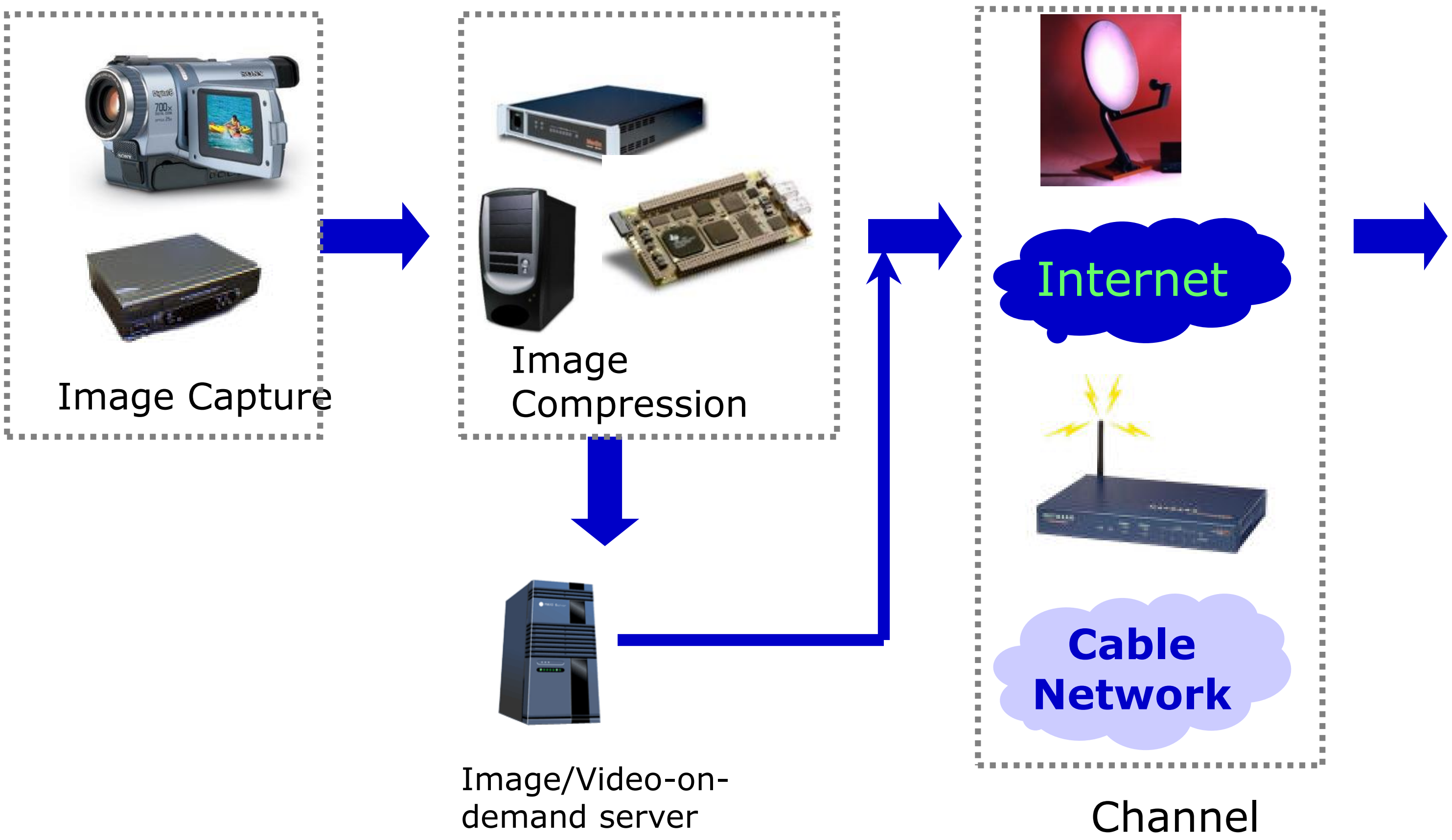
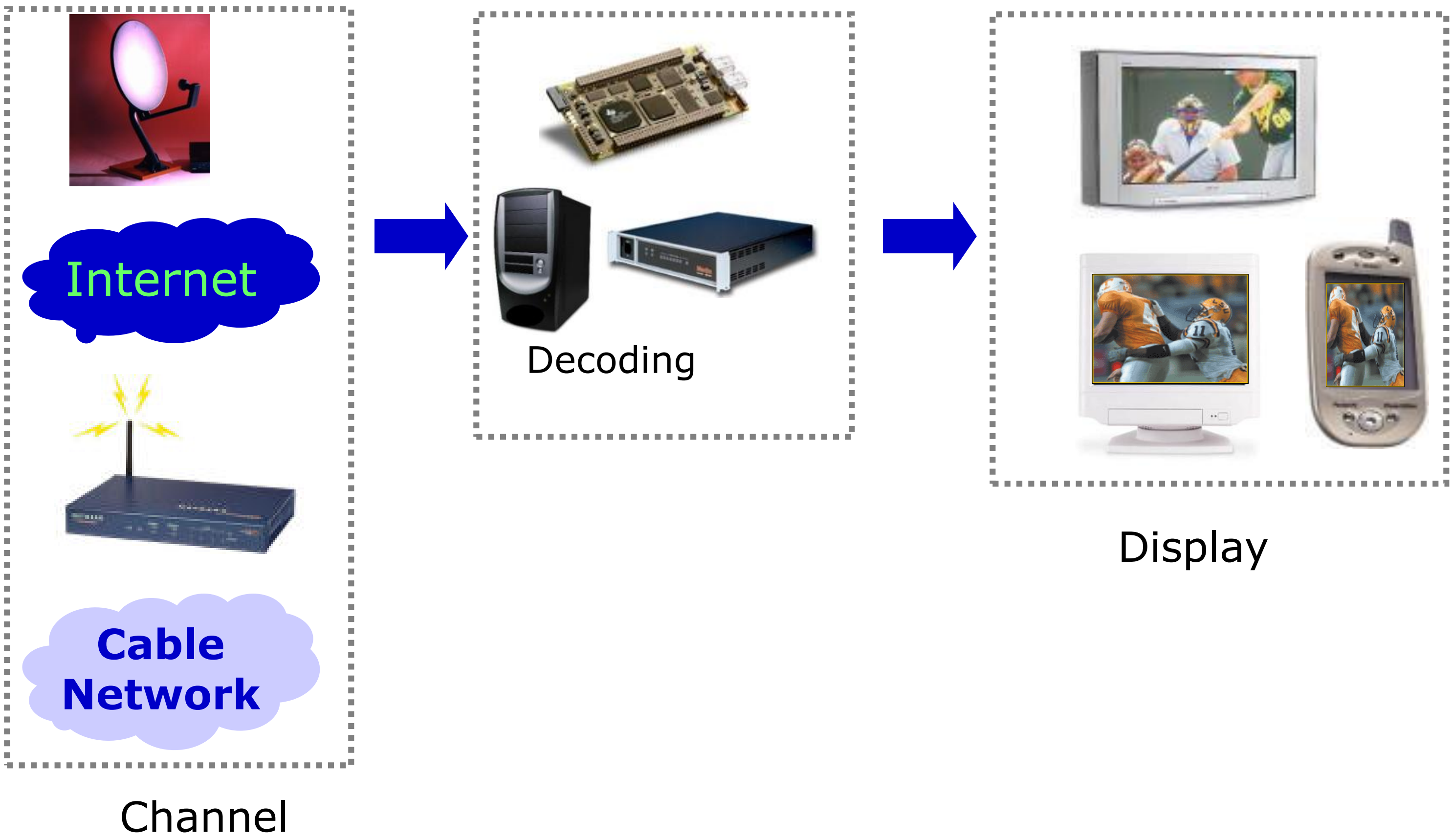
Introduction to Image Communication Over Networks

End-to-End Video Communication System

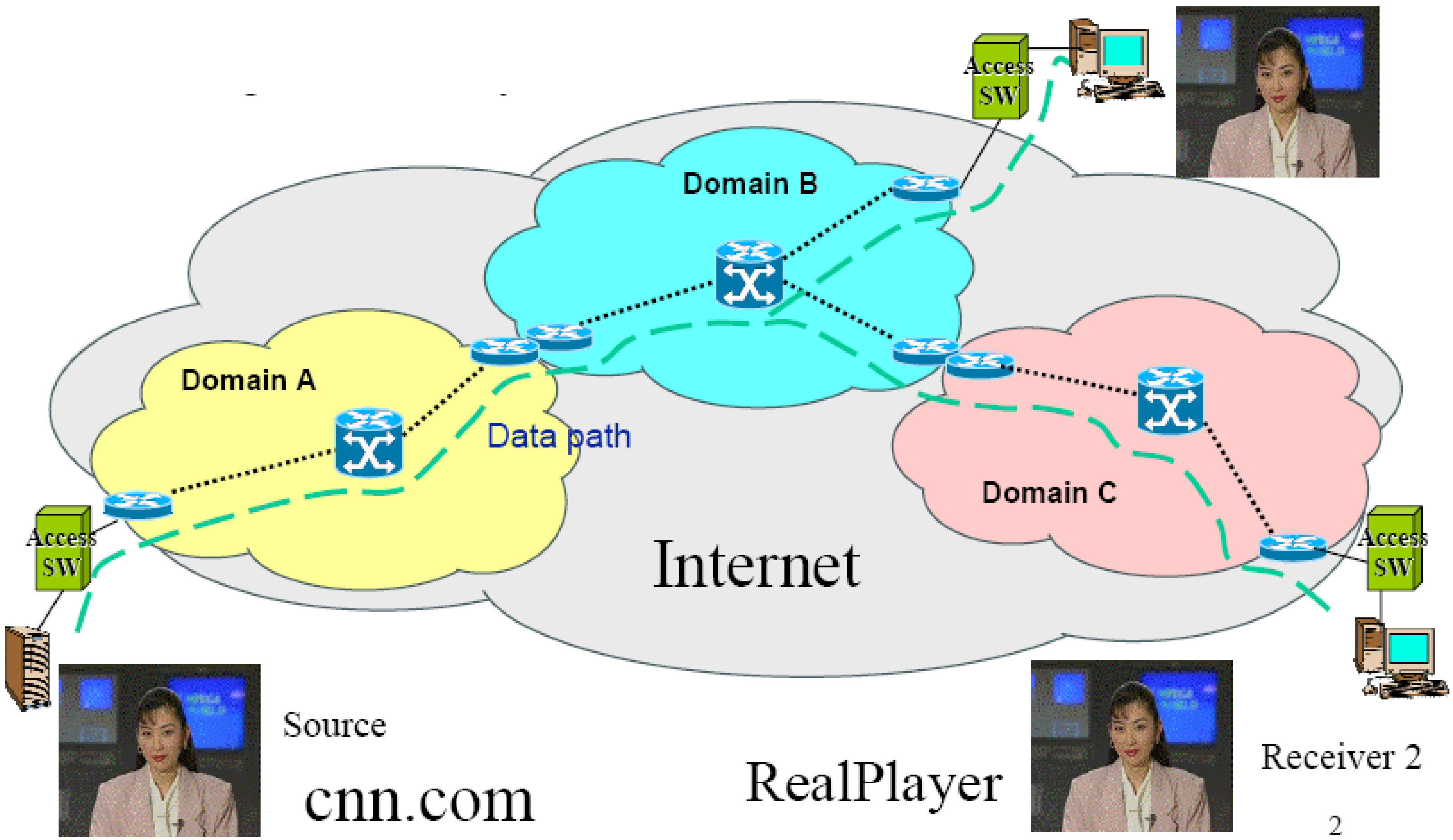


End-to-End Video Communication System

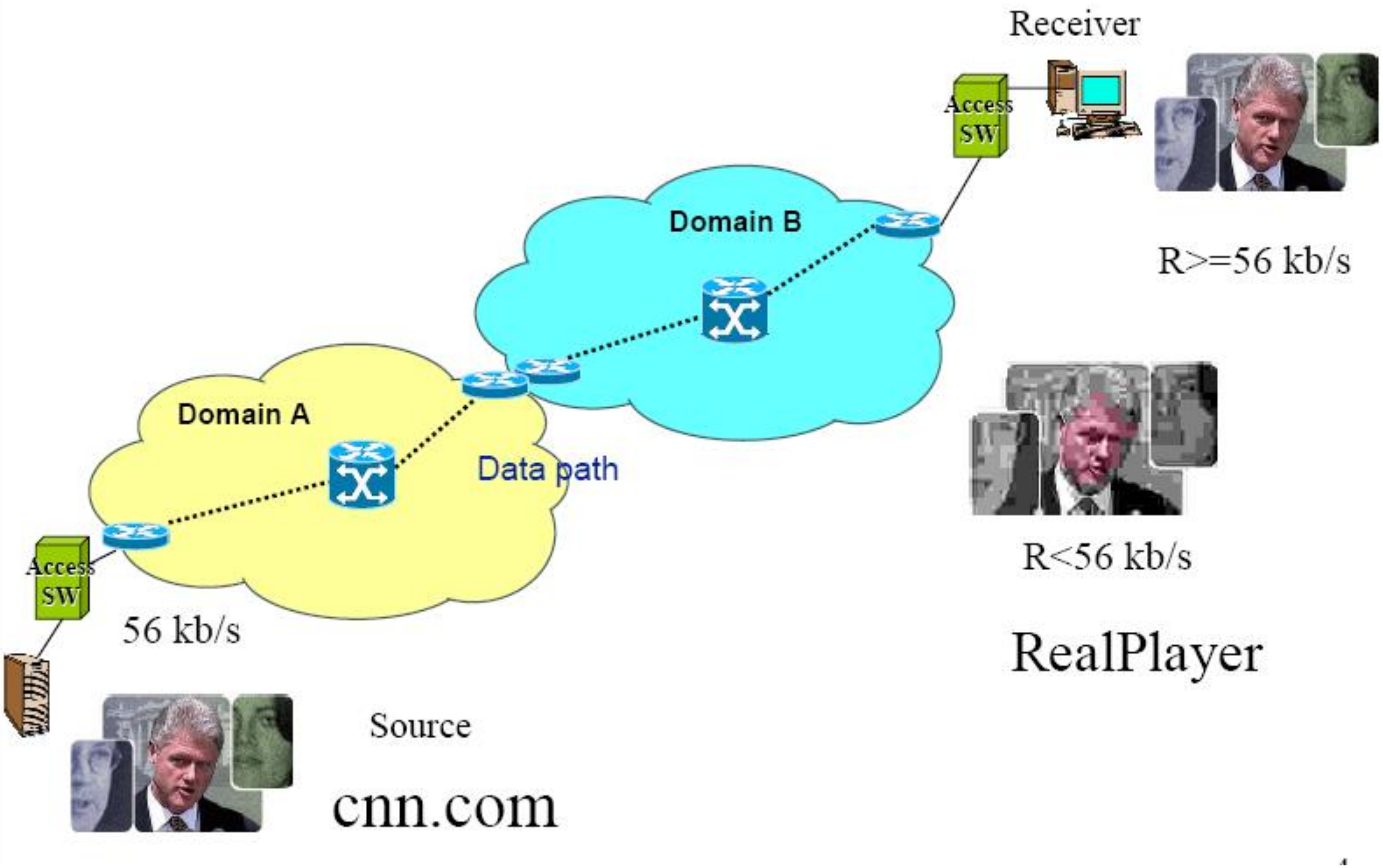


Networking

Image/Video Communication Over Networks

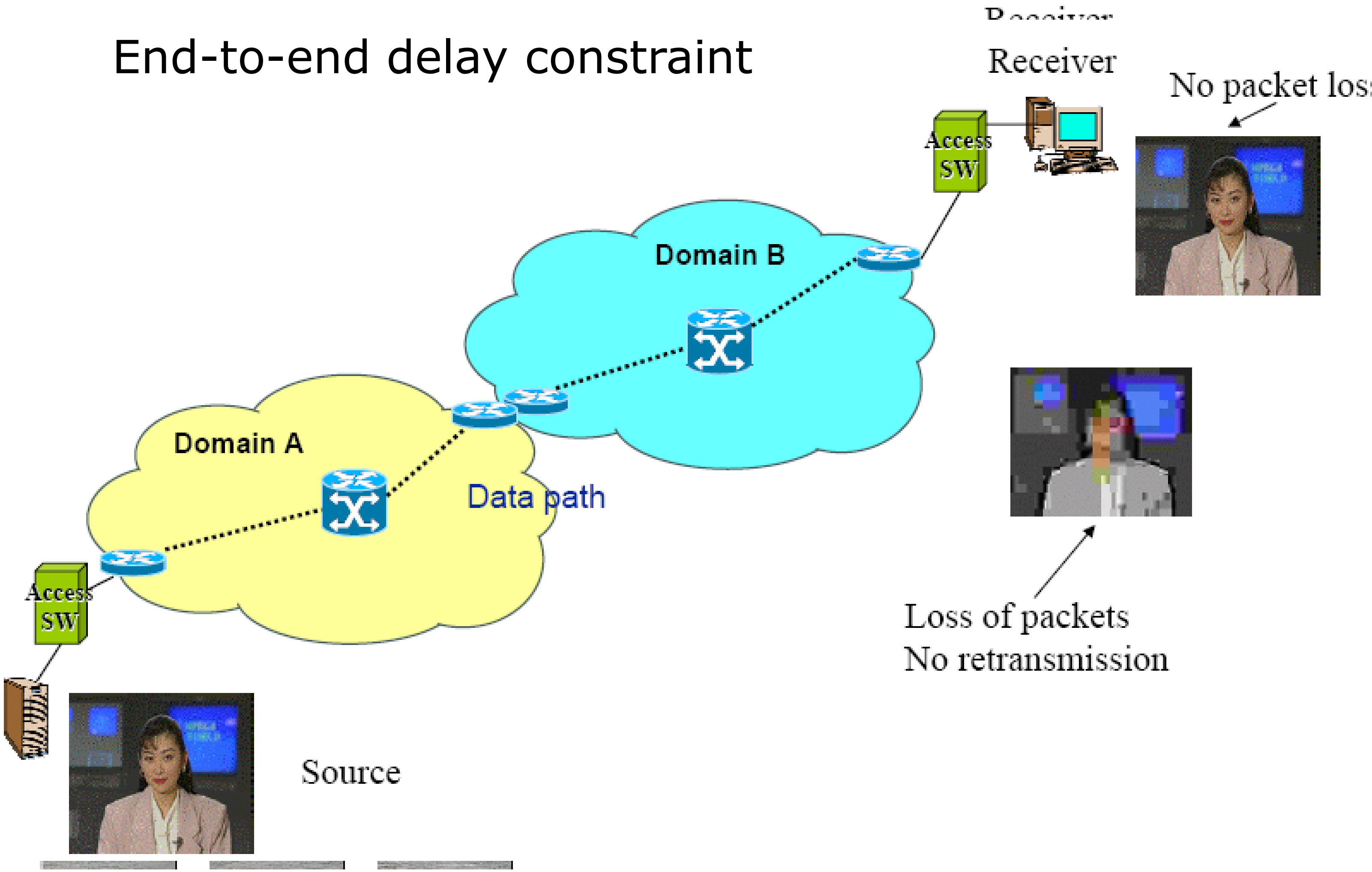


Time-Varying Bandwidth

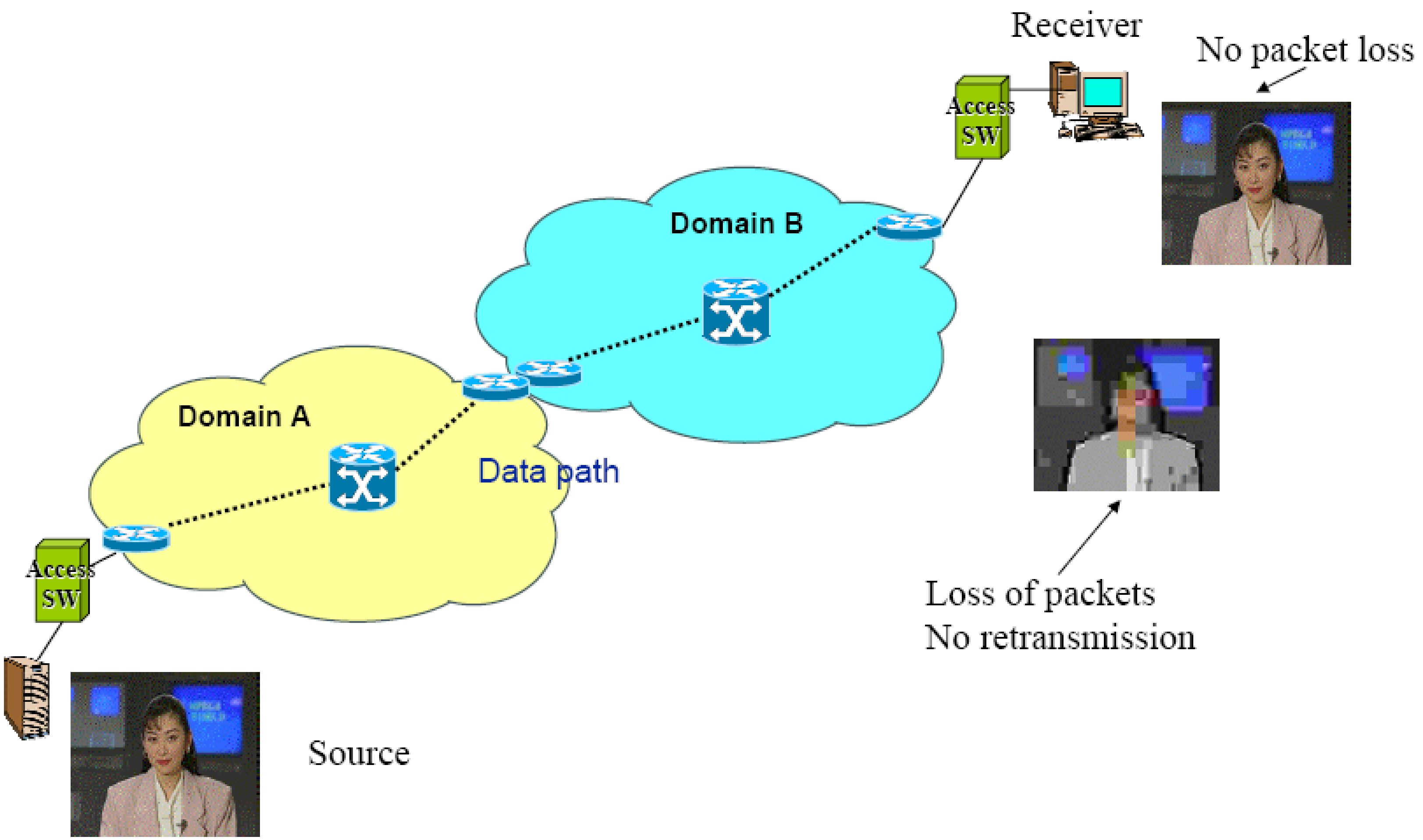


Time-Varying Delay

End-to-end delay constraint



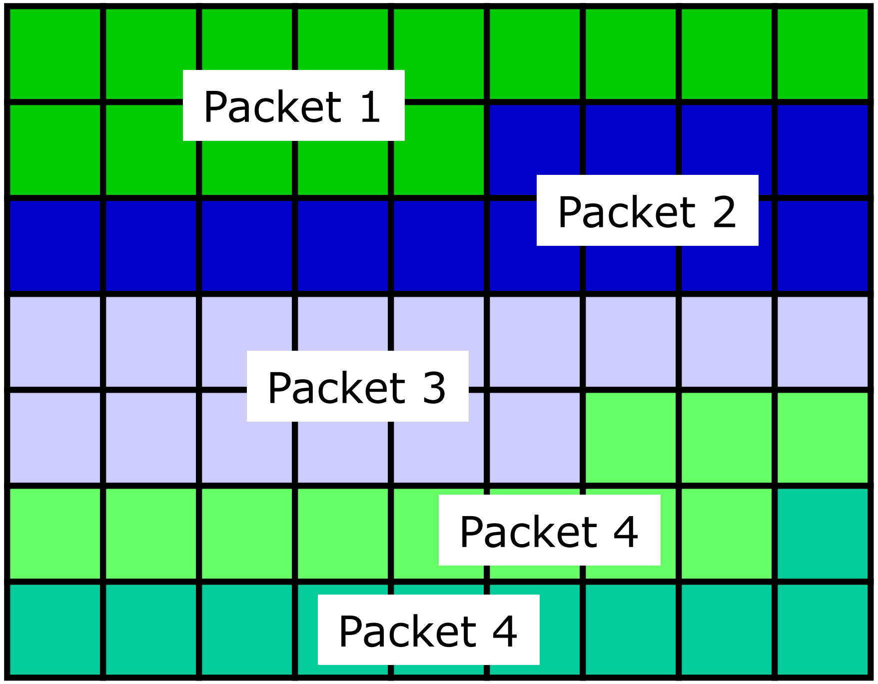
Effect of Packet Loss



Issues in Image Transmission

Packetization

- Parition the image data into packets / slices, each packet can be independently decoded.
- No prediction across packet boundary
- Typically align with block boundary
- Start with a unique packet_start_code



Issues in ImageTransmission

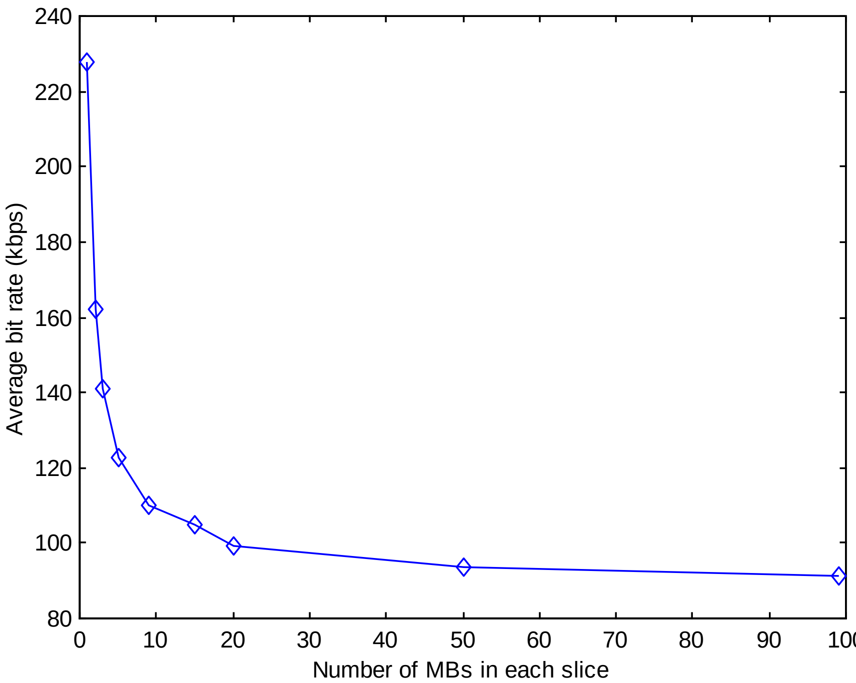
Packetization

- Bit error can translate into packet loss. If a bit cannot be decoded, search for the packet header, and jump to the next packet.
- More packets: Reduced coding efficiency, improved error resilience
- Tradeoff problem: optimum packetization

Channel bit error rate Pe; Packet length L Bits

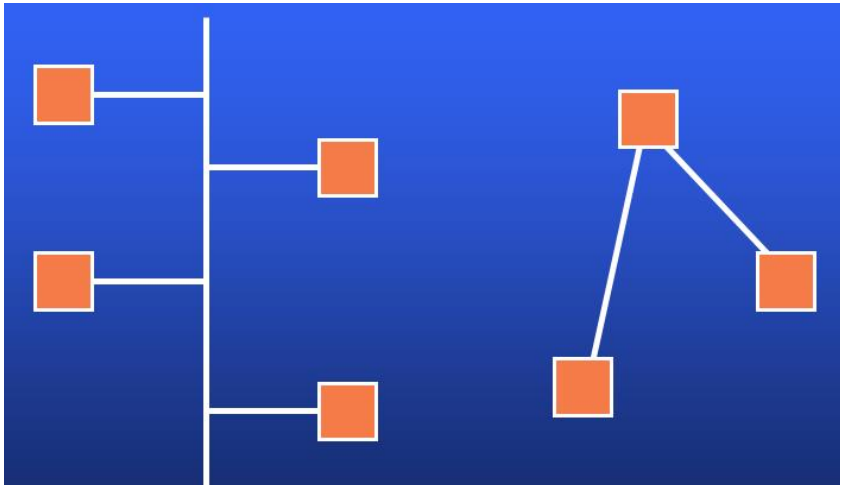
Packet loss ratio

$$PLR = 1 - (1-Pe)^L$$

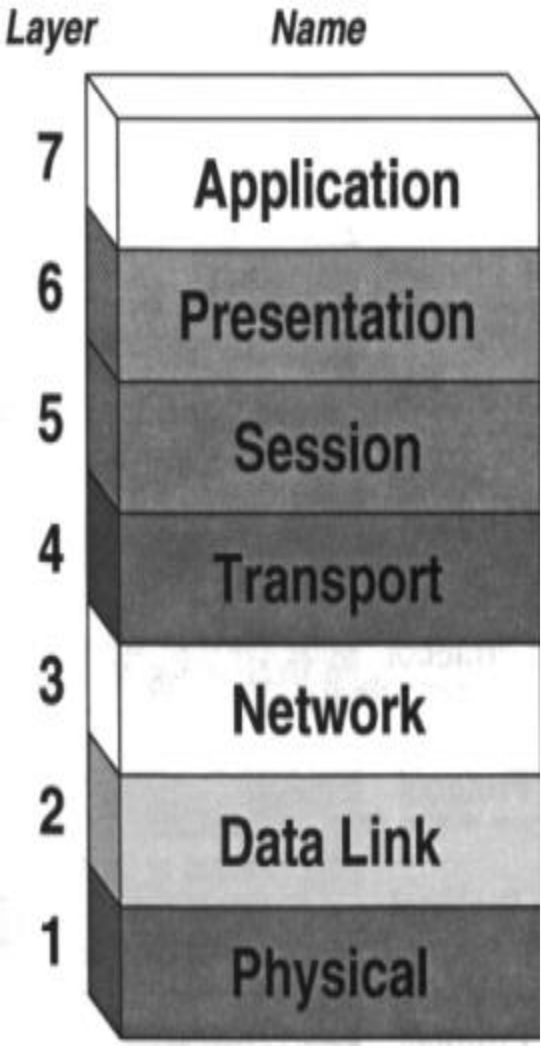


Multi-Access and P2P

- Multiaccess means shared medium.
  - many end-systems share the same physical communication resources (*wire, frequency, …*)
  - There must be some arbitration mechanism.
- Point-to-point
  - only 2 systems involved
  - no doubt about where data came from !



OSI Network Layered Model



Service (Web, HTTP, email, chat)

Encoding and decoding, encryption

Job management and tracking

Virtual path control
end-to-end flow control (TCP, UDP)

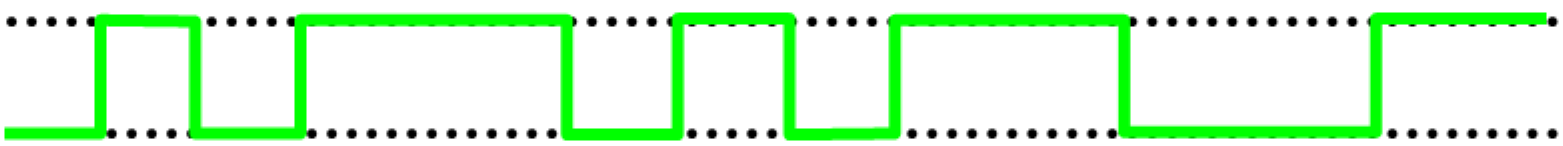
Path selection (IP)

Provide an error free communication link: addressing

Send a bit over the channel: modulation, de-

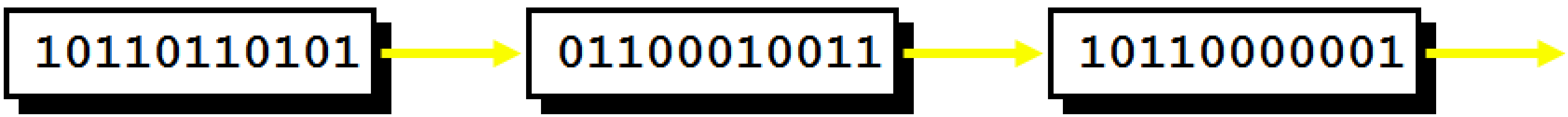
Physical layer

- Responsibility:
  - transmission of raw bits over a communication channel.
- Issues:
  - mechanical and electrical interfaces
  - time per bit
  - distances



Data Link Layer

- Responsibility:
  - provide an error-free communication link
- Issues:
  - *framing* (dividing data into chunks)
    - header & trailer bits
  - addressing



MAC Layer

- Medium Access Control - needed by mutiaccess networks.
- MAC provides DLC with “virtual wires” on multiaccess networks.

Network Layer

- Responsibilities:
  - path selection between end-systems (routing).
  - subnet flow control.
  - fragmentation & reassembly
  - translation between different network types.

Transport Layer

- Responsibilities:
  - provides virtual end-to-end links between peer processes.
  - end-to-end flow control
- Issues:
  - headers
  - error detection
  - reliable communication

Session Layer

- Responsibilities:
  - establishes, manages, and terminates sessions between applications.
  - service location lookup
- Many protocol suites do not include a session layer.

Presentation Layer

- Responsibilities:
  - data encryption
  - data compression
  - data conversion
- Many protocol suites do not include a Presentation Layer.

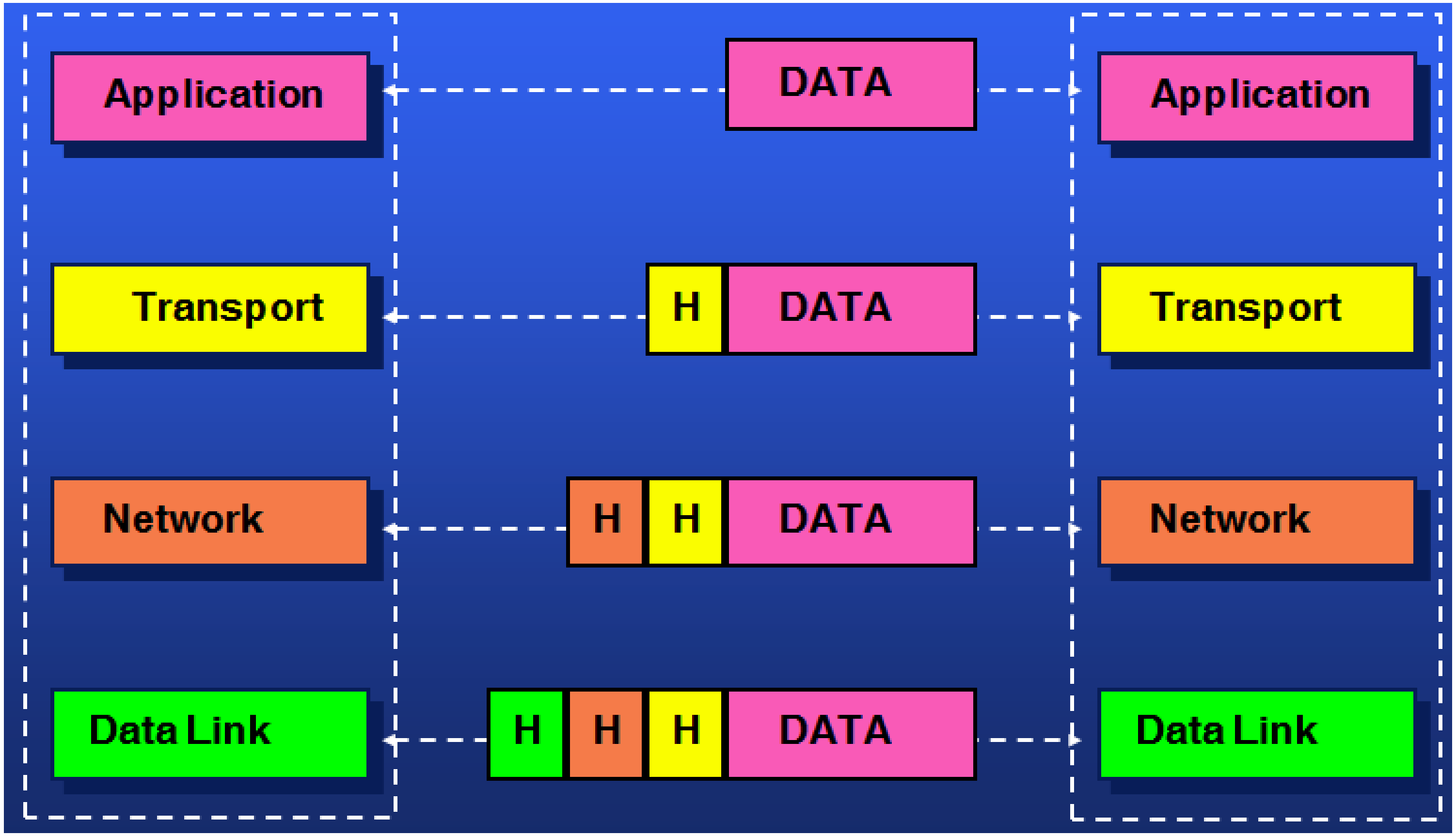
Application Layer

- Responsibilities:
  - anything not provided by any of the other layers
- Issues:
  - application level protocols
  - appropriate selection of "type of service"

Layer Header

- Each layer needs to add some control information to the data in order to do it's job.
- This information is typically prepended to the data before being given to the lower layer.
- Once the lower layers deliver the the data and control information - the peer layer uses the control information.

Layer Header



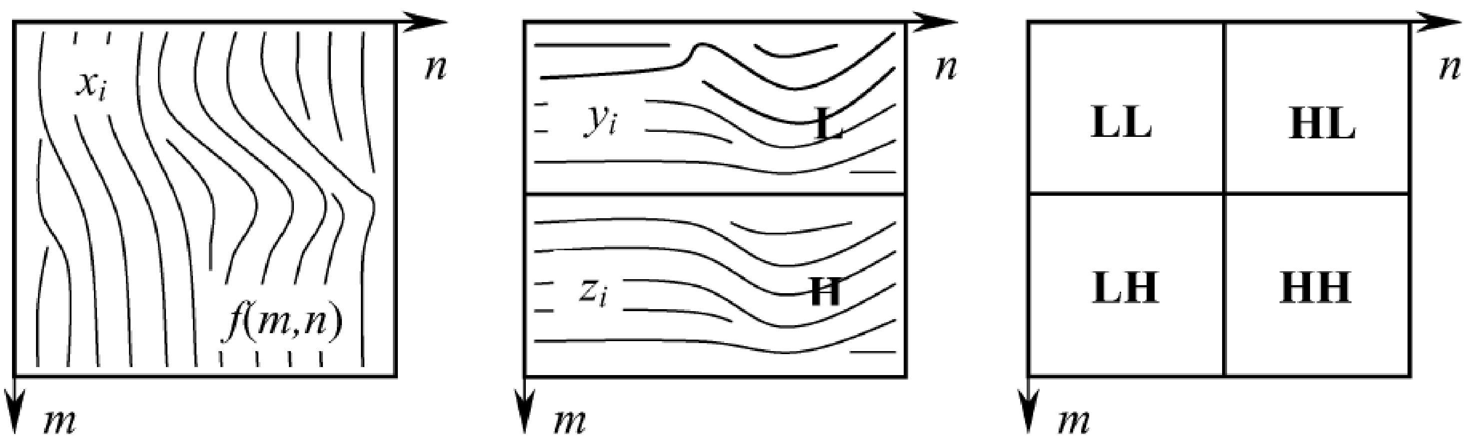
More on Image Compression

Curved Wavelet Transform

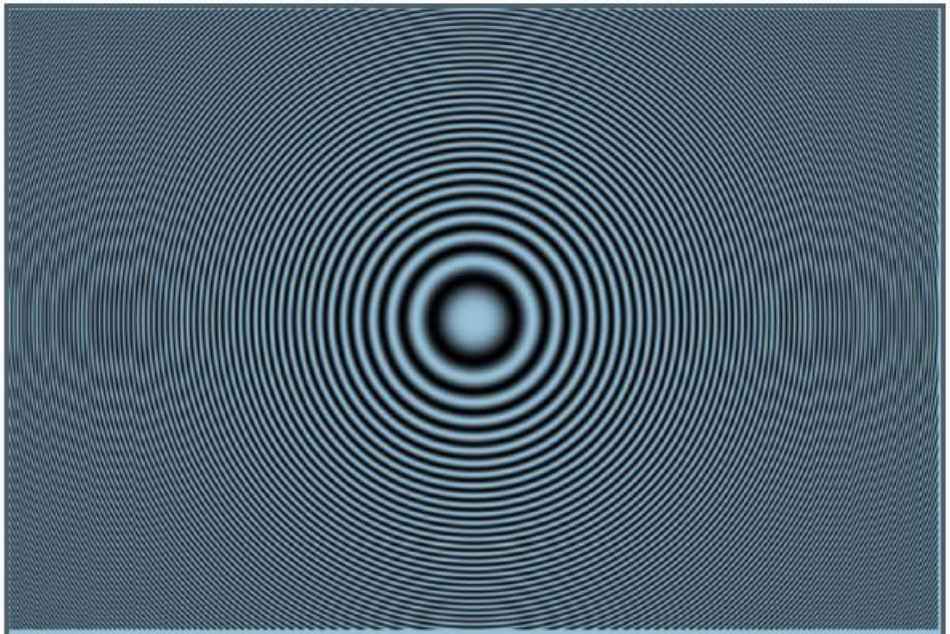
IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 15, NO. 8, AUGUST 2006

Curved Wavelet Transform for Image Coding

Demin Wang, Liang Zhang, André Vincent, and Filippo Speranza



Curved Wavelet Transform



(a)

Curved Wavelet Transform

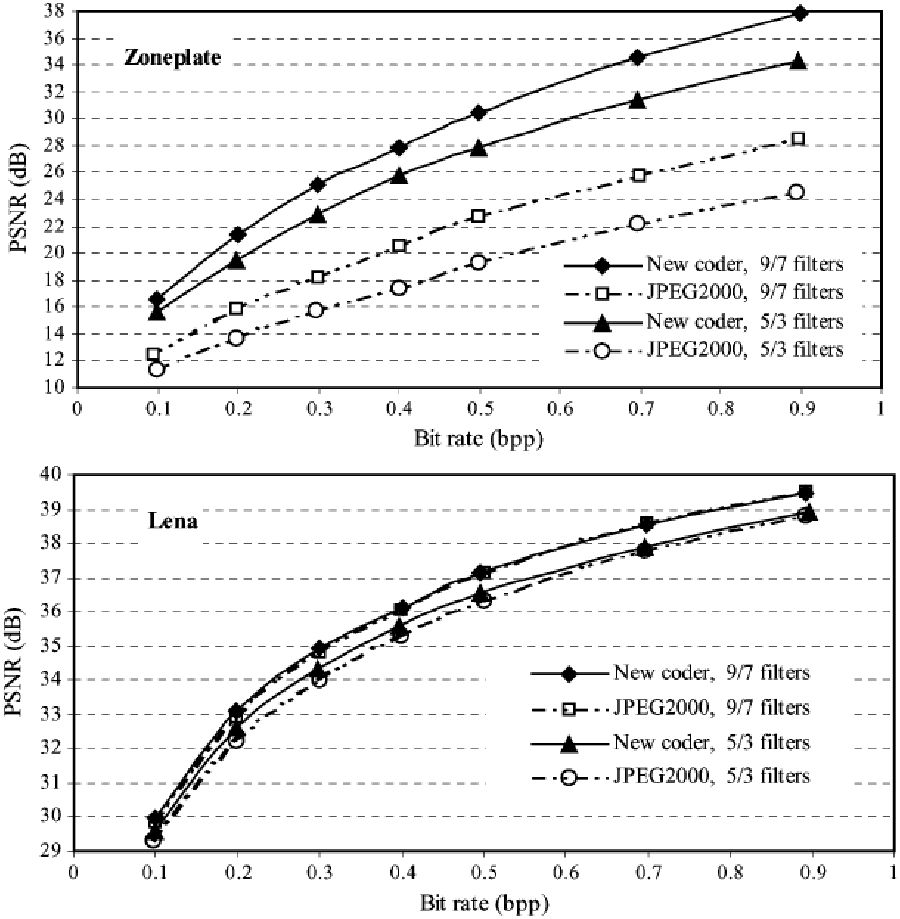


TABLE I
AVERAGE PSNR (dB) AND GAINS OF THE NEW CODER COMPARED WITH JPEG2000

Image	Filters	New coder	JPEG2000	Gain
Zoneplate	5/3	25.32	17.75	7.567
	9/7	27.70	20.62	7.085
Lena	5/3	35.07	34.82	0.241
	9/7	35.61	35.57	0.041
Barbara	5/3	30.96	29.52	1.444
	9/7	31.74	30.65	1.092
Goldhill	5/3	31.66	31.67	-0.007
	9/7	32.07	32.08	-0.006
Bike	5/3	31.85	31.30	0.558
	9/7	32.21	31.81	0.399
Woman	5/3	31.65	31.55	0.103
	9/7	32.18	32.21	-0.031

Global Camera Motion Estimation

Video Registration

1. Estimate the global camera motion parameters.

2. Warp video frames into the same coordinate system – mosaic

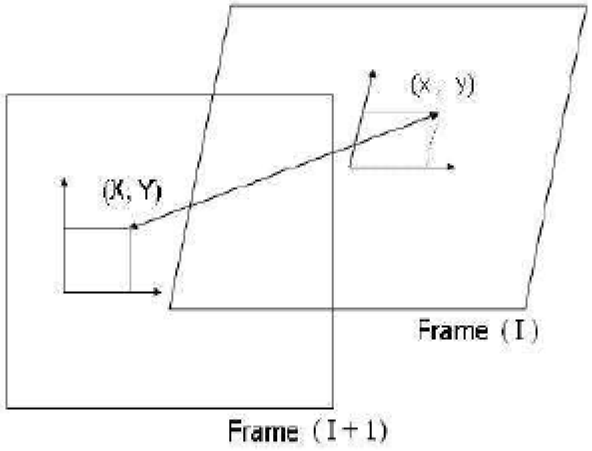
Global Camera Motion Estimation

Global Motion Equation

[x, y]   Frame n
[X, Y]   Frame n+1 after camera motion

$$\begin{bmatrix} X \cdot W \\ Y \cdot W \\ W \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$X = \frac{ax + by + c}{gx + hy + 1}, \quad Y = \frac{dx + ey + c}{gx + hy + 1}.$$



Global Camera Motion Estimation

Model fitting

Find the 8 camera parameters using least mean squared error approach

$$X_m = \frac{ax_m + by_m + c}{gx_m + hy_m + 1}$$

$$Y_m = \frac{dx_m + ey_m + f}{gx_m + hy_m + 1}$$

$$P_m \cdot G = Q_m, \qquad G = [a, b, c, d, e, f, g, h]^t, \qquad Q_m = \begin{bmatrix} X_m & Y_m \end{bmatrix}^t.$$

$$P_m = \begin{bmatrix} x_m & y_m & 1 & 0 & 0 & 0 & -x_m \cdot X_m & -y_m \cdot X_m \\ 0 & 0 & 0 & x_m & y_m & 1 & -x_m \cdot Y_m & -y_m \cdot Y_m \end{bmatrix},$$

Least mean squared error solution

$$G = (P^t W P)^{-1} P^t W Q.$$

Global Camera Motion + JPEG2000

Large Format Videos:

8K * 8K
2 frames per second
12 bits per pixel

Global Camera Motion

Frame #1

Logos Technologies, Inc

Background

Large Format Videos:

8K * 8K
2 frames per second
12 bits per pixel

Global Camera Motion

Frame #1

Logos Technologies, Inc

Background

Large Format Videos:

8K * 8K

2 frames per second

12 bits per pixel

Global Camera Motion

Frame #2

Logos Technologies, Inc

3-D Structures and Motion

Registration is an 2-D operation, performed on one plane!

Parallax caused by 3-D structure.

Need 3-D model info?!

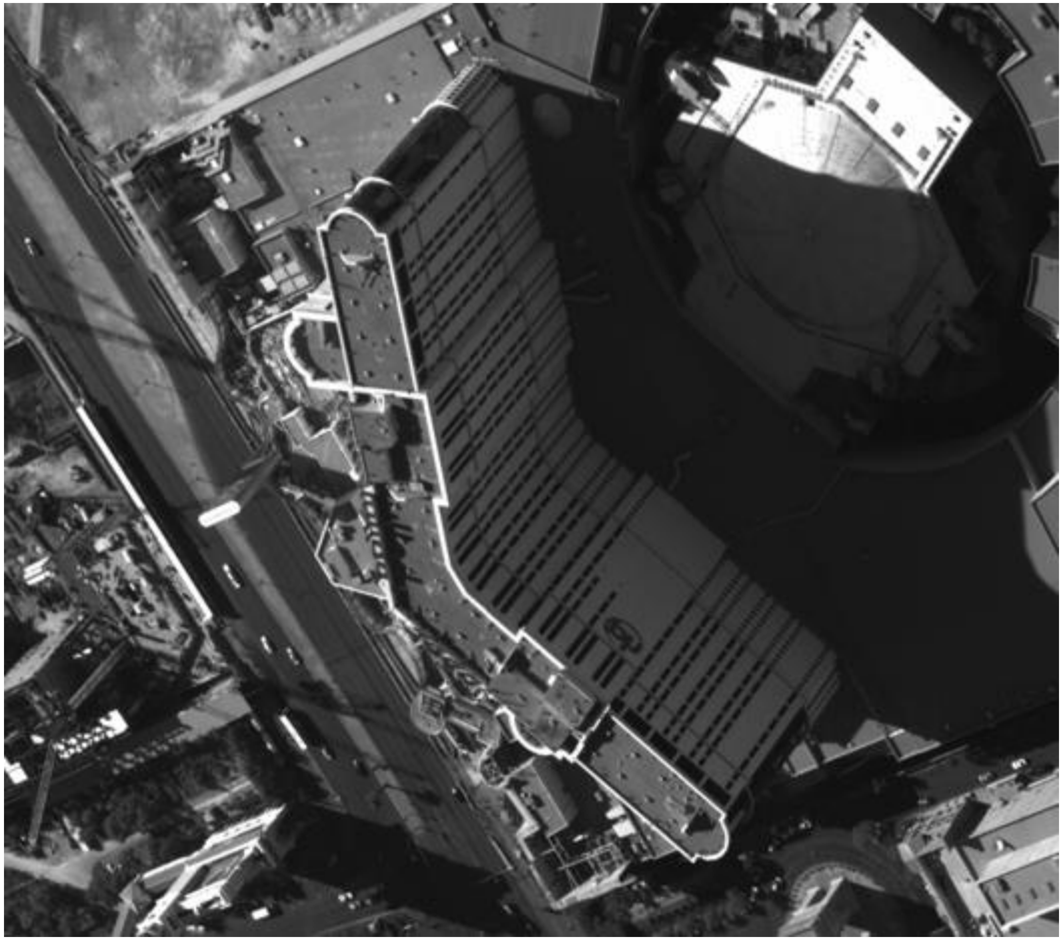
Frame #1

3-D Structures and Motion

Registration is an 2-D operation, performed on one plane!

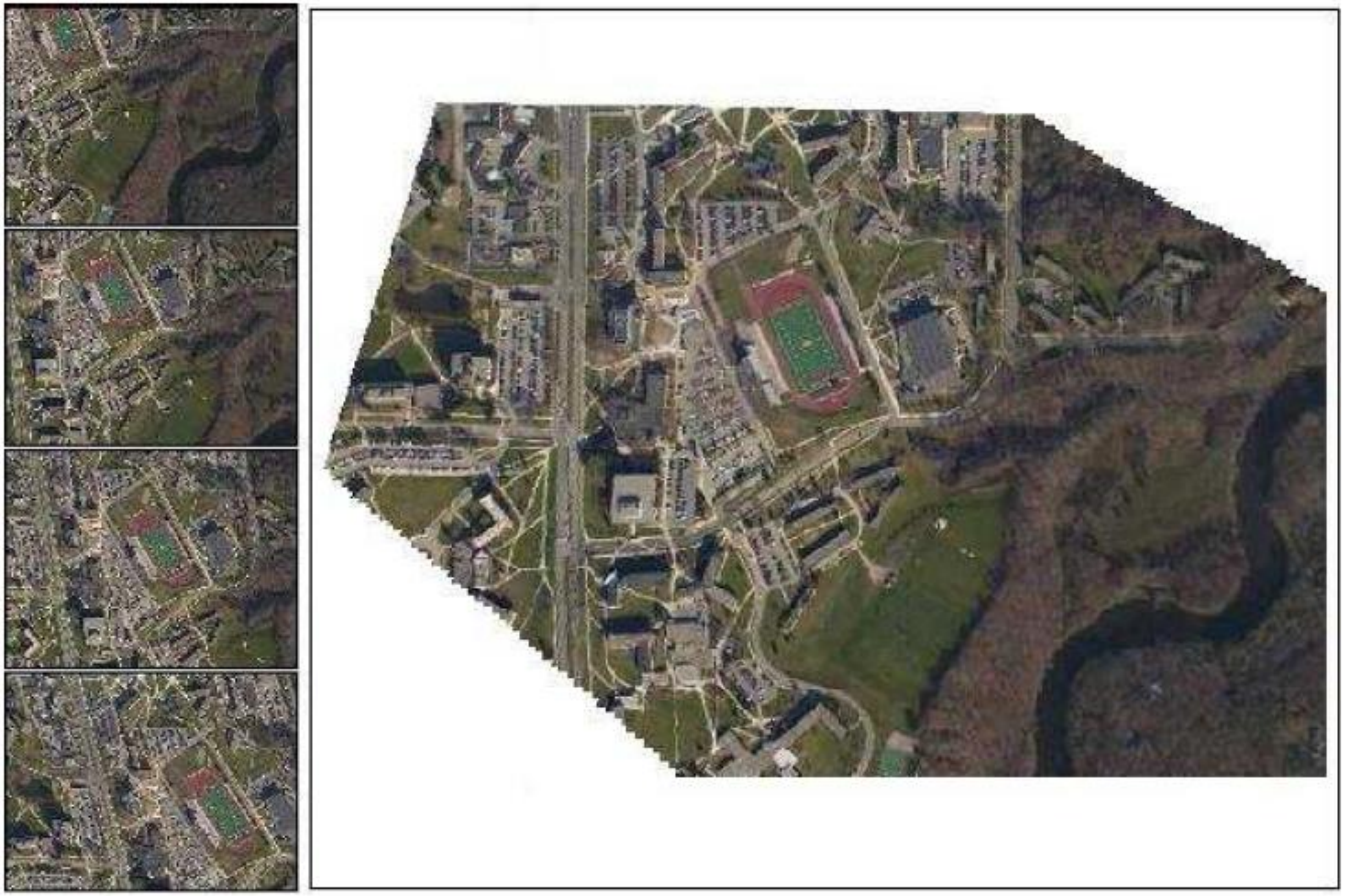
Parallax caused by 3-D structure.

Strong edges



Frame #2

Determine the Global Motion Parameters



Global Camera Motion + JPEG2000