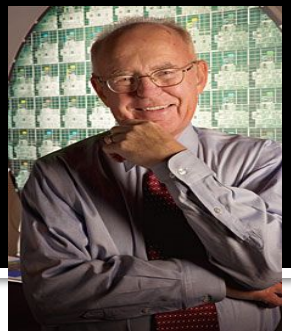
Improving Computer Performance

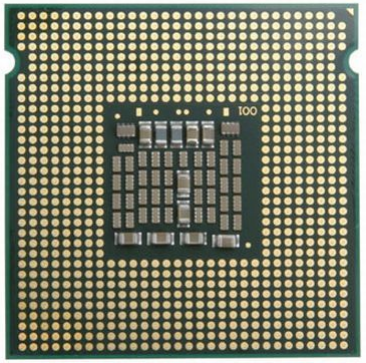
Khamitov Alim Nadimovich
alikhamt@umail.iu.edu

Moore's Law

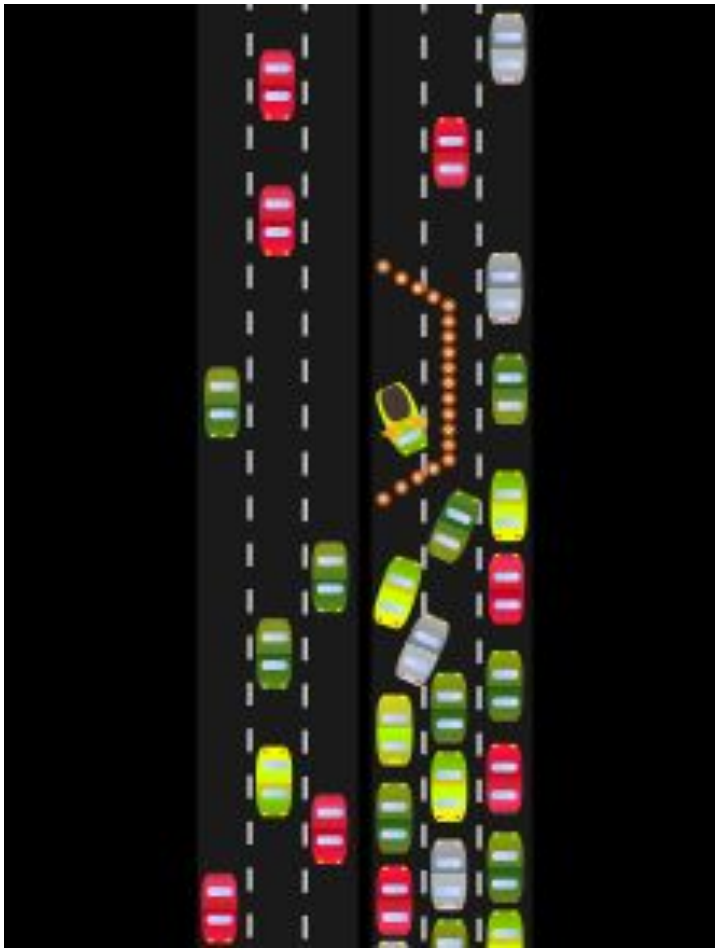


Number of transistors on a microchip doubles every 18 months.

- 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



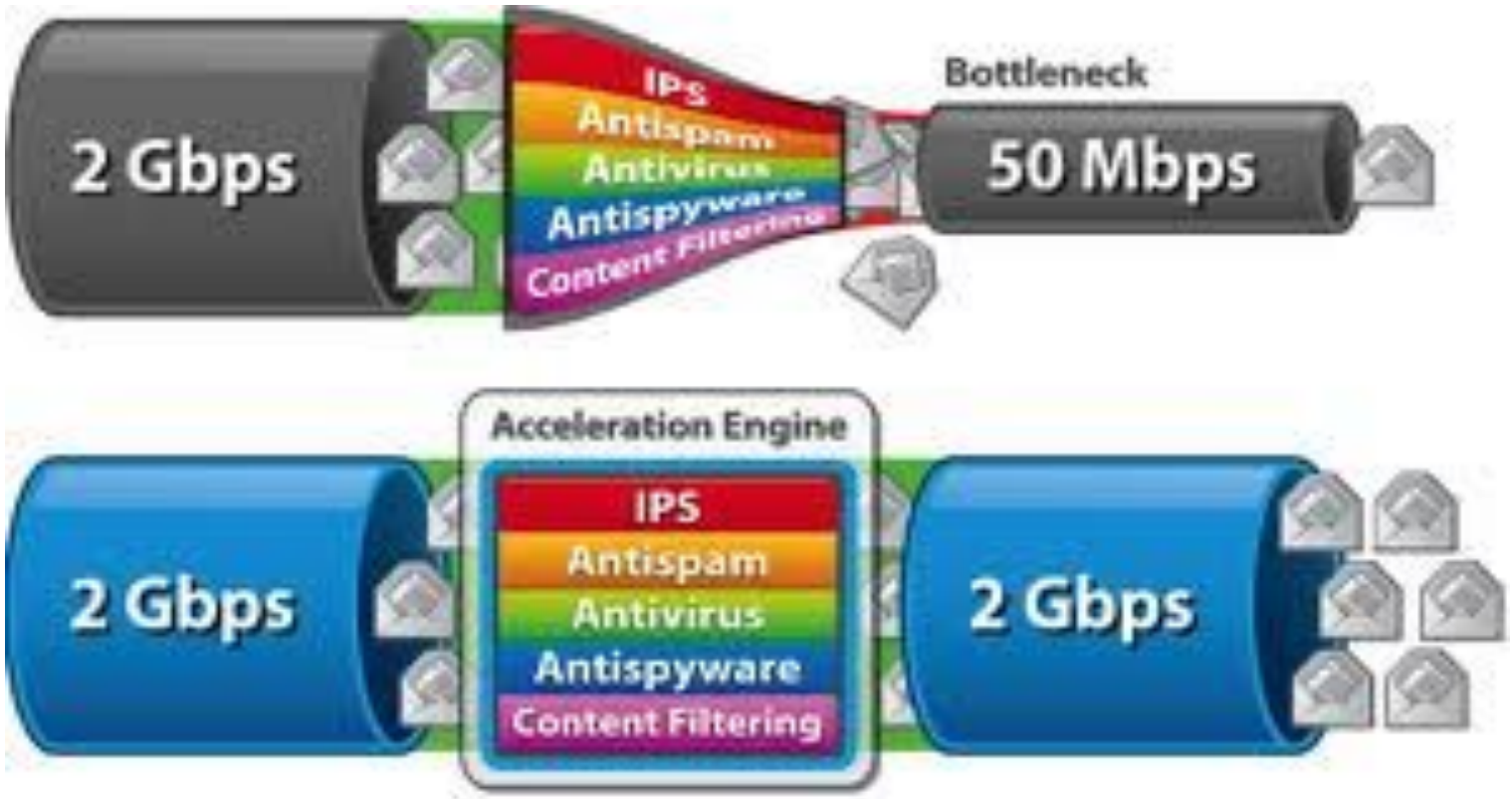
Bottlenecks



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)

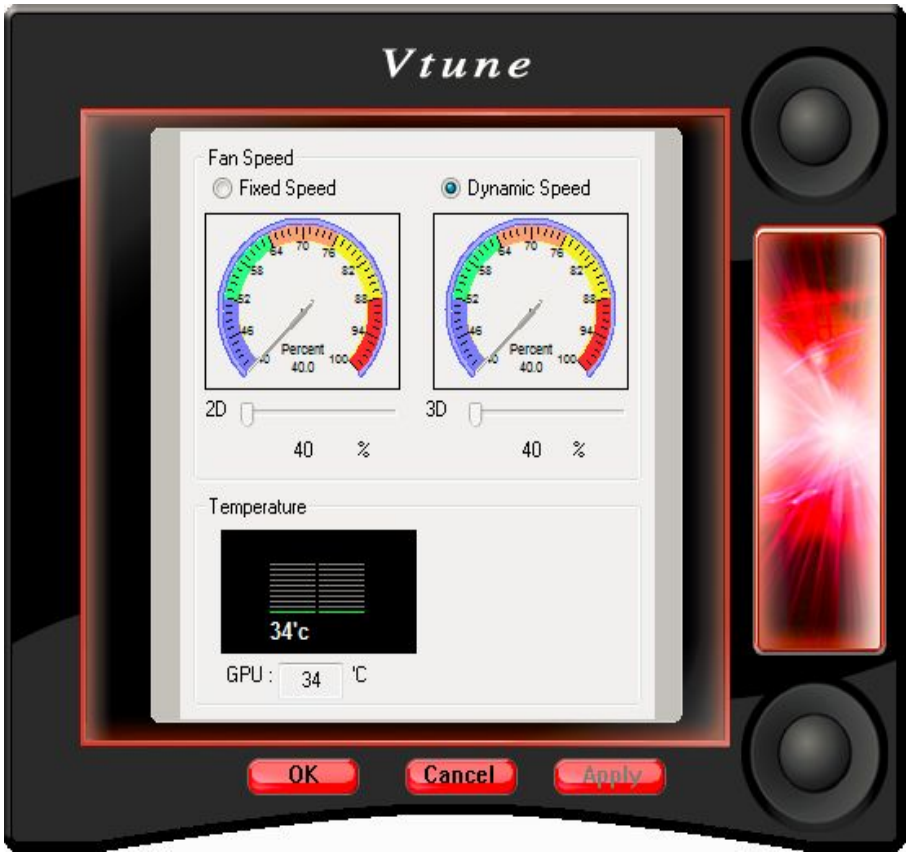
- **Typical bottlenecks**:
  - Cache
  - RAM
  - I/O (Information transfer, bus, hard drive)
  - Video card (particularly for 3-D gaming)

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

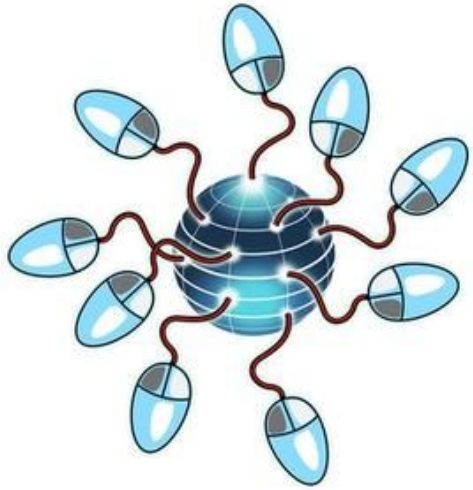
Vtune Performance Analyzer



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.

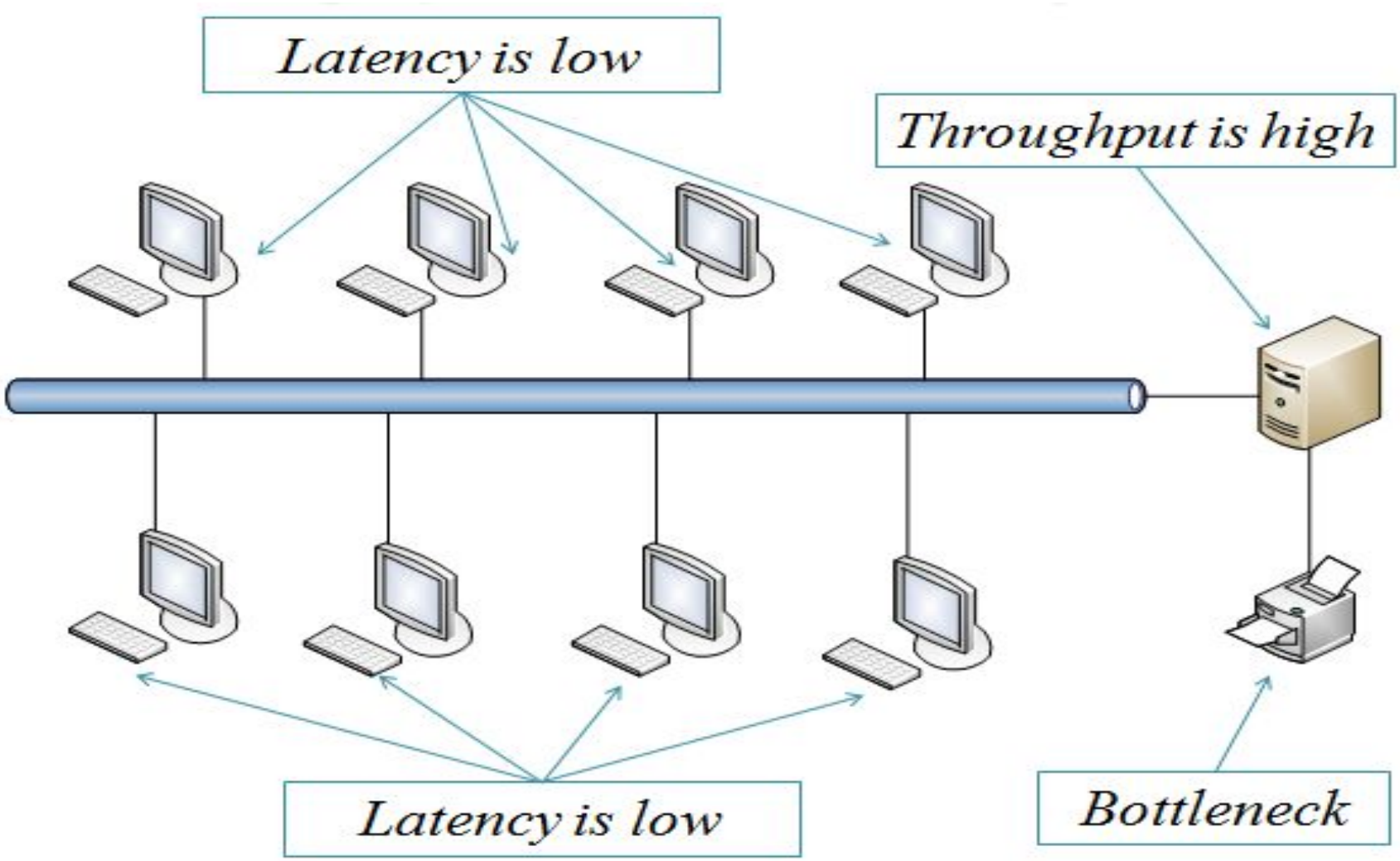
Latency

- 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

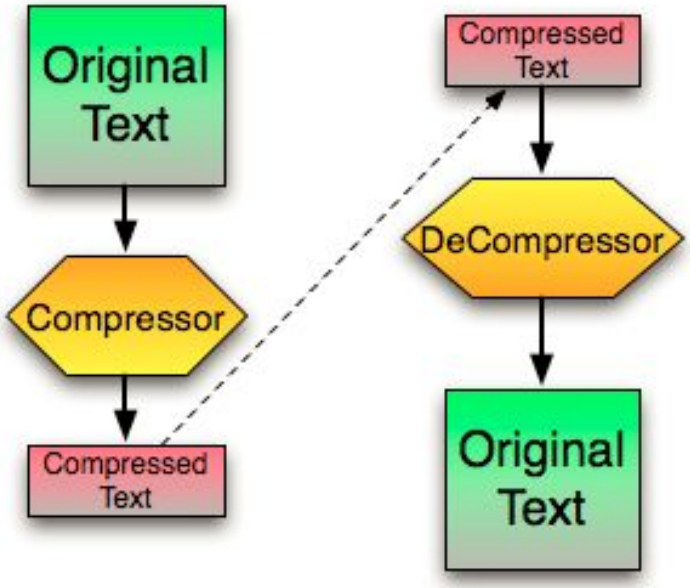
Data Compression

- **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

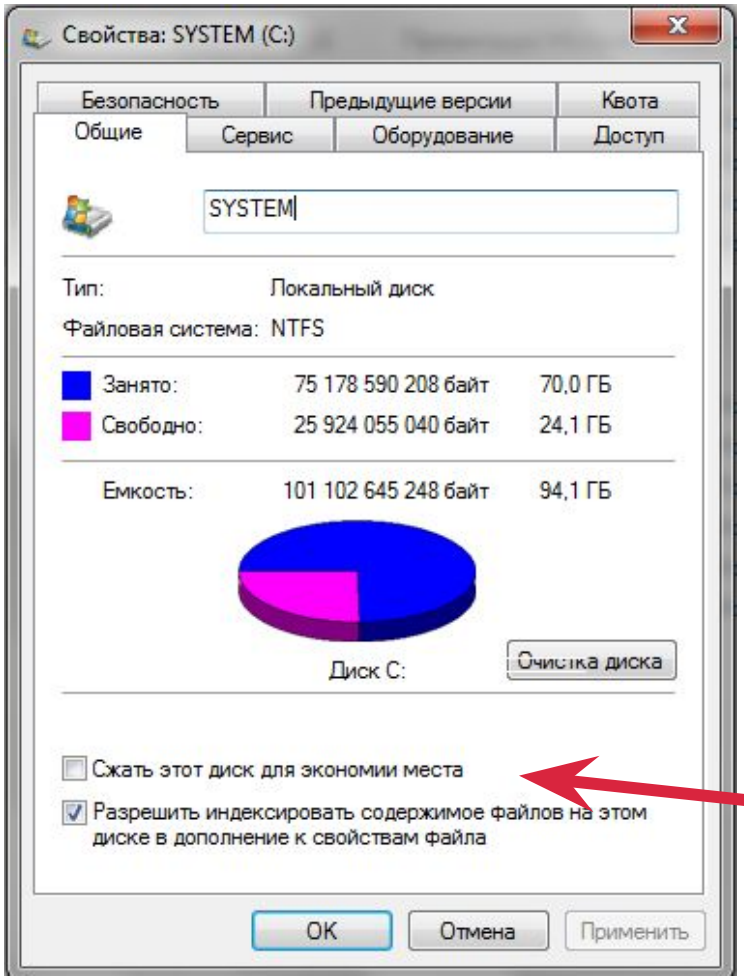
- **Codec (Compressor and Decompressor)** - hardware or software used to compress and decompress



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



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)

Compression ratio:

44 / (22 + 17) = 44 / 39 ≈ 1,13

Dictionary size

Initial text size

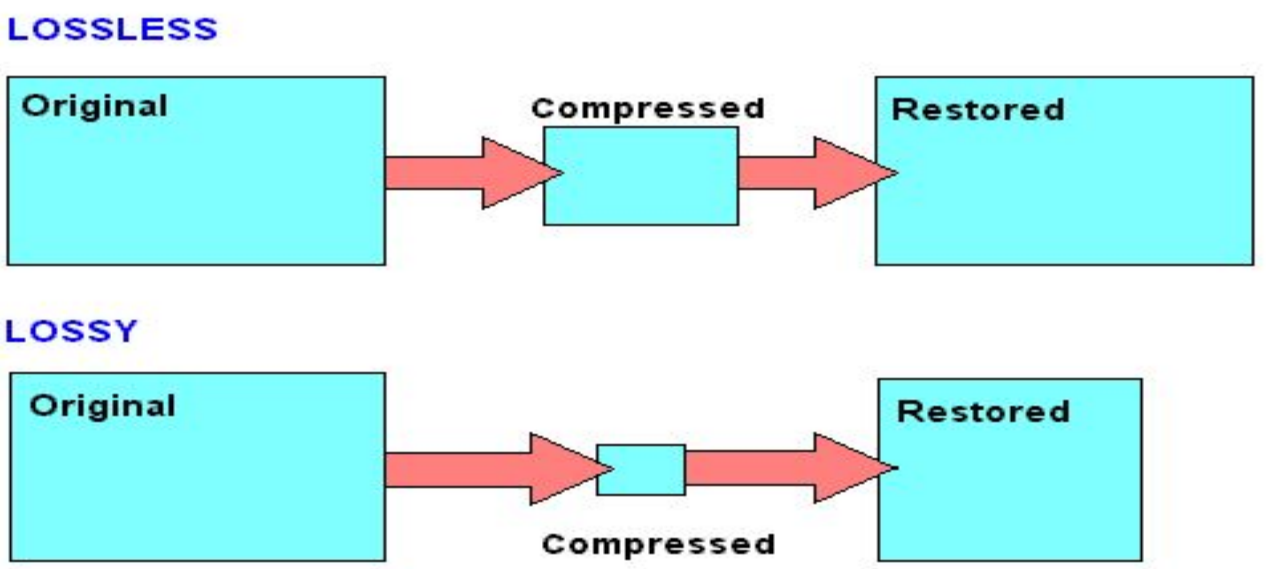
New text size

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**



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

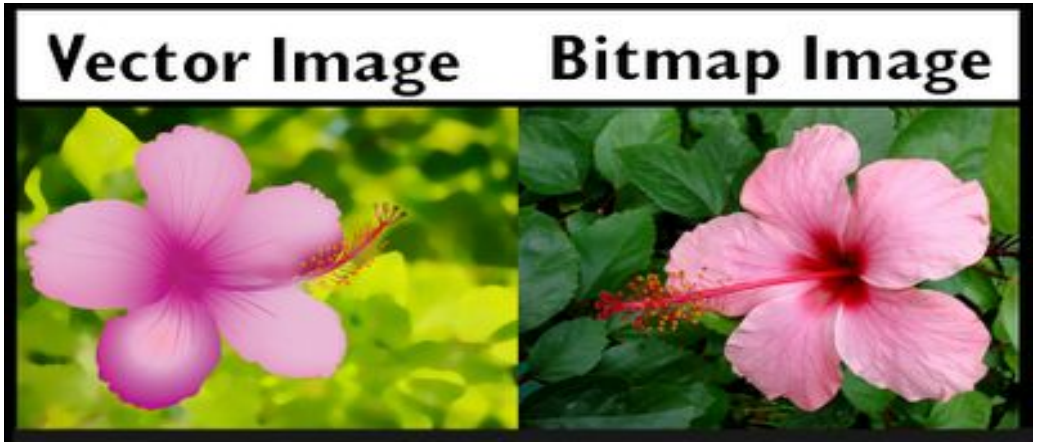
- **Lossless Compression** provides a way to reconstitute all of the original data in a graphics file.

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.

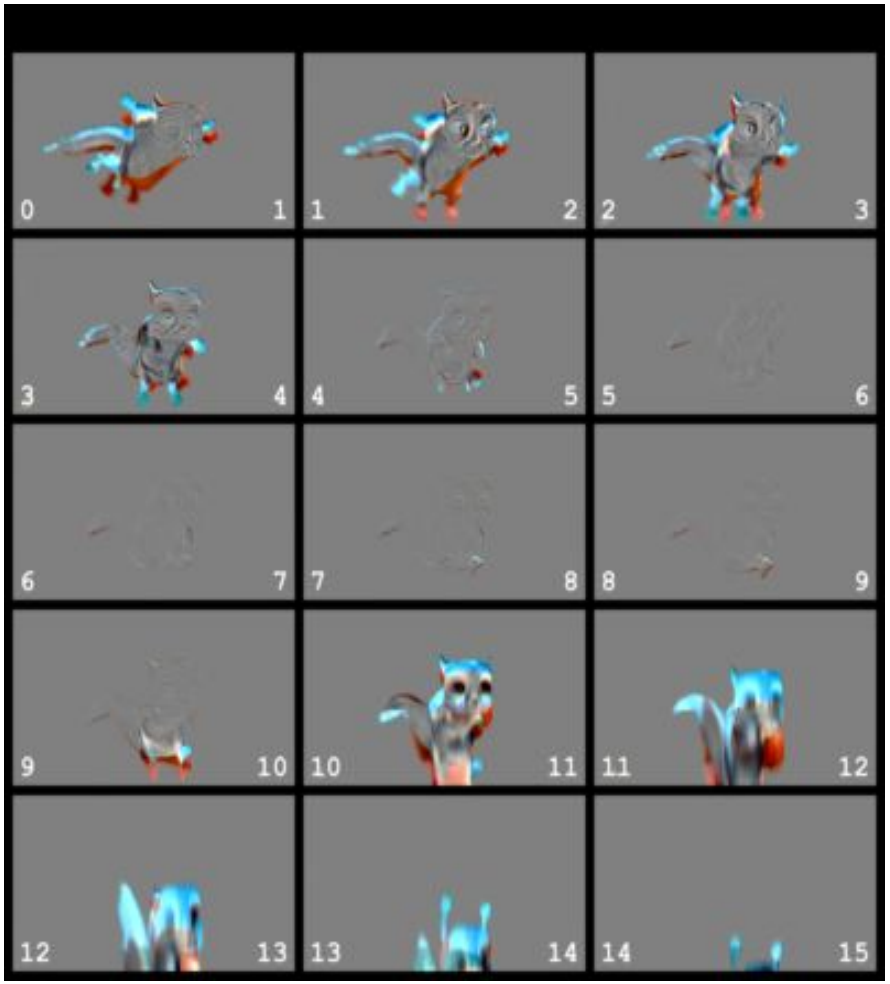
Video File Compression

- 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.