Quiz Corrections

This was out of the book.

Question 1 – Formula for bit rate of 601

What is bit rate? The rate at which bits on the stream are running, how fast we put the bits on the stream. Can bit rates vary in video? They can in computers for example when downloading a video from a server via the Internet. They can't in video; for a given data system, once it is chosen, the bit rate must stay constant else losses will occur.

SDI, D-1, 601, 4:2:2 – all are a form of component digital video

D-2 – composite digital video, is obsolete now even though still exists.

High definition video is **always** component video, never composite video.

How do we get the formula for the bit rate of 601? Luminance (13.5 MHz) plus chrominance (2 * 6.75 MHz) = 27.0 MHz (megabits per second). Multiply by 10 bits per sample, get 270 megabits per second.

Question 2 – Why do we convert parallel data into serial data to be transmitted over a wire?

Serial can travel farther than parallel due to timing issues; some bits will arrive earlier than others for long parallel runs. Also saves on cable (need 10 wires plus strobe plus ground), connectors (parallel connectors are not cheap). Would have to ensure connections were of excellent quality.

Trade off is the ten-times-higher frequencies we must handle in serial.

Question 3 – HANC is an acronym meaning?

Horizontal ancillary data. A place to add line-by-line information. Can find there time code, digital audio (16 channels of digital audio can fit in HANC).

Question 4 – VANC is an acronym meaning?

Vertical ancillary data. A place to add field-by-field information. Can find there frame rate.

Question 5 – In what form is audio when it is embedded into the digital video stream?

AES/EBU digital audio. Agreement between AES and EBU to come up with a standard for digitizing audio, and that is what we use. This is the audio format that we use. EBU stands for European Broadcasting Union. AES stands for Audio Engineering Society. MP3 is not AES/EBU, it is MPEG 2 Level 3, an MPEG format which is not what we use in video.

Question 6 – What is the name for component serial HD video signals?

HD-SDI.

Question 7 – The number of bits of video encoded is normally what?

10. May move to 12-bit system, there are occasions to use 12 bits. Predecessor was 8 bits. HDR (high dynamic range) video uses 32 bits.

Question 8 – The bit rate for composite digital video is what?

143 megabits per second. We got that by: 10 times 4FSC (4 times the subcarrier frequency = 14.318181).

Question 9 – The type of video used in the broadcast studio is what?

4:2:2, SDI, 601 in the digital domain. The digital to analog converters we have in the studio are about 500 to 600 dollars (what the market will bear). Converts SDI to component or composite. Studios have a large investment in broadcast-quality analog monitors, so they will pay higher prices for converters to allow them to run digital in their studios until their analog monitors need upgrading.

Question 10 – What are the three items normally used to create 601?

Luminance (Y), Chrominance (R-Y, B-Y (or Cr, Cb)).

Additional Questions Based on the Quiz

Ancillary Data

In Europe, there is teletext. A huge amount of data in letters. Must be 200 pages available to you at anytime so you can select what you want to look at. Flight arrivals/departures, weather, and other data.

MPEG has PSIP, which describes what's on the channel, where it is located. We will find out more later.

Lecture – Finish up on Digital Video

How we get video into the digital domain so we can use it in our studio.

Interleaved Data Stream

Look for EAV.

Immediately following is the line number (LN) and then the CRC (cyclic redundancy check/code). CRC is like parity; it is a way of checking if the data you got is correct.

Other Color Encodings

There's an EAV code for each stream. The example here is for HD; there is a dual-line (one for luminance and one for chrominance).

The dual-link and 3 Gbit/second interfaces additionally support other color encodings besides 4:2:2 YCbCr, namely:

- 4:2:2 and 4:4:4 YCbCr, with an optional alpha or data (used for non-video payload) channel

Advantage to sampling color more often? More definition. 4:1:1 is hard to edit, and chroma keys look awful.

4:2:2 HD sampled at 75 MHz + 2 * 37.5 MHz = 150 MHz * 10 bits per second = 1.5 Gbits/second. If sampled at 4:4:4, would have 3 * 75 MHz = 225 MHz, * 10 = 2.25 Gbits/second. If sampled at 8:8:8, would have 3 * 150 MHz = 450 MHz, * 10 = 4.5 gigabits/second.

Type	*Bit rate (megabits per second)*
Composite digital video (D-2)	143
Component digital video (601 / SDI)	270
Component HD digital video	1500

All the above are sampled at 4:2:2.

Analog NTSC will go away in a couple of years, but standard definition will stay around a long time. It will be standard definition digital video, though.

Advantage of dual-link is that it allows handling of more data. 1.5 Ghz is fairly reliable today. 4:4:4 has to be dual-link. If you had the alpha channel, you'd have another 750 megabits/second, resulting in a bit rate of 3.0 gigabits/second.

DaVinci makes a colorizer for film that runs in 8:8:8.

- 4:4:4 RGB, also with an optional alpha or data channel

Why do RGB instead of Y R-Y B-Y? Chroma keying works on RGB. Can subtract out a full blue screen or green screen, so RGB is good for chroma key.

- 4:2:2 YCbCr, 4:4:4 YCbCr, and 4:4:4 RGB, with 12 bits of color information per sample rather than 10.

Why 12 instead of 10? 10 isn't a power of 2. They really should have gone to 16 bits per sample. Limits were more for A to D converters (started with 6 bit, then was 8 bit).

Note that the interface itself is still 10 bit; the additional 2 bits per channel are multiplexed into an additional 10-bit channel on the second link. This implementation might go away. The problem is that when this data gets serialized, speeds are required that can't be handled today.

If an RGB encoding is used, the three primaries are all encoded in the same fashion as the Y channel; a value of 64 (40 hex) corresponds to 0 mV, and 940 (3AC hex) corresponds to 700 mV.

Additional bit depth would provide additional dynamic range, since reality has a greater dynamic range than what can be captured on cameras.

What does just the R signal look like? Plug it into a waveform monitor, vector scope, and color monitor? Will look black and white on monitor, will look like video on the waveform monitor except there is no burst, and the vector scope will have a dot in the center.

RGB is three black-and-white video signals, one representing each color.

12-bit applications are scaled in a similar fashion to their 10-bit counterparts; the additional two bits are considered to be LSBs.

12-bits not seen much; probably won't see it in a TV station. The industry might go up to a greater bit depth later, like a power of 2.

SDTI

Serial data transport interface. Invented by Sony. Originally called Sony digital transport interface. SMPTE took it on as a standard and renamed it.

There is an expanded specification called SDTI which allows compressed (i.e., DV, MPEG and others) video streams to be transported over an SDI line. This allows for multiple video streams in one cable or faster-than-realtime (2x, 4x, ...) video transmission.

Some manufacturers have QSDTI (quad SDTI). What's the advantage? It is taped, and if tied to tape, if can capture information and transfer at 4 times the speed, then slow down, can do copies and transmissions faster so can start editing that much sooner.

Look at the DVCAM deck in the back room, on it is a notation for SDTI.

A related standard, known as HD-SDTI, provides similar capability over a SMPTE 292M interface.

Line Counter and CRC

We had this last lecture.

The CRC and line counts are not provided in the SD and ED interfaces (ED is extended definition; better than SD but not as good as HD). Instead, a special ancillary data packet known as an EDH packet (Error Detection and Handling) may be optionally used to provide a CRC check on the data.

Break

Resume

Ancillary Data

Ancillary data is provided as a standardized transport for non-video payload within a serial digital signal; it is used for things such as embedded audio, closed captions, timecode, and other sorts of metadata.

Ancillary data is indicated by:

1. a 3-word packet consisting of 0, 3FF, 3FF (the opposite of the synchronization packet header),

followed by

2. a two-word identification code
3. a data count word (indicating 0-255 words of payload)
4. the actual payload, and
5. a one-word checksum

How does a checksum work? Perform a mathematical operation on the data. A one-bit checksum would be 0 or 1, 0 for even number of ones and 1 for an odd number of ones. Tells you there's something wrong with the data.

Other than in their use in the header, the codes prohibited to video payload are also prohibited to ancillary data payload.

Specific applications of ancillary data include embedded audio, EDH, VPID, and SDI. Error data handling.

In dual link applications, ancillary data is mostly found on the primary link. The secondary link is to be used for ancillary data only if there is no room on the primary link. One exception to this rule is the VPID packet; both links must have VPID present.

VPID

Video payload identifier. Increasingly used to describe the video format. In early versions of the SDI, it was always possible to uniquely determine the video format by counting the number of lines and samples between H and V transitions in the TRS.

With the introduction of dual link interfaces, and segmented-frame standards, this is no longer possible. Thus the VPID standard provides a way to uniquely and unambiguously identify the format of the video payload.

Could have a 1080i discussion between two people talking about sports, switch to 720p to show a clip of the sporting event, and switch back to 1080i later. Also need to do this for commercials.

Embedded Audio

Both the HD and SD serial interfaces provide for 16 channels of embedded audio. The two interfaces uses different audio encapsulation methods. SD uses SMPTE 272M, HD uses SMPTE 299M standards. In either case, an SDI signal may contain up to 16 audio channels (8 pairs) embedded 48 kHz, 24-bit audio channels along with the video. There are 55 megabits in each HANC unit. Typically, 48 kHz, 24-bit (20-bit in SD) PCM audio is stored in a manner compatible with the AES3 digital audio interface. These are placed in the H blanking periods, when the SDI signal carries nothing useful, since the receiver generates its own blanking signals from the TRS. In dual-link applications, 32 channels of audio are available; as each link may carry 16 channels.

Today, chips run at that speed in single-link, but just barely. A year ago, when the slides were prepared, chips didn't run fast enough.

Probably won't run into dual-link unless work for a specialty company. Stations won't have it. News

production doesn't need it.

Video Payload and Blanking

The active portion of the video signal is define to be those samples which follow an SAV packet and precede the next EAV packet, where the corresponding EAV and SAV packets have the V bit set to zero.

EDH

As the standard definition interface carries no checksum, CRC, or other data integrity check, an EDU (error detection and handling) packet may be optionally placed in the vertical interval of the video signal. Why? If it starts messing up, it's just a glitch in the picture (not that much of a problem). If in a production environment, may want this. If broadcasting a signal, may not care much about this.

This packet includes CRC values for both the active picture and the entire field (excluding those lines at which switching may occur, and which should contain no useful data).

EDH typically only used with the standard definition interface; the presence of CRC words in the HD interface make EDH packets unnecessary. This is the important thing to remember about EDH.

SMPTE Standard

Steve displays a draft SMPTE standard from http://www.smpte.org/smpte_store/standards/pdf/s292m.pdf. Starts with table of contents. Give some background/introduction. Lists references.

Tri-level Sync

Purpose is to cancel itself out in calculations of average picture level, so it becomes easier to calculate APL since don't have to skip or compensate for sync.

Used for analog HD.

Sync only happens in the analog domain, not in digital domain (except composite digital, because it digitizes the entire analog signal including sync and burst).

Sampling

Sampling is always done to an analog signal; it is part of digitizing an analog signal.

Analog HD

Analog HD never broadcast; it stays in the studio. Can't broadcast because analog has too high of a bandwidth requirement.