Digital Video Basics

What is Digital

- Need to be careful what you mean
  - Digital Display
  - Digital Processing
  - Digital Control
  - Digital Recording
  - Digital Transmission

What is DTV? Consumer Info Page

What is Digital

- A/D Converters (Analog to Digital)
  - Sound Card in Computer is Audio A/D and D/A
- Digital Videotape Formats
  - Digital Composite
  - Digital Component

What is DTV? Consumer Info Page

What is Digital

Bits	# of Possible Values	
◆ 8 bit	**256**	
◆ 10 bit	**1,024**	
◆ 16 bit	**65, 536**	(2- 8 Bit channels)
◆ 24 bit	**16, 777,216**	(3- 8 Bit channels)
◆ 32 bit	**4,294,967,296**	(3- 8 Bit channels) + 1- 8 Bit Alpha Channel for Transparency

What is Digital

- 8 Bits

BINARY									
MSB							LSB		
1	1	1	1	1	1	1	1		8
x 128	x 64	x 32	x 16	x 8	x 4	x 2	x 1		BIT
128	64	32	16	8	4	2	1	=	255

MSB = Most Significant Bit

LSB = Least Significant Bit

+ 0 = 256 Values

See Excel Bit Generator (digital.xls)

Quantization & Sampling

See Digital Video Tape BLUE 4

Quantization

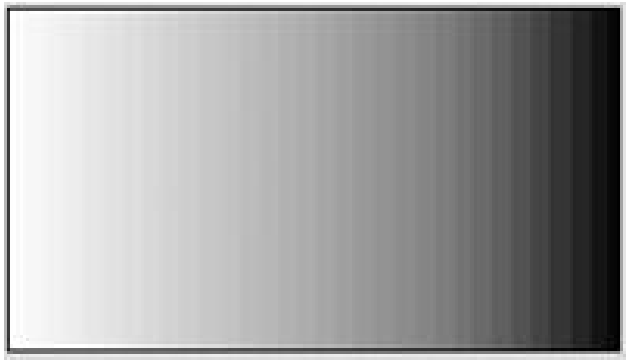
See Digital Video Tape BLUE 4

- Measures #of Amplitude Levels (Determines Bit-Depth)
- Assigns a Numerical Value to 3 basic Video components
  - Y (Luminance)
  - R-Y (Red - Luminance)
  - B-Y (Blue - Luminance)
  - 8 Bit= 256 Level for each

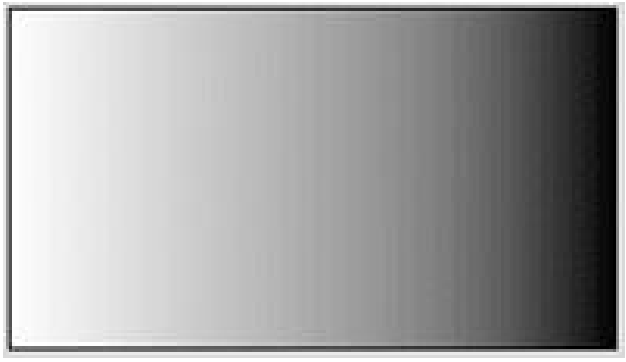
Quantization

See Digital Video Tape BLUE 4

- Gray Scale Examples



5 Bit = 32 Levels



8 Bit= 256 Levels

Sampling

See Digital Video Tape BLUE 4

- 1 Frame is stored 720 x 480 Pixels
- Each Pixel is processed for Y (Luminance) (B&W)
- 4:1:1 Samples 1 of every 4 pixels for Color
- 4:2:2 Samples 2 of every 4 pixels for Color
- 4:22 has twice the color detail of 4:11 (sharper color edges)
- 4:4:4 is not necessary as humans are more sensitive to changes in luminance than color

Sampling: http://www.adamwilt.com/pix-sampling.html

Sampling

See Digital Video Tape BLUE 4

- The first number refers to the 13.5 MHz sampling rate of the luminance
- The other two numbers refer to the sampling rates of the color difference signals R-Y and B-Y (or, more properly in the digital domain, Cr and Cb)

Sampling: http://www.adamwilt.com/pix-sampling.html

Sampling

See Digital Video Tape BLUE 4

- 4:2:2 systems (D-1, D-5, DigiBeta, BetaSX, Digital-S, DVCPRO50) color sampled at half the rate of luminance,
- Y is 13.5 MHz R-Y and B-Y is each **6.75** MHz
- **360** color samples (in each of Cr and Cb) per scanline.

- 4:1:1 systems (NTSC DV & DVCAM, DVCPRO Color data are sampled **half** as frequently as in 4:2:2
- Y is 13.5 MHz R-Y and B-Y is each 3.375 MHz .
- **180** color samples per scanline.

Sampling: http://www.adamwilt.com/pix-sampling.html

Sampling

See Digital Video Tape BLUE 4

- 4:2:2 Better for
  - Computer Graphics
  - Special Effects
  - Chroma Keying
  - Compositing
  - Matting

Uncompressed Sizes

See Digital Video Tape BLUE 4

- Using the ITU-R 601 4:2:2 digital Component coding standard
- Active Picture (Does not include sync Blanking etc as these can be regenerated)

See Compression Presentation (Compress.ppt)

Uncompressed Sizes

See Digital Video Tape BLUE 4

- For the **525** line TV standard the line data is: **720(Y) + 360(Cr) + 360(Cb) = 1,440 pixels/line**
- **487 active lines/picture there are 1,440 x 487 = 701,280 pixels/picture**
- **(sampling at 8-bits, a picture takes 701.3 kbytes)**

See Compression Presentation (Compress.ppt)

Uncompressed Sizes

See Digital Video Tape BLUE 4

- **1 sec takes 701.3 x 30 = 21,039 kbytes, or 21 Mbytes**
- **1 min takes 21,039 x 60 = 1,262,340 k bytes, or 1.26 gigs**

See Compression Presentation (Compress.ppt)

Uncompressed Sizes

See Digital Video Tape BLUE 4

- **BOTTOM LINE**
- **1 Gbyte will hold ~47 seconds**
- **1 hour takes ~76 Gbytes**
- Of Active Picture (Does not include sync Blanking etc as these can be regenerated)

See Compression Presentation (Compress.ppt)

Uncompressed Sizes

See Digital Video Tape BLUE 4

- **SO 1 hour takes ~**
- **Uncompressed 76 Gbytes**
- **2:1 Compression 38 Gbytes**
- **5:1 Compression 15 Gbytes**

- Of Active Picture (Does not include sync Blanking etc as these can be regenerated)

See Compression Presentation (Compress.ppt)

Compression Basics

See Digital Video Tape BLUE 4

- Converting video into digital produces **LARGE AMOUNTS OF DATA**
- Flow of Data measured by its **BIT RATE**
- Uncompressed Video Bit Rate is too much and must be reduced

See Compression Presentation (Compress.ppt)

Compression Basics

See Digital Video Tape BLUE 4

- Compression -many different Techniques & Methods
- Which you choose depends on Application

See Compression Presentation (Compress.ppt)

Compression Basics

See Digital Video Tape BLUE 4

- Compression Ratio –What do we throw away
- Divide amount of data start by what your finished with

Data Start / Data Finished

Be Careful, Compression
Ratio's Alone Don't tell
the Entire Story

See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- Uncompressed Video = 166 mbs
- Digital S allows 50 mbs to be recorded

$$\frac{\textbf{166mbs}}{\textbf{50 mbs}} = \frac{\textbf{3.3}}{\textbf{1}} \quad \textbf{Compression Ratio}$$

See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- 2 Techniques
  - **LOSSLESS**
  - **LOSSY**

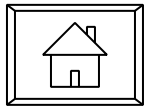
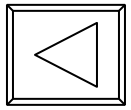
See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- LOSSLESS
  - Applied 1st
  - Non- Destructive
  - Looks for Redundant information from frame to frame
    - Why store the same Blue Background each time?
    - Less Information to send / store
    - Works best for:
      - Static images with
      - Not much Detail

See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- LOSSY
  - May be Applied for Images with
    - Little Redundancy
    - Much Movement
    - Fine Details
  - **Is DESTRUCTIVE (Can’t regain lost info)**

See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- LOSSY
  - 1st Eliminates Finest Details which the eye is less able to discern
  - Requantizes details more and more coarsely
  - Until Bit rate matches the tape

See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- Perceptually Lossless
  - There is a loss
  - But You **CAN NOT SEE** the loss
- Perceptually Lossy
  - You **CAN SEE** the loss

See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- Digital Artifacts May Include:
  - Blocky / Pixelized Images
  - Lack of Detail
  - Distorted Edges
  - “Mosquito” Noise

See Compression Presentation (Compress.ppt)

Compression

See Digital Video Tape BLUE 4

- Pics of Artifacts at: http://www.adamwilt.com/pix-artifacts.html

- Other Digital Picture Problems http://www.adamwilt.com/pix-defects.html

See Compression Presentation (Compress.ppt)

Panasonic/ABC 720P HDTV Truck

HDTV Truck at Lambeau Field

Digital TV Channel Allotments for the USA

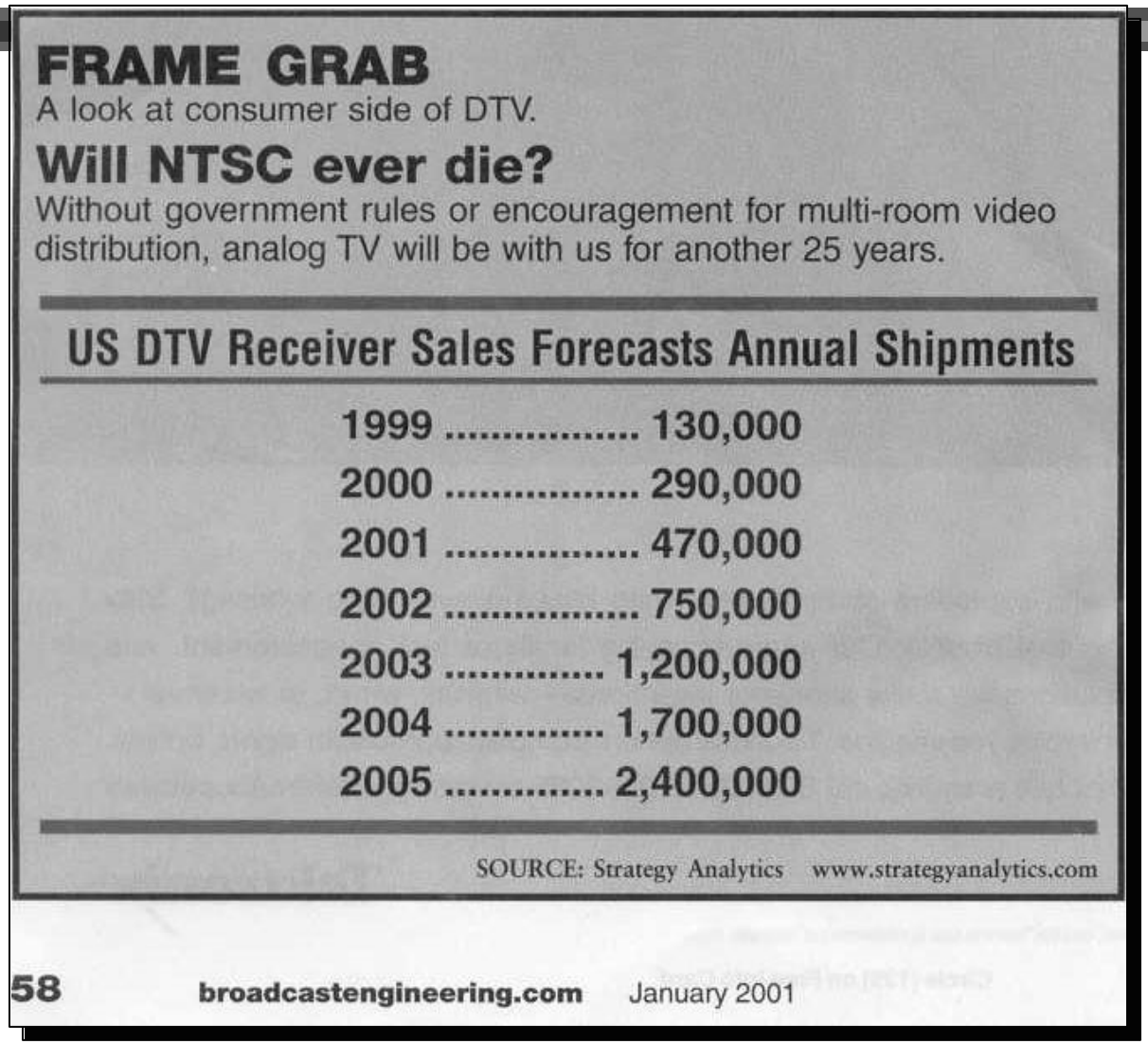
Transmission-Timeline

- **ABC, CBS, FOX, & NBC Must Broadcast DTV:**
- **10 largest markets by May 1, 1999**
- **11-30 markets by November 1, 1999**
- **All commercial stations by May 1, 2002**
- **All noncommercial educational stations must start by May 1, 2003**

DTV Transmission-Timeline

- Stations are allowed two six-month extensions just by filing a request. Any additional extensions must be granted by the full FCC Commission.
- **In theory, analog TV will be shut down in 2006**
- Depends on how many people still rely on their analog TVs-which can get **DTVwith a set-top box**)

DTV Transmission-Timeline



FRAME GRAB

A look at consumer side of DTV.

Will NTSC ever die?

Without government rules or encouragement for multi-room video distribution, analog TV will be with us for another 25 years.

US DTV Receiver Sales Forecasts Annual Shipments

1999	130,000
2000	290,000
2001	470,000
2002	750,000
2003	1,200,000
2004	1,700,000
2005	2,400,000

SOURCE: Strategy Analytics www.strategyanalytics.com

DTV Transmission-Timeline

- Digital TV Channel Allotments for the USA
- DTV Stations on the Air
- Top 10 Markets' DTV Status
- Top 11-30 Markets' DTV Status

Transmission

- All SDTV source material will suffer when upconverted to HDTV, compared with material originated in HD to begin with.
- 4:1:1 material is reported by some to be problematic in this aspect; certainly a 4:2:2 original will be more forgiving
- If upconversion is your primary goal, you may want to look closely at D-9 (Digital-S) or DVCPRO50

Transmission

- ATSC Standard in a nutshell
- http://www.broadcastengineering.com/html/2000/april/columns/00_04_atsc_standard.htm