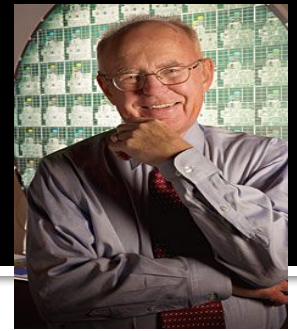


# Improving Computer Performance



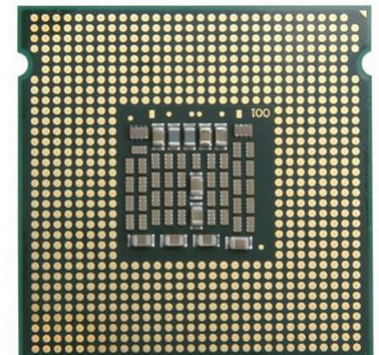
Khamitov Alim Nadimovich  
alikhamt@umail.iu.edu

# Moore's Law

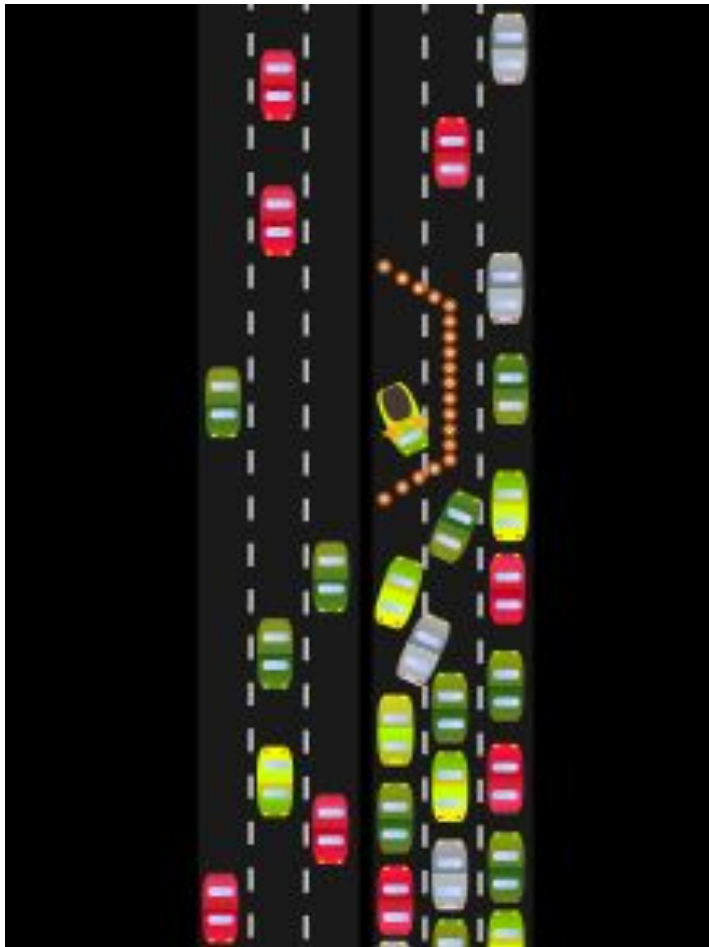


*Number of transistors on a microchip doubles every 18 months.*

- Predictions based on Moore's Law
  - Processing power (speed) doubles every 18 months.
  - Storage capacity of RAM and hard disk increases exponentially.
  - Computer price is decreasing



# Bottlenecks

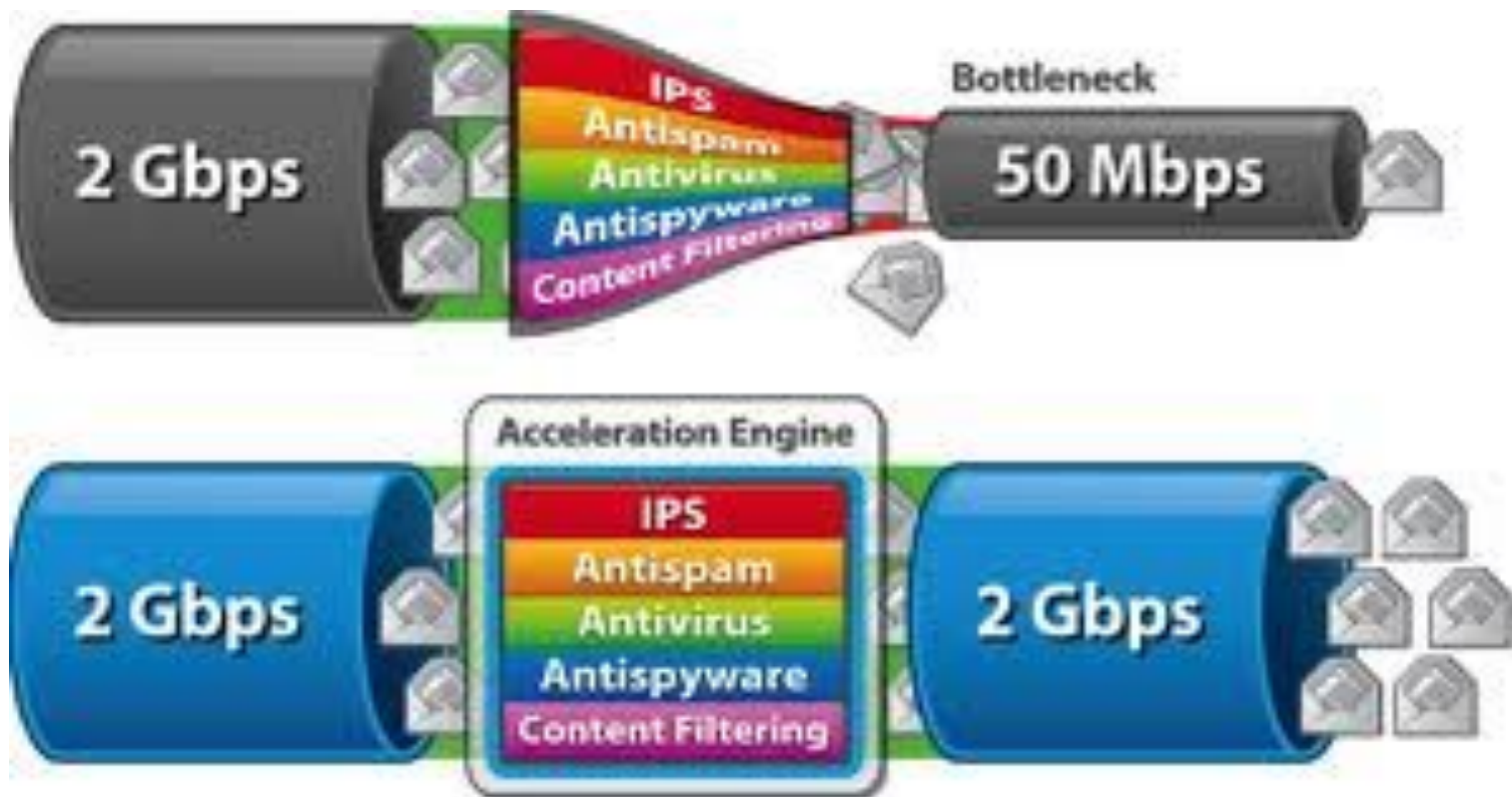


BEFORE



AFTER

# Bottlenecks



# Bottlenecks (critical element)

- ***Bottleneck*** is a step within a series of steps that takes the longest time to complete.
- Time required to perform a task consisting of several steps may be delayed by the bottleneck step.



# Bottlenecks (continued)

- **Typical bottlenecks:**
  - Cache
  - RAM
  - I/O (Information transfer, bus, hard drive)
  - Video card (particularly for 3-D gaming)

# Bottlenecks (continued)

- To speed up performance of a system:
  - Use profiling tools to measure each section's time taken to complete to determine the bottleneck steps
  - Improve upon the bottleneck steps
- VTune
- CodeAnalyst
- AQtime

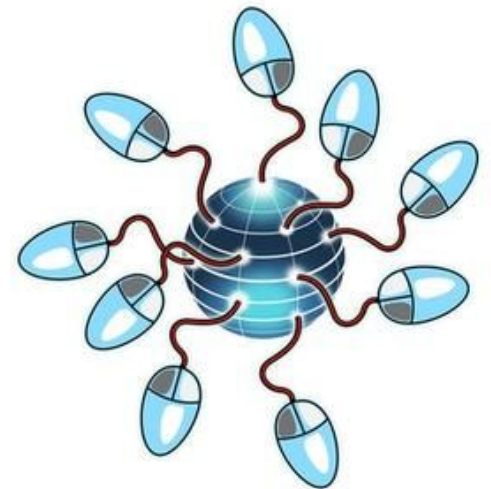
# Vtune Performance Analyzer





# Throughput and Latency

- **Throughput** (*пропускная способность*) - the rate at which data flows through the system
- **For example**, a computer might execute 500 million instructions per second



# Throughput and Latency

- **Latency (access time)** - time required to complete an individual operation
- **For example**, it might take five seconds to launch an application, or two minutes to reboot the entire system.

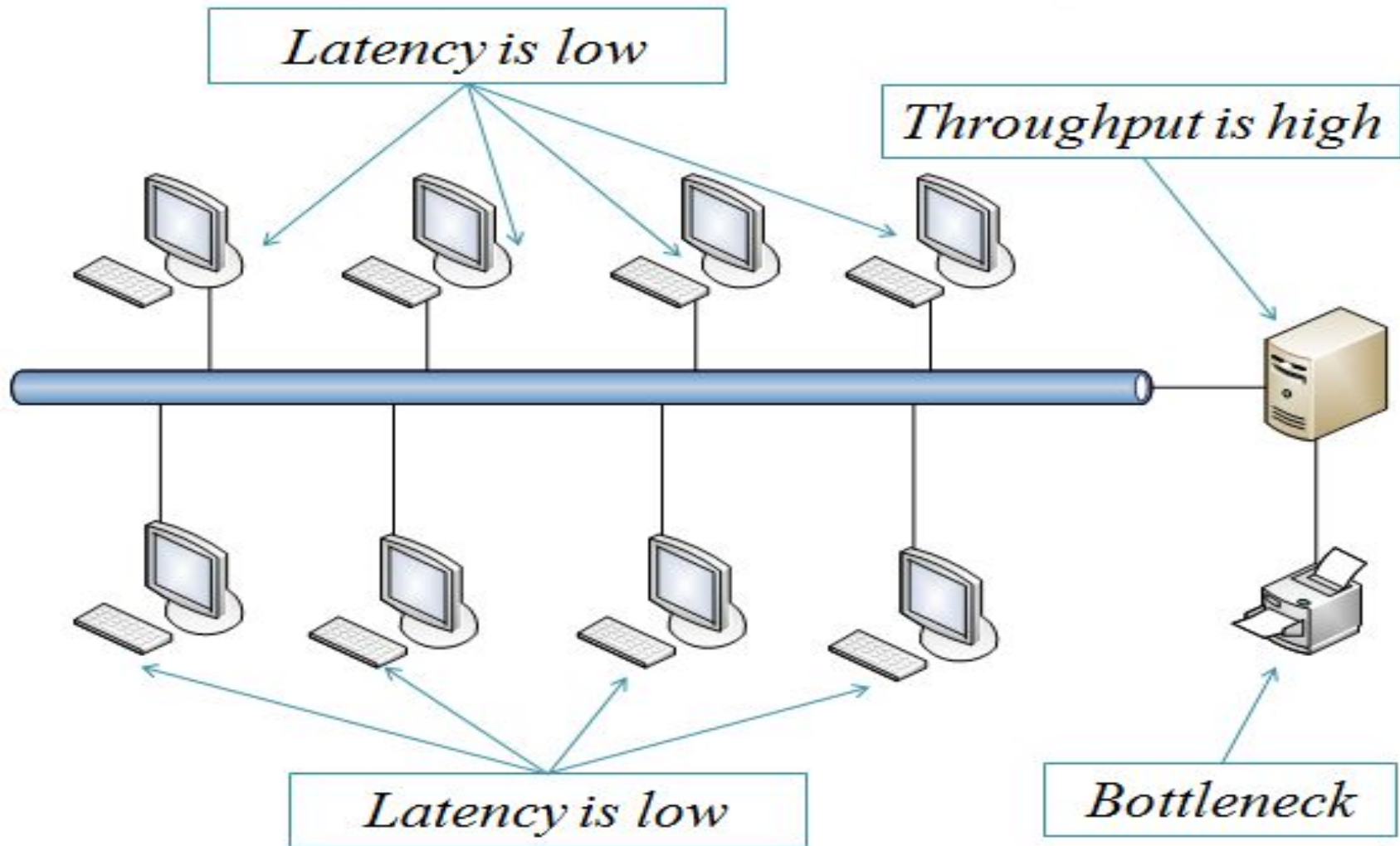


# Latency

- Image is a 1 MB file
- **Throughput** 10 megabits per second
- **Latency** to display the image will be at least 0.8 seconds.



# Throughput and Latency



# Your turn

- If you are selecting a provider for your Web server's network connection, you will be more concerned with ....?
- A) Throughput
- B) Latency

# Your turn

- If you are a user of the same web server, you will certainly be concerned with.... ?
- A) Throughput
- B) Latency

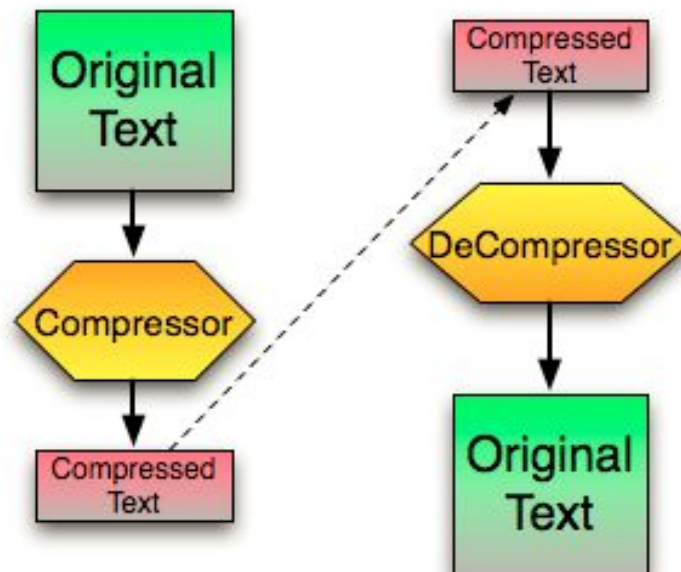
# Data Compression

- Storing data in a format that requires less space than usual
- When data is compressed, the file size shrinks.
- Amount of shrinkage is referred as ***compression ratio***

$$\text{Compression Ratio} = \frac{\text{Uncompressed Size}}{\text{Compressed Size}}$$

# Data Compression

- **Codec (Compressor and Decompressor)** - hardware or software used to compress and decompress

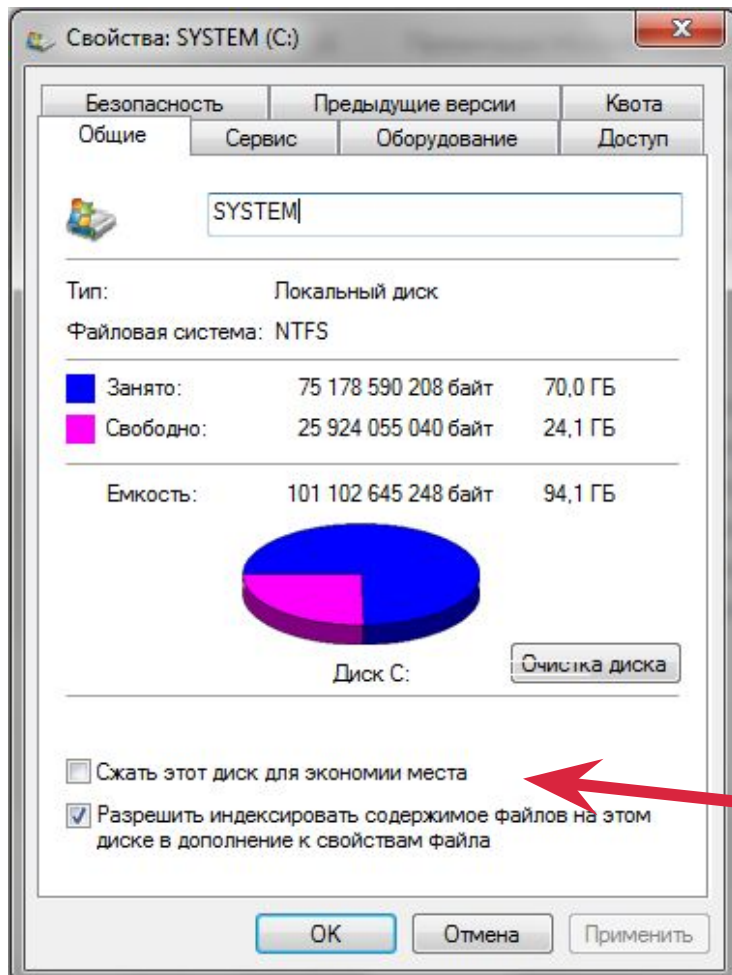




# Disk Compression

- Shrinks the files and places it in a special volume on the hard disk.
- **Disk volume** is a disk or an area of a disk which has a unique name and is treated as a hard disk.
- Use storage space more efficiently

# Disk Compression



*Why it is not  
a default  
feature?*



*Lets you to  
allow a disk  
compression*

# Disk Compression (continued)

## ■ *Advantages :*

- Gain storage space without any additional hardware.
- Under optimal circumstances, the hard disk capacity is doubled.

## ■ *Disadvantages:*

- File error in the compressed volume means the loss of all the data in that volume

# File Compression

- Shrinks one or more into single smaller file.
- Compressed file cannot be used until it is uncompressed.
- **WinZIP** and **WinRAR**
- Compressing a file is called *Zipping*
- Uncompressing a file is known as *Unzipping*



# Text File Compression

- **Adaptive Pattern Substitution:**
  - Designed for compressing text files.
    - Scans the entire text,
    - Looks for patterns of two or more bytes,
    - Substitutes a byte pattern and make a dictionary entry for it.
- Effectiveness depends on the content of the document

# Text File Compression

- Another type of compression scans and finds repeated words.
- Occurrences of the word is substituted with number and it acts as a pointer to the original occurrence

# Text File Compression (continued)

I Don't Like the Dogs (But the Dogs Like Me)

*Dictionary:*

\$ Like @ Dogs #the

*Compressed text:*

I Don't\$#@ (But #@\$Me)

*Dictionary  
size*

*Compression ratio:*

$$44 / ( 22 + 17 ) = 44 / 39 \approx 1,13$$

*Initial text size*

*New text size*

# Graphics File Compression

- **Run Length Encoding** is a technique that looks for patterns (i.e.) blocks of same color.
- Graphics file with **.tif** , **.gif**, **.pcx** and **.jpg** contain bitmap images that have already been stored in compressed formats
- Graphics software used to open and save files contains codes required to compress and decompress them.

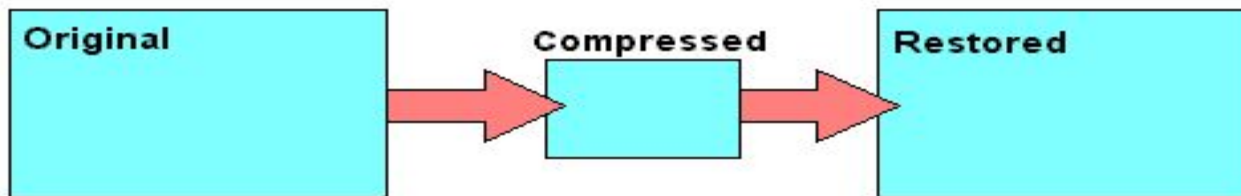


# Graphics File Compression (continued)

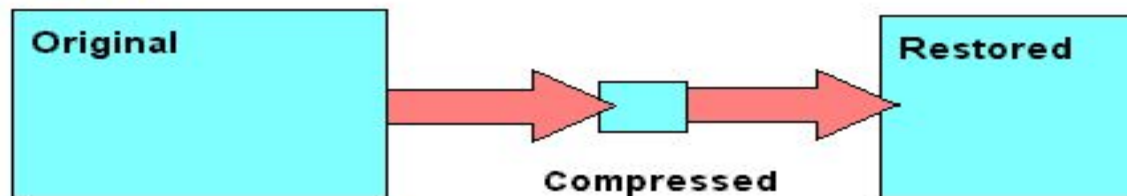
- Compressed file Formats use
  - Lossy Compression
  - Lossless Compression

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## LOSSLESS



## LOSSY



# Lossy compression

- Throws away some of the original data for the graphic
- JPEG(Joint Photographic Experts Group)

## *Example of Lossy Compression*



**Original Lena Image  
(12KB size)**



**Lena Image,  
Compressed (85%  
less information,  
1.8KB)**



**Lena Image, Highly  
Compressed (96%  
less information,  
0.56KB)**

# Lossless compression

- **Lossless Compression** provides a way to reconstitute all of the original data in a graphics file.



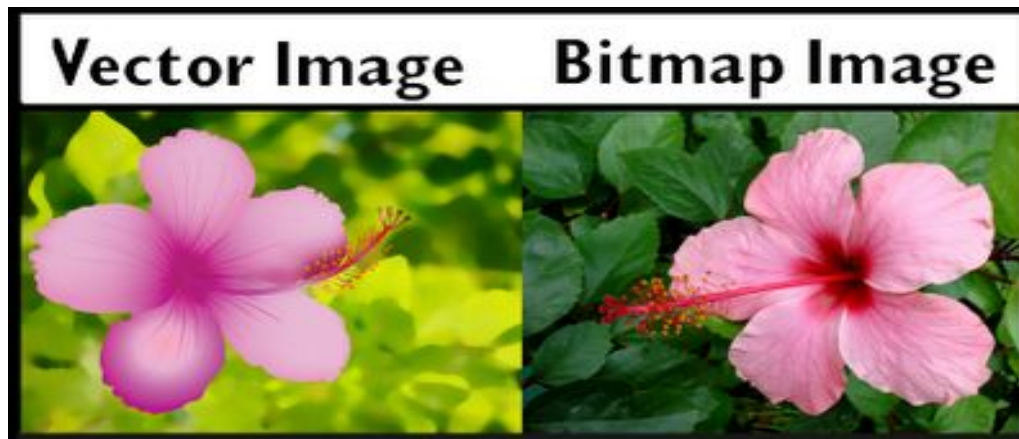
# Photoshop File (PSD.PDD)

- A Photoshop file
- File is both a vector image and also a raster
- Keep layers, layer masks and also the color like RGB
- Max - 300,000 by 300,000 pixels per image



# BMP (BMP.RLE.DIB)

- A raster type of file
- Made up of pixels
- Only uses RGB colors
- Cannot be used on WebPages
- Have a large file size



# JPEG (JPG.JPEG.JPE)

- Raster file
- Can be used for WebPages
- A small file that can be uploaded on WebPages and it will be good quality
- Support lots of color like RGB and CMYK.



# Video File Compression

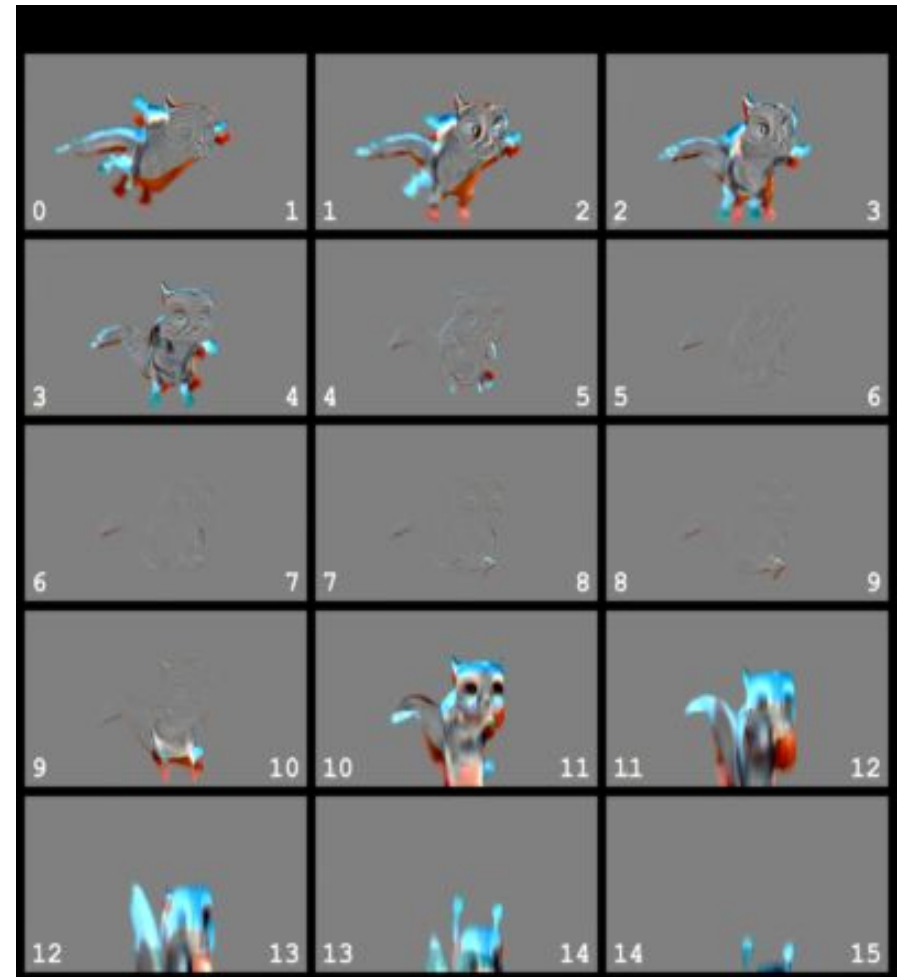
- Used to display video on the PC by
  - *Reducing number of frames displayed per second.*
    - Number of frames per second affects the smoothness of the video.
    - High quality video displays 30 frames/sec and low quality 10-15/sec

# Video File Compression (continued)

- ***Reducing the size of the video widow.***
  - Displaying an image  $1/4$  of the screen requires only  $1/4$  of the data required to display on a screen.
  - Technique is termed **Intra frame Compression**
- ***Coding only the changes that take place one frame to next***
  - Difference between frames are evaluated and the data changed are stored.
  - Technique is termed **motion compensation**



# Motion compensation



# Music File Compression

- **MP3** is a popular format for music compression
- **Type of lossy compression** technique as it filters the data outside the human hearing.
- Maintains a high degree of sound quality.
- **MP3 ripper software** is used to convert songs from the CD to WAV files.