

Introduction to Multimedia Computing

Scalable Video Coding



Topics

- Video On Demand Requirements
- Video Transcoding
- Scalable Video Coding
 - Spatial Scalability
 - Temporal Scalability
 - Signal to Noise Scalability
 - Drift Error



Communicating Multimedia

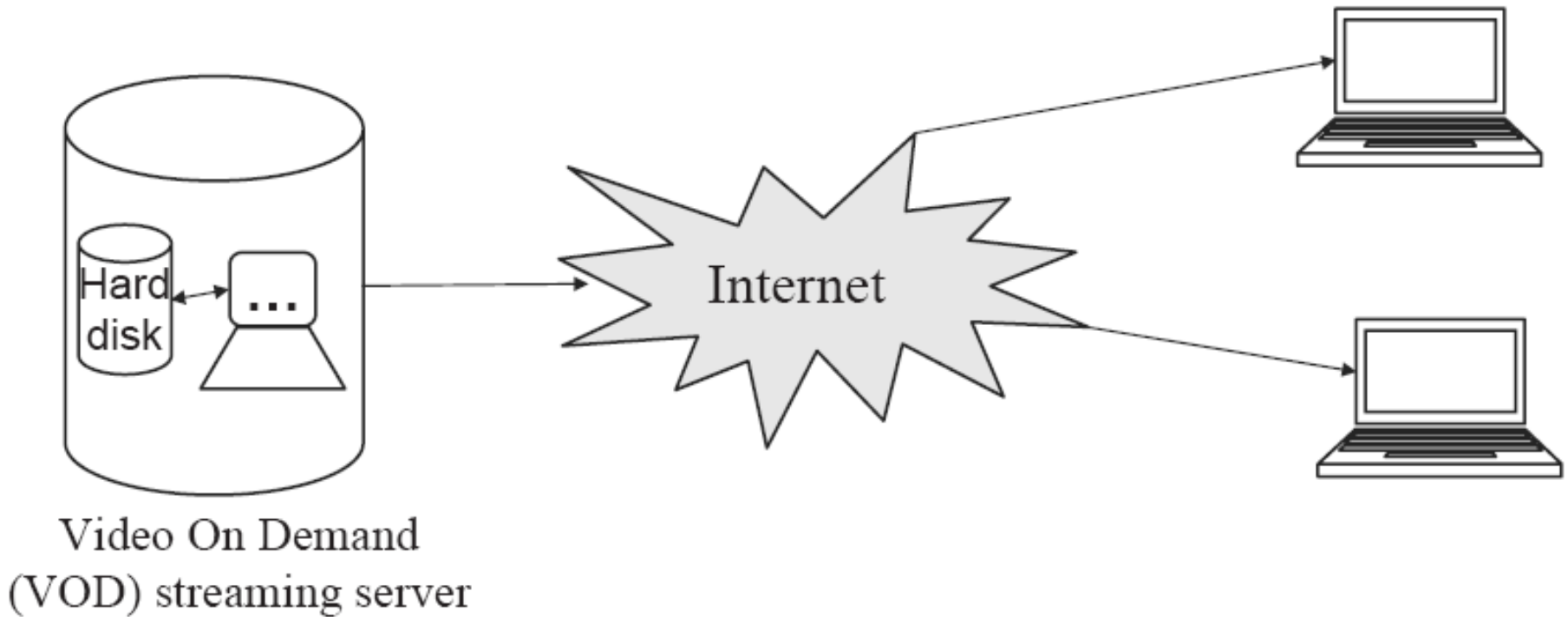
- Multimedia data is used from a distance using computer networks.
- The Internet is a public network that can be used for multimedia transmission.



Multimedia over the Internet

- Multimedia data can be used as:
 - Streaming data
 - Data (audio, video, etc) is presented to the end-user only once (without being saved to a file).
 - Downloadable
 - Data is downloaded to a file and presented to the end-user repeatedly.

Video on Demand over the Internet



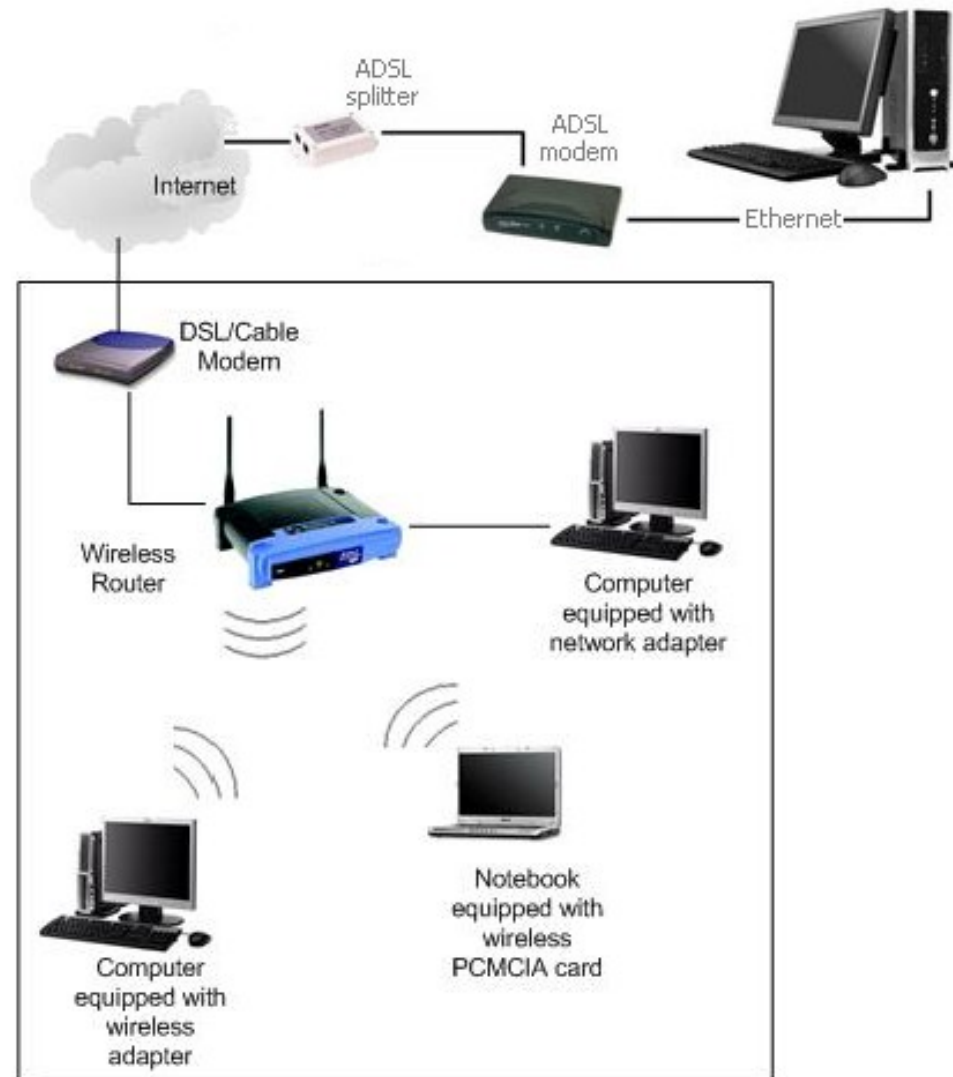


Computer Networks and the Internet

- The Internet has a heterogeneous structure.
- The Internet is a best-effort network.
- The Internet does not guarantee a fixed data rate over a connection.
- **Multimedia data should adapt itself with network data rate changes.**

Need for Adaptive Videos

- Networks have different bandwidths and data rates



Need for Adaptive Videos

- Display devices have different properties





Adapting Video (1): Transcoding

- Transcoding is defined as changing a video in
 - Resolution (Spatial Transcoding)
 - Frames per second (Temporal Transcoding)
 - Bits per pixel (SNR Transcoding)
 - Inserting additional data into the video (Content Transcoding)
 - Algorithm (Standard Transcoding)



Realtime Transcoding

- The routers in the network should perform transcoding
- Transcoding is slow because
 - Video should be decoded (include IDCT)
 - Video should be re-encoded (includes DCT and Motion Estimation)



Adapting Video (2): Scalable Video Coding

- In Scalable Video Coding, the receiver adapts the video to its capabilities.
- Video is coded in a way that the receiver can receive part of it.
- Adapting video should be fast.



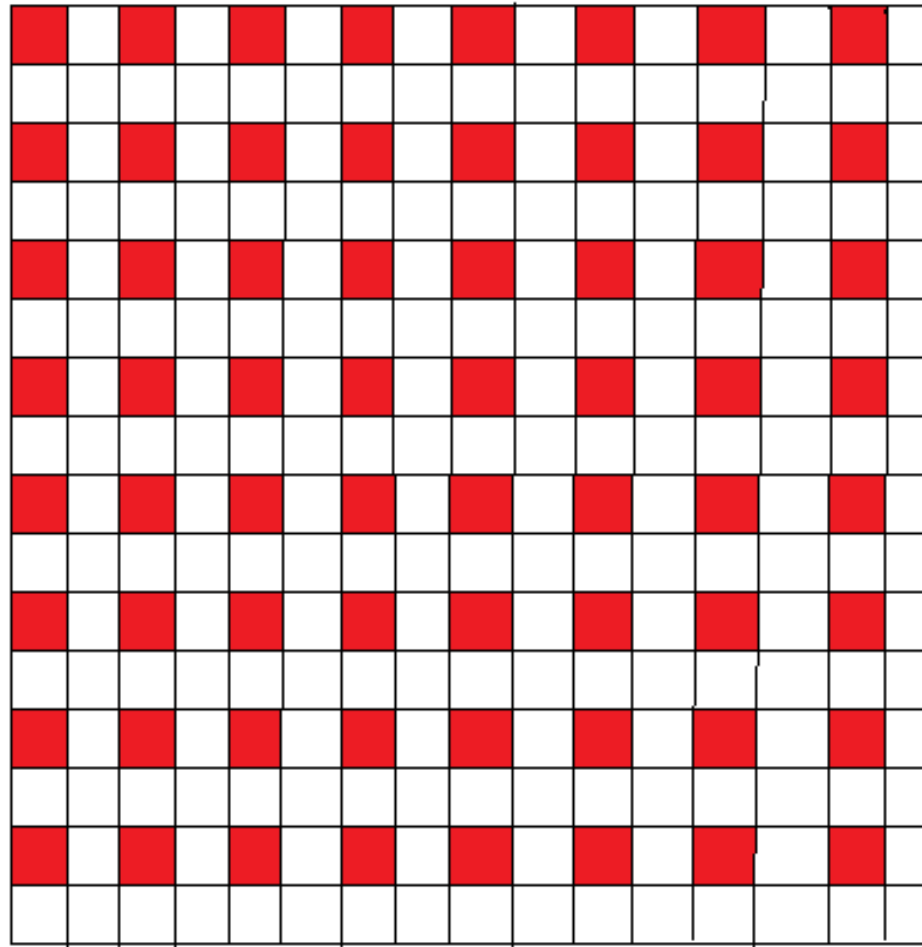
Scalable Video Coding

- Video is divided into multiple layers
- First layer is called **Base Layer**
- Base Layer defines the video in the lowest quality
- Remaining layers add to the quality of the video and are called **Enhancement Layers.**



Spatial Scalability

- Some pixels from each frame are put in the base layer and the remaining in the enhancement layer(s)
- e.g. The low resolution is the base layer, and the high resolution is base + enhancement layer frames



Red Pixels are Base Layer Pixels

Spatial Scalability

99	100	86	82
111	102	70	78
36	45	150	152
23	44	154	160

Original Frame

103	79
37	154

Base Layer

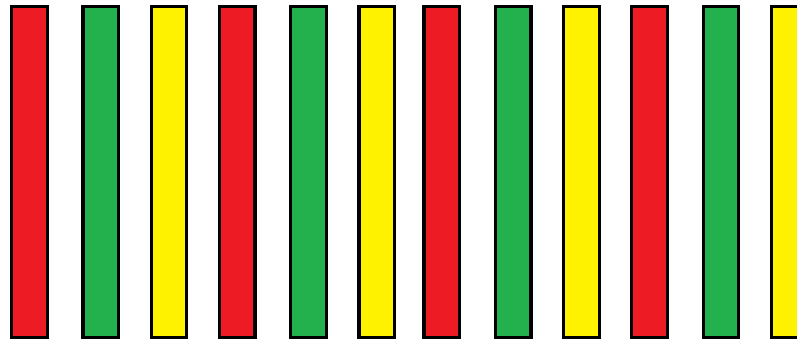
-4	-3	7	3
8	-1	-9	-1
-1	8	-4	-2
-14	7	0	6

Enhancement Layer

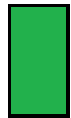


Temporal Scalability

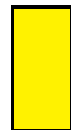
- In temporal scalability, some frames are put in base layer and some in enhancement layers
- The example below is a video with one base layer and two enhancement layers



Base Layer

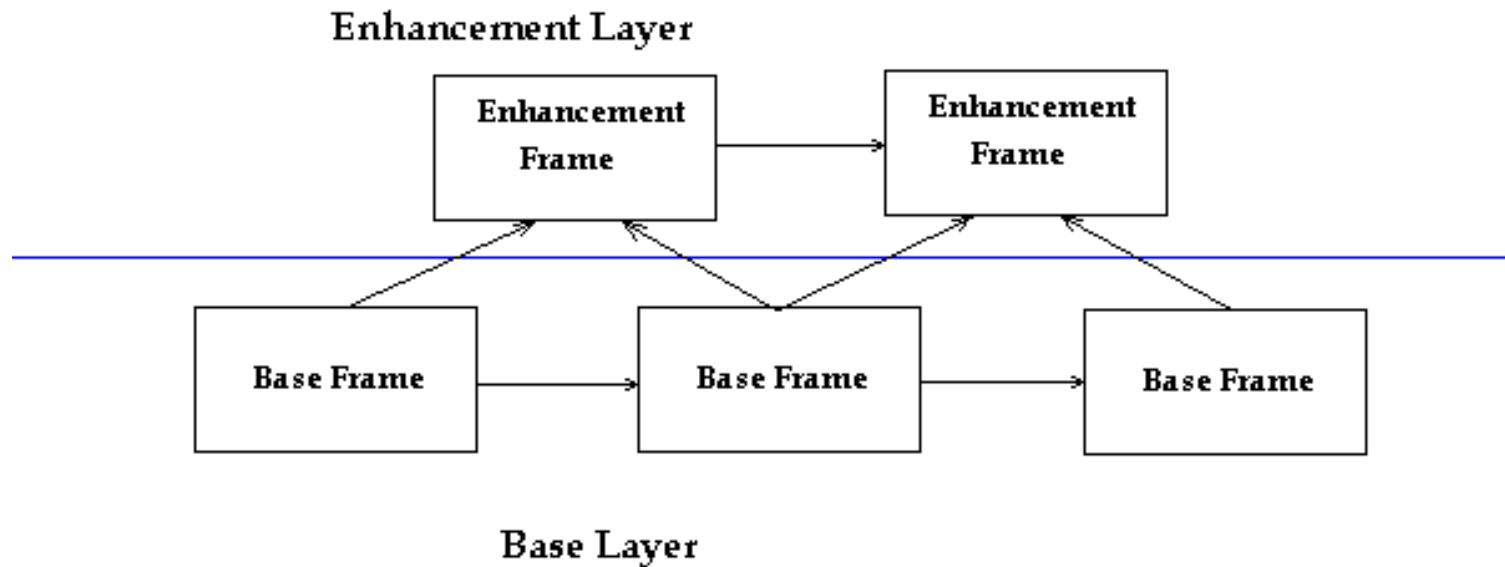


Enhancement Layer 1



Enhancement Layer 2

Temporal Scalability





SNR Scalability

- In Signal To Noise Scalability, significant bits are put in the base layer and the remaining bits in the enhancement layers.
- Receiver concatenates the bits to create high quality video

127	244	
230	190	

Original Frame

1	2	
2	1	

Base Layer

27	44	
30	90	

Enhancement Layer

100	200	
200	100	

Reconstructed using Base Layer Only

127	244	
230	190	

Reconstructed using both Layers

SNR Scalability

99	101	86	82
111	102	70	78
36	45	150	152
23	44	154	160

Original Frame

9	10	8	8
11	10	7	7
3	4	15	15
2	4	15	16

Base Frame

9	1	6	2
1	2	0	8
6	5	0	2
3	4	4	0

Enhancement Layer

Multilayer Scalability

Spatial scalability ↓



6.5 kbps



133.9 kbps



21.6 kbps



436.3 kbps

Quality (SNR) scalability →



Drift Problem

- In video coding each frame is obtained from the previous frame.
- Any error in reconstructing a frame causes error in the next frame.
- Accumulated error reduces the quality of the video.
(Drift Problem)



Multilayer Scalability Problem

- Receiver can receive data partially.
- Partial data is used for reconstructing the next frame.
- Drift problem happens



Summary

- On Demand Video requires adaptation with network properties
- Transcoding is used for video adaptation but requires a long processing time
- Scalable video coding encodes video in a way that it can adapt without decoding/encoding



Questions?