Implications of HDTV Technology on Circuit and System Design

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Today’s Topics

- HDTV Standards for Broadcast Applications
- HDTV Implications on Broadcast Facilities
- HDTV Implications on Consumer TV
- Worldwide HDTV Activities
A Little Terminology

- **SD**: Standard Definition TV
  - The TV we’ve known and loved for the past 55 years.
  - Based on the NTSC or PAL standards
- **HD**: High Definition TV
  - Dozens permutations of resolution and timing
  - Most common “1080i” and “720p”
- **3G-HD**: The transmission of full 1080p/60 uncompressed HDTV over a single link
HDTV Standards

• Standard Definition (SD)
  – ITU-R BT-601
    • Defines how video is represented in a digital manner
    • Samples color information half as often as luminance (4:2:2)
  – SMPTE 259
    • Defines how BT-601 is then transmitted in a serial manner
    • Applies to both PAL and NTSC timing formats
HDTV Standards

• High Definition (HD) - Uncompressed
  – Several standards define HD resolutions
  – SMPTE 274: 1920 x 1080
    • 1080i and 1080p
  – SMPTE 260: 1920 x 1035
    • 1035i
  – SMPTE 296: 1280 x 720
    • 720p
  – SMPTE 295: 1920 x 1080 @50 Hz
    • 1080i/50
HDTV Standards

• Audio and Data for HD
  – SMPTE 299: 24-bit audio format
    • How AES3 digital audio is mapped into HD stream – SMPTE 292
    • Up to 16 audio channels
  – SMPTE 348: General packet data transport within SMPTE 292
HDTV Standards

• High Definition (HD)
  – Different frame rates are defined for various applications and backward compatibility with NTSC and PAL
  – In Hertz: 60, 59.94, 50, 30, 29.96, 25, 24, 23.98
    • Some are interlaced (i), some progressive (p)
  – Not all spatial resolutions are defined at all frame rates
HDTV Standards

• High Definition (HD)
  – One standard defines HD transmission
    • SMPTE 292
      – Defines how the video, audio and data standards are transmitted in a serial manner over copper
      – Defines other electrical parameters
      – Rise time, jitter, amplitude
    • Defines the valid combinations of resolution and frame rate
HDTV Standards

• High Definition (HD)
  – SMPTE 292
    • Defines the transmission Data Rate (uncompressed)
      – 1.485 Gb/s
      – 1.485/1.001 Gb/s
    • 1.485 Gb/s is used for whole number vertical sync frequencies
      – 60, 50, 30, 25, 24 Hertz
    • 1.485/1.001 Gb/s is used to sync (genlock) with NTSC
      – 59.94, 29.96, 23.98 Hertz
HDTV Standards

• 3Gb/s High Definition (3G-HD)
  – SMPTE 424
    • Defines the Data Rate
      – 2.97 Gb/s
      – 2.97/1.001 Gb/s
    • Supports 1080p/50 and 1080p/60
    • Uses just one coax or fiber signal path
      – Single-link
    • Some facilities are installing for the future
HDTV Standards

- Fiber Optics for HD and SD
  - SMPTE 297: One standard defines fiber optic transmission for 3G-HD, HD and SD
    - LC connector is “preferred”, others are “optional”
    - Defines: jitter, rise time, amplitude and data rate accuracy for HD and SD serial data transmitted over fiber
HDTV Standards

• A Few Observations
  – None of these resolutions have any compatibility with computer resolutions
  – Only one HD resolution, 1920x1080, matches the native resolution of some of the TVs on the market today
  – Worldwide preference is for 1080i/50 (PAL countries) and 1080i/59.94 (NTSC countries)
  – US is a mix of 1080i and 720p
HDTV Standards

• A Few Observations
  – 1080i broadcasters: CBS, NBC, HBO, Showtime, SNY, YES
    • 1/3 more detail in image than 720p (movies)
    • Frame rate is only 29.96i frames/second
  – 720p broadcasters: ABC, FOX, ESPN
    • Frame rate is 59.94p frames/second
    • Good for fast motion (football, NASCAR)
HDTV Implications on Broadcast Facilities

• Compatibility with SD Broadcasts
  – There is still the need to broadcast in SD
  – Impractical to do two separate SD and HD productions
  – Produce in HD, do SD “4:3 cutout” for SD
  – Produce in SD, do 4:3 up conversion to HD raster
    • No increase in detail, but image has HD timing
  – Lot’s of new equipment needed to perform conversions either way
HDTV Implications on Broadcast Facilities

• Up converting SD Material
  – Most remote facilities are still SD 4:3
  – Stretch, crop, anamorphic lens, 16:9 within 4:3 up convert …???
  – Computer source material is mostly 4:3
  – Spatial resolution conversion needs to be dealt with properly
    • Target resolution has more BW than source
HDTV Implications on Broadcast Facilities

• Genlocking the Equipment
  – One timing reference is needed for both SD and HD signals within facility
  – HD equipment will reference timing to NTSC or PAL composite video
    • Vertical sync frequencies must be the same
  – Equipment must have wide genlock phasing range – one vertical period
HDTV Implications on Broadcast Facilities

• Transmission Bandwidth
  – Some coax cable cannot handle the increased BW of HD (6x that of SD)
  – Practical distances for “HD” grade coax with equalization at receiving device
    • 300m for HD
    • 100m for 3G-HD
  – Fiber will be used as backbone for facilities
HDTV Implications on Broadcast Facilities

• Audio – Video Skew
  – Frame synchronizers and compressed video will be more commonplace
  – Audio could lead video by 10s or 100s of milliseconds as it propagates through plant
  – Intelligent audio delay equipment will be needed for synchronization
HDTV Implications on Consumer Televisions

- Image Data Compression
  - MPEG2 used for terrestrial broadcast
  - MPEG4, H.264 used for most all other modes of distribution
  - Quality can vary greatly depending on BW allocated for a particular transmission
  - Compression ratios of 100:1 or greater
HDTV Implications on Consumer Televisions

• The Native Resolution Problem
  – Most all “HD” TVs today are based on computer, not HD, resolutions
  – 720p sets are really 1366x768
  – 99% of all plasmas are 1366x768 or 1024x768 or 1024x1024
  – Excellent circuits are needed for spatial scaling and de-interlacing
HDTV Implications on Consumer Televisions

• The Trend in TV Displays
  – Most newer HDTVs have a native resolution of 1920x1080 ("full HD")
    • Progressive scan
    • Solves the scaling problem but not the de-interlacing problem
    • Hint: fix the set-top box to 1080i so the display does not have to scale spatially
HDTV Implications on Consumer Televisions

• The HDMI Interface
  – Combines digital HDTV and audio on one connector
  – Some implementations will support 1080p
  – Will become essential for HD DVD players
    • Blu-Ray and HD-DVD
  – A new version, v1.3, will support 30-bit color depths (presently 24-bit)
  – In practice, this is a very “quirky” interface for several reasons
Worldwide HDTV Activities

- **US**: active transition to HD
  - Feb 17, 2009 for giving up analog channels
- **North Asia**: active transition to HD
  - Northern China driven by 2008 Olympics
- **Southern Asia**: slow to adopt
- **Europe**: Making the transition by gov’t mandate – being pushed by satellite
- **South America, Aus/NZ**: Almost nothing
Worldwide HDTV Activities

- HDTV Distribution is Changing
  - Compression algorithms allow for many more distribution channels than analog TV
  - Mobile phones (Europe and Japan)
  - The Internet (Apple iTV, YouTube)
  - Via Telephone lines
  - Fiber to the Home (FTTH)
Conclusions

• Follow the SMPTE standards in guiding your designs
• SD and HD equipment and facilities will continue to co-exist for years to come
• Fiber will become commonplace
• HDTV consumer products need to consider future trends and be made “idiot-proof”
• HDTV will be distributed in more ways than traditional TV outlets