Audio in Cable, Broadcast, and Satellite Distribution

Issues & Solutions for the Digital Transition via Audio Metadata

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SMPTE 142nd Technical Conference
Outline

- Brief Audio in TV History
- Current Digital Cable Network Overview
  - Audio Issues
- Important Dolby Digital Metadata
  - Dialog Normalization
  - Dynamic Range Control
  - Demonstrations
- Conclusion
## Consumer TV Audio Formats

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>Number of Channels</th>
<th>Consumer Equipment</th>
<th>Dynamic Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mono TV, ~1965</td>
<td>1</td>
<td></td>
<td>~55 dB</td>
</tr>
<tr>
<td>MTS Stereo TV, ~1986</td>
<td>2</td>
<td></td>
<td>~65 dB</td>
</tr>
<tr>
<td>Hi-Fi VCR, ~1980</td>
<td>2, 4 (Dolby Surround)</td>
<td></td>
<td>~90 dB (Hi-Fi), ~45 dB (linear)</td>
</tr>
<tr>
<td>Laserdisc, 1980, PCM, ~1990</td>
<td>2, 4 (Dolby Surround)</td>
<td></td>
<td>~96 dB (16 bit digital audio)</td>
</tr>
<tr>
<td>Dolby Digital, 1995</td>
<td>1 to 5.1</td>
<td></td>
<td>&gt; 100 dB</td>
</tr>
</tbody>
</table>
Typical End-End Cable Delivery

Programmer Uplink

Turnaround Uplink

Cable Headend

MPEG-2/DD Encoder

Decode/Re-encode

MPEG-2/DD Encoder

Digital Turnaround

Multiplexer

Broadcast TV

Integrated Receiver

Transcoder

Return Path Equipment

Hybrid Fiber Coax (HFC) Network

Subscriber Home

Set Top

TV

Subscriber Home

Set Top

TV

Subscriber Home

Set Top

TV

Video Production Center/Soundstage

Telecine / Soundstage

Typical End-End Cable Delivery
Service Provider Audio Issues

- Levels that do not violate FCC analog NTSC modulation rules (broadcast)
- Levels and dynamics that are similar to other channels and programs, both analog and digital
- Maximizing the consumer experience
  - Full range frequency response
  - Clear dialog, undistorted signal
  - Desired dynamic range
  - Consumer flexibility
Consumer TV Audio Issues

- acceptable performance throughout the home
  - small monophonic TV in the kitchen, but full 5.1 in the home theater
    - Downmixing
    - Loudness Uniformity
    - Dynamic Range Control

- uniform audio level from channel to channel and program to program

- maximum functionality from their consumer electronics equipment
Audio Metadata

- Dolby Digital provides valuable features controlled by metadata
- This metadata should be authored as the program is mixed and/or encoded
- So… This metadata should flow through the entire delivery process to the subscriber’s Dolby Digital decoder (STB)
“Dialog” level

Consumer experience...

- People know how to set their TV volume:
  - sample the program a few seconds
  - adjust the volume until it sounds right

- People know if the next program is OK or not:
  - listen to the new program
  - readjust volume if necessary

- This judgement is based on what we call “dialog level”, but may also apply to programs without dialog, such as music.
Anatomy of an audio signal

Digital Full Scale
Reference Level for this program

ORIGINAL SIGNAL

0 dBFS
-10 dBFS
-20 dBFS
-30 dBFS
-40 dBFS
-50 dBFS

DIALNORM VALUE
DIALOG LOUDNESS

AVERAGE DIALOG
SIGNAL PEAKS

Reference Level for this program
Anatomy of an audio signal

Digital Full Scale

0 dBFS

-10 dBFS

-20 dBFS

-30 dBFS

-40 dBFS

-50 dBFS

AVERAGE DIALOG

SIGNAL PEAKS

SIGNAL WITH
DIALOG NORMALIZATION

PROGRAM LEVEL
SHIFTED
-11 dB

DIALOG LOUDNESS
AT -31 dBFS
(decoder operating in Line Mode)
Typical audio signals

- Average dialog levels:
  - -20 dBFS
  - -10 dBFS
  - -20 dBFS
  - -30 dBFS
  - -40 dBFS

- Signal peaks:
  - -20 dBFS: 27
  - -10 dBFS: 24
  - 0 dBFS: 21
  - 10 dBFS: 20
  - 20 dBFS: 10
  - 30 dBFS: 20
Normalized audio signals

<table>
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<tr>
<th></th>
<th>ACTION MOVIE</th>
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<th>SYMPHONY</th>
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- SIGNAL PEAKS

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Demonstration Now!

- AVERAGE DIALOG
- SIGNAL PEAKS
Audio Headroom

*above dialog.*

- Digital audio delivery offers extreme dynamic range.
- Generally speaking there is no standard for the level of dialog in a program
  - The dialog in Star Wars is at a lower level than the dialog in a used car commercial…
  - major motion pictures = ~ -27dBFS (dialog)
- Different dialog levels really mean different amounts of available headroom for music and effects to create a dramatic impact
**dialnorm**

*Is the most misunderstood metadata parameter.*

- An indicator of the *Dialog Level* of a program
- Quantified using the equivalent loudness method - $L_{Aeq}$
- It is NOT the Standard Operating Level of your facility..

*dialnorm* will minimize the average channel to channel dialog/loudness problems.. *when utilized correctly!!*
How to set dialnorm value:

- **Subjective method**: compare your program to a known reference. Make them match.
  - Dolby provides reference examples

- **Objective tools are available**
  - Integrating sound level meters = Leq “A” weighted

- **New tools are in development**
  - Dolby DP570 - objective & subjective - *available Jan. 01*
  - Dolby dialog normalization CD with reference examples
Where should *dialnorm* be set?

- The programmer (in most cases) is responsible for the value of *dialnorm* which is transmitted.
- The level of dialog is easiest to measure and control in post-production.
  - Determine *dialnorm* in post, pass the value on to the programmer... to carry to subscriber.

- *We need to develop more metadata connectivity...*
  - Dolby E offers a path...
Programmer Uplink

Programmer Uplink

Level Control

Analog

PCM

Dolby E

MPEG-2/DD Encoders

Dolby Digital Metadata
Embedded

Dolby Digital Metadata
Must be configured

Telecine / Soundstage

Video Production Center / Soundstage

DD

MMM

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Turnaround Uplink

- No audio control on digital turnaround
- Local encoding or re-encoding are similar to uplink
Cable Headend

IRTs transcode satellite QPSK / access control to cable QAM / access control
- No Headend A/V Controls on Digital services

- Analog broadcast TV audio may be level adjusted
- Digital broadcast TV transcoded to 256 QAM, no A/V controls

Hybrid Fiber Coax (HFC) Network
Set Top Terminal

- Set Tops typically must support RF, baseband, and digital audio interfaces
- *dialnorm* is always applied in the Set Top
- The subscriber wants a seamless surfing experience
  - Analog or digital programs
Dynamic Range Control (DRC)

- Digital coding systems can easily deliver extreme amounts of dynamic range
- The dynamic range needed by different listeners varies
  - Full dynamic range for home theatre enthusiast
  - Narrow dynamic range for portable TV
  - Audio should be sent without processing, but in a form useable for each type of listener
- The AC-3 bit stream includes a dynamic range control element
  - Used by decoders to implement dynamic range limiting
  - Protects 2 ch downmix of 5.1 ch service against overload
  - Use may be altered or defeated under control of the listener
  - The user may enjoy either wide or narrow dynamic range from the same bit stream
  - An inherent part of the AC-3 system; not an after thought
- The audio which is transmitted is *not* modified
Example Dynamic Range Profile

- Compression gain
- Boost ratio
- Max boost
- Null band
- Cut ratio
- Max cut
- Input level
DRC ‘Music Light’ Profile (dialnorm = -25, Correct)
DRC ‘Music Light’ Profile (dialnorm = -31, Incorrect)

LINE MODE

SOURCE

ADJUST FOR DIALNORM
dynrng

COMPRESSION

SOURCE

RF MODE

ADJUST FOR DIALNORM +11dB
compr

COMPRESSION

Demonstration Now!
Conclusions

- Accurate Dolby metadata at the set top is essential for maximum consumer satisfaction.
- Dolby metadata is best determined in post production and passed into the uplink encoder(s) via Dolby E.
- If the programming metadata is not known, it must be determined and provisioned at the uplink encoder(s) along with an appropriate dynamic range compression profile.
- We are developing better tools and assisting programmers with these measurements.
The Audience is Listening!