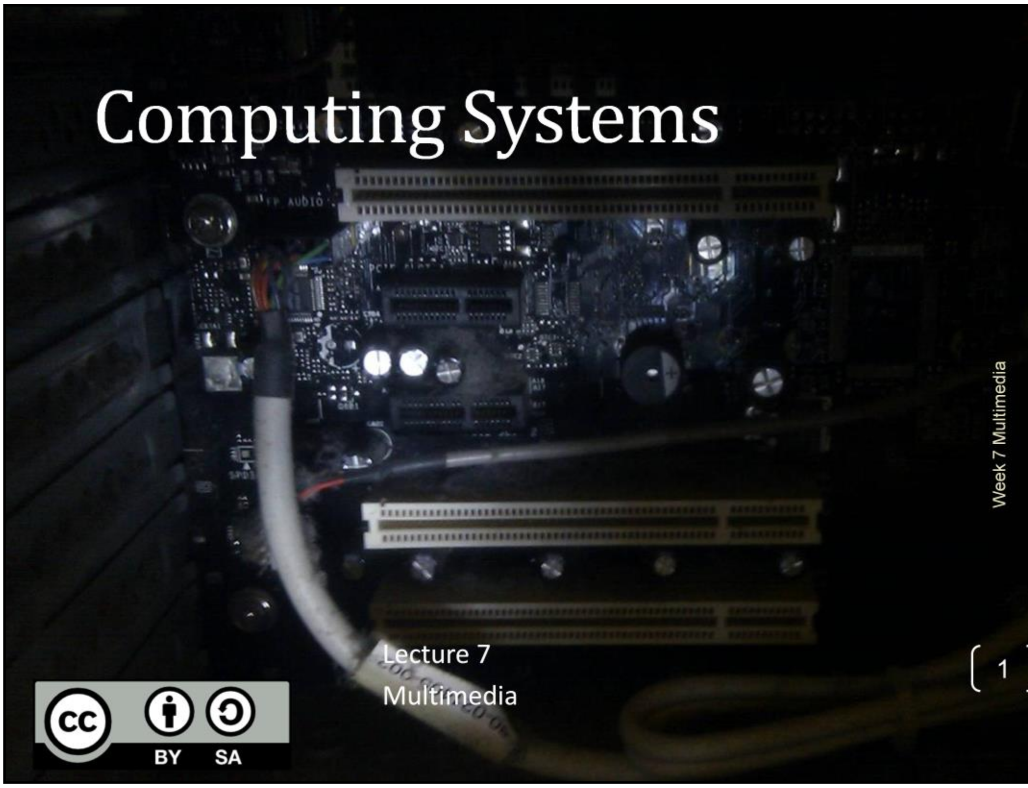
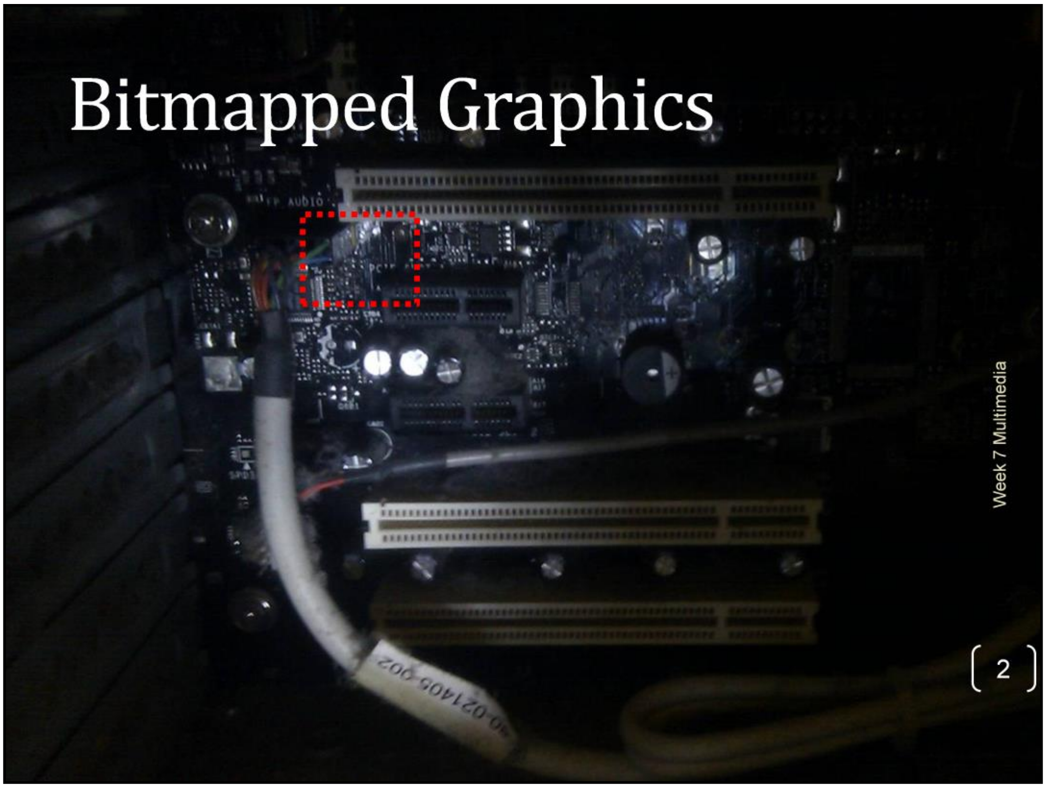
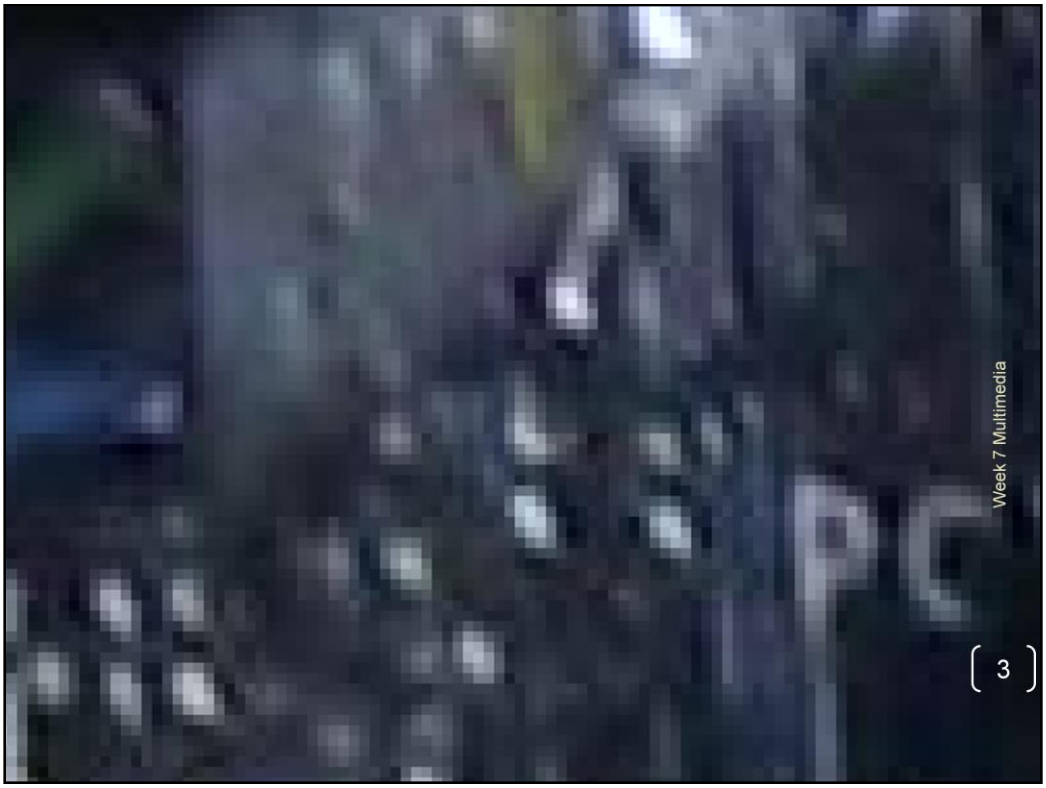

Computing Systems
Week 7 Multimedia
Lecture 7
Multimedia
1
BY SA


Bitmapped Graphics
Week 7 Multimedia
2



Can see the individual pixels – picture elements – that make up the digital image. Each image has rows and columns of pixels, each one is a different colour.

Bitmapped File

- The header a **bitmapped** file begins with a **signature** that identifies the file as a bitmap.
- You don't see this signature, but you can tell that a file is a bitmap if it has an extension such as .BMP, .PCX, .TIF, or .JPG.
- Following the signature, the header tells the width and height of the image in **pixels,** which are distinct points of light, and then defines the *palette* (how many and which colours are used in the image) .

Black-and-White Bitmap

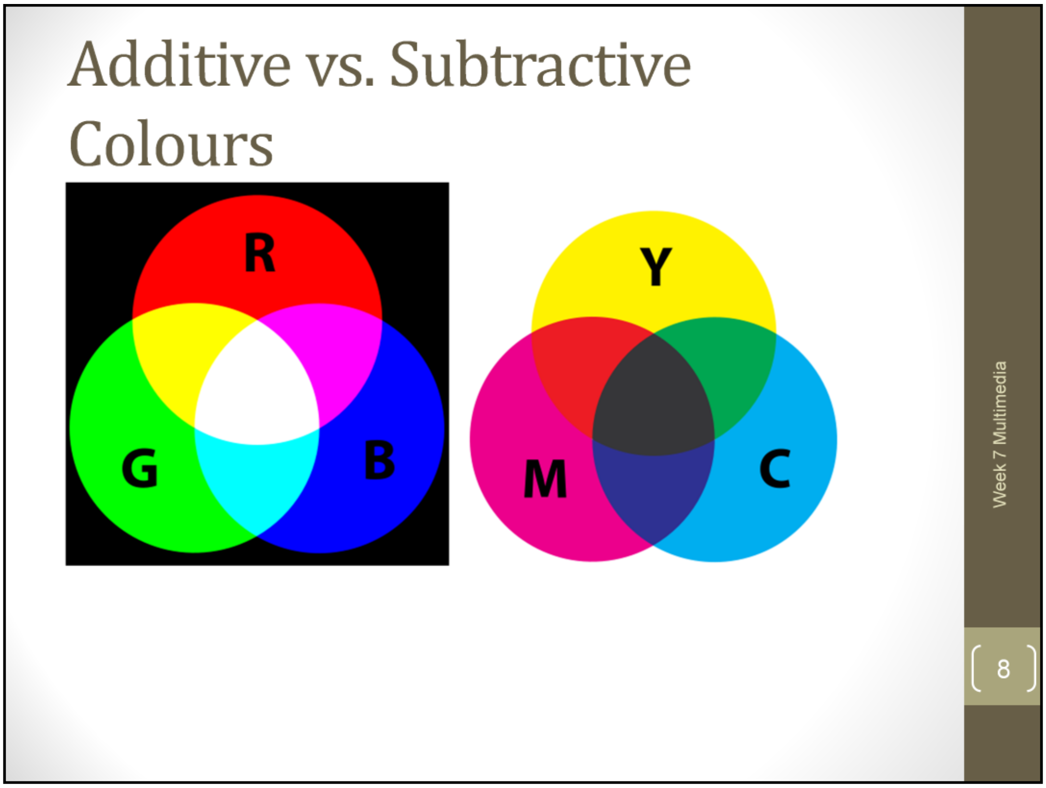
- The simplest bitmapped image has only black-and-white pixels.
- For images of this type, the graphics program needs only two pieces of information: the location of a pixel and whether to turn the pixel on or off.
- The locations of the pixels are determined by the image's width and height as defined in the header.
- In the memory set aside for video display, the bytes that make up the black-and-white image consist of some bits set to 1 and the rest to 0. A 1 means a pixel that corresponds to that bit should be turned on. A 0 bit indicates a pixel should be turned off.

Colour Bitmap

- A colour bitmap requires more than 1 bit of information for each pixel.
- Eight bits (or 1 byte) per pixel are enough data to define a palette of 256 colours because 8 bits of binary information has a total of 2^8 possible values, or 256.
- For 24-bit graphics, 3 bytes of memory are used to define each pixel.
- Three bytes provide enough data to define more than 16 million possible colours (2^{24}), which is why 24-bit colour is sometimes referred to as **true colour** – it's difficult to imagine that any real-life shade would not be among the 16 million.

Colour Bitmap

- Note that in configuring Windows, you're likely to see 32-bit as a colour depth option .
- The higher number doesn't mean more colours, however.
- In this case, the extra bits are used to render an **alpha channel** that handles the transparency and translucency of images and objects.

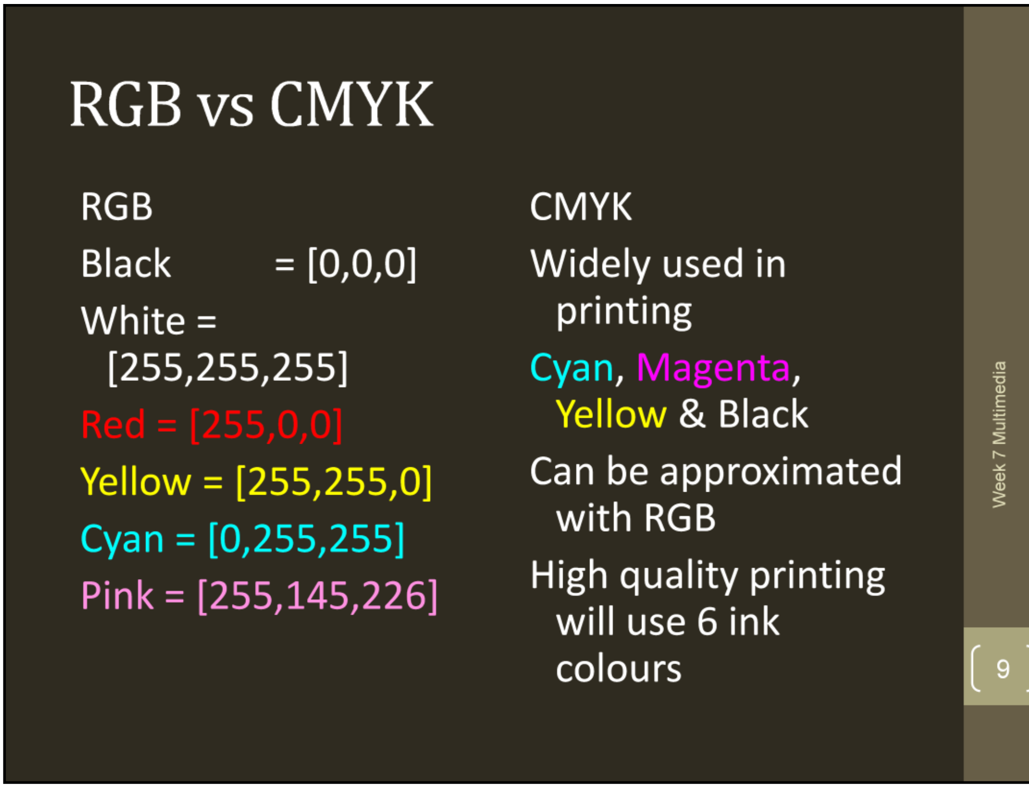


Y, M, C Paint and dye are **subtractive** – the more paints and dyes you combine, the darker the end colour will be. Yellow, Magenta and Cyan you get a darker and darker shade which gets nearer and nearer to black.

R, G, B Computer monitors, lcd screens, televisions etc. have **additive** colours – the more colour you add, the brighter/whiter the end result.

When you mix **Red, Green and Blue** you get **White**. We are mixing light.

Each pixel can be represented by a 3 byte value: one byte each for the amount of Red, Green and Blue that is present. 3x8bit = 24bits. Sometimes called **true-colou**r.

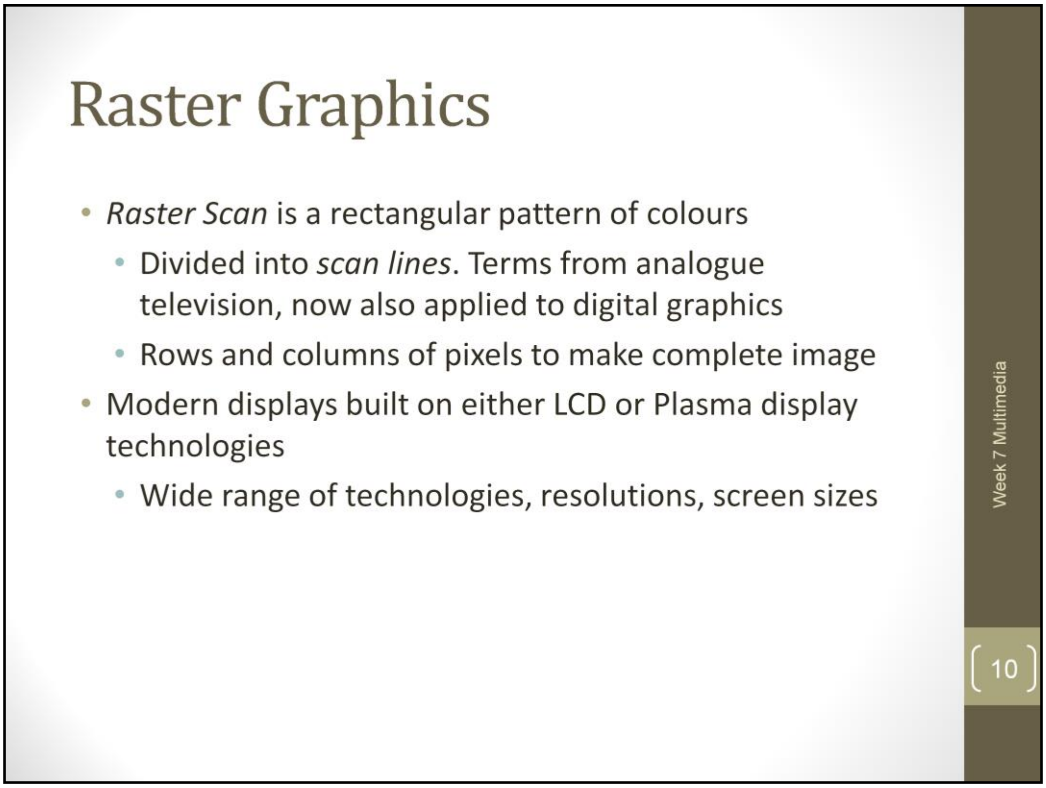


Monitor → Screen colour using light

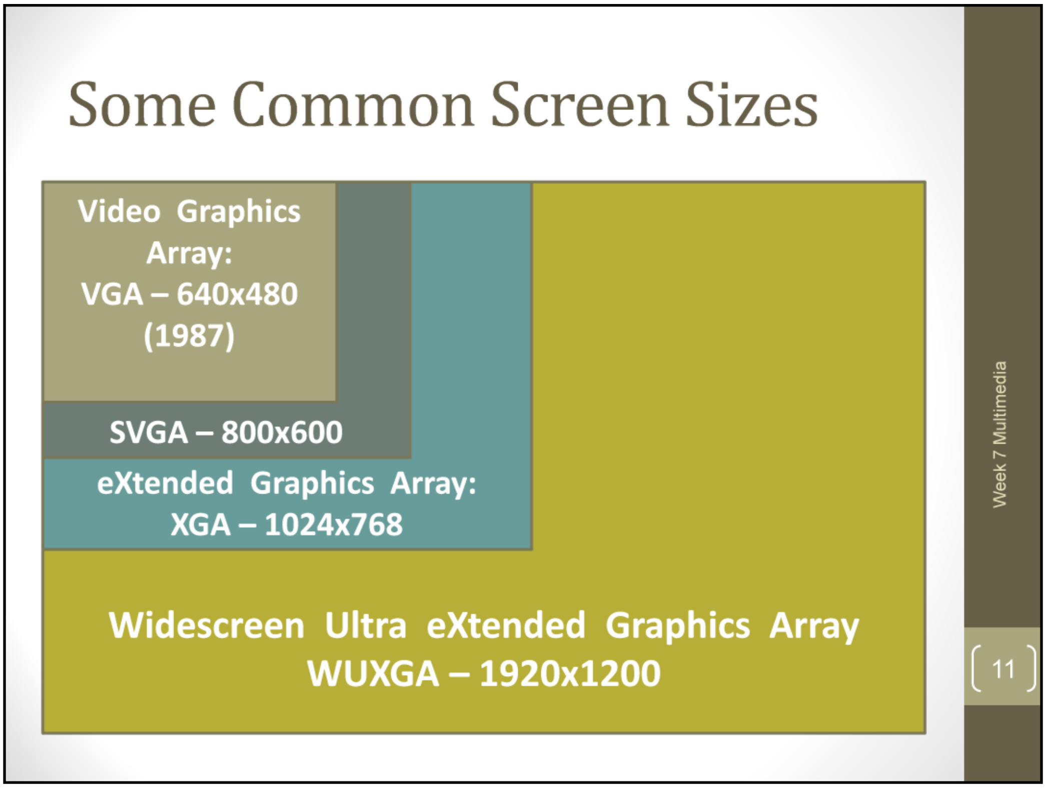
With RGB, White is [255, 255, 255] The maximum value of each component and Black is [0, 0, 0] the minimum value of each component.

Printing → using dye.

CMYK, K-key which is usually black, is used in printing. Black ink is used as it is difficult to get black from the mix of CMY. Inks are mixed.



BITMAP graphics → also known as RASTER Graphics.



Displaying HD content on a WUXGA display, there are 60 unused lines at top and again at bottom of display – slight letterboxing, but keeping the same image aspect ratio.

There are lots and lots of other display sizes. My current laptop has a resolution of 1366x768 which is one of several resolutions referred to as WXGA (1280x720 to 136

6x768)

Widescreen Ultra eXtended Graphics Array

WUXGA – 1920x1200 → nearest computer monitor screen resolution close to a TV.

How much display RAM is required for WUXGA?

For a single 24 bit image

= 3 bytes x 1920 x 1200

= 6.9 million Bytes ~ 6.6MB

Current graphics cards typically have 0.5 – 2 GB of dedicated graphics memory

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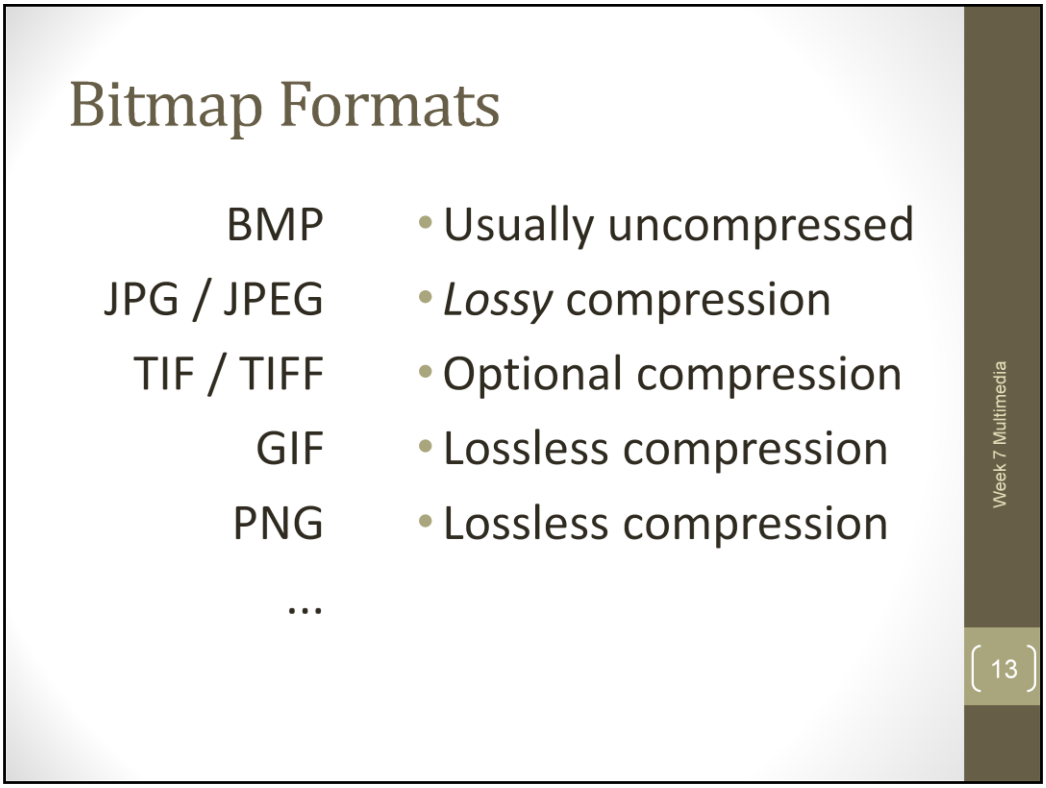
Will see later some of the other ways that graphics cards use memory – and why they need so much more than just needed to store the image that will be output to the screen. Graphics Cards have to store more than just the screen buffer, they need to store details required for generating the screen image, therefore must larger screen buffer, especially 3d games there is a lot of other texture and image data.

24 bits for each pixel → 8 for Red, 8 for Green, 8 for Blue



BMP → widely used in Windows and is usually uncompressed, therefore very large file sizes. E.g. a screen shot could be 6Mb in size.

GIF used to be one of the most common and widely used image formats, but the compression algorithm used was the patented LZW one. When the owners decided to charge license fees to software developers, it quickly fell from popular use. The PNG format was adopted by the W3C (World Wide Web Consortium) as a web standard and is now, along with **JPEG** and **TIFF**, one of the most widely used formats.

Most web-browsers support **JPEG** and **PNG** formats, as well as **SVG** (see next!). **GIF** usually still supported, but not often used other than for short animated images.

Need to discuss **lossy vs lossless** compression. Smaller files sizes in compressed files.

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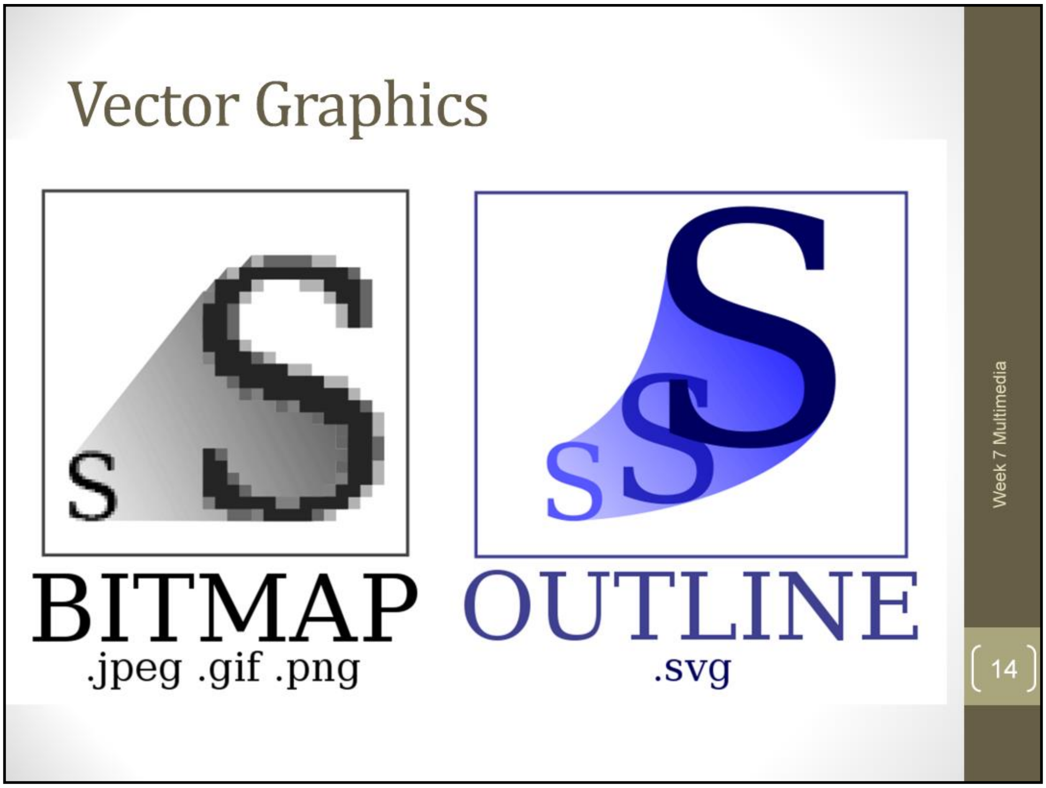


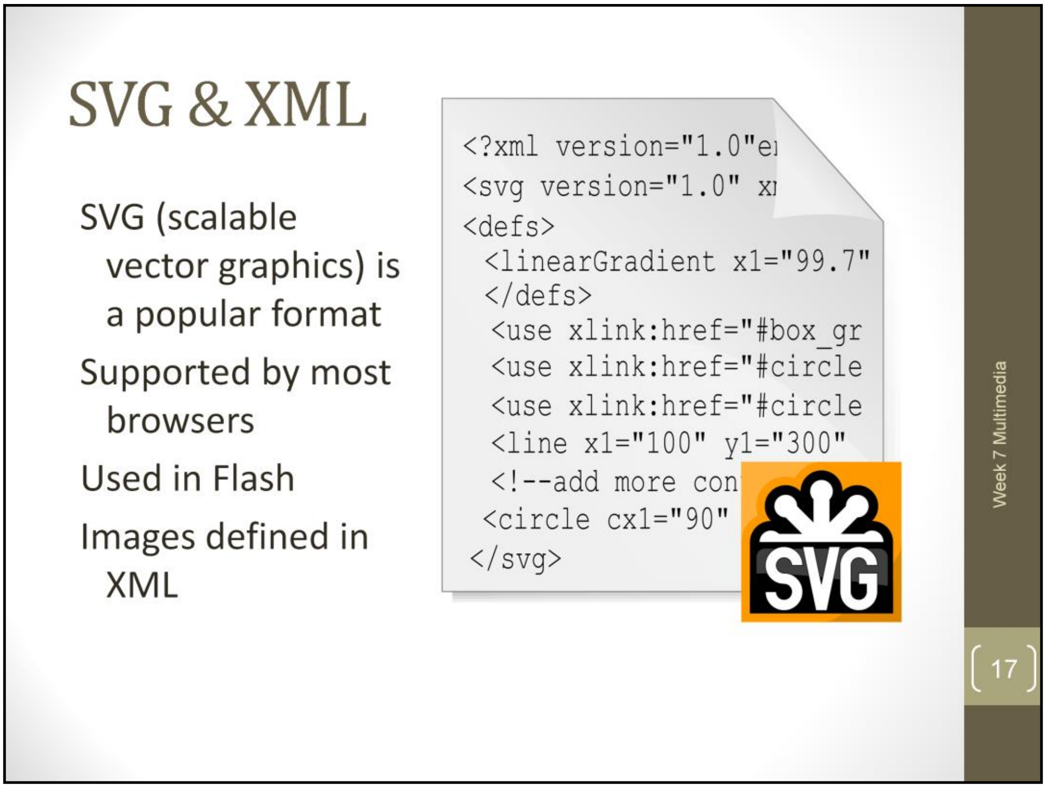
Vector graphics store instructions on how to draw the image... How to draw lines, curves, do fills etc.. The image on right shows a single letter S scaled to different sizes – but based on the same source image. Curves are stored as a set of parameters that describe the curve therefore the curve is always maintained. Scaled image is always picture perfect.

Vector Graphics

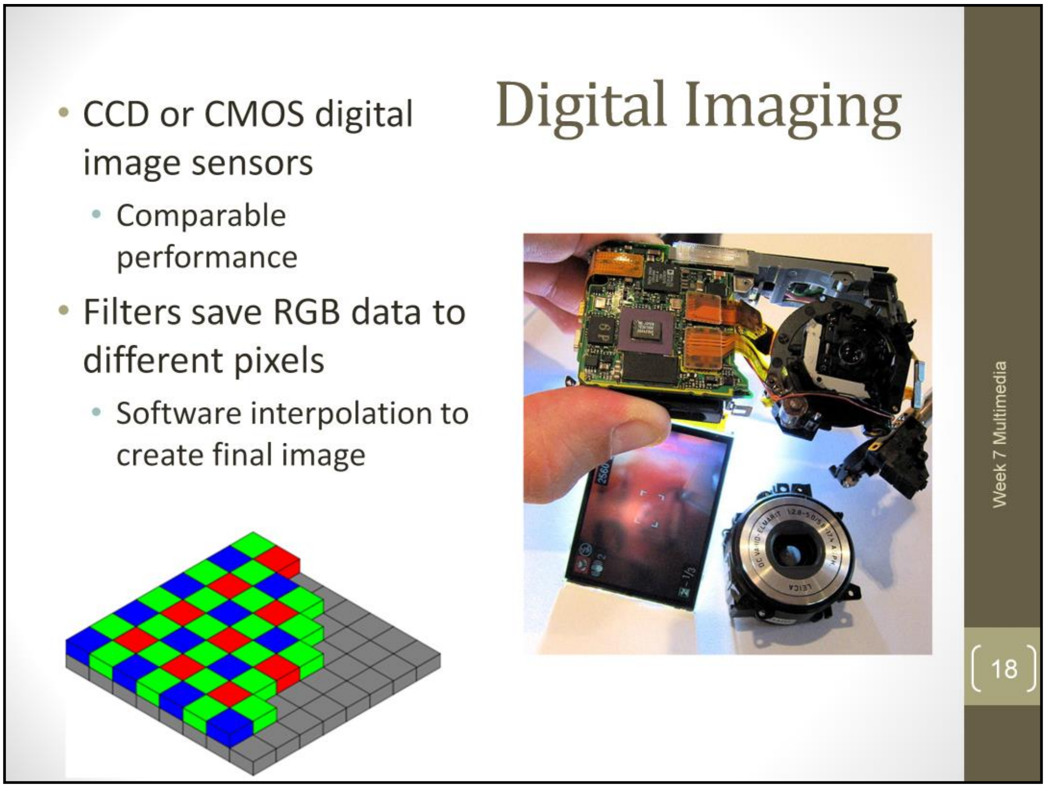
- Vector graphics differ from bitmapped graphics, which are locked into an unchanging size and shape.
- Vector graphics can change size and shape by changing the maths that defines them.
- To display a vector image, the graphics program reads all the formulas and their accompanying data from the display list and uses them to compute a bitmapped image. This process is called *viewing transform*.

Vector Graphics

- To display a **fill**, the program computes a mathematical formula that determines the locations of all the pixels that make up the edge of the shape.
- With that information, the program can determine which pixels are inside the shape and change the colour values for all those pixels to match the fill.
- Any time you change or move a shape, change a shape's attributes (such as its colour), or add a new object to the image, the software changes the data stored in the display list for all the affected objects.
- Data for any object not changed is left unmodified.
- *Viewing transform* then re-computes the display bitmap to update the screen.



SVG images are very popular and are supported by most modern web browsers and are used in Flash using XML to define the image.



Live digital camera which is working, the lens has been removed therefore it is not in focus and the image is very blurry.

Two main types of imaging sensor: CCD and CMOS.

CCD →Charge Coupled Devices

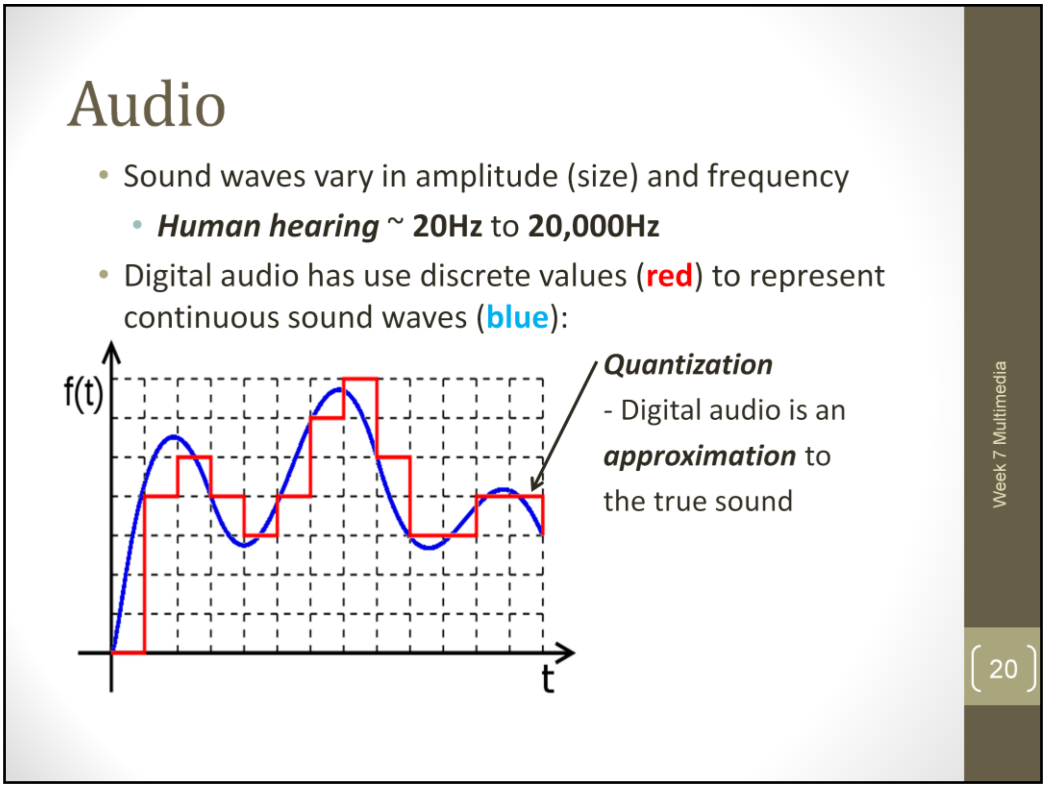
CMOS → **Complementary metal–oxide–semiconductor**

Broadly comparable performance, neither is a particular favourite or more popular one.

Each Pixel has it’s own image sensor.

CMOS vs CCD

- Unlike the photo sites in CCDs – pretty much passive **capacitors** – the CMOS image sensor uses the amplifiers that are part of each photo site.
- This eliminates the need for the charges to go through an amplifier in single file after they've left the sensor.

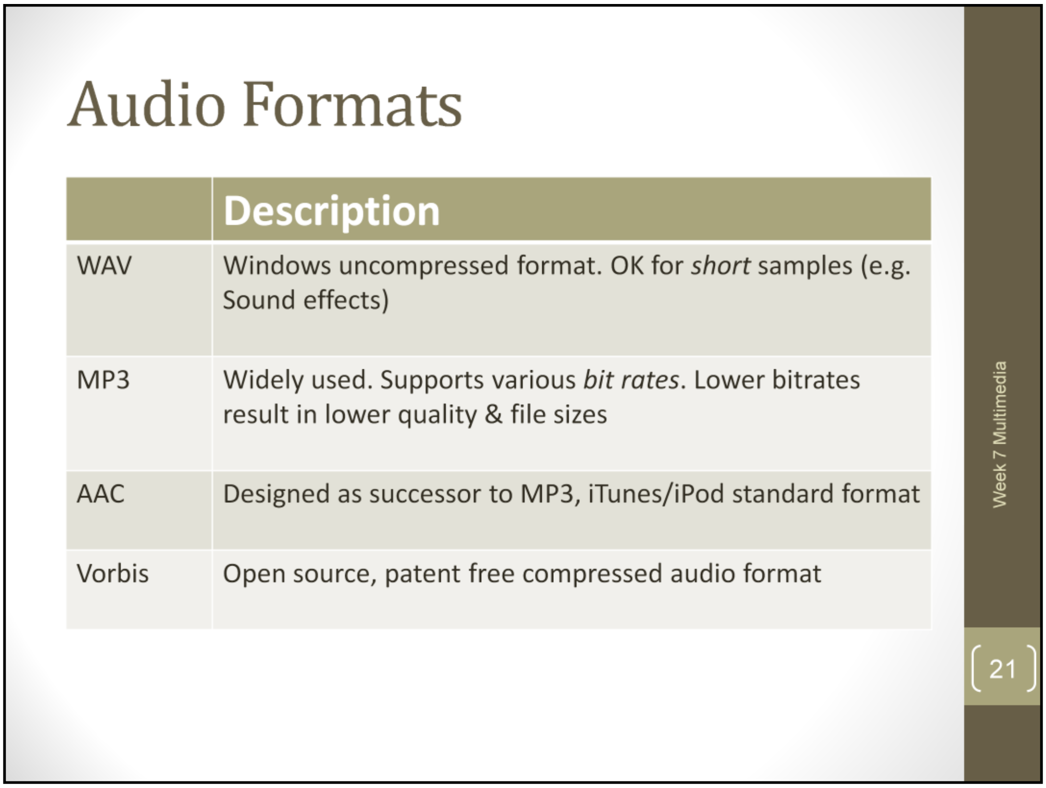


Can also mention that to minimise perceptible errors in quantization, the frequency of the quantization needs to be a little over **twice** the perceptual range – which is why for music a frequency of 44KHz is common. E.g. Standard CD audio is 44.1KHz This minimizes audible sampling errors.

F(t) → Height is **Amplitude** information

T → Time samples taken at set times.

Quantization - Digital audio is an *approximation* to the true sound → red.



Audio Formats

	Description
WAV	Windows uncompressed format. OK for *short* samples (e.g. Sound effects)
MP3	Widely used. Supports various *bit rates*. Lower bitrates result in lower quality & file sizes
AAC	Designed as successor to MP3, iTunes/iPod standard format
Vorbis	Open source, patent free compressed audio format

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MP3 at 128 Kb/s is about 1/10th the file size of standard (uncompressed) CD audio

WAV files are uncompressed – so about the same as CD audio → ok for short sound effects, used by Windows. Not suitable for music because of the size of the files.

Vorbis is comparable but **patent free**. This is important to software and hardware developers as using **MP3** or **AAC** may involve **licensing** costs.

How Sound Cards Work

- From microphones or equipment such as an audio CD player, a sound card receives a sound in its native format – a continuous analogue signal of a sound wave that contains frequencies and volumes that are constantly changing.
- The sound card can handle more than one signal at a time, allowing you to record sounds in stereo.
- The signals go to an **analogue-to-digital converter (ADC)** chip.
- The chip changes the continuous analogue signal into the 0s and 1s of digital data.

How Sound Cards Work cont.

- The ADC sends the binary information to a chip, called a **digital signal processor (DSP),** that relieves the computer's main CPU of most processing chores involving sound.
- The DSP gets instructions about what to do with that data from the memory chip.
- Typically, the DSP compresses the incoming signal so that it takes less storage space.
- The DSP sends the compressed data to the PC's main processor, which, in turn, sends the data to a hard drive to be stored, typically as a **.WAV** or **.MP3** file.

How Sound Cards Work cont.

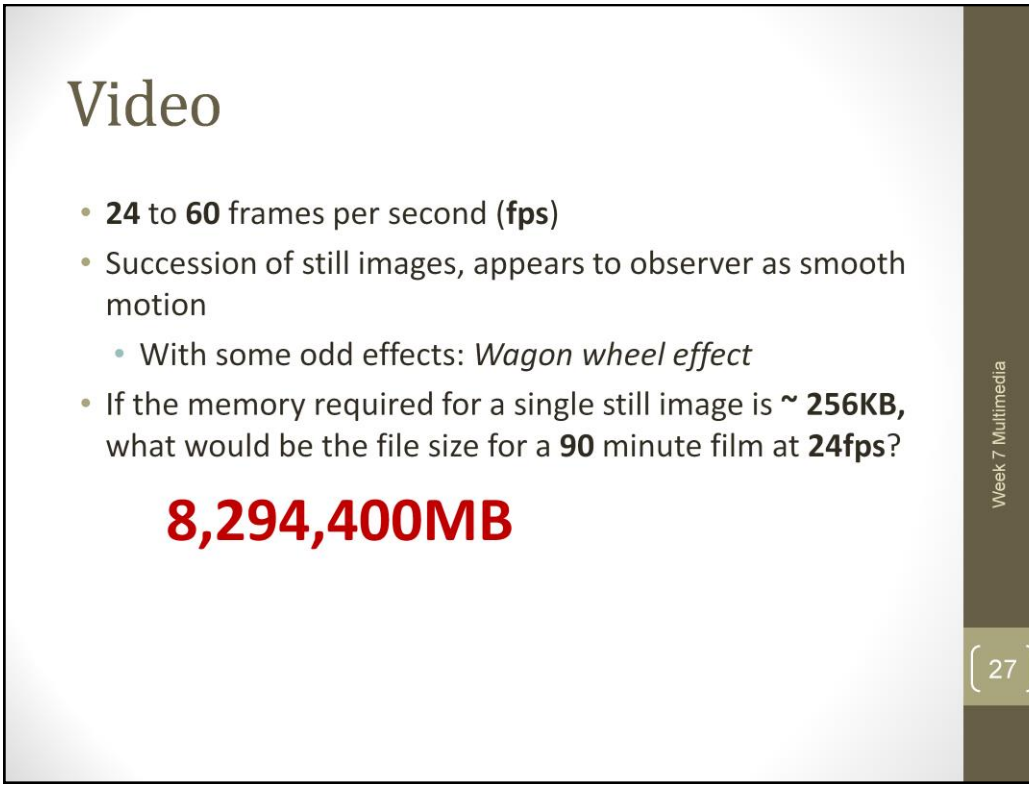
- To play a recorded sound, the CPU fetches the file containing the compressed digital replication of the sound from a hard drive or CD-ROM and sends the data to the DSP.
- The DSP decompresses the data on the fly and sends it to a **digital-to-analogue converter (DAC)** chip, which translates the digital information to a constantly wavering electrical current.
- The analogue current is amplified, usually by an amplifier built into the PC's speakers. Then, the stronger current powers an electromagnet that's part of the speaker, causing the speaker's cone to vibrate, which re-creates the sound.

Multichannel Sound

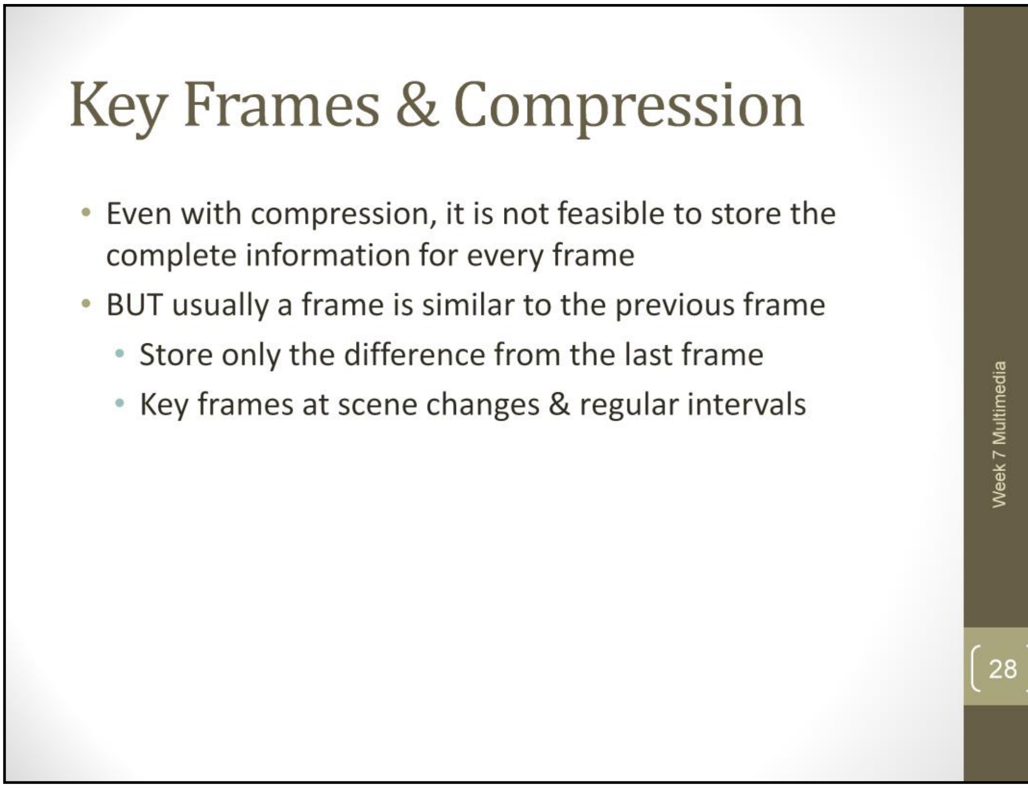
- Full **Dolby Digital *5.1,*** also called **AC3,** records sounds in six channels.
- Five channels record the same range of sounds, from 3 Hz to 20,000 Hz.
- The sixth channel, the .1, is narrower. It's the **low frequency effect (LFE)** channel. It carries bass sounds from 3-120 Hz, used for explosions, crashes, and similar loud sounds.
- When replayed on a Dolby Digital 5.1 system, the sounds are separated along the six channels to individual speakers, typically three front speakers and two surround speakers to the sides.

Multichannel Sound

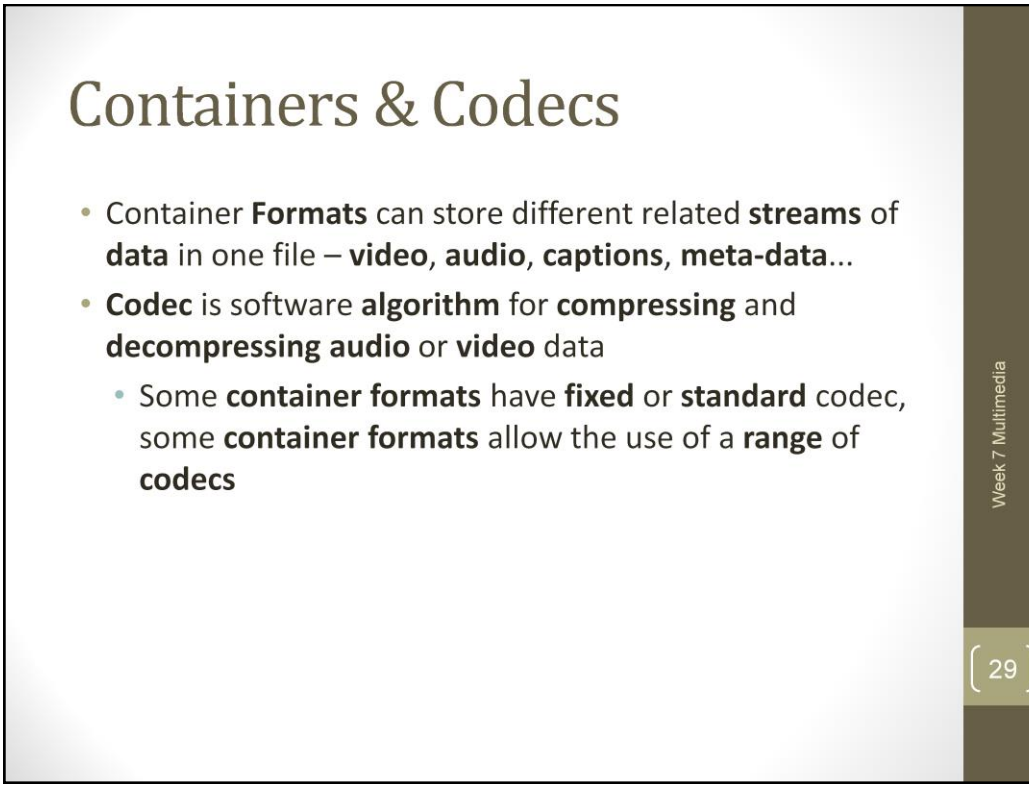
- The sixth channel, with its explosive bass, goes to a non-directional subwoofer that can be positioned anywhere.
- AC3 recordings can be played on systems that have only one, two, or four speakers. In this case, Dolby mixes the signals from the six channels as needed to create the most realistic sound it can for that system.



Wagon wheel → with bicycle or wagon wheels, almost like a strobe effect and the wheels appear to turn in reverse.



Key frames → used to store the difference between each frame, as most of the scene is not changing. When the scene changes we present a new key frame.



e.g. **AVI →** standard windows video format but it does not specify which codec will be used, there is a very large range of codecs AVI can work with. You can copy an AVI and it does not run on your PC, this is because the codec is not installed on your PC. Codec is separate from the container. Playing the AVI relies on the codec being installed.

Video Formats

	Description
AVI	Standard Windows container. Allows user-defined codecs
WMV	Another Microsoft format, with optional DRM. Available in Blu-Ray
MP4	MPEG-4, based on Apple's Quicktime. H.264 codec favoured by Apple & Microsoft & available in Blu-Ray
WebM	Google sponsored. License free VP8 video and Vorbis audio codecs. Patent dispute with MPEG group?

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Video formats can be quite confusing. The three letter filename extension does not always indicate what codec is used – especially for AVI where there is a huge range of codecs available. There are many windows based applications that use their own codecs – which can leave unsuspecting users with AVI videos that they cannot play on other machines, unless they also install the codec first. MP4 & WebM have a limited range of codecs so appropriate players are unlikely to fail.

As a general rule, a MP4 file renamed from xxxx.mp4 to xxxx.mov will usually play without problems in Apple Quicktime.

MPEG → Moving Pictures

Streaming

- Streaming, used with a variety of players and audio/video formats, enables your PC to play the file as soon as the first bytes arrive, instead of forcing the PC to wait for an entire multimedia file to finish downloading.

Streaming Audio

- When you click on a word or picture linked to an audio source, the web browser contacts the web server holding the current web page.
- The server sends your browser a small file called a **metafile.** The metafile indicates where your browser can find the sound file, which doesn't have to be located on the first server. Your PC also gets instructions on how to play that type of audio.
- The metafile tells the web browser to launch the appropriate audio player. The players are **plug-ins,** mini-programs designed to work with a particular browser such as Mozilla Firefox or Microsoft Internet Explorer.

Streaming Audio

- The audio player contacts the audio server providing the sound file and tells this server how fast your Internet connection is.
- Based on the speed of your connection, the audio server chooses one of several versions of the audio file. It sends higher-quality sound, which requires a wider bandwidth, over faster links, and lower-quality sound over slower connections.
- The server sends the audio files to the PC as a series of packets in **User Database Protocol (UDP),** which permits the occasional packet to get lost without critically disrupting the transmission.

Streaming Audio

- When the packets arrive at your PC, your system decompresses and decodes them and sends the results to a **buffer,** a small portion of RAM that holds a few seconds of sound.
- When the buffer fills up, the audio player starts to process the file through your sound card, turning file data into voices, music, and sounds while the server continues to send the rest of the audio file.

Streaming Video

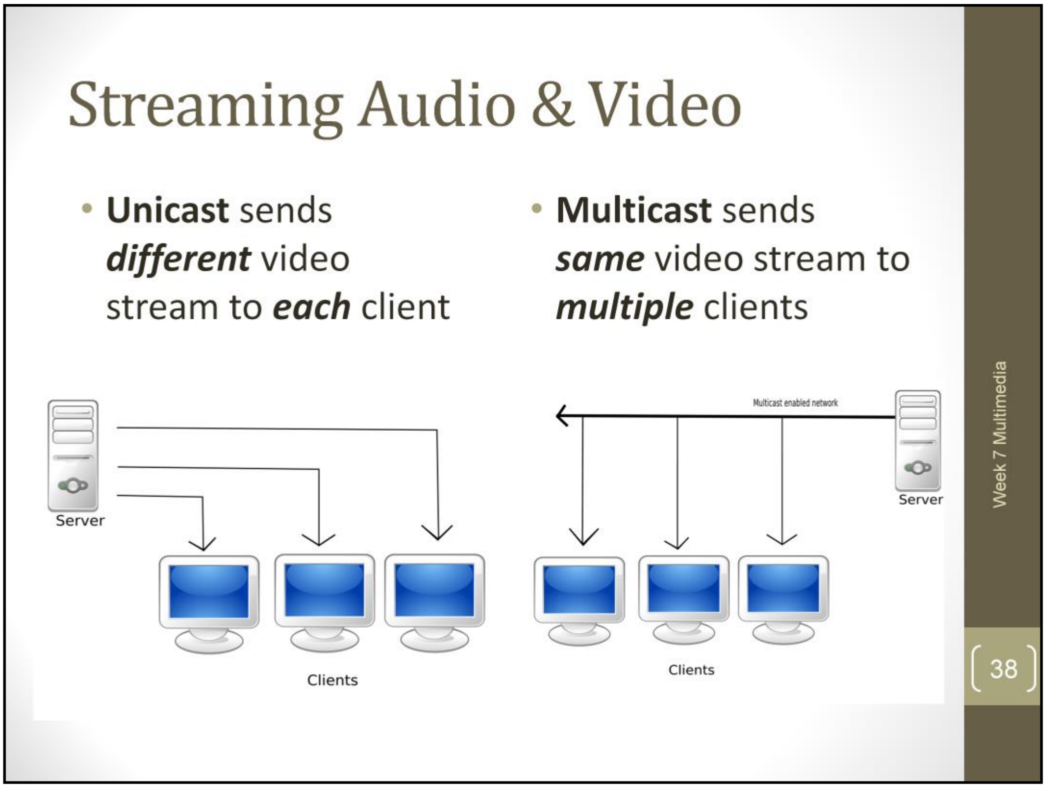
- Inside the computer that acts as a server for Internet video, a video capture expansion card receives the ordinary analogue video signal from its source, either a live feed or recorded tape.
- The capture board turns the analogue signal into digital information at a rate of **30 frames a second**.
- The capture board sends the digital information through a **codec, a compression/ decompression** algorithm. Different codecs use several methods to compress the video.

Streaming Video cont.

- The server breaks up compressed video into one of two types of packets for two types of transmission protocols.
- One type is called **IP (Internet provider) multicast** packets.
- IP multicast uses less bandwidth, which is helpful when transmitting the same video to several people at different PCs.
- The video server sends a single signal to a computer acting as a multicast server, which duplicates the video signal for all client PCs attached to it.

Streaming Video cont.

- The other protocol is **User Database Protocol (UDP),** discussed in the previous illustration.
- **UDP video** delivery is more **common** because it **doesn't require** special **network hardware**, such as a multicast server.
- **UDP packets** must be sent to ***every*** client PC, which uses **more bandwidth** but is more **efficient** in preventing gaps or pauses in the audio part of the signal.
- The PCs receiving the signals *decompress* the video and load it into a small buffer in **RAM**.
- From there, the signal **splits** into **video** and **audio** components, which are sent to the **video card** and **sound card**.
- As with pure audio streaming, video streams simply **skip packets** that they can 't handle in real time.



Most streaming audio/video uses UDP (User Datagram Protocol) rather than TCP. UDP does not automatically report or retransmit lost packets, though this can be added to the application. In particular, for live streaming, lost packets will result in temporary loss or quality drop of video and/or audio.

Multicast requires specialist server hardware. Clients that cache the media can allow individual users to pause the media, without having to resort to unicast.

Media Hardware

- Audio signals are analogue (***continuous***) waves
  - **Quantization** requires ***Analogue*** to ***Digital*** Conversion
  - ***Digital*** to ***Analogue*** Conversion for ***reproduction***
  - ***ADC*** and ***DAC*** circuits built into audio devices
- Audio & video involve processing large quantities of data
  - ***Special Digital Signal Processors*** (***DSP***) used so that the ***CPU*** doesn't have to do this
  - Designed specifically for high performance on typical media ***algorithms***

Further Reading

- Wikipedia:
  - Bitmap, Colour Space, SVG, Image File Formats, Image Sensor, Digital Audio, Video Compression, Codec, Streaming Media, ...
- PCH
  - Displays in Chapter 11

Required Reading For Next Week

- HCW:
- Part 5: Input/Output
  - Introduction
  - Chapter 14 – How Data Gets Into Your PC
- Part 6: Games And Multimedia
  - Introduction
  - Chapter 22 – Games Hardware
  - Chapter 23 – 3D Worlds

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SVG example – CC-BY-SA Dr. E.F. Tymac, http://en.wikipedia.org/wiki/File:SVG.svg

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