June 15, 2004

What is Broadcast Quality?

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Broadcasting technology continues to evolve at a rapid pace. During the past decade alone, broadband and broadcast communication technology has migrated away from analog towards digital, from NTSC to ATSC, from the traditional TV screen to the computer display, and far, far beyond. Throughout these transitions, precise definitions of what is and what is not acceptable quality has been lost, confused or ignored.

This white paper attempts to offer a reminder of what broadcast quality should or could mean in this age of new media and emerging technology. Its focus is on the transport or transmission aspects of the signal and not necessarily about the storage or manipulation aspects of video and audio.

Obviously, this subject is controversial. If there was an easily definable answer, then there would not be so much debate on the subject. The reader should consider these parameters as recommended guidelines as opposed to hard factual standards. It is not deemed realistic to be so precise as to comprehensively answer this question to a degree that would eliminate any further debate. Rather, this paper proposes a reference point to establish a definition of the term, broadcast quality. Its goal is to offer guidelines.

Why? Because the question of what is broadcast quality is not solely learned from objective cold technical specifications. Business cases, return on investment formulas, content demands, applications, and platform environmental factors, also contribute to the subjective side of this equation. There are varying degrees as to what a viewer may or may not deem to be acceptable in a visual and aural presentation. As the old adage goes, “beauty is in the eye of the beholder”.

Broadcast Work Flow

Before a position is established on the subject, it is important understand that in a typical broadcast network, there are different signal qualities desired at different stages within the signal and process workflow. As well, based upon the actual content make-up, different qualities can be considered acceptable. For example, the quality needed for action within sports content may be much higher than the quality standard for a talk show, which is often an easier type of program to encode to digital and ultimately compress.

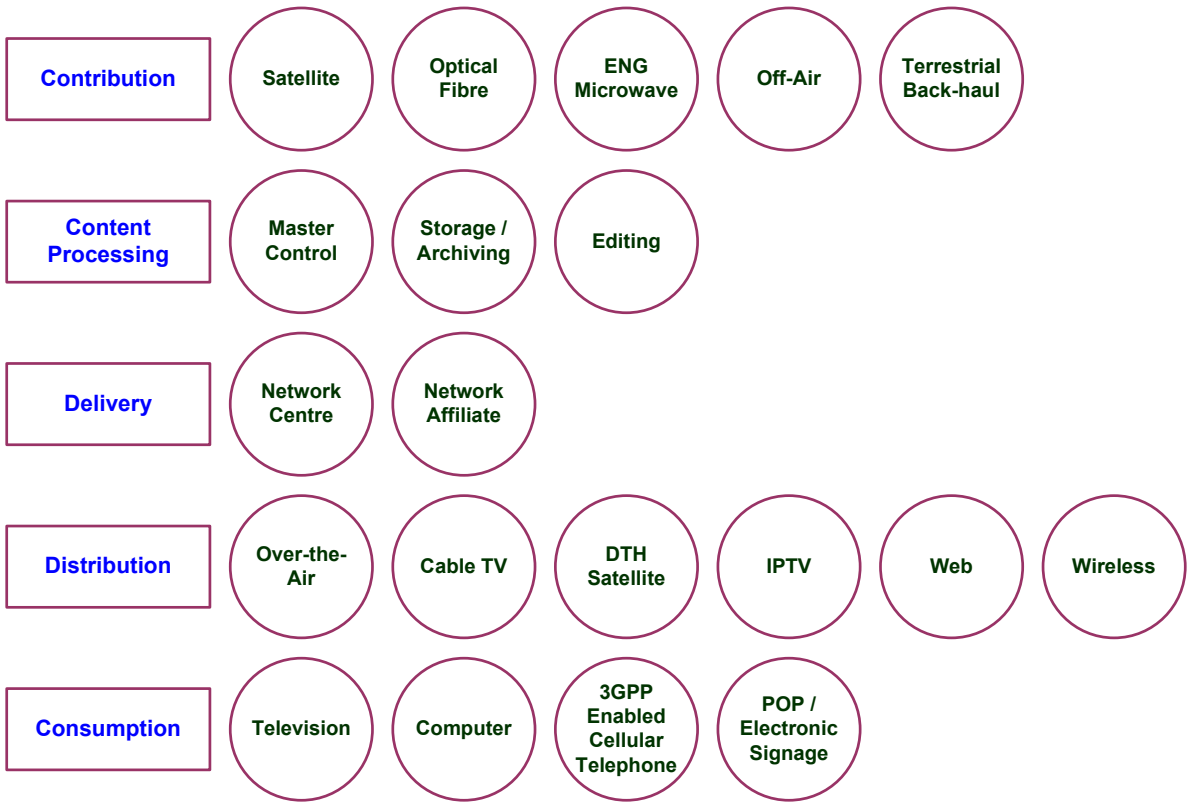
Typical work flow stages may be defined as follows below. Depending upon the type of network and the scale of the network, some of these stages may be unnecessary or consolidated where you work. Alternately, you may have more stages then are shown in this reference model.

- Contribution / Acquisition / Ingest
- Content Processing
- Delivery
- Distribution /Transmission
- Consumption

In Figure 1, there is a basic definition of some of the infrastructure elements that are components of the various workflow stages. There may be other elements depending upon the specific requirements of each network design.

Figure 1 - Workflow Model

Classic Broadcast Signal Workflow Model



The following table (Table 1) illustrates what each stage may require in the NTSC standard definition television model.

Table 1 – Traditional Standard Definition Network Stages

Stage	Contribution	Delivery	Distribution	Distribution	Display
Function	Collection of Content	Inter-Station Content Exchange	DTH, Digital Cable, IPTV and Wireless	Analog Cable and Off-Air	TV set, Computer or Electronic Signage Display
Digital / Analog	Digital	Digital	Digital	Analog	Analog
Aspect Ratio	4:3	4:3	4:3	4:3	4:3
Scan	Interlace	Interlace	Interlace / Progressive	Interlace	Interlace
Resolution (Pixels x Lines)	720 x 480	720 x 480	720 x 480	720 x 480	720 x 480
Colour Space	4:2:2	4:2:2	4:2:2 / 4:1:1	4fsc	4fsc
Composite	No	No	No	Yes	Yes
Component	Yes	Yes	Yes	No	No
SNR (dB)	>53	>52	>48	>46	>46
Compressed	No	Yes	Yes	No	No
Data Rate (Mbps)	270	10 - 15	1.5 – 4.0	N/A	N/A
Frame Rate	30	30	30	30	30
Specifications	ITU-R BT601 ITU-R BT656 SMPTE-259M	MPEG-2 DVB-ASI	MPEG-2 / 4 DVB-ASI IP	SMPTE-170A CATV Off-Air	SMPTE-170A IP

As new media and emerging technology evolves, it generally rises to the level of quality demanded by the users or it will fail. When MPEG-2 first arrived, it was not as suitable for the application of TV distribution as it is today. It was continuously refined and optimized to the high calibre of picture that we see on air everywhere. It adapted to numerous applications and was configured to permit the transport of video when and where it was needed. It is still not perfect nor does it meet every requirement. That is why MPEG-4 is being developed and is rapidly launching into the marketplace. At this time, MPEG-4 has a few challenges just as MPEG-2 did in its early days. But, there are great hopes for MPEG-4.

MPEG-4 is capable of compressing video for use in television applications, computer displays, and to PDAs and cellular telephones. The quality of the video will vary for each application. The audio is already reputed to be far superior compared to any previous techniques. It will undoubtedly advance to

further improve the image and sound quality over these platforms. But, it will still be important that it keeps an eye out for what is generally accepted to be broadcast quality.

Composite Digital NTSC SDTV

Uncompressed Composite Digital NTSC	
Parameter	**Specification**
Signal-to-Weighted-Random-Noise-Ratio	60 dB (10 KHz to 4.2 MHz)
Signal-to-Low-Frequency-Noise-Ratio	48 dB (0 to 10 KHz)
Signal-to-Periodic-Noise-Ratio	62 dB (300 KHz to 4.2 MHz)
Frequency Response (Relative to a 50-IRE-unit test signal, e.g., 50-IRE multipulse or multiburst)	
0.5 MHz	+1.5 to -1.4 IRE units or +0.26 dB to -0.25 dB)
1.0 MHz	+2.4 to -2.0 IRE units or +0.40 dB to -0.35 dB)
2.0 MHz	+2.8 to -2.7 IRE units or +0.47 dB to -0.48 dB)
3.0 MHz	+3.6 to -3.3 IRE units or +0.60 dB to -0.59 dB)
3.58 MHz	+2.1 to -2.0 IRE units or +0.36 dB to -0.35 dB)
4.2 MHz	+4.2 to -3.9 IRE units or +0.70 dB to -0.71 dB)
Chrominance to Luminance Gain Inequality	± 4 IRE
Chrominance to Luminance Delay Inequality	33 ns
Line-Time Waveform Distortion	1 IRE unit peak-to-peak
Field-Time Waveform Distortion	3 IRE unit peak-to-peak
Short Term Waveform Distortion	2.00%
Long Time Waveform Distortion	8 IRE units, 3 second settling time
Insertion Gain	+5.9 to -5.5 IRE units
Insertion Gain Variation	
Hourly	+3.5 to -3.3 IRE units
Over one second	±1.7 IRE units
Luminance Nonlinearity	4 IRE units
Differential Gain	5 IRE units
Differential Phase	1.3°
Chrominance to Luminance Intermodulation	2 IRE
Chrominance Non-Linear Gain	
20-IRE-unit chroma signal	±2 IRE
80-IRE-unit chroma signal	±2 IRE
Chrominance Non-Linear Phase	2.0°
Dynamic Gain of Picture Signal	3 IRE units
Dynamic Gain of Synchronizing Signal	1.6 IRE units
Transient Synchronizing Signal Nonlinearity	2.0 IRE units

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Component Digital NTSC Video and Audio - SDTV

Uncompressed Component Digital NTSC Video as an SDI Stream (SMPTE 259M Level C Compliant)	
Parameter	**Specification**
Signal-to-Weighted-Random-Noise-Ratio	67 dB (10 KHz to 4.2 MHz)
Signal-to-Low-Frequency-Noise-Ratio	53 dB (0 to 10 KHz)
Signal-to-Periodic-Noise-Ratio	67 dB (300 KHz to 4.2 MHz)
Frequency Response (Relative to a 50-IRE-unit test signal, e.g., 50-IRE multipulse or multiburst)	
0.5 MHz	+0.7 to -0.7 IRE units or +0.12 dB to -0.12 dB)
1.0 MHz	+0.9 to -0.9 IRE units or +0.16 dB to -0.15 dB)
2.0 MHz	+1.0 to -1.0 IRE units or +0.17 dB to -0.18 dB)
3.0 MHz	+1.2 to -1.1 IRE units or +0.21 dB to -0.19 dB)
3.58 MHz	+0.6 to -0.6 IRE units or +0.10 dB to -0.11 dB)
4.2 MHz	+1.2 to -1.1 IRE units or +0.21 dB to -0.19 dB)
Chrominance to Luminance Gain Inequality	± 2 IRE
Chrominance to Luminance Delay Inequality	20 ns
Line-Time Waveform Distortion	1 IRE unit peak-to-peak
Field-Time Waveform Distortion	3 IRE unit peak-to-peak
Short Term Waveform Distortion	2.00%
Long Time Waveform Distortion	8 IRE units, 3 second settling time
Insertion Gain	+5.9 to -5.5 IRE units
Insertion Gain Variation	
Hourly	±1.7 IRE units
Over one second	±1.2 IRE units
Luminance Nonlinearity	2 IRE units
Differential Gain	2 IRE units
Differential Phase	0.7°
Chrominance to Luminance Intermodulation	1 IRE
Chrominance Non-Linear Gain	
20-IRE-unit chroma signal	±1 IRE
80-IRE-unit chroma signal	±1 IRE
Chrominance Non-Linear Phase	1.0°
Dynamic Gain of Picture Signal	2 IRE units
Dynamic Gain of Synchronizing Signal	1.2 IRE units
Transient Synchronizing Signal Nonlinearity	1.0 IRE units

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Digital Audio for SDTV

Uncompressed Digital NTSC Audio – Component and Composite	
Parameter	**Specification**
Signal to Idle Channel Noise Ratio	66 dB, Minimum (50 Hz to 20 KHz)
Total Harmonic Distortion	0.50%
Frequency Response (relative to reference level at 400 Hz)	
50 Hz to 100 Hz	+0.5 to -1.0 dB
100 Hz to 7.5 KHz	+0.5 to -0.5 dB
7.5 KHz to 15 Hz	+0.5 to -1.5 dB
Insertion Gain	0 dB ±0.5 dB
Gain Difference Between Channels (relative to the first channel)	
50 Hz to 100 Hz	1.0 dB
100 Hz to 7.5 KHz	0.5 dB
7.5 KHz to 15 Hz	1.0 dB
Phase Difference Between Channels (relative to the first channel)	
50 Hz to 100 Hz	10°
100 Hz to 7.5 KHz	3°
7.5 KHz to 15 Hz	10°
Crosstalk Coupling Between Channels	56 dB (50 Hz to 20 KHz)
Audi-to-Video Time Differential Range	25 ms lead, 40 ms lag

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