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HIGH DEFINITION TELEVISION SYSTEM

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7.1 INTRODUCTION

HDTV is all about giving you a bigger and better picture, better audio, and generally making your TV-watching experience more like a movie watching experienced. In fact, HDTV is so realistic that it's often described as "looking through a window". It offers wider pictures with greater detail and the clarity of motion pictures.

The Advanced Television Systems Committee (ATSC) defined this new TV format to be a significant improvement over the legacy National Television Standards Committee (NTSC) conventional format that has been in existence for over 50 years [1]. Key improvements are in the areas of TV transmission method, aspect ratio, resolution, color, and audio. Importantly to remind that not all the digital television (DTV) is HDTV. There are some criteria to define HDTV. High-definition television (HDTV) is an arbitrary term that applies to any television production, transmission, or reception technology with a scanning rate that exceeds the 525 lines of the present U.S. NTSC standard. [3]

HDTV is variable-resolution examples of advanced television technology. By shifting from an analog to a digital transmission scheme, electronic engineers have merged the previously incompatible worlds of television and computers. Advanced television sets will have the capability to be linked into

the same digital networks as personal computers for accession of global services such as the Internet.[3]

Digital television system means that the picture and sound information are converted from the analog at the transmitting end, into digital representation. That digital information is sent as a stream of bits to the receiver. Because it's digital, the picture displayed by the receiving device will be a faithful reproduction of the picture that was sent by the transmitting device. The displayed HDTV will not show any of those imperfections that we sometimes see in an analog TV broadcast: ghosts, snow, spark lies. The HDTV picture will either be perfect, or it will not be received at all. [2]

7.2 IMPROVE TRANSMISSION METHOD

ATSC programming is broadcast digitally and uses a better modulation scheme than conventional analog NTSC broadcasts. "Modulation" refers to how the audio and video is encoded onto a radio frequency (RF) carrier signal. ATSC transmits a digital signal containing MPEG-2 compressed video and multichannel AC-3 audio streams. In contrast, NTSC transmits raw analog video and audio signals. This difference applies whether the transmission medium is terrestrial broadcast or delivered via cable or satellite TV.[1]

The transport system is based on fixed-length transport stream packet, as defined by MPEG. This type of transport layer fits well with the characteristic of both terrestrial broadcast and cable. The use of moderately long, fixed-length packets fits in with the needs and technique of error protection in both types of environments. This approach is also flexible enough so it can accommodate the initial needs ATV to multiplex video, audio and data, while providing the capability to add additional services in the future that are compatible with the existing system. Another advantage of basing the transport layer on MPEG-2 is that these assure that the system will be compatible with other media and standards.[2]

The improved ATSC modulation method, combined with digital signaling, means that HDTV signals are less susceptible than NTSC signals to transmission interference that causes noise effects such as “ghosting” or “snow.” The result is much better picture quality with HDTV. [1]

7.3 HIGHER RESOLUTION

HDTV provides a more detailed picture than NTSC by increasing the number of pixels in the format. Pixels are individual addressable picture elements, arranged in rows and columns, which together form the TV’s picture. The higher the resolution, the more detailed the image and the sharper the image.

Each pixel is made up of individual color elements called sub pixels. These sub pixels contain the red, green, and blue color information that produces a pixel's overall color at any point in time. The NTSC format is 640 horizontal lines of pixels by 480 vertical lines of pixels and a 4:3 aspect ratio. ATSC improves on this resolution by providing a range of formats up to 1080 lines of resolution, and by widening the aspect ratio to 16:9. The ATSC formats enable a wider TV screen than NTSC, and provide for a more theater-like experience at home due to the 6x increase in the number of pixels displayed.

Figure7.1 Comparison between NTSC format and HDTV [4]

7.4 SCAN TYPE & RATE

Scan type come in two forms;

- Interlaced scan: These TV images are created by lighting up every other row of horizontal lines on the screen in one instant and then going back through and lighting up the remainder of the lines in the next instant. These groups of lines is called field.
- Progressive scan: These systems light all the horizontal lines in the same instant, which can make the images, seem smoother and more like real. This all grouping of lines is called frame.

Scan rate is the measure of how often a picture is redrawn on the screen. Measured in terms of number of fields or frames per second.

7.5 WIDER ASPECT RATIO

The arrangement of rows and columns determines a TV's aspect ratio, which is the ratio between the number of pixels per row and the number of pixels per column. NTSC TVs have a 4:3 aspect ratio. An HDTV's 16:9 aspect ratios enable a wider field of view than NTSC TVs.

Scene elements that are “off screen” when captured by an NTSC camera (such as the first baseman during a double play in a baseball game) are now viewable with HDTV. [1]

7.6 BETTER COLOUR

Color performance refers to the ability of a TV to accurately display all possible colors in the incoming video signal. ATSC formats can transmit and display more vivid and distinguishable colors. Color reproduction is an important part of TV performance. TV transmission standards such as NTSC and ATSC define “color gamuts,” which express the range of colors that can be recorded and displayed by broadcast equipment. Manufacturers will often

specify the color performance of a TV as a percentage of one of these color gamut definitions. For example, a TV that can produce the entire range of colors defined by the NTSC standard is said to have a "100% NTSC color gamut," The ranges of colors that make up the gamut are defined by chromaticity coordinates for the maximum red, green, and blue values. [1] Figure 7.2 shows the HDTV color gamut.

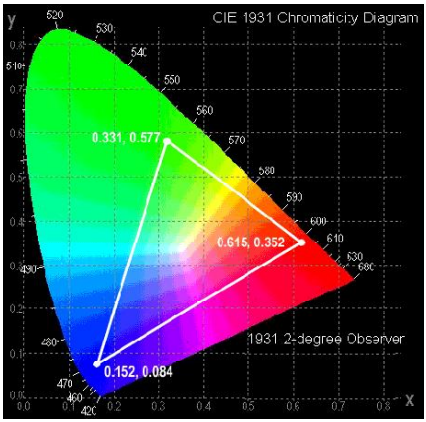

Figure7.2 HDTV color gamut[1]

Another factor in determining color performance is the "color depth" of the TV. Color depth governs the number of discrete colors per pixel that the TV can display. The higher the color depth, the greater the number of distinct colors that can be displayed.

7.7 DOLBY DIGITAL SURROUND SOUND

NTSC transmissions include basic analog stereo audio in conjunction with the video signal. ATSC improves on this by providing multichannel digital audio transmission based on Dolby Digital 5.1 surround sound that has 6 channels. This enables an HDTV to function as a home theater, driving two front speakers,

two rear speakers, a center channel, and a subwoofer. Each speaker has its own unique signal coded in the AC-3 format, which is the same approach as that used on DVD movie discs. [1]

7.8 ATSC FORMATS

When creating the HDTV specification, the ATSC defined a range of formats that encompass standard-definition TV (SDTV) and high-definition formats. SDTV refers to a digital television format with quality that is equivalent to conventional analog NTSC. The ATSC format-naming convention is based on the number of lines of resolution, followed by a letter that indicates whether the scan type is "interlaced" or "progressive."

ATSC formats that are interlaced are indicated by an "i" after the format name. ATSC formats that are progressive scan are indicated by a "p" after the format name. Standard-definition ATSC formats (or SDTV) are based on 480 lines of resolution, like NTSC, but provide for both interlaced and progressive scan transmission. Highdefinition formats range from 720 to 1080 lines of resolution.

HDTVs are required to be able to display all of these formats. However, the picture quality of each format on a particular TV is based on its deinterlacing and scaling capabilities, as well as its native resolution. [1]

An HDTV based on a digital display technology such as LCD, plasma, or micro display for projection, is a "fixedpixel" display. This means that, unlike a CRT, it is hard-wired to display an optimal "native resolution" and must "scale" the incoming video to display full screen at any other resolution.

For example, a multifunction monitor/LCD TV may have a native resolution of 1280 x 768 (WXGA). This means that the TV can display 768 horizontal scan lines that are 1280 pixels long. This resolution allows the TV to be compatible with PC video

timings, but requires that a scaling engine be included in the display to scale incoming TV content in 480i (NTSC), 480p, 720p, or 1080i formats to fit the native display resolution.[1]

Broadcasters vary in which formats they have chosen to adopt for their digital programming. For instance, ABC channel has chosen 720p for their HD broadcasts, Fox is currently transmitting 480p but migrating to 720p, and NBC and CBS have selected 1080i. [1]

7.9 HDTV TECHNOLOGIES

Figure 7.3 shows the logical components of HDTV program reception and their functions. The three main components are HDTV programming, a receiver, and the HDTV display.

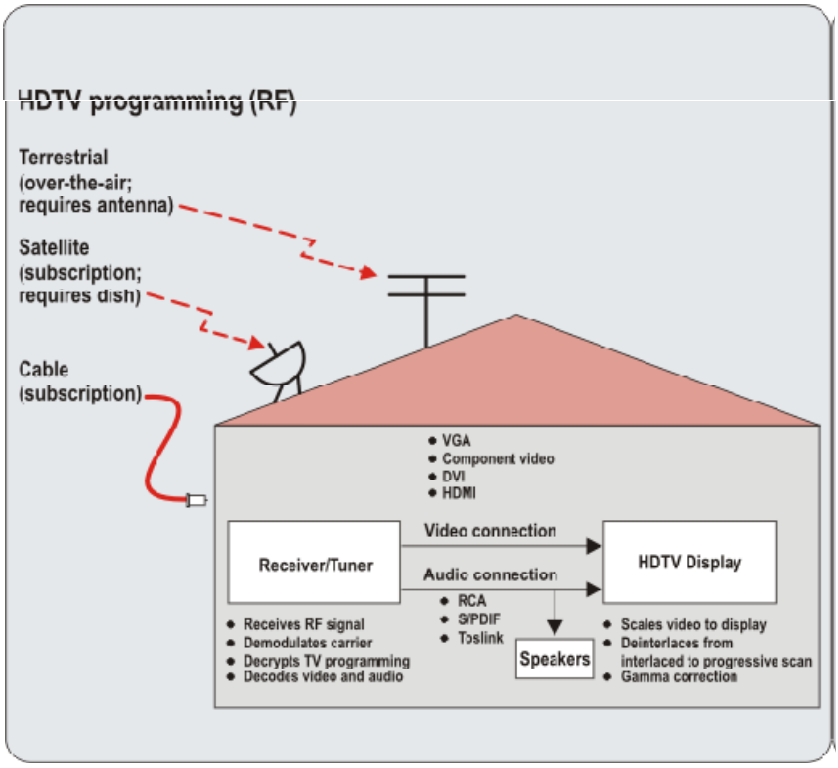

Figure7.3 Components of HDTV[1]

7.9.1 Programming

HDTV programming is either broadcast over the air or transmitted by a cable or satellite TV provider. RF signaling is used and the content is compressed using MPEG2 and AC-3 compression. Content from cable or satellite TV companies is also encrypted.

7.9.2 Receiver

At its destination, an ATSC-compliant receiver demodulates the signal to "tune in" the particular channel to be viewed. In the case of a subscription service, the receiver then decrypts the program stream using a decryption key that is stored in the set-top box or on a smart card that is inserted into the set-top box. The receiver then decodes the MPEG-2 video and AC-3 audio streams for output.

ATSC-compliant receivers can decode all ATSC TV formats. The ATSC-compliant receiver may be integrated into a HDTV set, which enables the set to receive over-the-air digital broadcasts. All that is required to view HDTV with this type of TV is an antenna. In some cases, an indoor antenna may be sufficient; in many, an outdoor antenna is required. Most HDTV broadcasts are in the UHF band, and can be received by a standard UHF TV antenna. The type of antenna required depends on local conditions such as the strength of HDTV signals and the local topography. The antenna connects to the TV through a threaded coaxial connector, known as an "F" connector on the back of the set.[11] TVs that do not include an ATSC receiver, but can display ATSC formats delivered over a video connection are called "HDTV Ready." These TVs require an external receiver component to view HDTV programming. This receiver may be installed in a PC, provided in the form of a set-top box by a cable or satellite company, or included with the TV as a separate component.[1]

7.9.3 Audio/Video Connections

The audio and video connections between an HDTV and other consumer electronics devices, including receivers, are an important consideration for HDTV usage. HDTVs require video connections that can support the high resolutions of ATSC formats. High-definition video connections available today include the component video, video graphics array (VGA), Digital Visual Interface (DVI), and High Definition Multimedia Interface (HDMI).

- **Component Video** — a component video connection can be either analog or digital, and consists of three separate cables, one each for red, green, and blue color components. The analog version is referred to as "YPbPr," and the digital version, "YCbCr." Component video delivers higher-quality video than a composite video or S-video connection. Most DVD players, set-top

boxes, and HDTVs have at least one set of component video connections.[4]

- **VGA** — VGA is the traditional PC analog display interface and is commonly available on multifunction displays that can be used either as a PC monitor or as a TV. A VGA connection supports both ATSC high-definition formats (720p and 1080i), but the graphics driver on the PC must support the ATSC timings in addition to standard PC display timings.[4]
- **DVI** — DVI is a digital interface for sending pixel data to flat-panel displays, but it has been adopted in some TVs and set-top boxes because of copy protection requirements. Unlike VGA, DVI includes an optional means of protecting the transmitted video content using the High-Bandwidth Digital Copy Protection (HDCP) protocol.[4]
- **HDMI** — HDMI is an emerging connection that is based on the same fundamental technology as DVI. However, HDMI has a smaller connector than DVI and includes multichannel audio capability. Unlike DVI and the other video connections, HDMI does not require a separate audio connection to the TV. The stereo audio connections used with component video, DVI, and VGA display connections are RCA-style analog audio jacks with a white plug for the left channel and a red plug for the right channel. HDTV receivers can include digital audio outputs for connecting to a separate audio amplifier for surround sound. Digital audio connections include the Sony-Philips Digital Interface (S/PDIF) and the Toslink optical connector. These connections can carry compressed multichannel surround sound in several formats including Dolby 5.1 and Digital Theater Systems (DTS).[1]

7.9.4 Display

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If required, the display electronics deinterlaces and scales the incoming ATSC video format to fit the native resolution of the display. Alternatively, this conversion may be performed by the set-top box. For example, 1080i programming must be deinterlaced and scaled to display on a fixed-pixel 1280 x 768 HDTV display. The quality of the deinterlacing and scaling engines is an important determinant of picture quality, and this feature set is commonly called out by TV manufacturers to differentiate their products. Advanced deinterlacing techniques include "3:2 pull down" for converting feature film content for TV display.[1]

7.10 BLU-RAY DISC

An emerging removable storage medium called Blueray Disc will provide a solution to the removable media storage problem. A Blue-ray Disc is a higher-capacity, rewritable optical disc that will approximately accommodate more than two hours of HDTV or 12 hours of standard video.

A Blue-ray Disc will also support content protection, enabling HDTV recording. The Blue-ray Disc specification is currently being finalized, but solutions are not expected until the second half of 2005. [1]

7.11 CONCLUSION

HDTV is a revolutionary improvement over the analog NTSC format that has predominated since the 1950s. The new ATSC high-definition formats provide higher resolution and, thus, more detailed scenes, better color, and surround-sound audio.

Digital programming is increasingly available via local over-the-air broadcasts or through cable and satellite subscription services. Digital TV set technology improvements parallel the growth of HDTV programming. Mirroring the trend in computer

displays, bulky and heavy CRT-based TVs are being displaced by TVs based on the latest digital display technologies. These HDTV sets offer high resolutions, great picture quality, and lightweight, sleek form factors.

REFERENCES

[1] http://dell.com/whitepaper/

[2] Howard W. Sams, Conrad Persson. “Guide to HDTV SYSTEMS” Prompt publications(Indianapolis),1999

[3] http://www.museum.tv.com/

[4] Danny Briere. “HDTV FOR DUMMIES” Wiley Publishing(Indianapolis), 2007

[5] http://www.hdtvinfoport.com/

[6] http://www.wikipedia.com/

[7] Andrews E.L., and J.Brinkley. "The Fight For Digital TV's Future." New York Times (New York), January 22, 1995.

[8] CasaBianca, L., editor. The New TV: A Comprehensive Survey of High-definition Television. New York: Meckler, 1992.

[9] Niblock, Michael. The Future for HDTV in Europe: The Role of Broadcasters in the Commercial Development of a European Standard for High Definition Television. Manchester (England): European Institute for the Media, 1991.

[10] U.S. Congress, Office of Technology Assessment. The Big Picture:HDTV & High-resolution Systems. OTA-BP-CIT-64, Washington, DC: U.S. Government Printing Office, 1990.

[11] http://antennaweb.org

[12] Y.Ninomiya, L. Chiariglione. “SIGNAL PROCESSING OF HDTV,IV”, Proceeding of the International Workshop on HDTV 1994, Turin, Italy, October 1994.