencies it can mask
    - As a consequence, if two tones are widely separated in frequency then little masking occurs
  - **Temporal Phenomenon**: any loud tone will cause the hearing receptors in the inner ear to become *saturated* and require time to recover

14.2 MPEG Audio

- **MPEG audio compression** takes advantage of psychoacoustic models, constructing a large multi-dimensional lookup table to transmit masked frequency components using fewer bits
  - Applies a filter bank to the input to break it into its frequency components
  - In parallel, a psychoacoustic model is applied to the data for bit allocation block
  - The number of bits allocated are used to quantize the info from the filter bank – providing the compression

MPEG Layers

- Each succeeding layer offering more complexity in the psychoacoustic model and better compression for a given level of audio quality
  - Layer 1 quality can be quite good provided a comparatively high bit-rate is available
    - Digital Audio Tape typically uses Layer 1 at around 192 kbps
  - Layer 2 has more complexity; was proposed for use in Digital Audio Broadcasting
  - Layer 3 (MP3) is most complex, and was originally aimed at audio transmission over ISDN lines
- Most of the complexity increase is at the encoder, not the decoder – accounting for the popularity of MP3 players

Summary

- Apply different set of heuristics (than video), yet achieve the goal of attaining good compression by removing components that the human ear is not good at distinguishing
- More complexity at the encoding phase leads to better compression
- Humans are lot more sensitive to dropped “frames” in audio than in video. Audio should also be well synchronized - otherwise distracting
- Humans also like audio better than video, TVs/ DVDs send higher fidelity audio