

Jargon Busting

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Surround Sound in HDTV

What big ears you have....

- **Ears** enable us to locate sound all around us
- **Eyes** have a relatively narrow field of view
- A screen can completely fill the field of view...
- ...but to feel 'drawn in' it helps considerably if we are **enveloped** by sound

Surround Sound & Pictures

- **1941**: Film industry introduced surround sound
- **1950s**: Premier cinemas using discrete surround sound routinely
- **Mid 1970s**: Most cinemas using **Dolby** matrix surround sound format
- **1991**: **NICAM** allows broadcast programmes to carry matrix surround sound
- **Mid 1990s**: **DVD-Video** format spurred take up of surround sound in the home

The Dolby contribution

- Dolby Laboratories developed noise-reduction technology
 - Dolby **A** & **SR** in professional applications
 - Dolby **B** / **C** / **S** in consumer applications

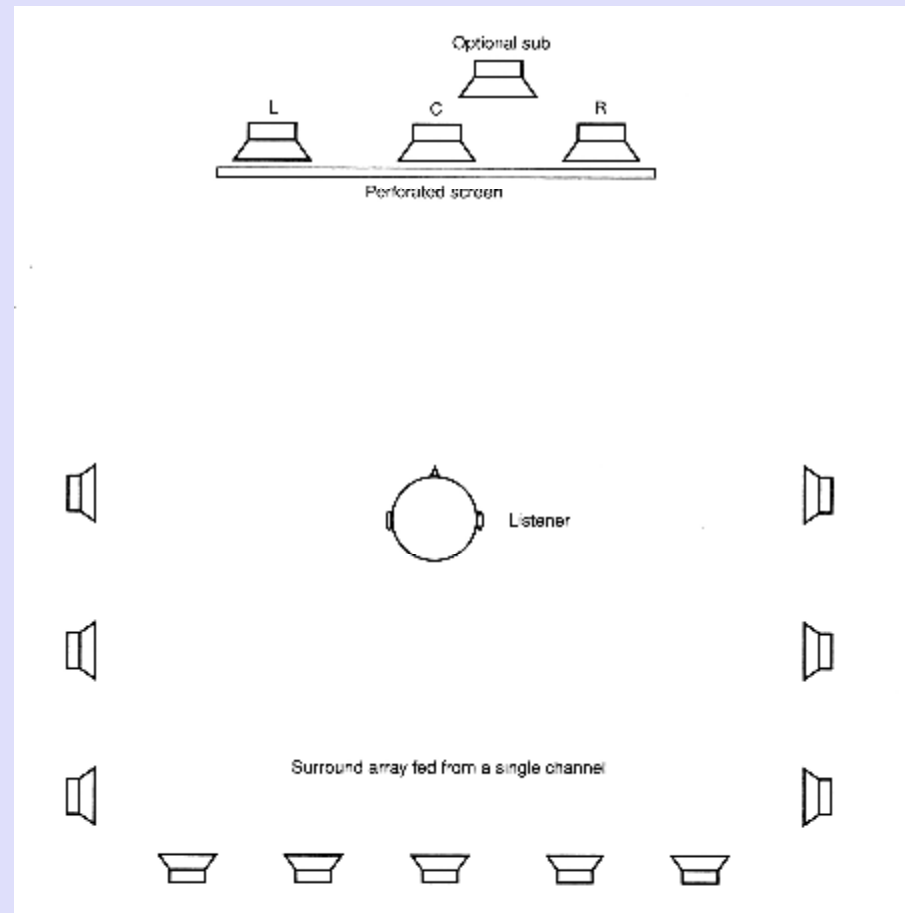
- Dolby **A** adopted to improve sound quality of optical soundtrack on 35mm films
- Improvement allows track to be halved for stereo

The Dolby contribution

- Industry required 4 channels (LCRS)
- Dolby launched **Motion Picture (MP) Matrix**
 - Four discrete channels encoded (matrixed) onto two audio tracks.

- Format called **Dolby Stereo** in cinemas
- Called **Dolby Surround** in consumer products/media

The Dolby contribution



The Dolby contribution

- The 'matrixed' signal is referred to as **Lt/Rt**
 - Mono and stereo compatible
- **Matrix technique is flawed**
 - Channels suffer inherently from crosstalk – they don't have the separation of true, discrete channels
 - Practical limitations on how the channels can be used, which has to be taken into account when mixing
 - Surround channel has restricted bandwidth

The Dolby contribution

- Audience can extract **LCRS** channels from the stereo source to enjoy surround sound at home
- **Dolby Pro-Logic**
- Original decoders were all analogue, but most home theatre equipment uses digital algorithms
- Updated version **Dolby Pro-Logic II** decodes LCRS and converts to 5.1 format

Audio data reduction

- **Data Reduction Systems** discard 'redundant' or 'irrelevant' information from an audio signal
- Remove elements of sound that you can't hear while they are masked by other, more important sounds
 - Eg. you might not be able to hear something on the car radio while you're driving over a rough road surface

Dolby Digital (AC3)

- Dolby invented a data reduction system called **AC3**
- Encodes Up to **6** audio channels very efficiently (15:1)
 - 6 channels of 24bit / 48kHz = 5.76 Mbps
 - 6 channels encoded in AC3 = **384 kbps**
- Claimed imperceptible change in quality

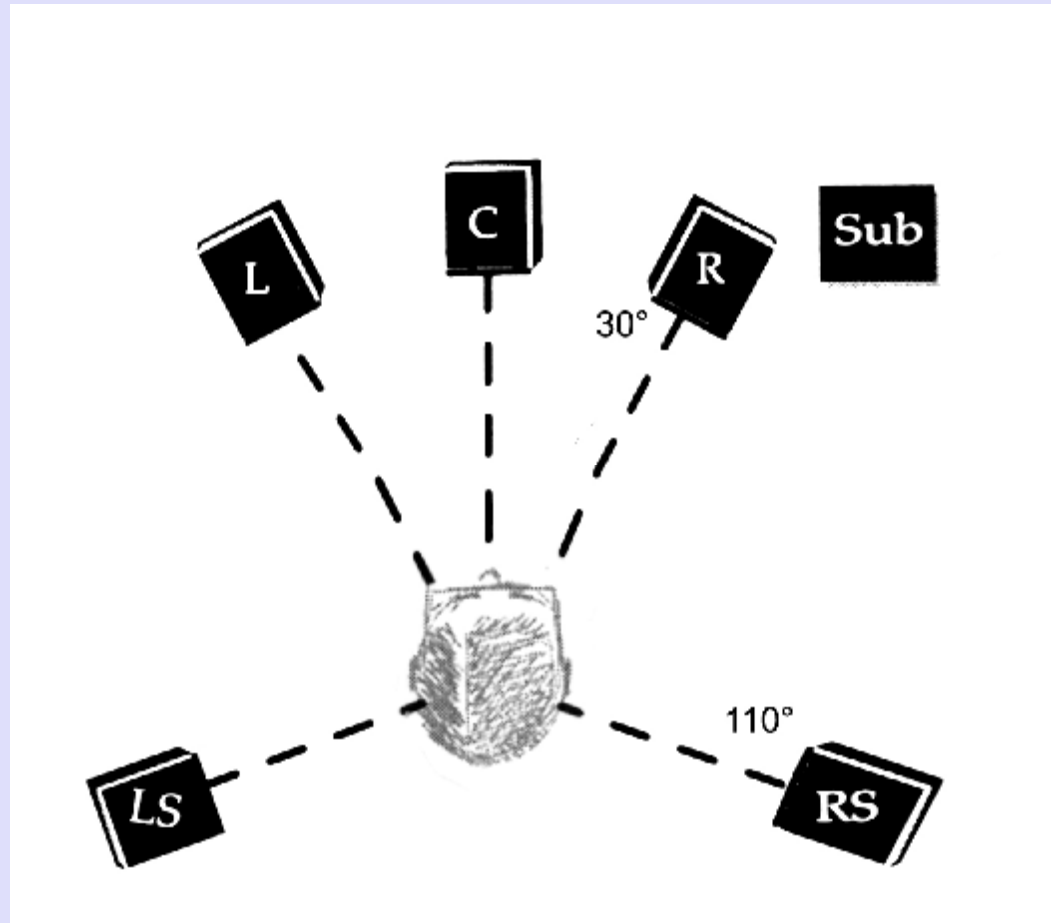
Dolby Digital (AC3)

- Colossal reduction in amount of audio data sufficient to allow it to be printed as blocks of tiny black and white data pixels located between the sprocket holes on 35mm film
- The data reduction algorithm is called **AC3**, but the application is known as **Dolby Digital**

The 5.1 format

- Six audio channels – arrangement known as 5.1
- Three front channels: L / C / R
- Two surround channels: Ls / Rs
- Dedicated Low Frequency Effects channel: LFE
- Five *full bandwidth* main channels – the 5
- One *restricted bandwidth* LFE channel – the .1

The 5.1 format



The LFE channel

- The **LFE** channel is intended only for sound effects that require serious bass augmentation
- NB. The five main channels all have a full 20Hz to 20kHz bandwidth – there is no low frequency restriction in the main channels
- Often, the LFE channel is not required at all

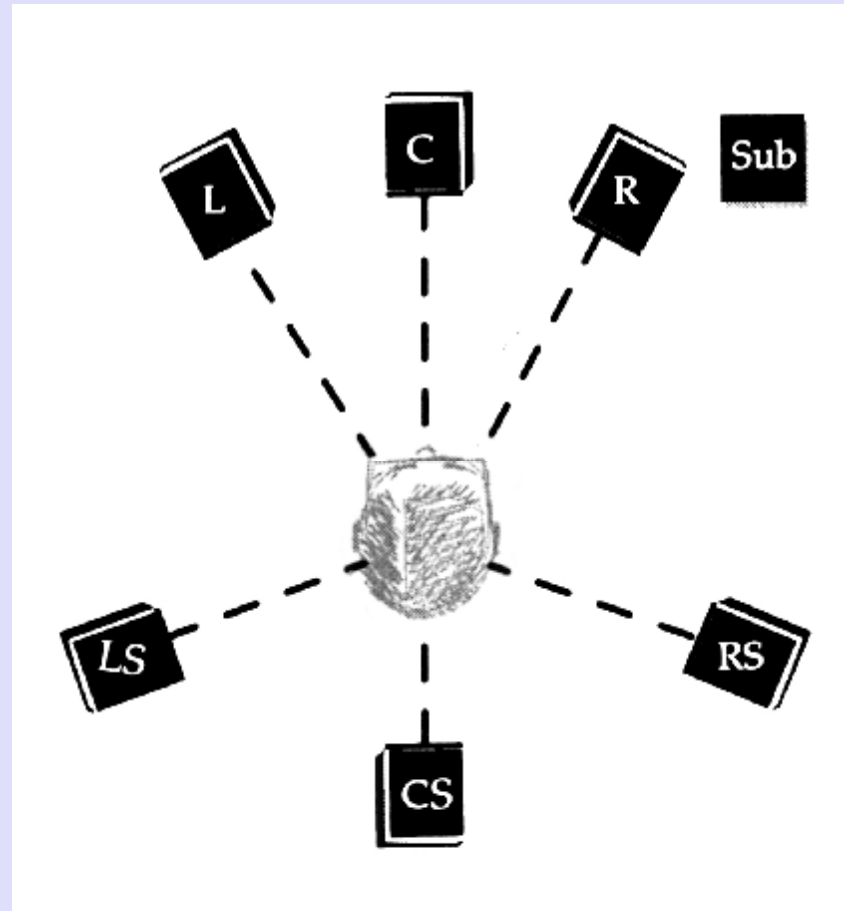
Dolby Digital Plus

- An enhanced version of Dolby Digital recently introduced called **Dolby Digital Plus**
 - Optimised for integration within an **MPEG 4** data stream used for HD broadcasts
 - Standard for **Blu-Ray** and **HD-DVD** formats
- Provides additional audio channels for alternative
 - Audio description, director commentaries, multilingual
- Backwards compatible with Dolby Digital

Cinema 6.1

- A centre rear channel added in cinemas – 6.1
 - Dolby Digital Surround EX
 - DTS-ES 6.1
- Rear channel encoded as a matrixed signal within left and right surround channels
- Conveyed in a conventional 5.1 format

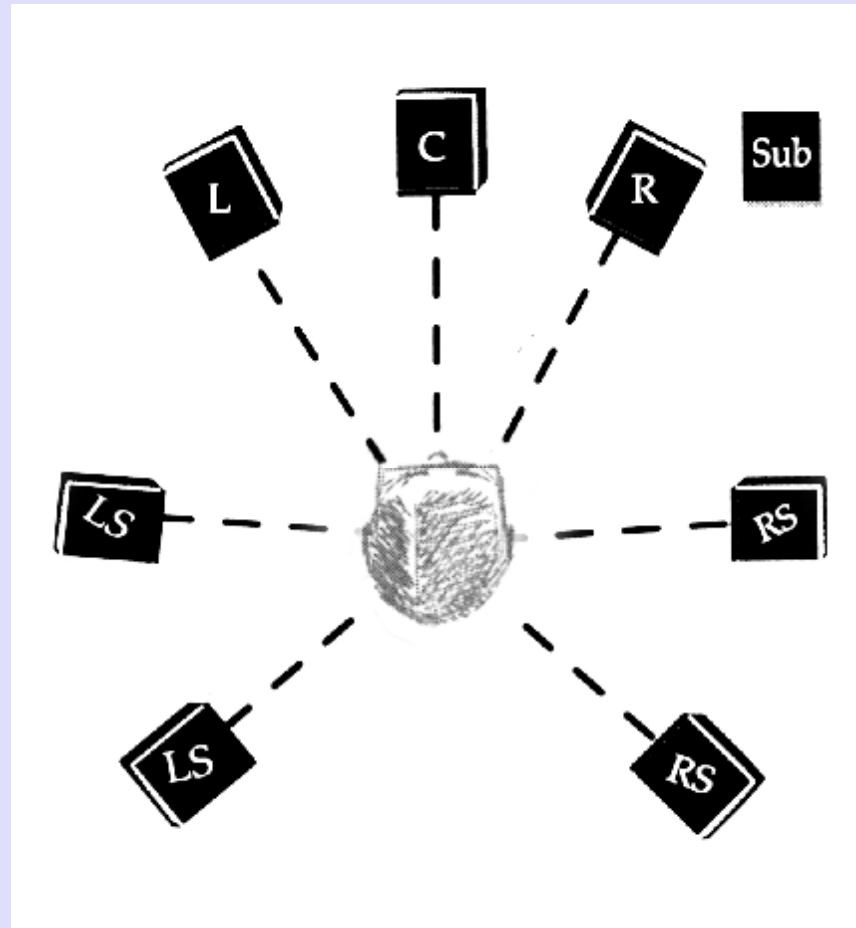
Cinema 6.1



Home 7.1

- Many home theatre systems expand the 5.1 (or 6.1) source material into a 7.1 format
- Rather than providing additional front channels, these decoders provide **additional rear or side channels**
 - Spread the available Ls/Rs surround information around a bit more
 - Provides a better sense of envelopment from the surround channels in a relatively small domestic environment

Home 7.1



Surround format

- Surround sound can be produced in several formats
- The selection is normally being an artistic decision
- Also influenced by the programme destination or release format

LCRS

- Where only a two-channel medium is available, the surround mix will often be produced in the LCRS format
- As this format involves matrixed channels rather than discrete ones, it does not use the number system
- The source is referred to as **LCRS**, and the encoded stereo track as **Lt/Rt**

Dolby Digital

• Dolby Digital (AC3) can carry any number of channels up to 6, but is often used to carry only one or two

• Markings on DVD-Video boxes indicate the channels in use



Mono



Stereo



Dolby Surround



5.1-ch. Dolby Digital

4.0

- ÿ Where multiple discrete channels can be used, the simplest surround sound format is 4.0
 - o Essentially a quadraphonic format
 - o Uses the front left and right channels, along with the stereo surround channels

- ÿ Ideal for music programmes where a centre dialogue channel is not required, and where there is no need for low frequency effects

5.0

- A commonly employed surround format in television
- Uses all five main channels – including the centre channel for dialogue – but not the LFE channel
 - The five main channels carry normal levels of bass information
 - Earth-shattering rumbles and explosions are rarely required in most TV productions, so the LFE channel is often unnecessary

5.1

ÿ The complete 5.1 format is available for those productions that really require it...

Production formats

- Surround production requires the storage of 5.1 discrete audio channels
- Some areas record 5.1 surround mix on a separate eight channel audio recorder
- Often a **Tascam DA98** machine



Production formats

- BBC Worldwide currently uses this approach
- Similar techniques and equipment are often employed in dubbing houses

- There are several different track layout arrangements in different parts of the industry
 - Internationally agreed form is:
L, R / C, LFE / Ls, Rs // Lt, Rt

Production formats

- Tracks 1-6 carry the 5.1 channels
- Tracks 7&8 are normally used to carry a stereo version of the mix
- That stereo version could itself be encoded as an LCRS 'downmix' of the full 5.1 surround mix

Dolby E

- Separate Audio recorders not always convenient
- Surround sound audio can be recorded as data spread across a pair of digital audio tracks using **Dolby E**
- The standard in-house arrangement using current **HDCam** recorders is to carry a stereo audio mix on tracks 1&2, with Dolby E on tracks 3&4
- Dolby E configured with 5.1 surround in channels 1-6, plus a stereo mix on channels 7&8

Dolby E

- Dolby E is similar in concept to Dolby Digital
- It uses digital audio data reduction techniques to squeeze **eight** discrete audio channels into the space normally required for **two**
- Dolby E uses considerably less data reduction than Dolby Digital
- Optimised to allow editing on video machines
- *Designed to withstand multiple concatenation*

Dolby E

- Every encode and decode pass of Dolby E introduces **one video frame of audio delay** (40ms)
- Dolby E is likely to be a short term solution for in-house recordings
- Forthcoming **HDCamSR** machines have sufficient audio tracks to allow discrete 5.1 channel recording.
- Dolby E likely to remain in use for some inter-studio or OB links

Home Theatre

- **Dolby Digital (Plus)** surround sound is embedded within the transmitted MPEG digital data stream
- Dolby Digital will be extracted and decoded in the **Set-Top Box (STB)**, or provided via a separate digital output for external **Home Theatre** equipment

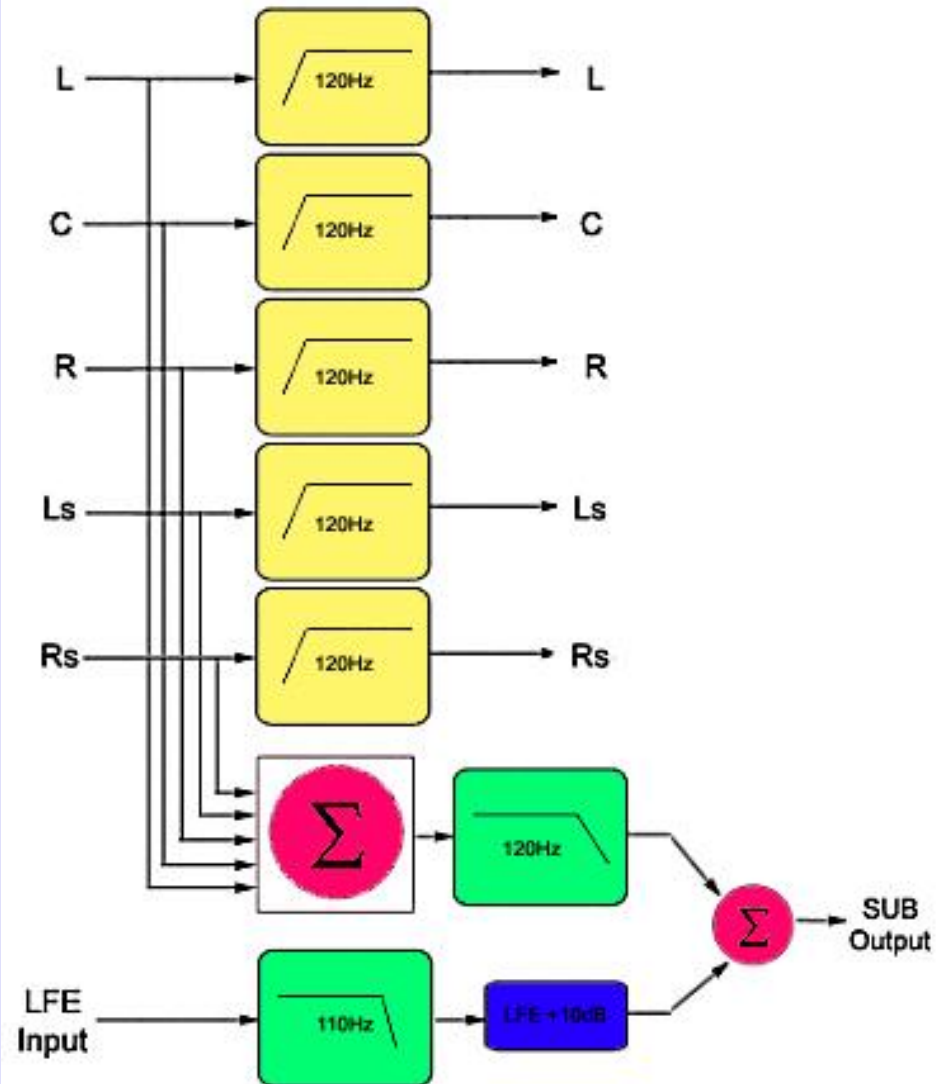
Home Theatre

- Ideally, the home user will have five large, full bandwidth main speakers (for the three front and two rear channels), plus a subwoofer to handle the LFE channel
- However, this is rarely practical or domestically acceptable... so a more typical arrangement would be **five compact speakers for the main channels, plus a subwoofer**

Bass Management

- However, compact loudspeakers cannot reproduce low frequencies well
- **Bass Management** is built in to the vast majority of home theatre systems
- Low frequency portion of each of the five main channels is stripped off, and routed instead to the subwoofer – along with the LFE signal
- Having all the bass coming from a single subwoofer doesn't affect the surround sound effect or imaging

Bass Management



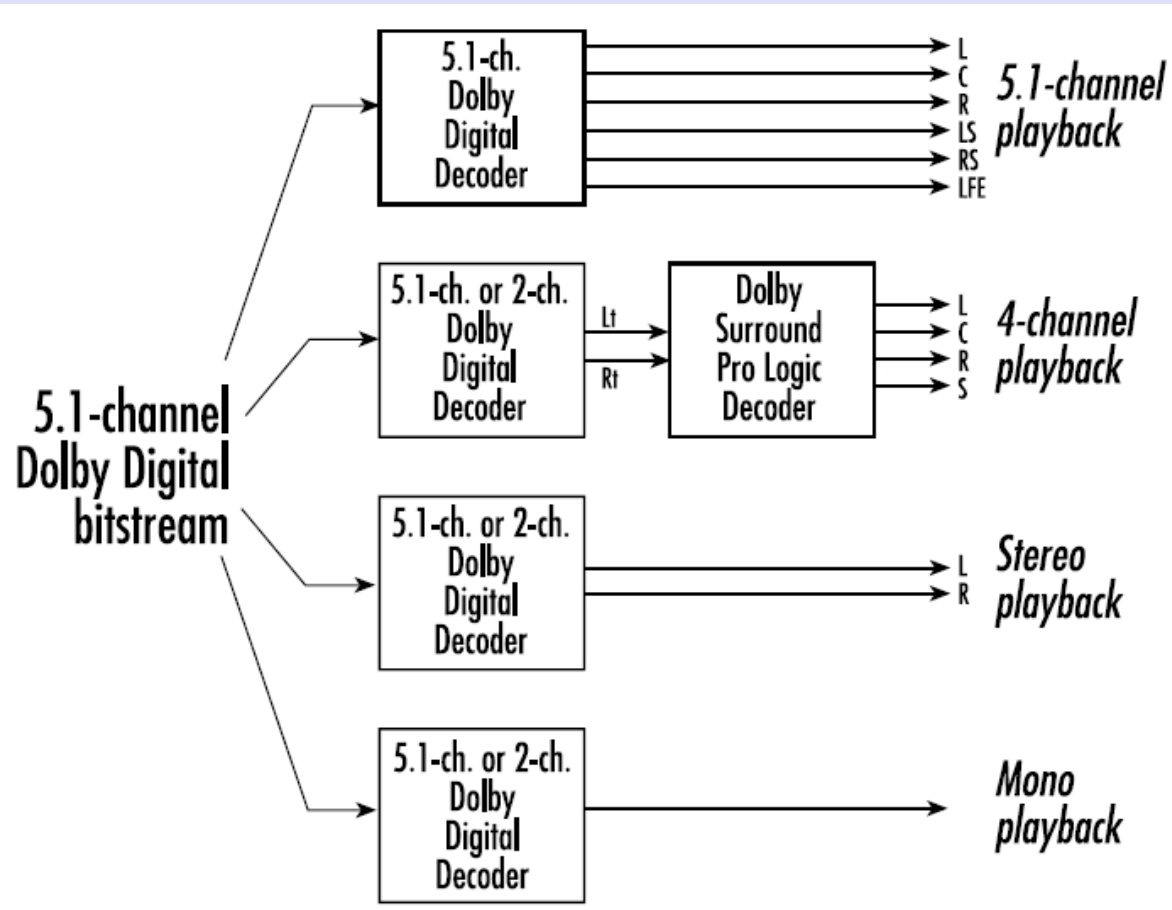
Metadata

- Dolby E and Dolby Digital both encode 'metadata' along with the audio
- Dolby's metadata system is very sophisticated and allows a wide range of programme-specific parameters to be established

Downmix metadata

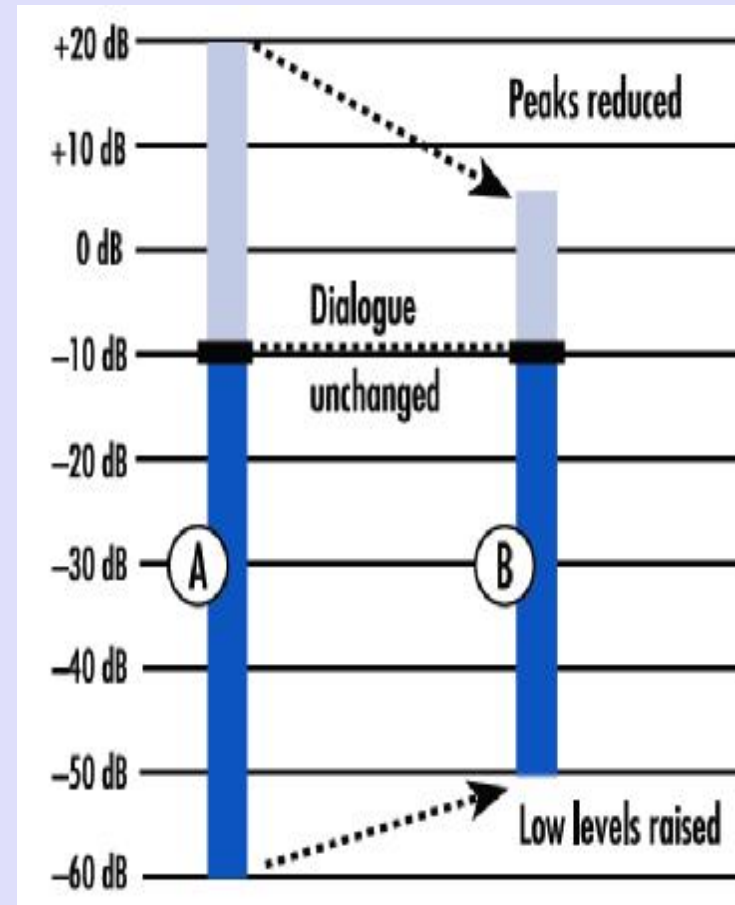
- Metadata instructs the decoder what to do with the surround signals if there are no surround speakers
- The surround channels are automatically folded into the front left and right speakers to create a stereo 'downmix'
- Downmix formats and relative levels can be decided at the time of mixing the surround tracks

Downmix metadata



Dynamic range metadata

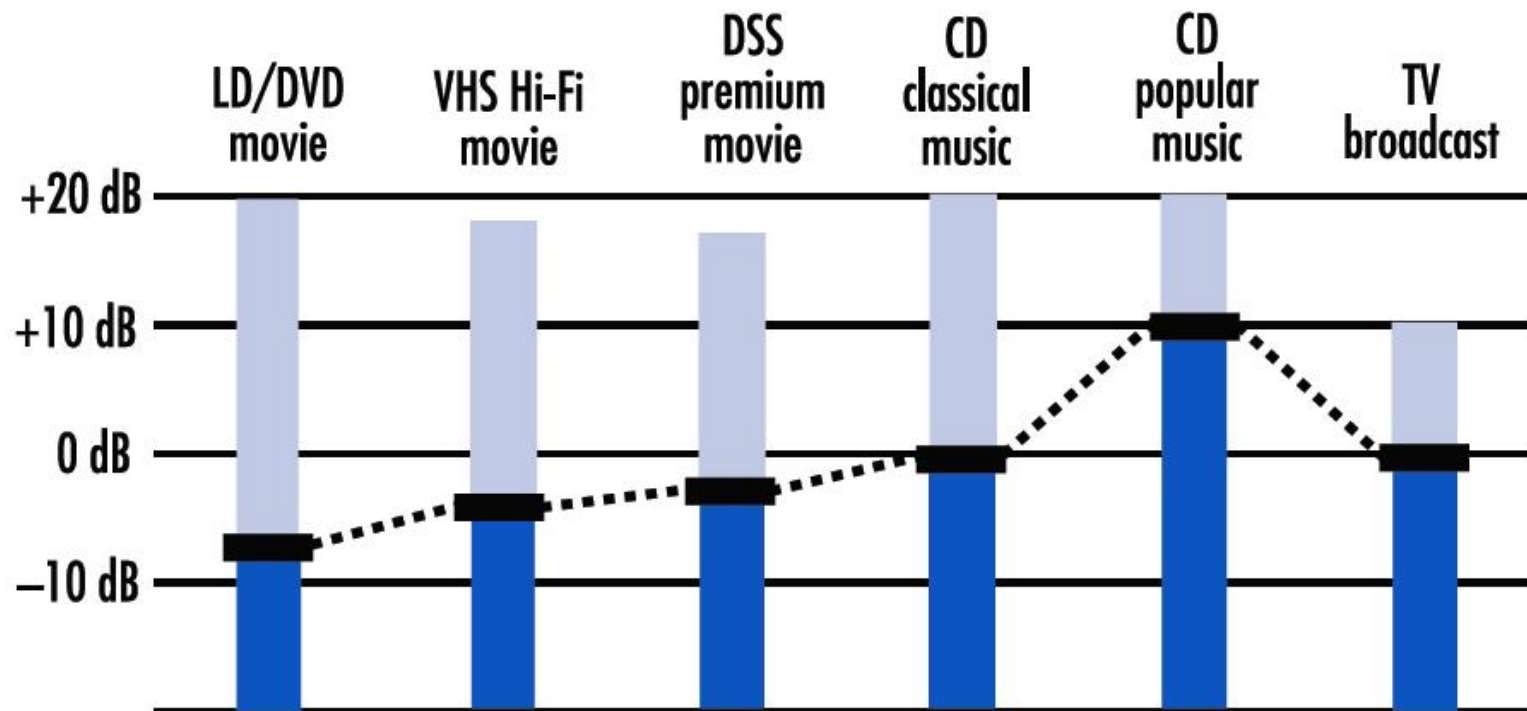
• Metadata controls the optimised reduction of **dynamic range** for late night listening (midnight mode), or in conditions of high ambient noise



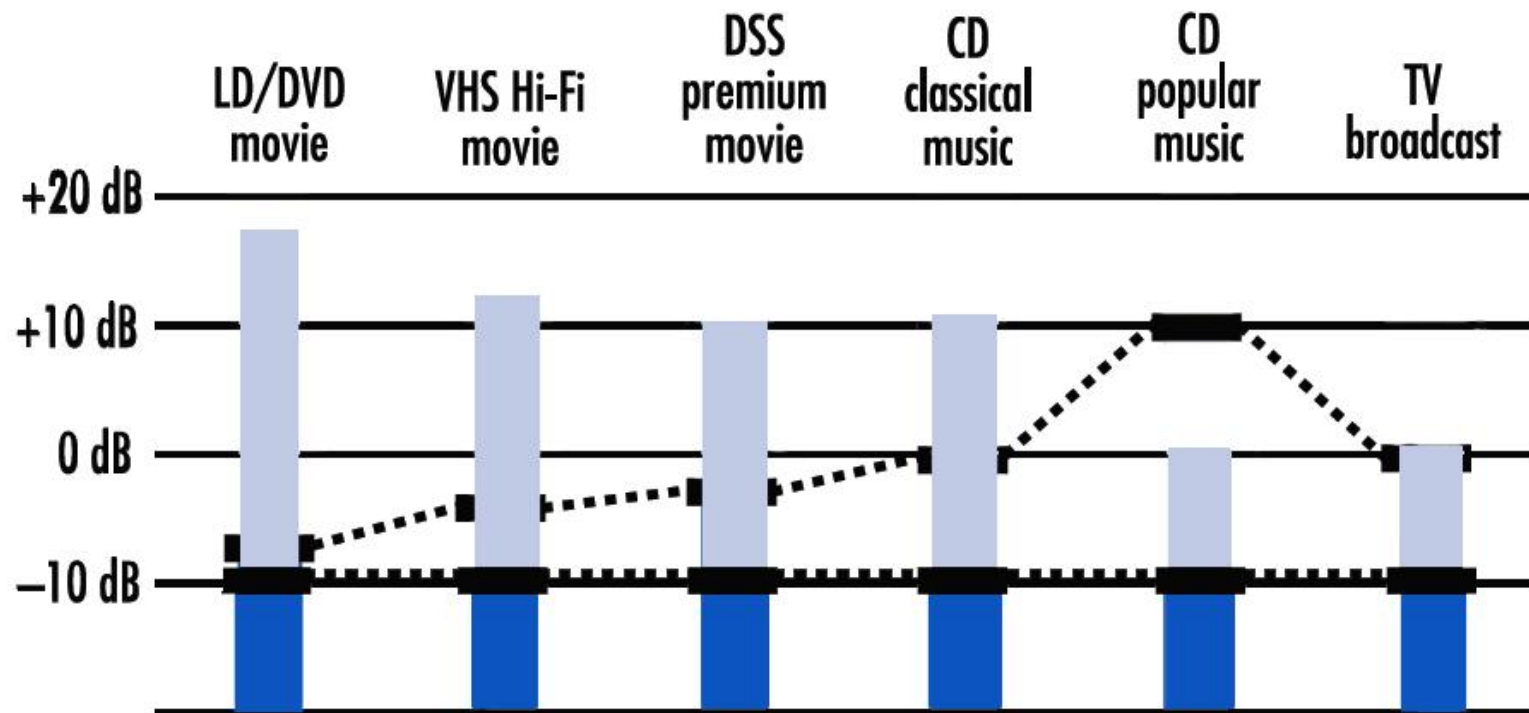
Dialnorm metadata

- The **dialnorm** setting used to determine the replay volume (based on the perceived average level of dialogue) to ensure a consistent volume of speech between different programmes

Dialnorm metadata



Dialnorm metadata



The HD web page

<http://www.bbc.co.uk/commissioning/production/hd.shtml>

The HD web page