# 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

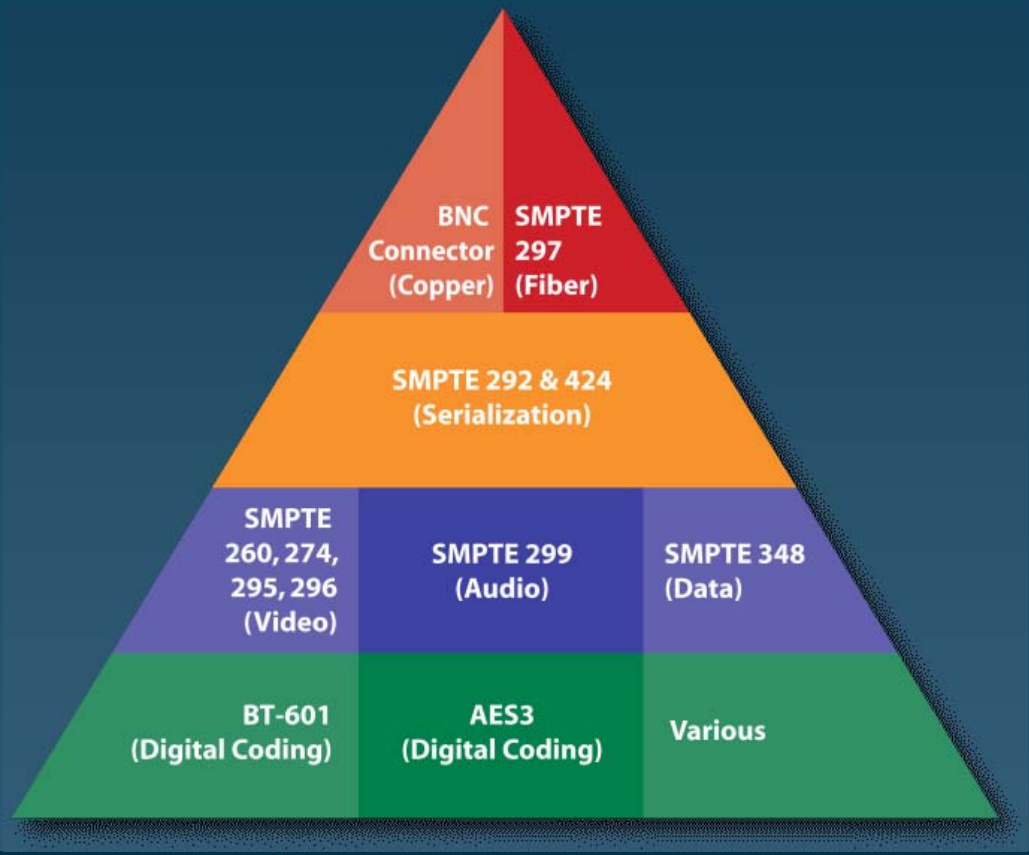
- 3Gb/s High Definition (3G-HD)
  - SMPTE 424
    - Defines the Data Rate
      - 2.97 Gb/s
      - 2.97/1.001 Gb/s
    - Supports 1080p/50 and 1080p/60
    - Uses just one coax or fiber signal path
      - Single-link
    - Some facilities are installing for the future

# 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

## Uncompressed HDTV Standards Tree



# 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 1080**p**
  - 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