

Analysis of MPEG

MPEG: the Organization

- Moving Picture Experts Group**
- Established in 1988**
- Standards under International Organization for standardization (ISO) and International Electro technical Commission (IEC)**
- Official name is: ISO/IEC JTC1 SC29 WG11**

MPEG vs. Competitor

❑ Generally produces better quality than the other formats such as:

- ❑ Video for Window

- ❑ Index and QuickTime

❑ MPEG audio/video compression can be used many applications:

- ❑ DVD player

- ❑ HDTV recorder

- ❑ Internet Video

- ❑ Video Conferences

- ❑ Others

MPEG Overview

- ❑ MPEG-1 : a standard for storage and retrieval of moving pictures and audio on storage media
- ❑ MPEG-2 : a standard for digital television
- ❑ MPEG-4 : a standard for multimedia applications
- ❑ MPEG-7 : a content representation standard for information search
- ❑ MPEG-21: offers metadata information for audio and video files

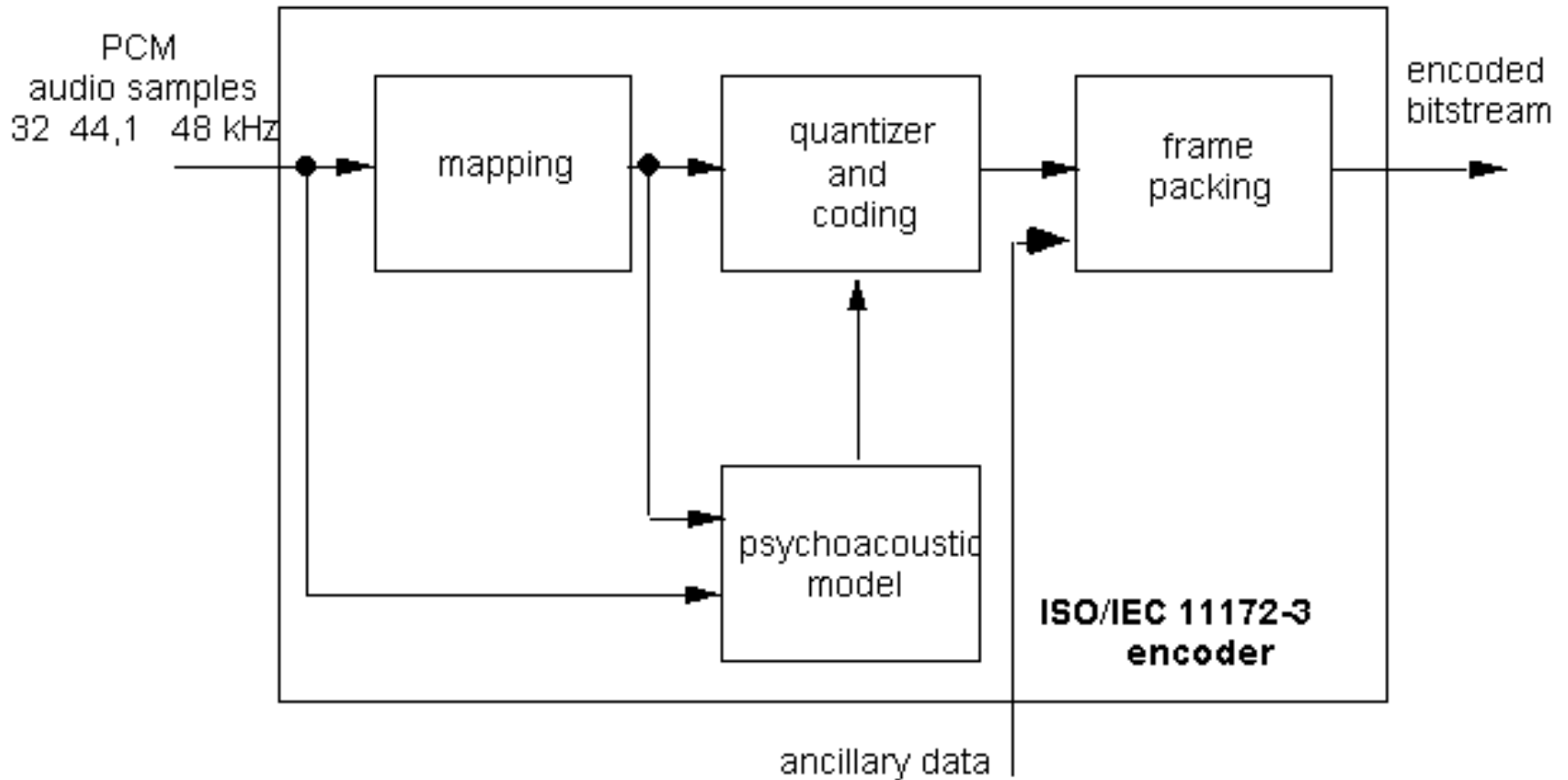
MPEG 1

- ❑ First standard to be published by the MPEG organization (in 1992)
- ❑ A standard for storage and retrieval of moving pictures and audio on storage media
- ❑ Example formats: VideoCD (VCD), mp3, mp2

5 Parts of MPEG 1

- ❑ Part 1: Combining video and audio inputs into a single/multiple data stream
- ❑ Part 2: Video Compression
- ❑ Part 3: Audio Compression
- ❑ Part 4: Requirements Verification
- ❑ Part 5: Technical report on the software implementation of the Parts 1 - 3

Basic Structure of Audio Encoder



Note: A decoder basically works in just the opposite manner

Processes of and Audio Encoder

- ❑ Mapping Block – divides audio inputs into 32 equal-width frequency subbands (samples)
- ❑ Psychoacoustic Block – calculates masking threshold for each subband
- ❑ Bit-Allocation Block – allocates bits using outputs of the Mapping and Psychoacoustic blocks
- ❑ Quantizer & Coding Block – scales and quantize (reduce) the samples
- ❑ Frame Packing Block – formats the samples with headers into an encoded stream

MPEG-1 Layers I, II, III

- ❑ MPEG layer differences lie in processing power and resulting audio/sound quality
 - ❑ Mp1 – little processing needed, poor quality
 - ❑ Mp2 – minimal processing, “okay” quality
 - ❑ Mp3 – massive processing, high “CD” quality

MPEG-2 Overview

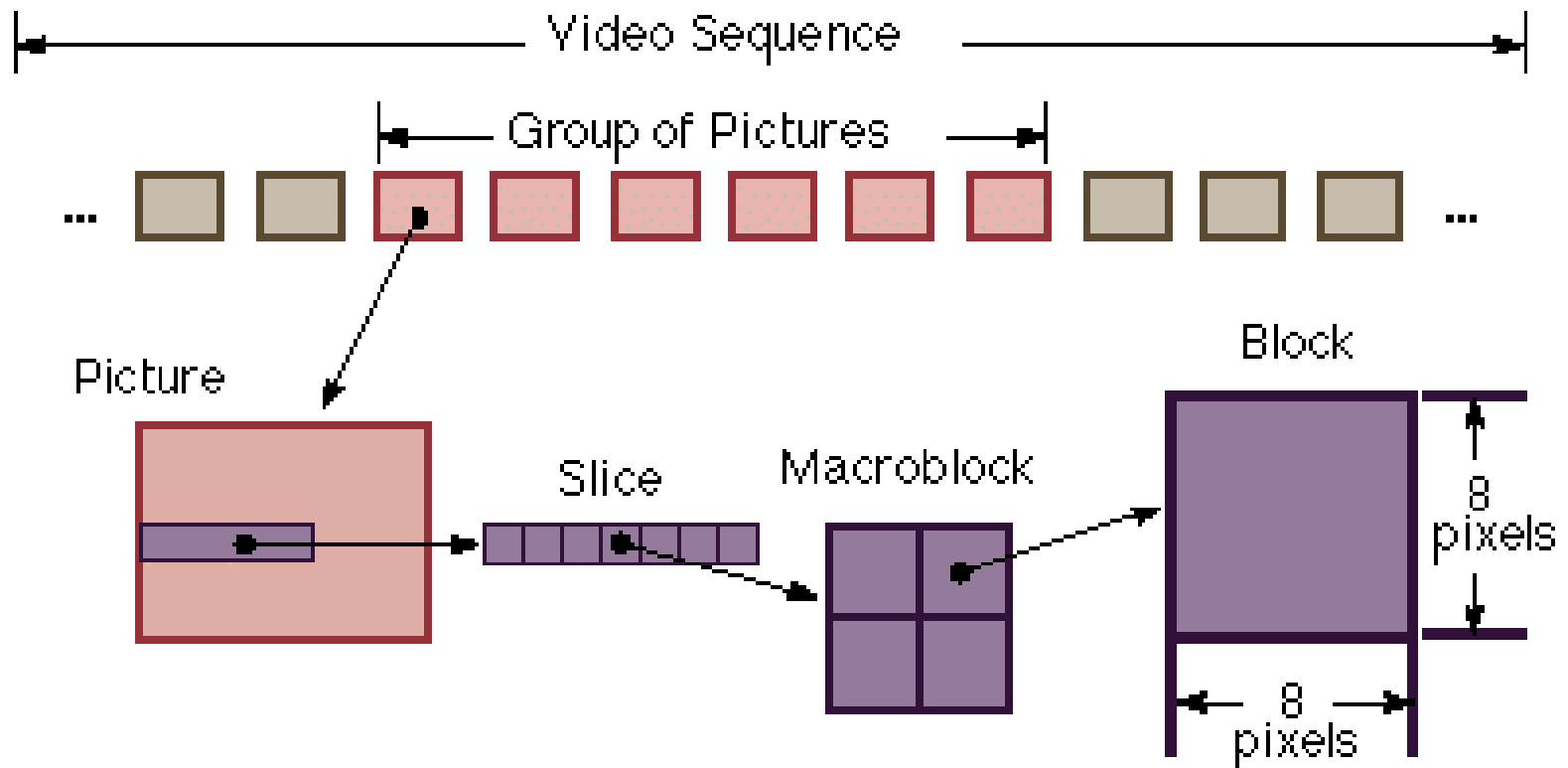
- ❑ Extends video & audio compression of MPEG-1
 - ❑ Substantially reduces bandwidth required for high-quality transmissions
 - ❑ Optimizes balance between resolution (quality) and bandwidth (speed)

10 Parts of MPEG-2

- ❑ Part 1: Combine video and audio data into single/multiple streams
- ❑ Part 2: Offers more advanced video compression tools
- ❑ Part 3: Is a multi-channel extension of the MPEG-1 Audio standard
- ❑ Part 4/5: Correspond to and build on part 4/5 of MPEG-1
- ❑ Part 6: Specifies protocols of managing MPEG-1 & MPEG-2 bitstreams
- ❑ Part 7: Specifies a multi-channel audio coding algorithm
- ❑ Part 8: (was discontinued because of obsolescence)
- ❑ Part 9: specifies the Real-time Interface (RTI) to Transport Stream decoders
- ❑ Part 10: the conformance part of Digital Storage Media Command and Control (currently under development)

MPEG-2 Video Compression Overview

VIDEO STREAM DATA HIRERARCHY



MPEG-2 Video Compression Overview

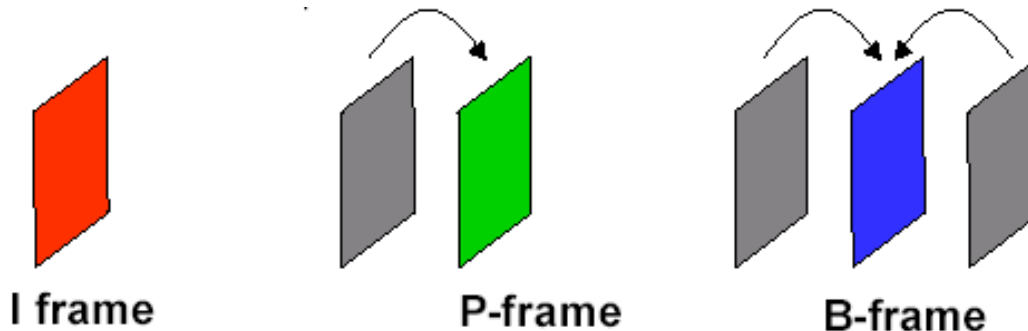
□ Video stream

□ Group of Pictures (GOP)

□ **I-frames**: can be reconstructed without any reference to other frames

□ **P-frames**: forward predicted from last **I-frame** and **P-frames**

□ **B-frames**: forward and backward predicted



MPEG-2 Video Compression Overview

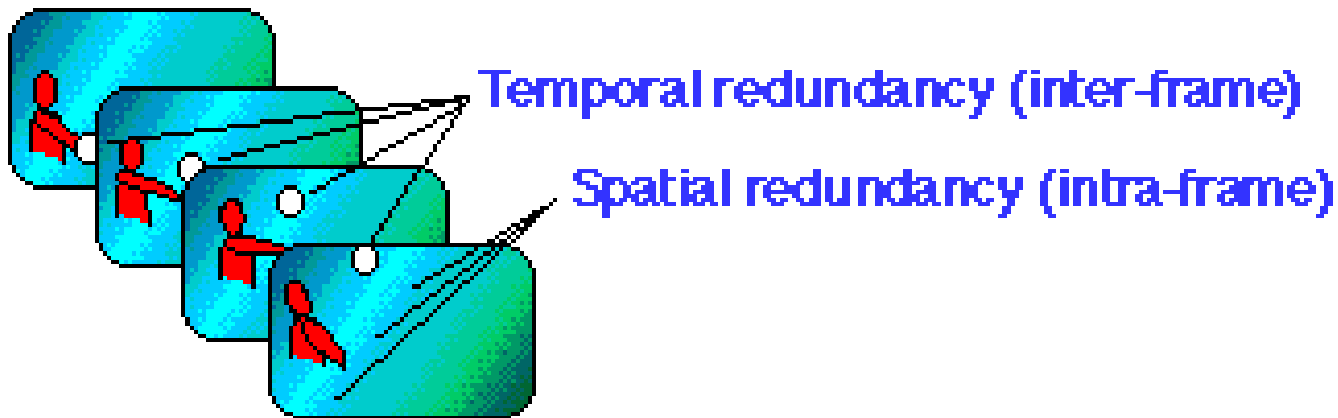
❑ Compression: Eliminating Redundancies

❑ Spatial Redundancy

- ❑ Pixels are replicated within a single frame of video

❑ Temporal Redundancy

- ❑ Consecutive frames of video display images of the same scene



MPEG-2 Video Compression Overview

Four Video Compression Techniques:

1. Pre-processing
2. Temporal Prediction
3. Motion Compensation
4. Quantization

MPEG-2 Video Compression Overview

□ Pre-processing

- Filters out unnecessary information

- Information that is difficult to encode

- Not an important component of human visual perception

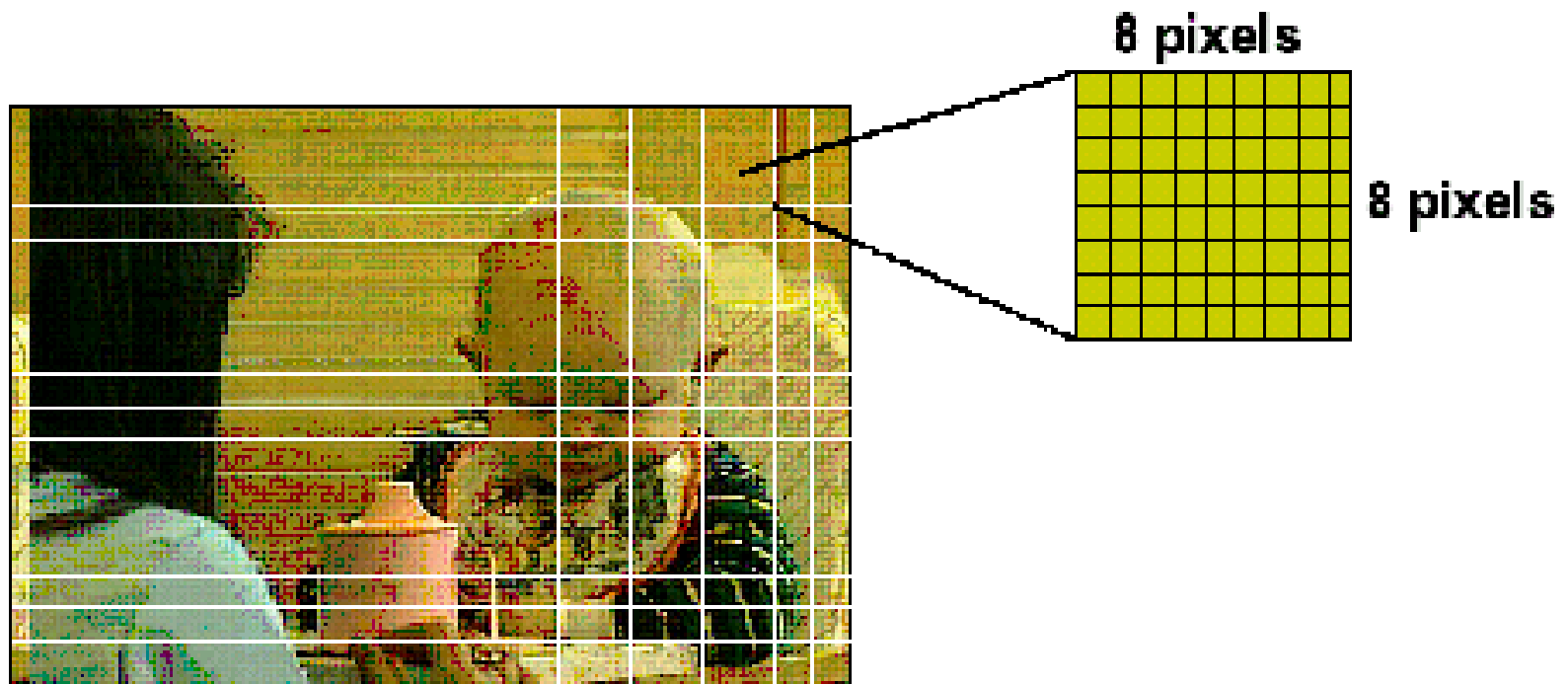
MPEG-2 Video Compression Overview

□ Temporal Prediction:

- Uses the mathematical algorithm Discrete Cosine Transform (DCT) to:

- Divide each frame into 8X8 blocks of pixels
- Reorganize residual differences between frames
- Encode each block separately

MPEG-2 Video Compression Overview



MPEG-2 Video Compression Overview

Only Moving Areas Have to Be Coded



Encoder

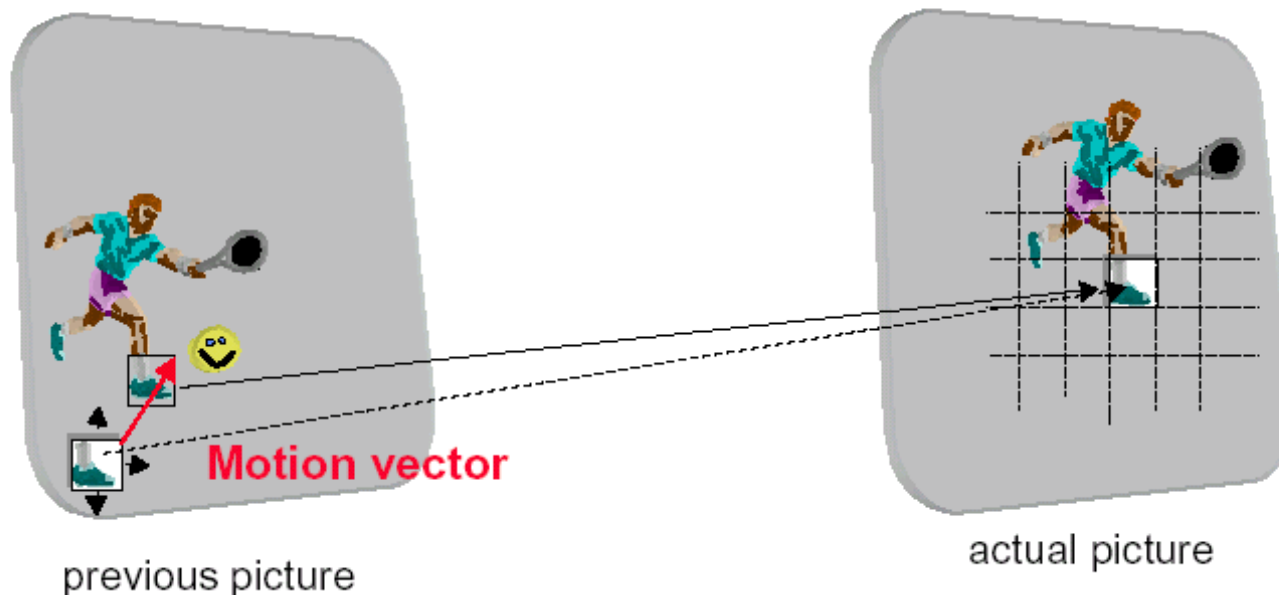
Decoder



MPEG-2 Video Compression Overview

Motion Compensation

- Try to match each block in the actual picture to content in the previous picture. Matching is made by shifting each of the 8 x 8 blocks of the two successive pictures pixel by pixel each direction -> Motion vector
- Subtract the two blocks -> Difference block
- Transmit the motion vector and the difference block



MPEG-2 Video Compression Overview

□ Quantization:

- Refers to DCT coefficients
- Removes subjective redundancy
- Controls compression factor
- Converts coefficients into even smaller numbers

MPEG-2 Video Compression Overview

❑ Where It Is Used:

- ❑ Multimedia Communications
- ❑ Webcasting
- ❑ Broadcasting
- ❑ Video on Demand
- ❑ Interactive Digital Media
- ❑ Telecommunications
- ❑ Mobile communications

MPEG-2 Transmission Overview

□ Building the MPEG Bit Stream:

□ *Elementary Stream (ES)*

- Digital Control Data
- Digital Audio
- Digital Video
- Digital Data

□ *Packetised Elementary Stream (PES)*

- Each ES combined into stream of PES packets.
- A PES packet may be fixed (or variable) sized block.
- Each block has up to 65536 bytes per block and a 6 byte protocol header.

MPEG-2 Transmission Cont.

□ MPEG-2 Multiplexing

□ *MPEG Program Stream*

- Tightly coupled PES packets
- Used for video playback and network application

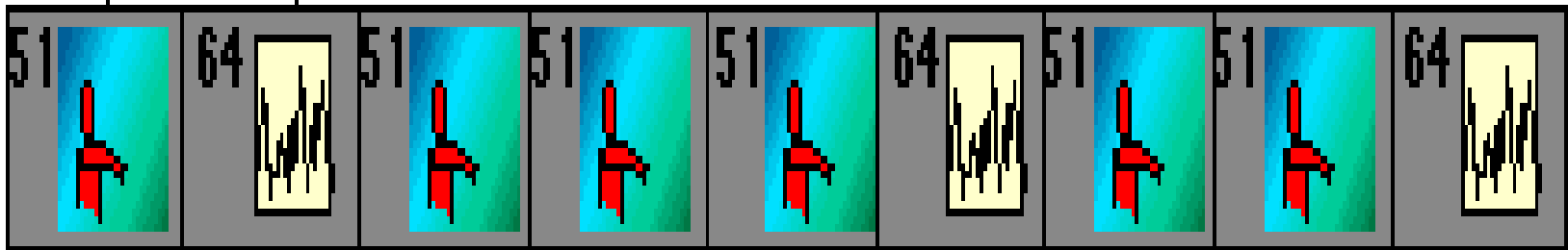
□ *MPEG Transport Stream*

- Each PES packet is broken into fixed-sized transport packets

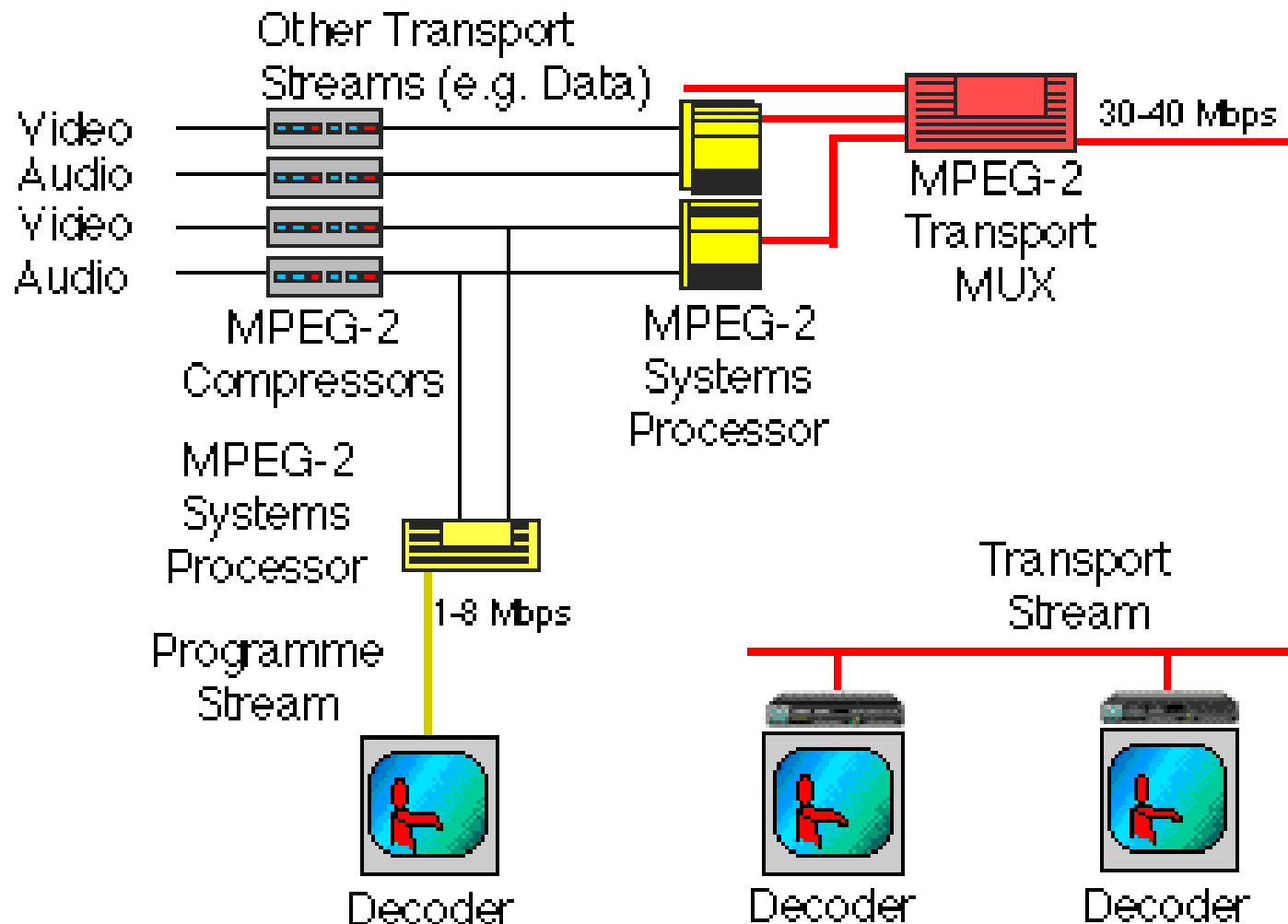
MPEG Transport Streams

Video packet

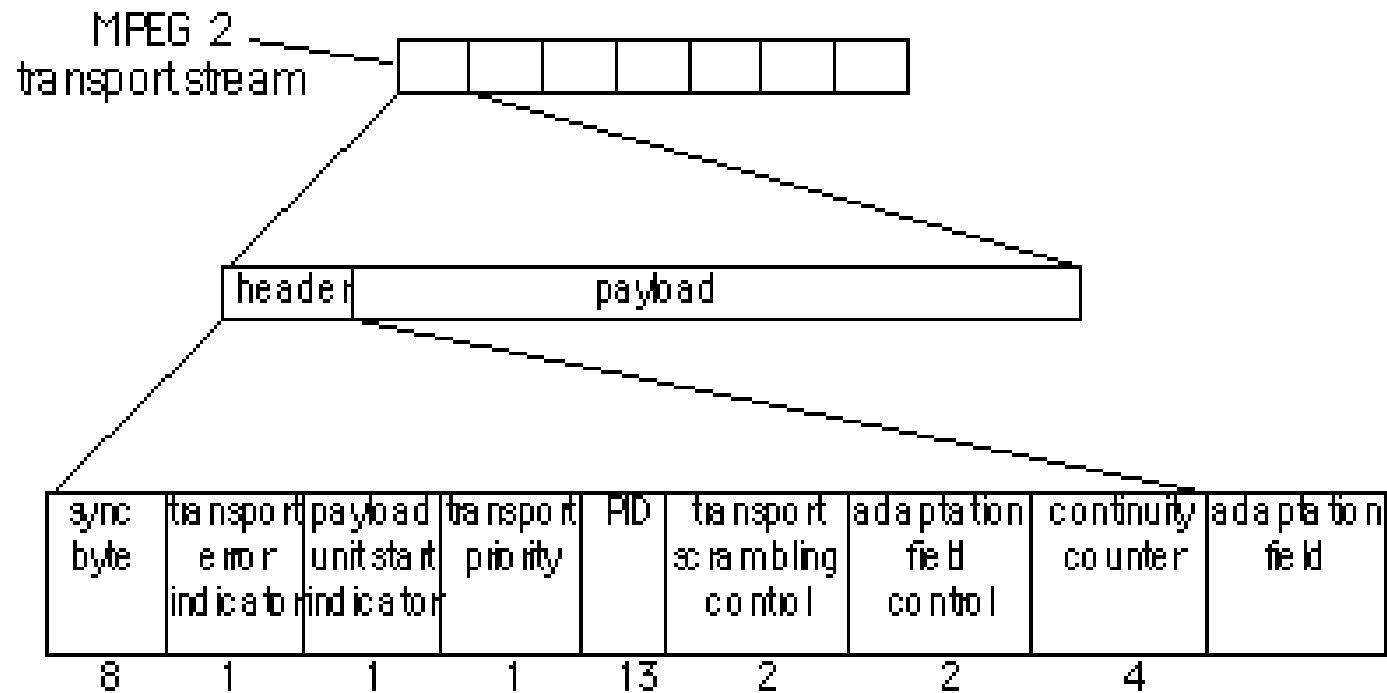
Audio packet



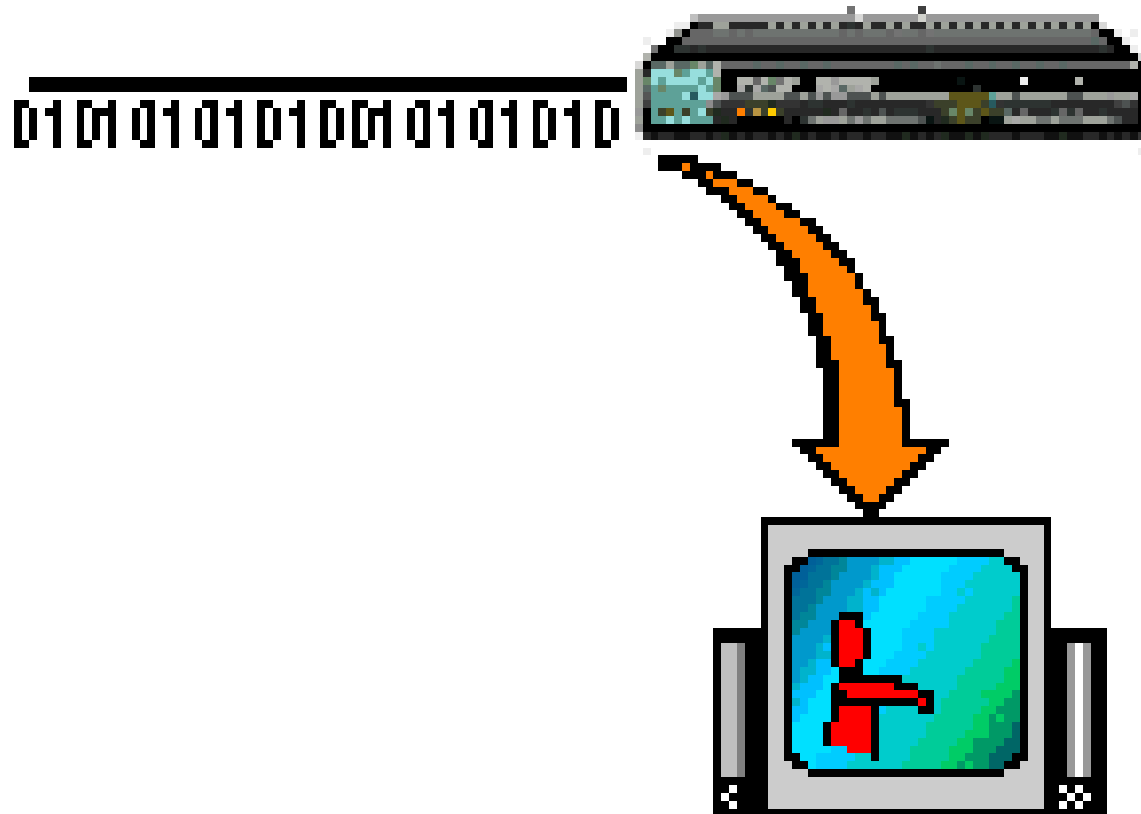
Combining ES from Encoders into a Transport Stream



Format of a Transport Stream Packet



MPEG-2 Encoders

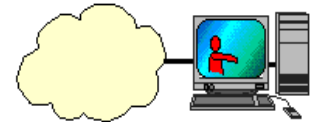


Types of MPEG-2 Decoders

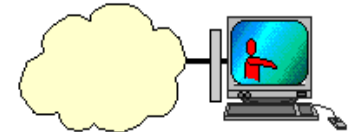
1. MPEG-2 Software Decoder & PC-Based Accelerator



2. MPEG-2 Computer Decoder



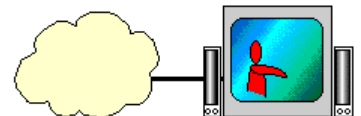
3. MPEG-2 Network Computers/Thin Clients



4. MPEG-2 Set-Top Box



5. MPEG-2 Consumer Equipment



MPEG-4 Overview

□ Submergence

- Handle specific requirements from rapidly developing multimedia applications

□ Advantages over MPEG-1 and MPEG-2

- Object-oriented coding

MPEG-4 Standard: 6 Parts Overview

- ❑ **Part 1: Systems** - specifies scene description, multiplexing, synchronization, buffer management, and management and protection of intellectual property.
- ❑ **Part 2: Visual** - specifies the coded representation of natural and synthetic visual objects .
- ❑ **Part 3: Audio** - specifies the coded representation of natural and synthetic audio objects.
- ❑ **Part 4: Conformance Testing** - defines conformance conditions for bit streams and devices; this part is used to test MPEG-4 implementations.
- ❑ **Part 5: Reference Software** - includes software corresponding to most parts of MPEG-4, it can be used for implementing compliant products as ISO waives the copyright of the code.
- ❑ **Part 6: Delivery Multimedia Integration Framework (DMIF)** - defines a session protocol for the management of multimedia streaming over generic delivery technologies.

Features & Functionalities

❑ Object Oriented

- ❑ Primitive Audiovisual Objects are Coded

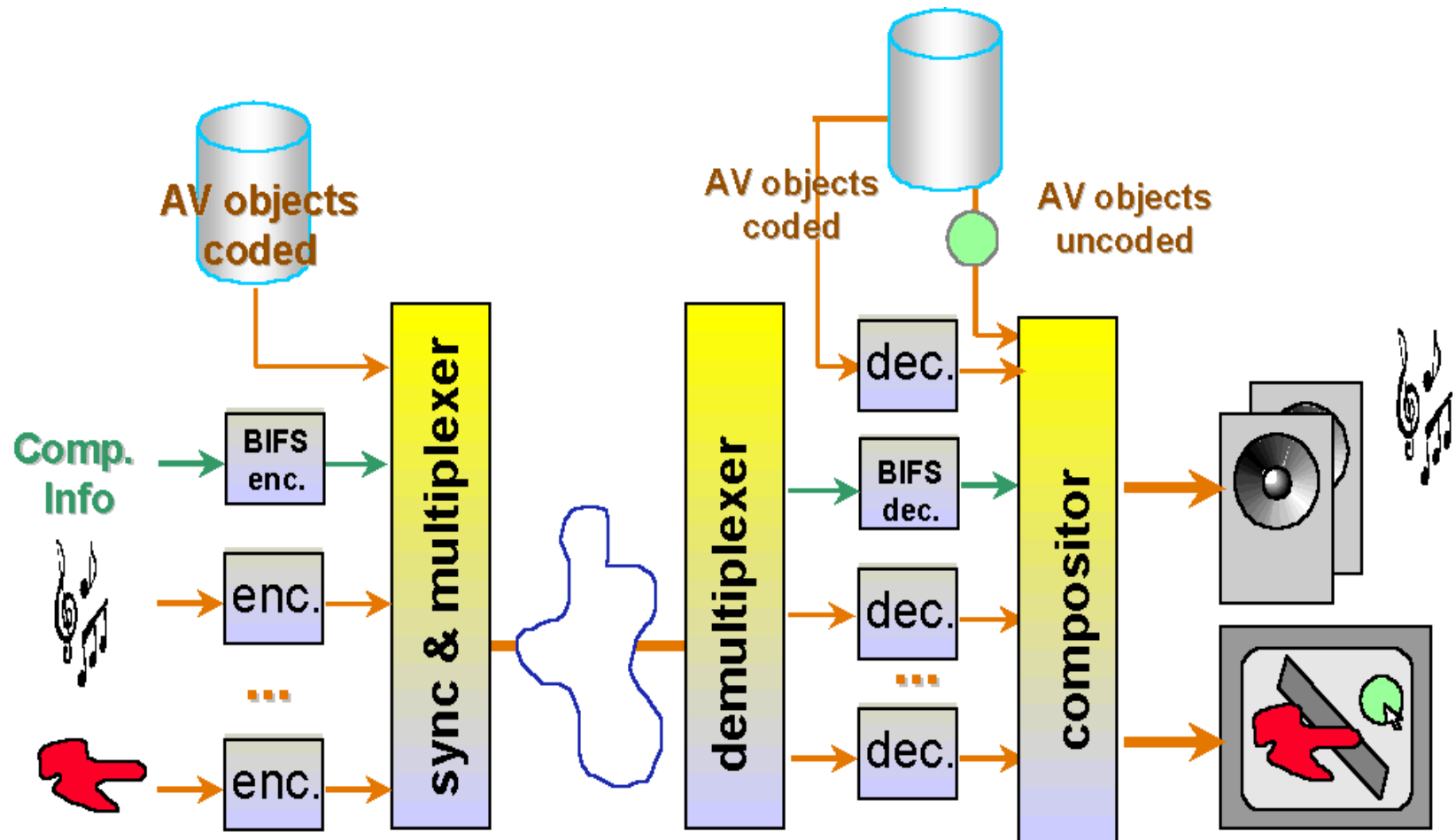
❑ Low Data Rate

- ❑ Allows for high quality video at lower data rates and smaller file size

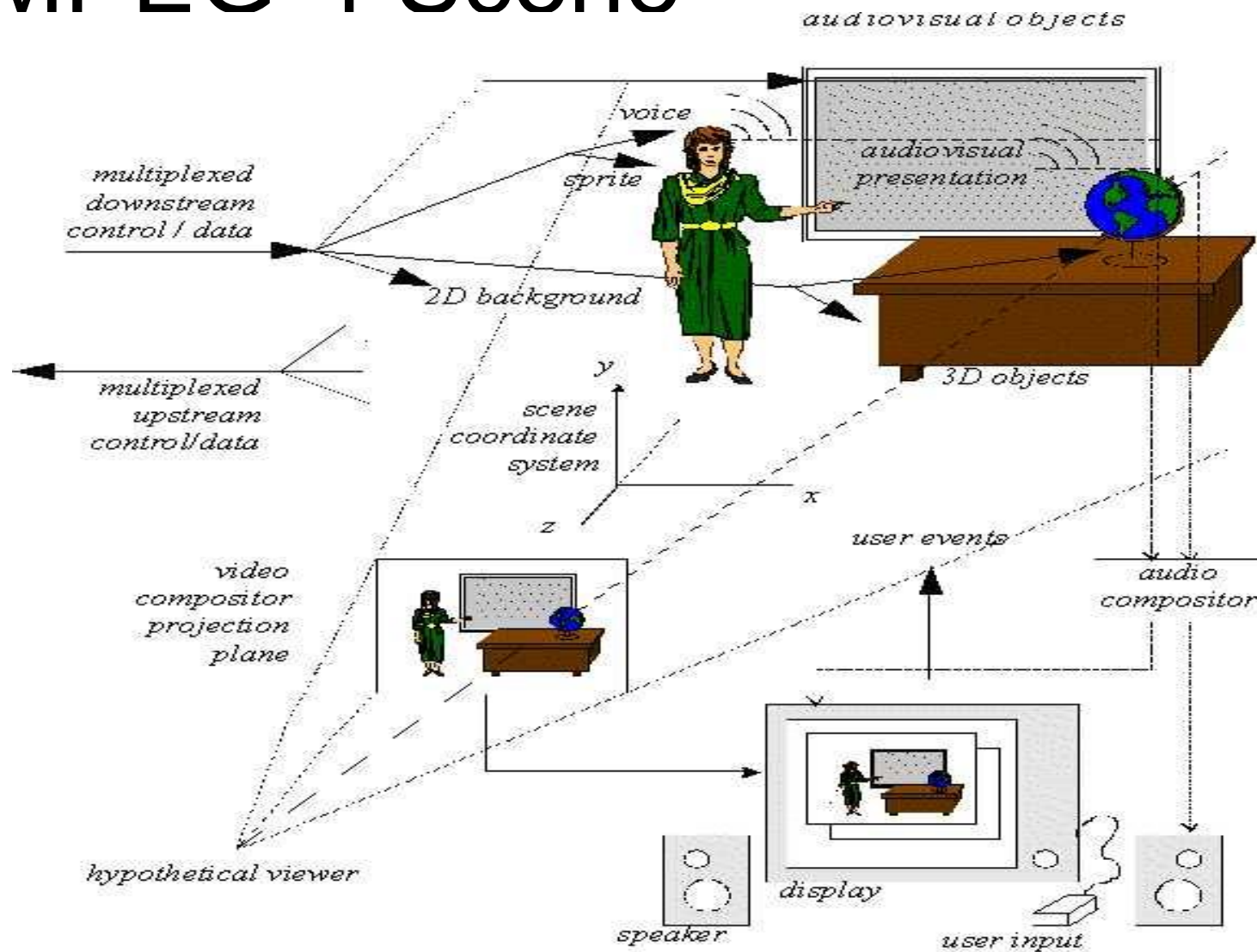
❑ Interoperability

- ❑ Opens methods in playing with audiovisual scenes

MPEG-4 Object Based Coding Architecture



MPEG-4 Scene



Targeted Applications

❑ Digital TV

- ❑ TV logos, Customized advertising, Multi-window screen

❑ Mobile multimedia

- ❑ Cell phones and palm computers

❑ TV production

- ❑ Target viewers

❑ Games

- ❑ Personalize games

❑ Streaming Video

- ❑ News updates and live music shows over Internet

MPEG 7

- ❑ Another ISO/IEC standard being developed by MPEG
- ❑ Content representation standard for information search
- ❑ Makes searching the Web for multimedia content as easy as searching for text-only files
- ❑ Operates in both real-time and non real-time environments

The Future: MPEG21

- ❑ “Multimedia framework”
- ❑ Based on two essential concepts:
 - ❑ Digital Item
 - ❑ Concept of Users interacting with Digital Item
- ❑ More universal framework for digital content protection
- ❑ Most of MPEG-21’s elements are set for completion in 2003 and 2004.