Audio Systems for DTV

ITU Seminar
Kiev, Nov. 14, 2000

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Don’t forget the audio

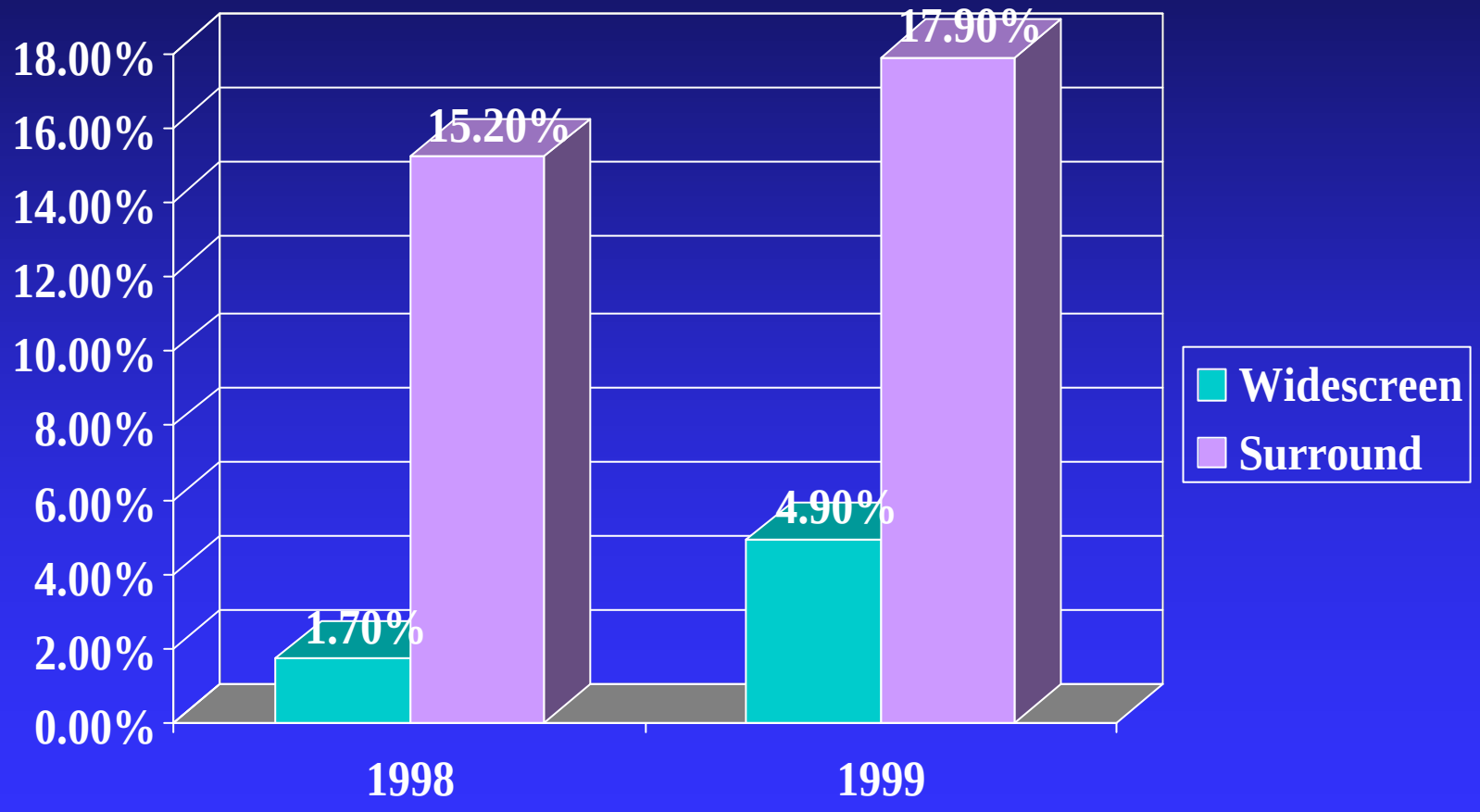
"The cost of entertainment, at least as far as the hardware is concerned, is falling: inexpensive chip-sets, lower-cost flat-screen televisions, free or inexpensive set-top boxes, and not forgetting Dolby multi-channel surround sound (said by more than a few experts to have been responsible for selling more large-screen televisions that any other technological advance since colour)."

THE BUSINESS OF DIGITAL TELEVISION by Chris Forrester
Page 7, chapter 1

http://www.bh.com/bookscat/samples/0240516060/0240516060.pdf

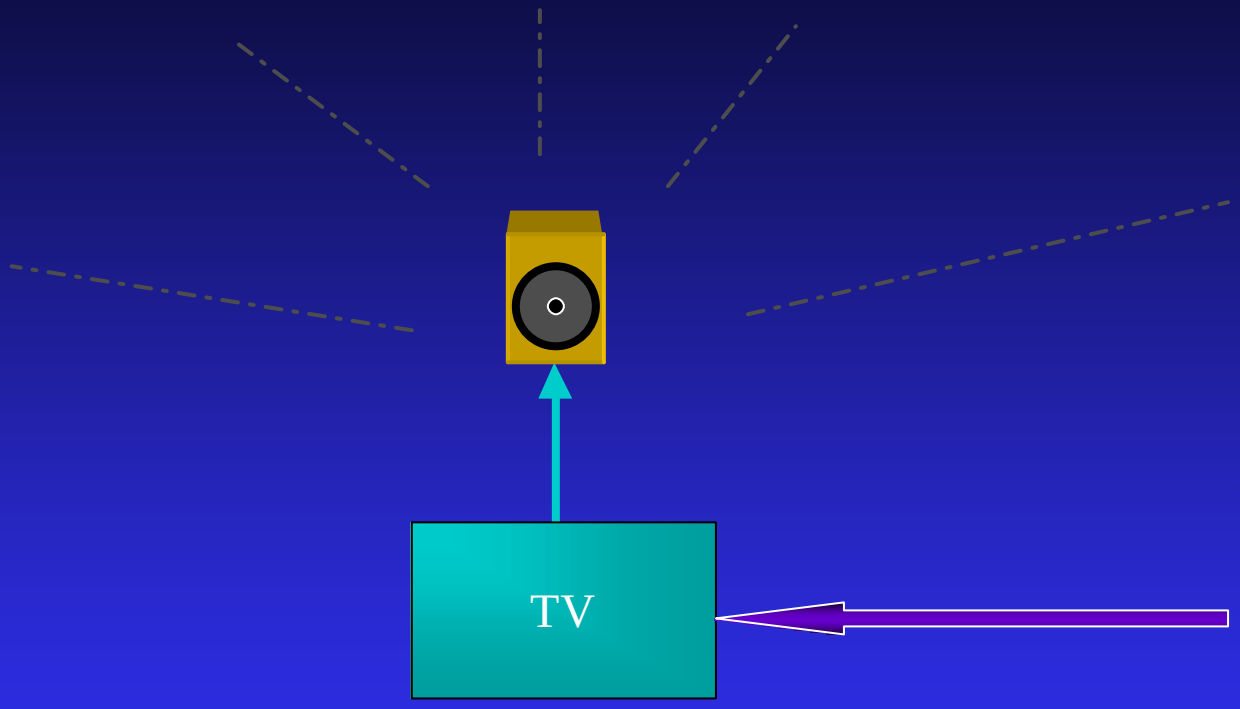
UK Household Penetration

Widescreen vs Dolby Surround

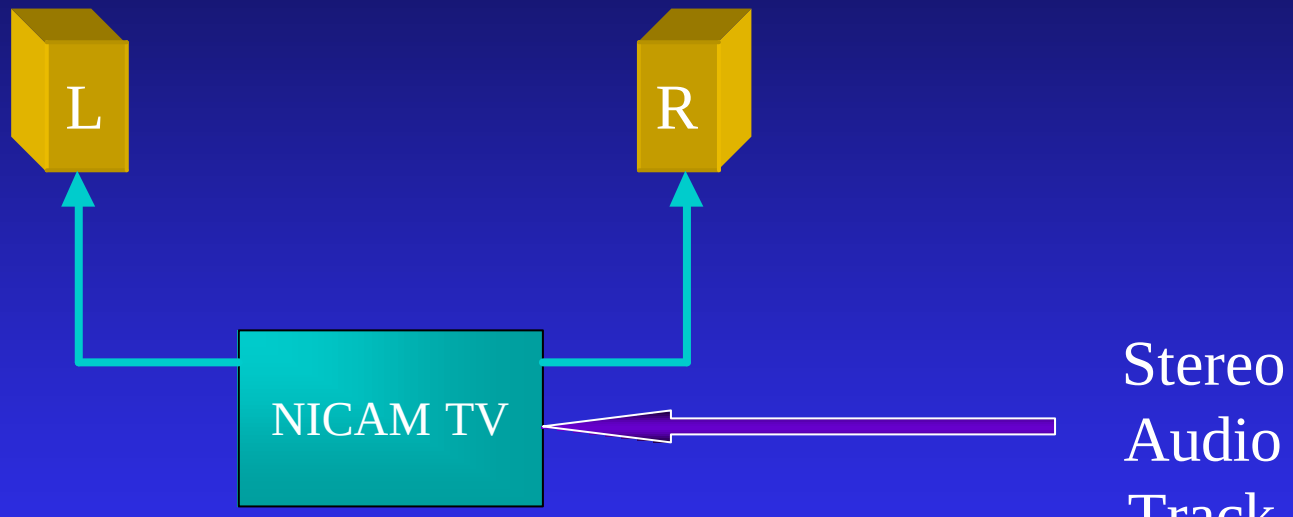


Source: Understanding & Solutions

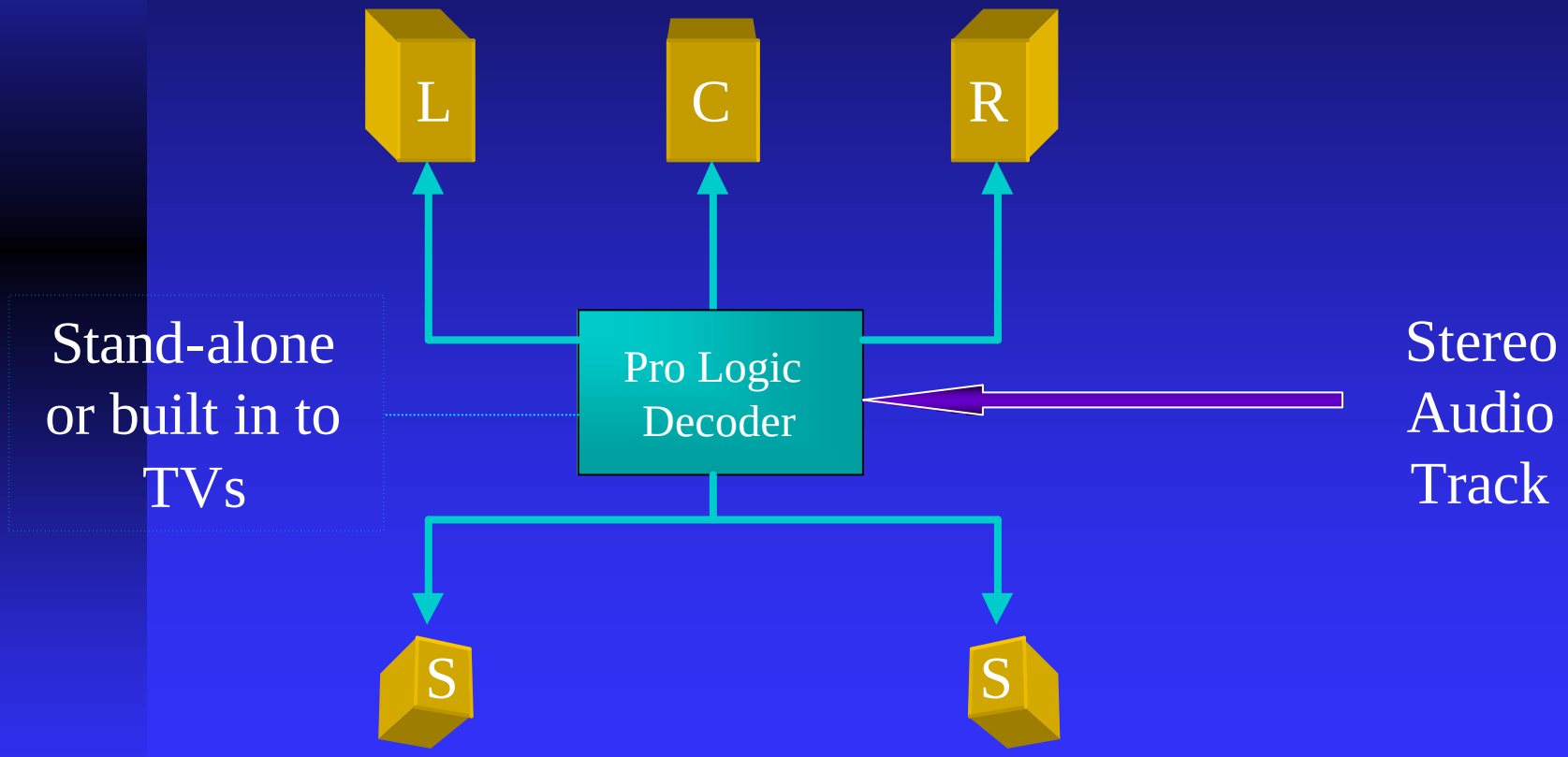
Audio - mono beginnings



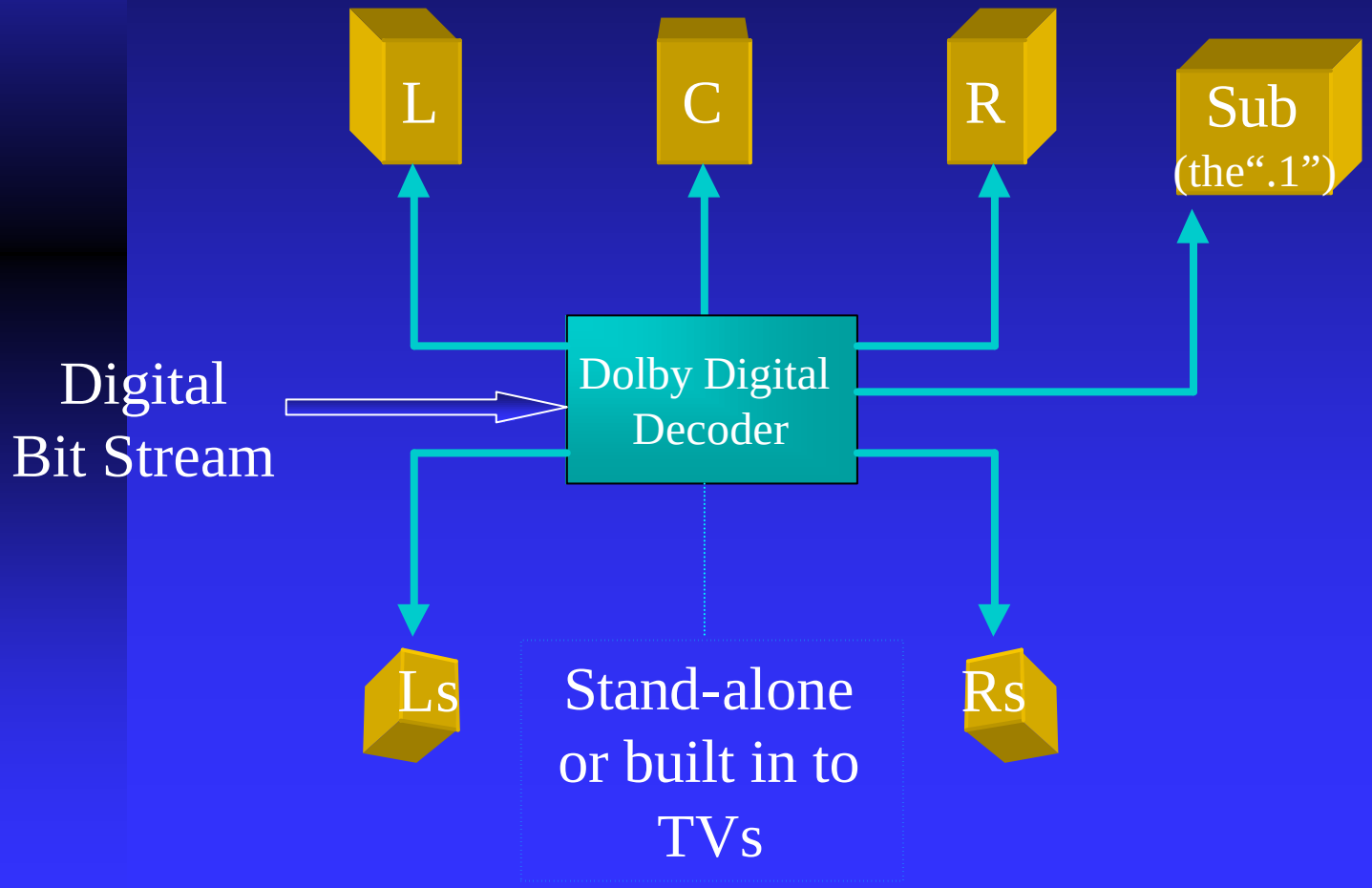
Stereo - rather better



Dolby Surround - Matrix audio



5.1 discrete audio



“5.1” audio is important

- Surround sound has become very popular
- ITU-R Rec. BS.775-1
- All new media support 5.1 ch audio
  - Movies in the cinema
  - Digital Terrestrial TV
  - DVD-V and DVD-A
  - Digital Cable TV
  - Digital Satellite TV

The audio systems for DTV:

- MPEG-1,2 Layer II
  - DVB
- Dolby Digital (technical name: “AC-3”)
  - ATSC
  - DVB
- MPEG-2 AAC
  - ISDB

Common attributes of all of these audio coders

- Significant reduction of bit rate compared to PCM audio
  - compression factors of 6-1 to 12-1
- Can be used for mono, 2ch stereo, 5.1 ch
- Internationally standardized by ISO/IEC or ITU-R
- Open specification and availability of patent license

Differences between coders

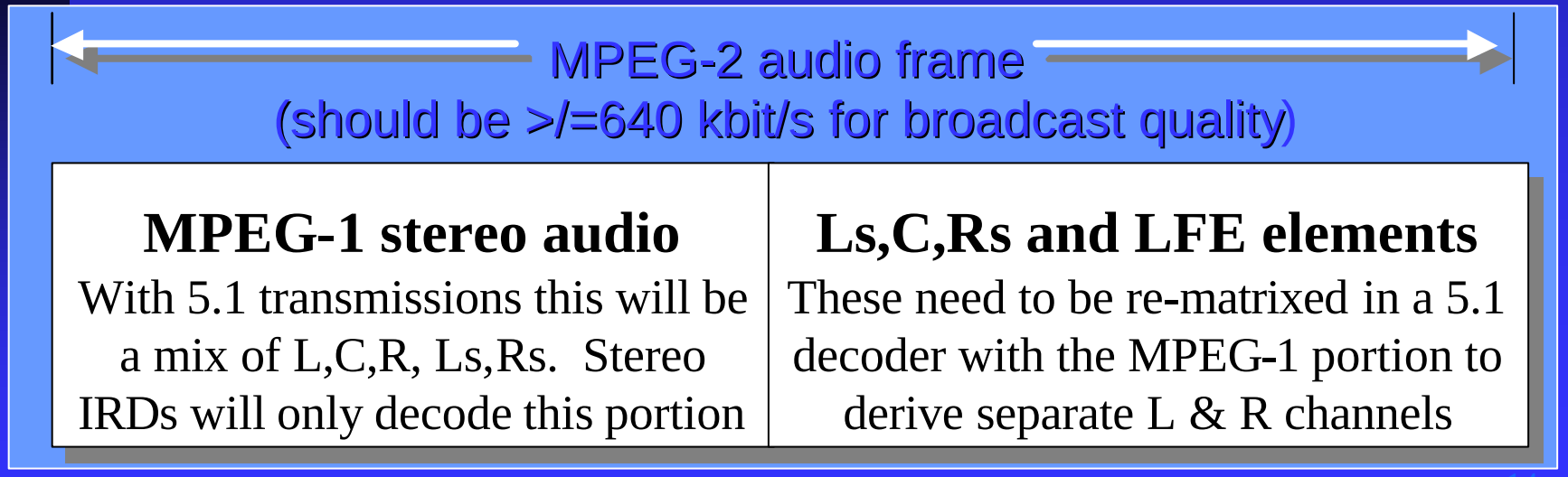
- Efficiency (quality vs bit-rate)
- Consumer features to improve audio service
  - Level control
  - Dynamic range control
  - Down-mixing
- Cost
- Adoption by significant applications
- Marketplace success
- Technology support

MPEG-1 Layer II Technology

- MPEG-1 Standard
  - Mono, 2ch stereo audio
- ITU-R Recommendation BS.1115 (2 ch)
- Originally developed as coding system for digital radio
  - Eureka 147 (became DAB)
  - Basic 2 channel delivery pipe
  - Capability to carry aux data
  - No consumer features included

MPEG-2 Layer II Technology

- MPEG-2 Standard – includes 5.1 surround
- ITU-R Recommendation BS.1196
- MPEG reacted to Dolby announcement of 5.1ch AC-3
  - MPEG-2 is MPEG-1 stereo plus a BC (backward compatible) extension to provide extra channels



MPEG-2 Layer II Technology

- MPEG-2 Standard
- ITU-R Recommendation BS.1196
- MPEG reacted to Dolby announcement of 5.1ch AC-3
  - MPEG-2 is MPEG-1 stereo plus a BC (backward compatible) extension to provide extra channels
- Technical deficiencies due to BC requirement
  - Higher bit rate needed for 5.1 chs

MPEG Layer II Adoption

- Basic in DVB system (MPEG-1 2ch)
- Employed in VCD (MPEG-1 2ch)
- Specified for PAL DVD but then rejected (MPEG-2 5.1ch)
- Widely applied for mono, 2ch stereo
  - market failure for 5.1 ch
- Significant 2ch presence in marketplace
  - but not visible to consumers

Dolby Digital (AC-3) Technology

- ATSC Standard A/52
- Designed specifically to carry any audio
  - Mono, stereo, surround, 5.1
  - Consumer features designed in to improve audio service
- ITU-R Recommendation BS.1196
- Designed to balance cost / complexity / performance
  - Key to early and widespread market acceptance

Dolby AC-3 Adoption

- Basic in ATSC system
  - Also in U.S. CATV, DBS
- Employed in DVD (worldwide)
- Used in computer gaming platforms
- … for mono, 2ch stereo, 5.1 ch audio
- Option in DVB (ETR-154 Annex C)
  - Selected by Australia, Singapore, etc.
- Substantial and growing presence in home video marketplace
  - Dominant system for 5.1 ch
  - Highly visible to consumers

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DVD – the PAL format that nearly wasn't

- Compromise standard
  - NTSC 525/60 disc use AC-3 (like ATSC)
  - PAL 625/50 disc use Layer II (like DVB)
- Unsuccessful launch of PAL 625/50 format
  - Lack of support for MPEG-2 audio
  - Poor performance of MPEG-2 audio
- Standard changed so AC-3 *could* be used in all discs
  - Marketplace decision which to use on PAL 625/50 discs

DVD

9 February 1998 Vol 1/No 3

First with news and analysis of the global market for DVD products

Intelligence

Dolby AC-3 Wins Mandatory Status On PAL/SECAM Discs

DOLBY LABORATORIES CELEBRATED victory when, last December, in a development underreported, the DVD Forum upgraded the company's AC-3 audio system from an option to a mandatory inclusion in DVD Video discs produced for the PAL/SECAM territories. Officially, the DVD discs for these markets are no longer required to include MPEG Multichannel audio, which its progenitor, Philips, fought hard to impose as primary system. ***Jean-Luc Renaud reports.***

At the Intercontinental Hotel in Tokyo on December 5, the 10 members of the Steering Committee of the DVD Forum voted 8-2 to change the DVD-V specifications (see official tables p. 2).

They agreed to include Dolby Digital (AC-3) in the list of audio types, at least one of which must be on 625/50 PAL/SECAM discs. This means that in effect 625/50 discs can be made with a Dolby Digital track alone and obviating the need for MPEG audio.

The member companies supporting the change comprised Hitachi, Matsushita, Mitsubishi, Pioneer, Thomson Multimedia, Victor Company of Japan (JVC), Time Warner and Toshiba. Philips and Sony were the dissenting voices.

In a press statement, Dolby was quick to characterise this as "a welcome change for those content providers who wish to provide content which contains a 5.1 channel Dolby Digital track and, for reasons of limited disc capacity, do not wish to also have to include a 2-channel MPEG-1 audio track." Making the point clear, Dolby stated: "With the specification change, the MPEG-1 track is no longer required for conformance."

Philips had announced at the IFA consumer electronics fair at Berlin in August that agreement had been reached mandating MPEG Multichannel for PAL countries. As it turned out, Philips' triumph was to be short-lived. The Dutch company was reportedly behind schedule in delivering MPEG-2 Multichannel encoders to DVD developers.

Philips, naturally, has deplored the result of the December vote. "We are sincerely convinced that in the long run the decision of the DVD Forum is not in the interest of the consumer," said Jan Oosterveld, senior director of corporate strategy at Philips.

continued on page 2

$720bn Euro software spend forecast to year 2010, p 4

DVD Intelligence
LABORATORIES INC.
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First with news and analysis of the global market for DVD products

DVD Publishers Turn Deaf Ear To MPEG Multichannel Sound

SIX MONTHS AFTER THE DVD FORUM UPGRADED Dolby AC-3 audio from an option to a mandatory inclusion in DVD Videos published in PAL/SECAM territories, the rival MPEG-2 Multichannel Audio system appears to be on the way out. And the simpler MPEG-2 stereo option fares no better. *Barry Flynn reports*.

Initially, Philips succeeded in mandating MPEG Multichannel alone as the audio standard (see *DVD Intelligence*, April/May 1997), but the policy was reversed by the DVD Forum in December 1997 (see *DVD Intelligence*, February 1998).

Of the publishers surveyed by *DVD Intelligence*, only Columbia TriStar has had a consistent policy of using both types of audio on its European discs. But now the studio is thinking again. According to Steve Brown, the UK operations director: "Columbia are reviewing their options on what to do with sound."

Brown will not reveal which way the studio is leaning, but the implication is that one of the two systems could be ditched. Given current market sentiment, *DVD Intelligence* guestimates that MPEG Multichannel is the most likely casualty. Indeed, Columbia's forthcoming titles such as ***Sense And Sensibility*** and ***Midnight Express*** are Dolby-only.

Warner Home Video's Neil McEwan says that the studio's current policy for European-aimed DVD Videos is "all Dolby AC3 and only AC-3 – either stereo or 5.1."

Suggesting that this is likely to be Warner's policy for the foreseeable future, he adds: "It's our view that at the moment there is no market demand for (MPEG Audio). The rest of the market is going AC-3. At this point in time there is no reason for anybody to buy kit in MPEG-2."

Although the music products of Warner Vision, a separate division within Time-Warner, might seem to dictate a different policy, it is eschewing MPEG audio also. Frank Brunger, Warner Vision's senior director of international marketing and sales, says: "All our discs are DVD10s: we use (Dolby AC-3) 5.1 on one side and LPCM (Linear Pulse Code Modulation) on the other." His division is not planning to use MPEG Audio, he adds, because "everybody is using AC-3 where they're putting multichannel sound on."

It is so far unclear what Buena Vista's policy is. The

continued on page 2

Dolby Digital in DVB

Panasonic ad for German broadcaster ProSieben

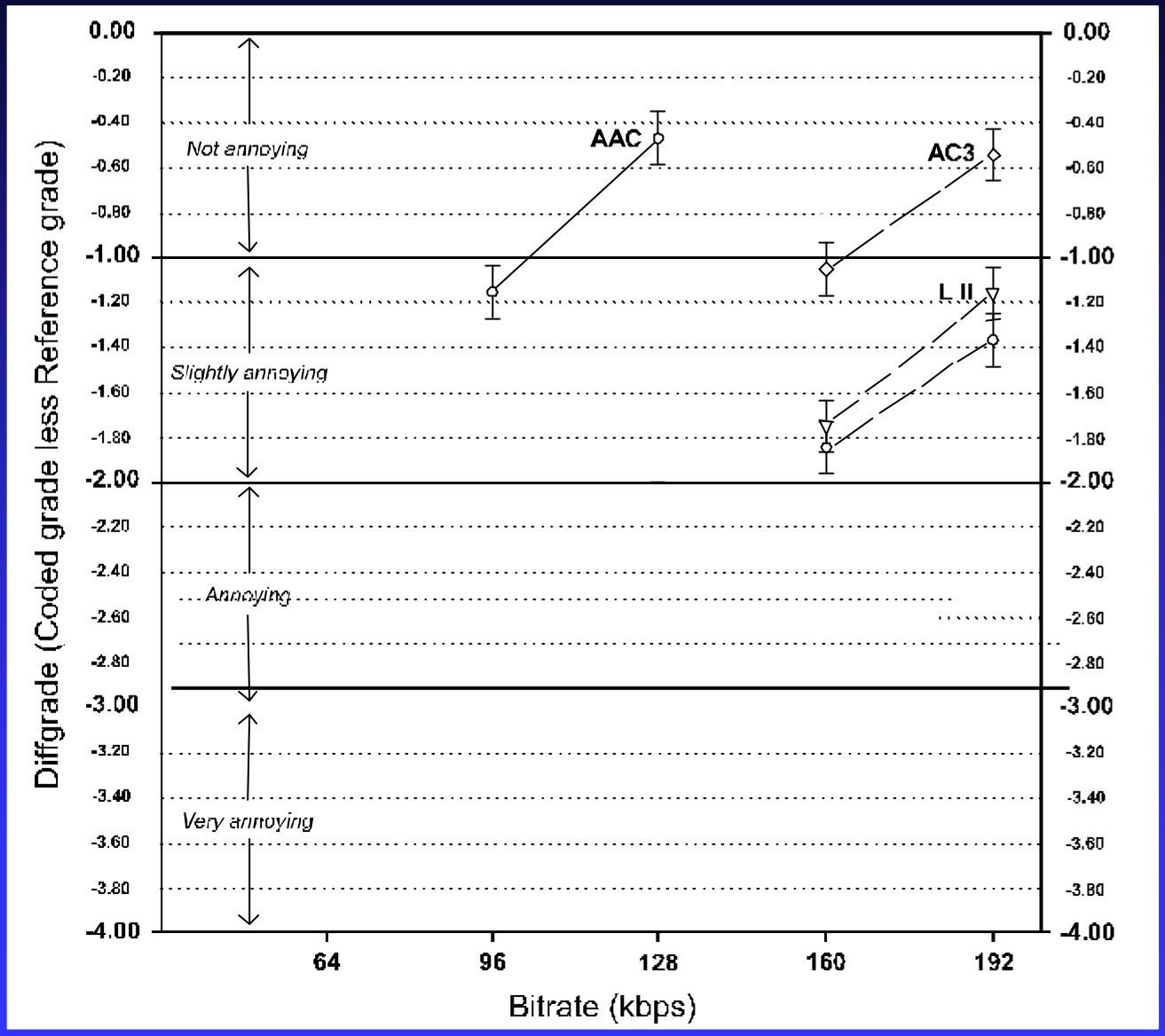
MPEG-2 AAC Technology

- MPEG-2 standard (part 7)
- Developed after Dolby, AT&T showed that non-BC codecs could offer higher performance than the BC Layer II standard
- Main contributions from 4 partners
  - AT&T, Dolby, Frauenhofer, Sony
  - Dolby administers the patent licensing
- Higher performance & complexity than other codecs

MPEG-2 AAC Adoption

- Basic in ISDB system
- Employed in internet audio, solid state audio players, some digital radio
- Used for mono, 2ch stereo
  - not yet applied to 5.1 ch
- Growing presence in music delivery marketplace
  - But no presence in home video (yet?)

Audio Quality (CRC test)



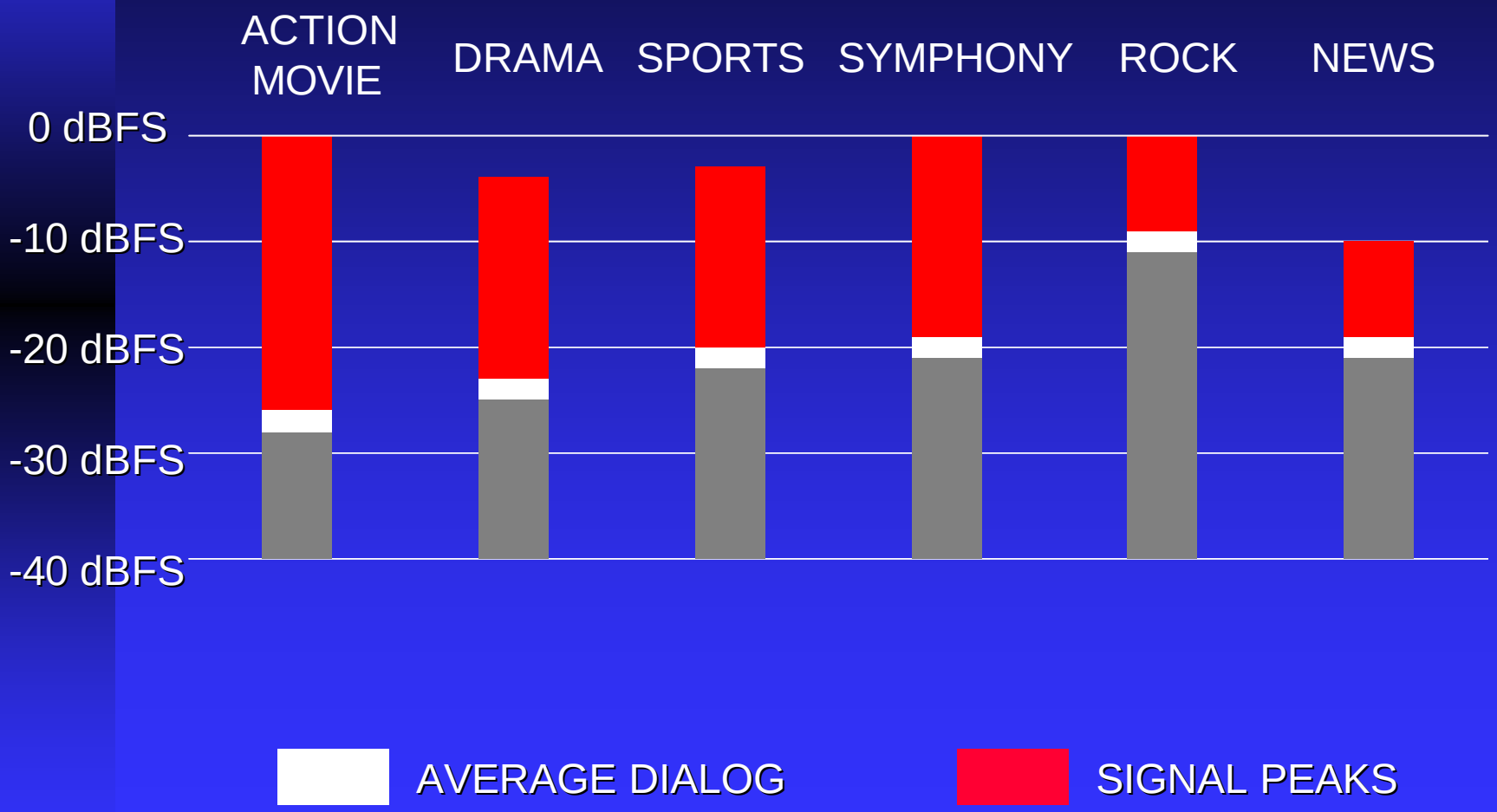
Bit rate for high quality 5.1 ch

- MPEG-2 Layer II
  - 640 kb/s
  - 448 kb/s (average - with variable bit rate)
  - no significant commercial usage
- Dolby Digital (AC-3)
  - 384 - 448 kb/s
  - extensive usage in DVD, LD, DTV
- MPEG-2 AAC
  - 320 kb/s
  - no commercial usage (yet)

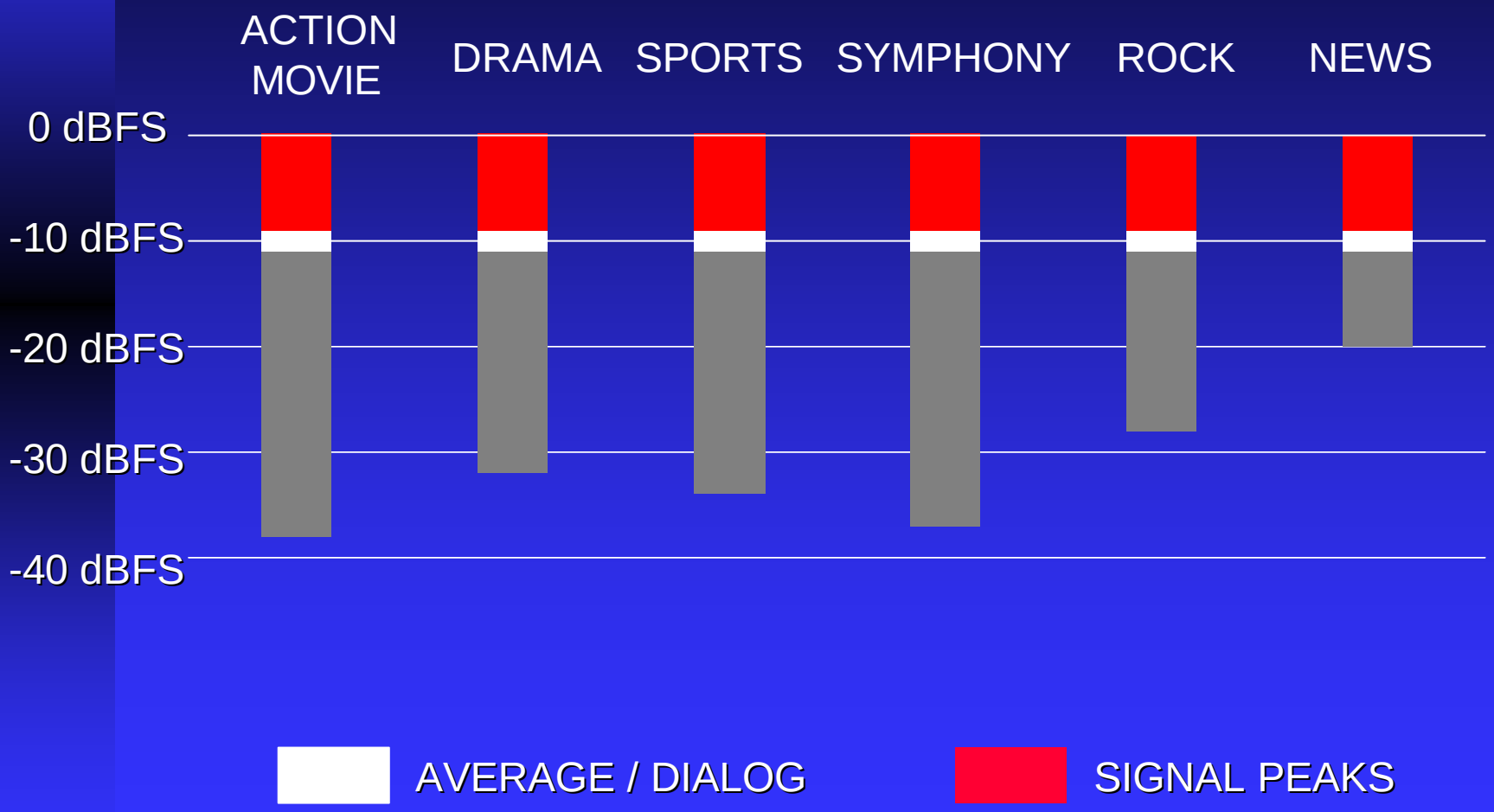
Important Consumer Features

- Level control in the decoder
  - Achieve uniform loudness / Avoid level changes:
    - between program segments
    - between channels, signal sources
- Dynamic range control
  - Capability to deliver both:
    - wide dynamic range for audio enthusiast
    - narrow dynamic range for general listeners
- Downmixing
  - Serve mono, 2 ch and 5.1 ch listeners with the same bit stream

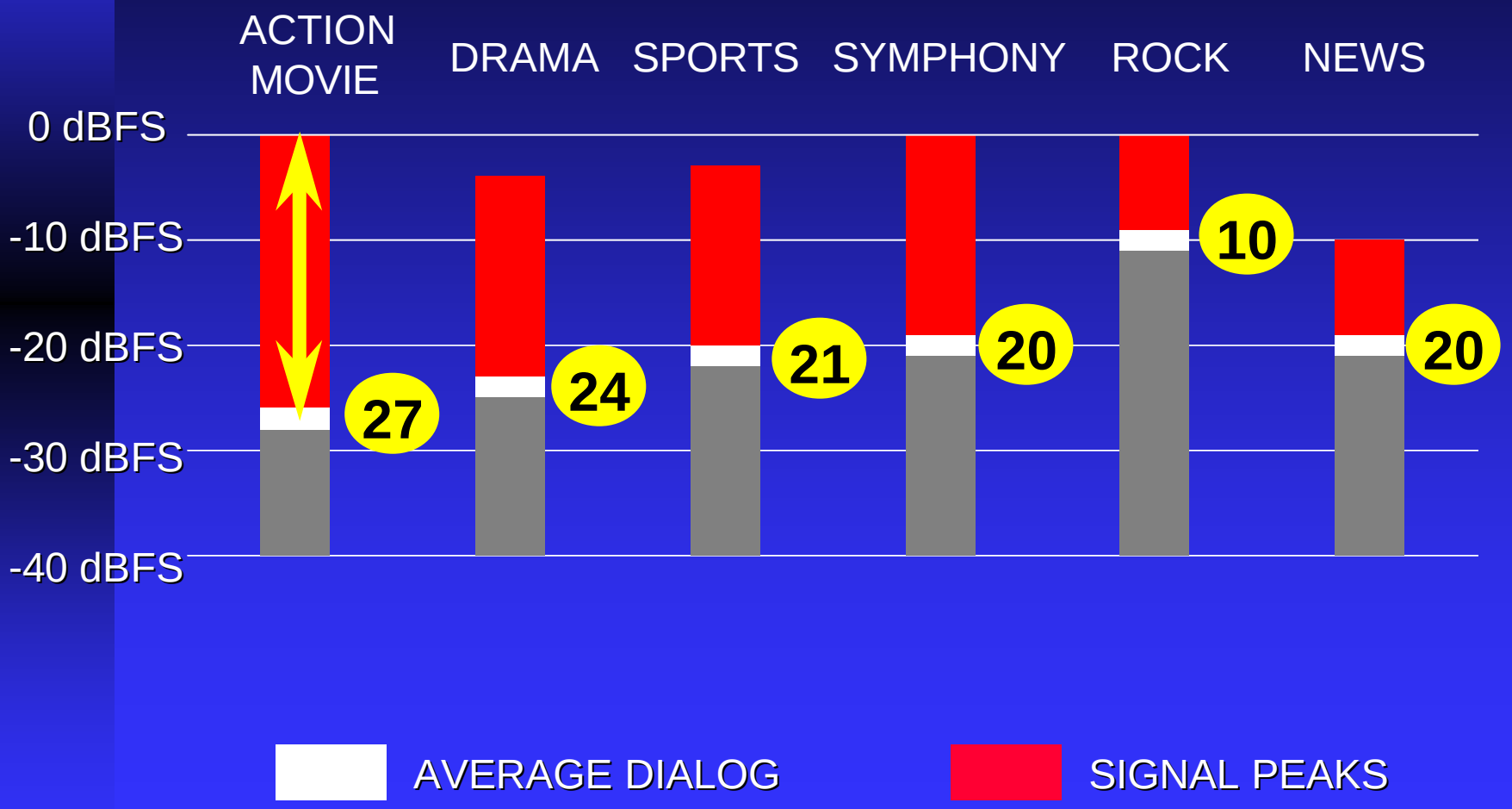
Typical audio signals



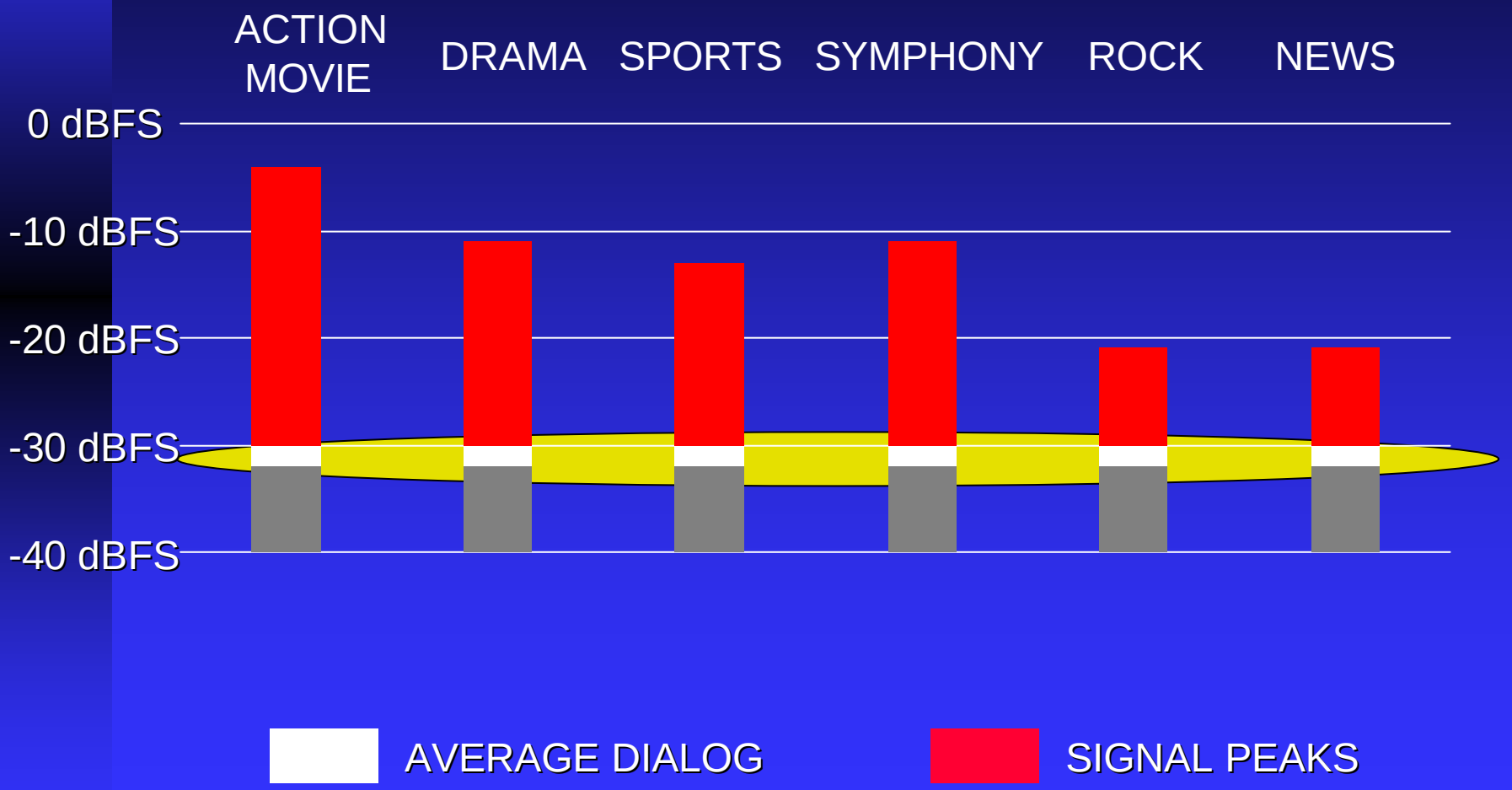
How we broadcast audio today



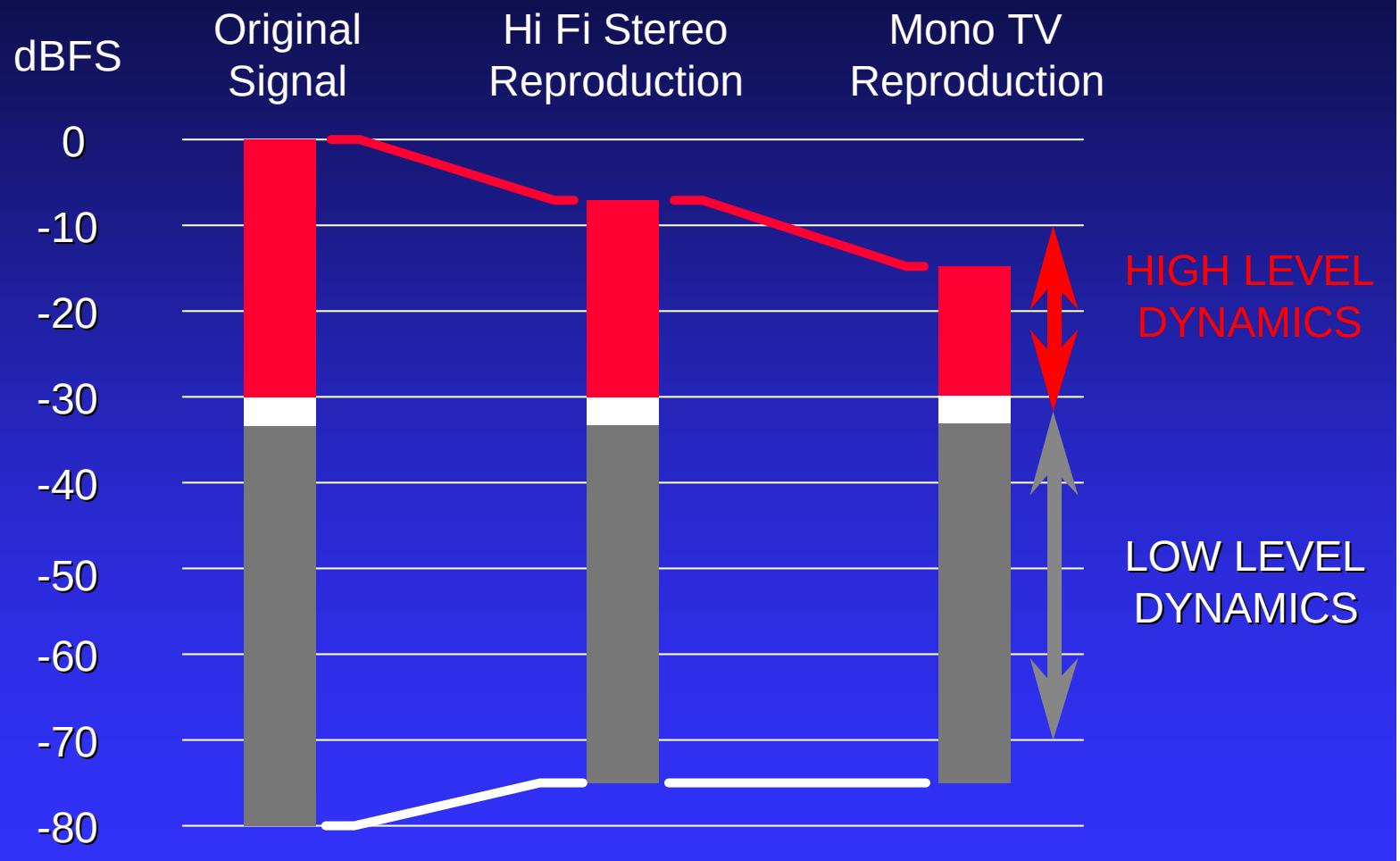
Typical audio signals



Normalized audio signals



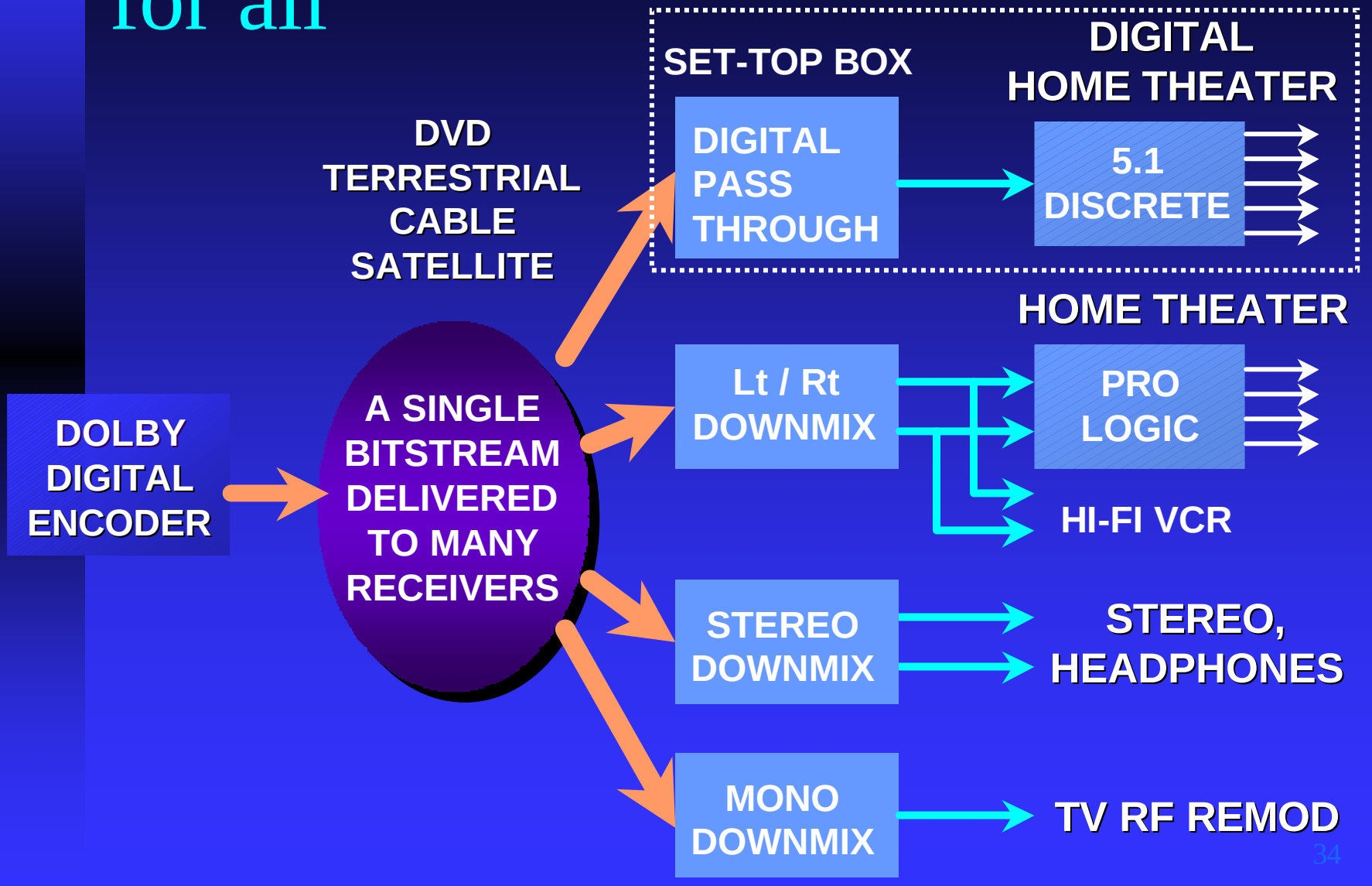
Dynamic range control



Downmixing

- Optimize downmix at decoder
  - Mono compatible
  - Surround compatible
- Match level between 2ch and 5.1 ch content
- Avoid clipping / overload of downmix
  - 14 dB buildup in level of mono downmix!

Downmixing: One Bit-stream for all



Implementation Status of Consumer Features

- Dolby Digital (AC-3)
  - First system designed to include these features
  - Universal implementation
- MPEG Layer II
  - Dolby Digital feature set recently copied and documented in ETR-154 Annex D
  - Negligible implementation
- MPEG-2 AAC
  - Some specifications to enable in specification
  - Negligible implementation
  - No coordinating entity to ensure consistency

Licensing for MPEG Layer II

- Layer II
  - Basic patent only license for CE manufacturers
  - No support with know-how

Licensing for AC-3

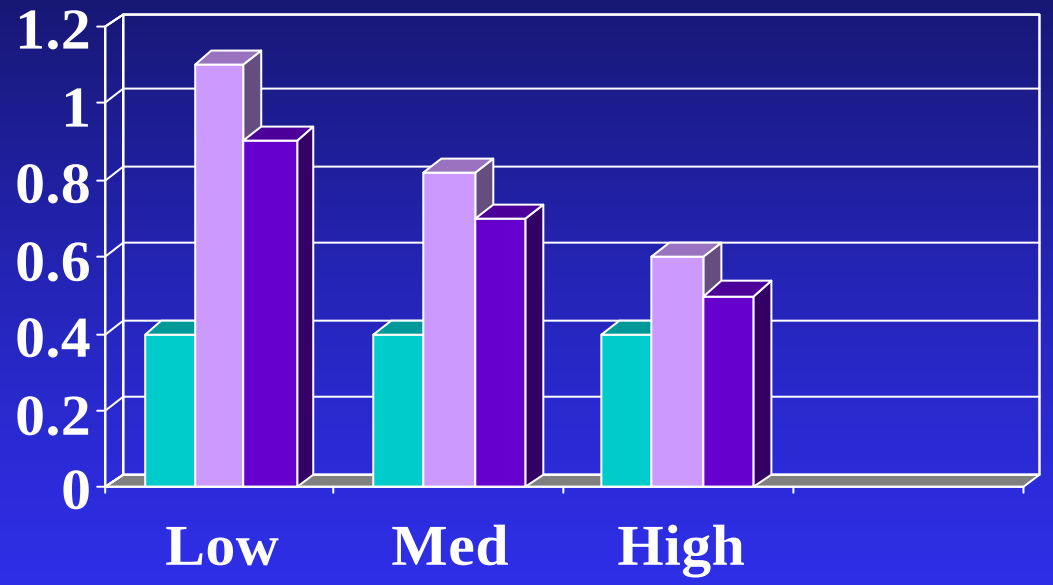
- Patent plus know-how license for CE manufacturers.
  - No royalty on IC's
  - Reference code provided
  - Comprehensive design manual
- Extensive support of licensees
  - Support during design phase
  - Test and verification of all product models
  - Visit licensees twice per year

Licensing for AAC

- Basic patent-only license issued by Dolby
  - For patents owned by AT&T, Dolby, Frauenhofer, Sony
- Know-how can be purchased for an extra charge
  - Dolby will offer a know-how package
  - Dolby support for AAC will not be as extensive as Dolby support for AC-3
    - Due to relative market sizes

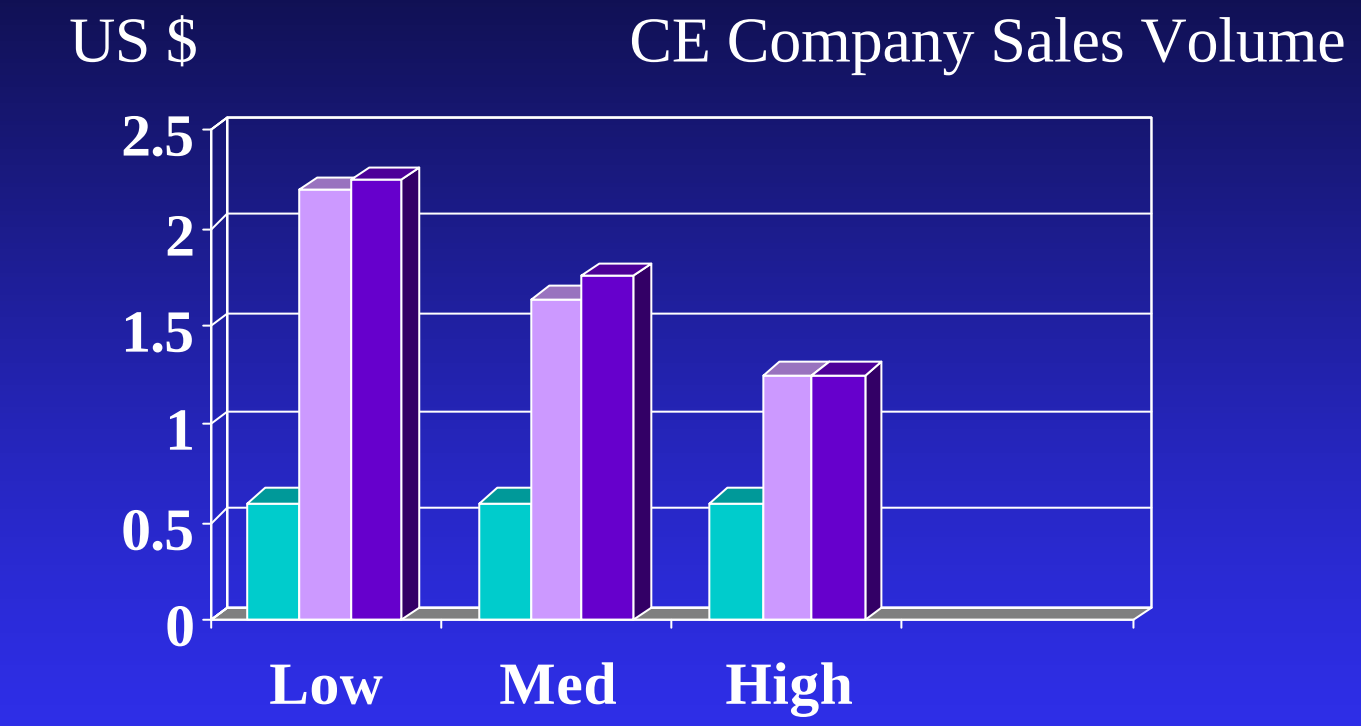
License fees - 2ch product

US $ CE Company Sales Volume

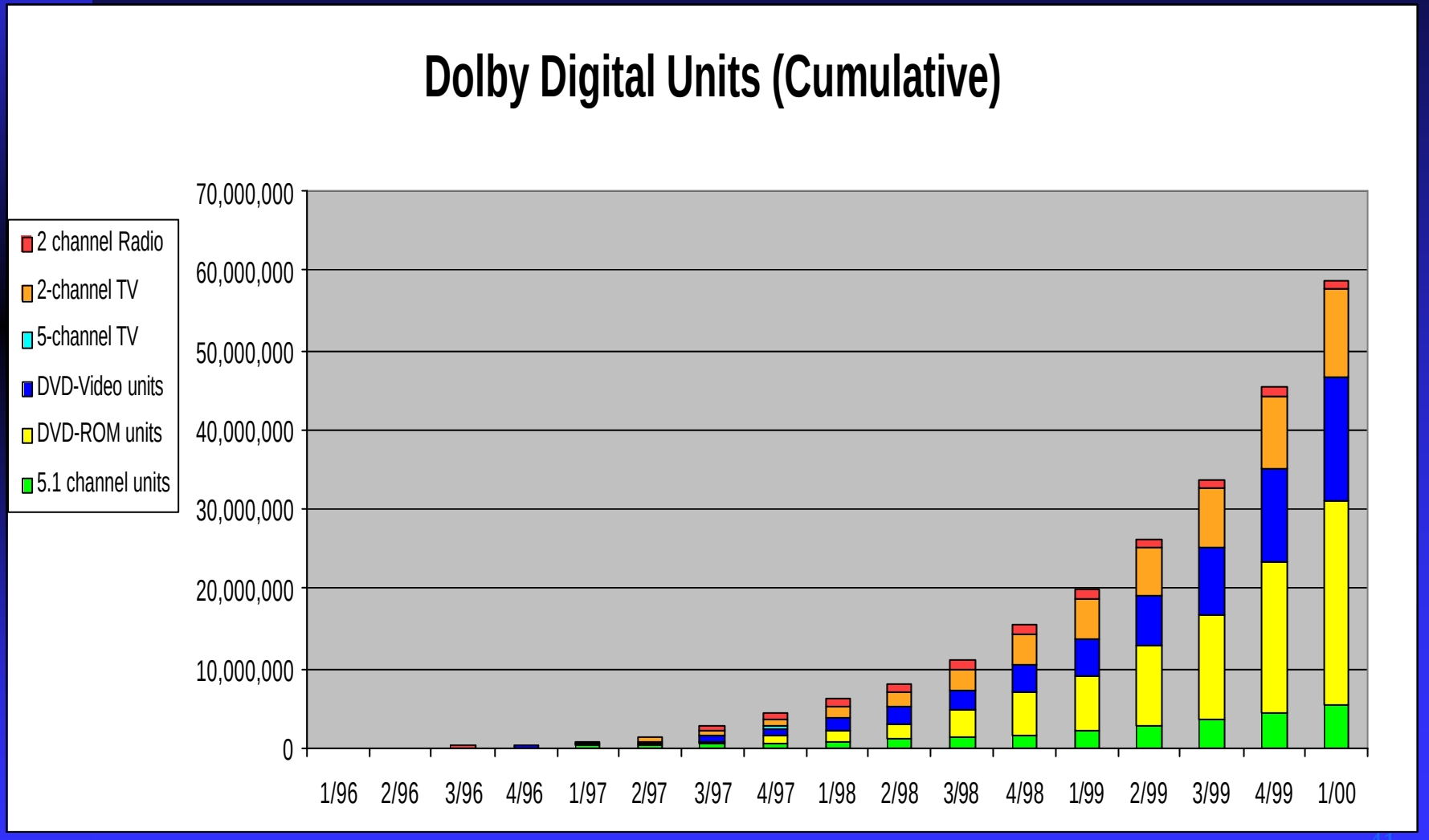


- Layer II (patent)
- AC-3 (patent+knowhow)
- AAC (patent)

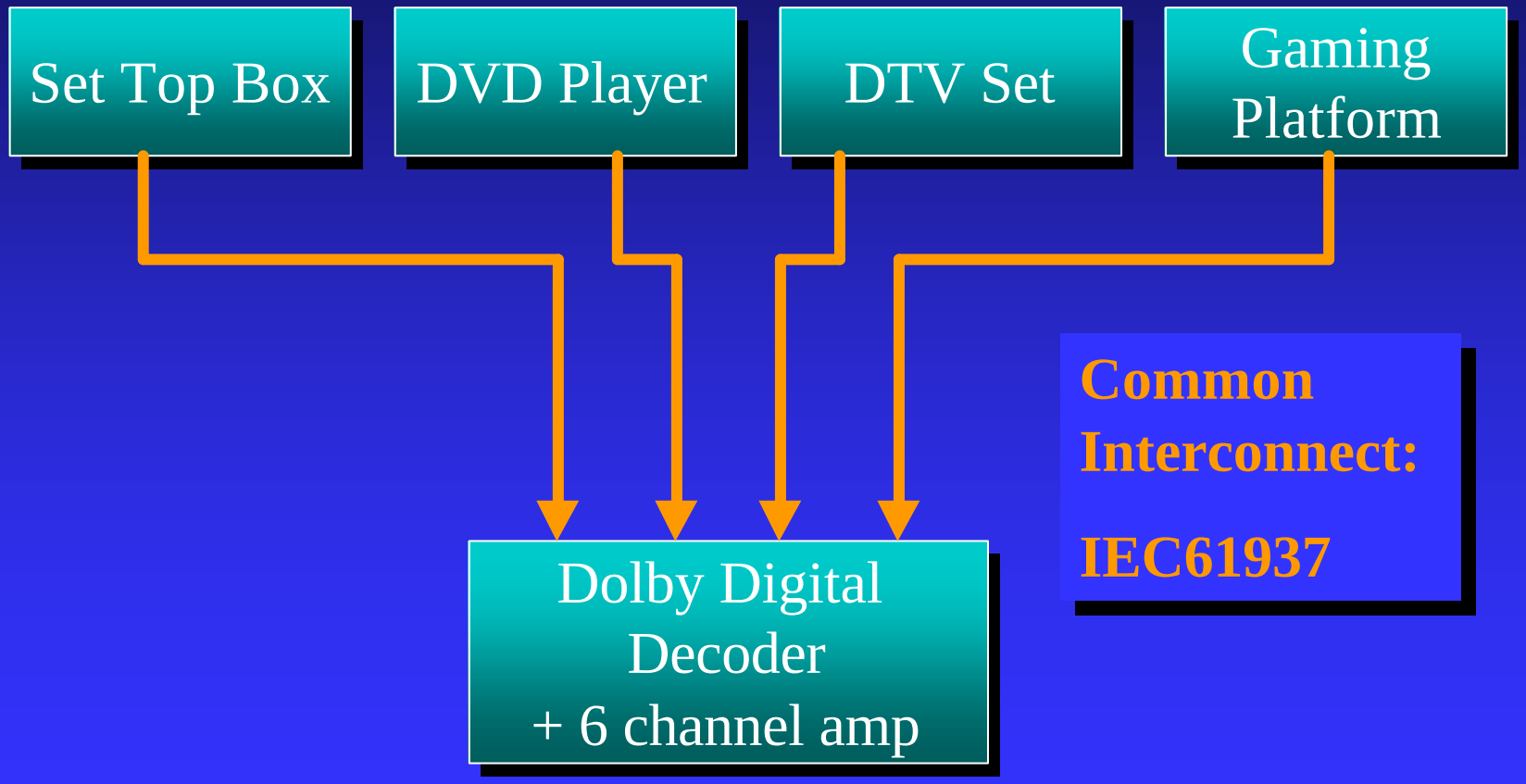
License fees - 5.1ch product



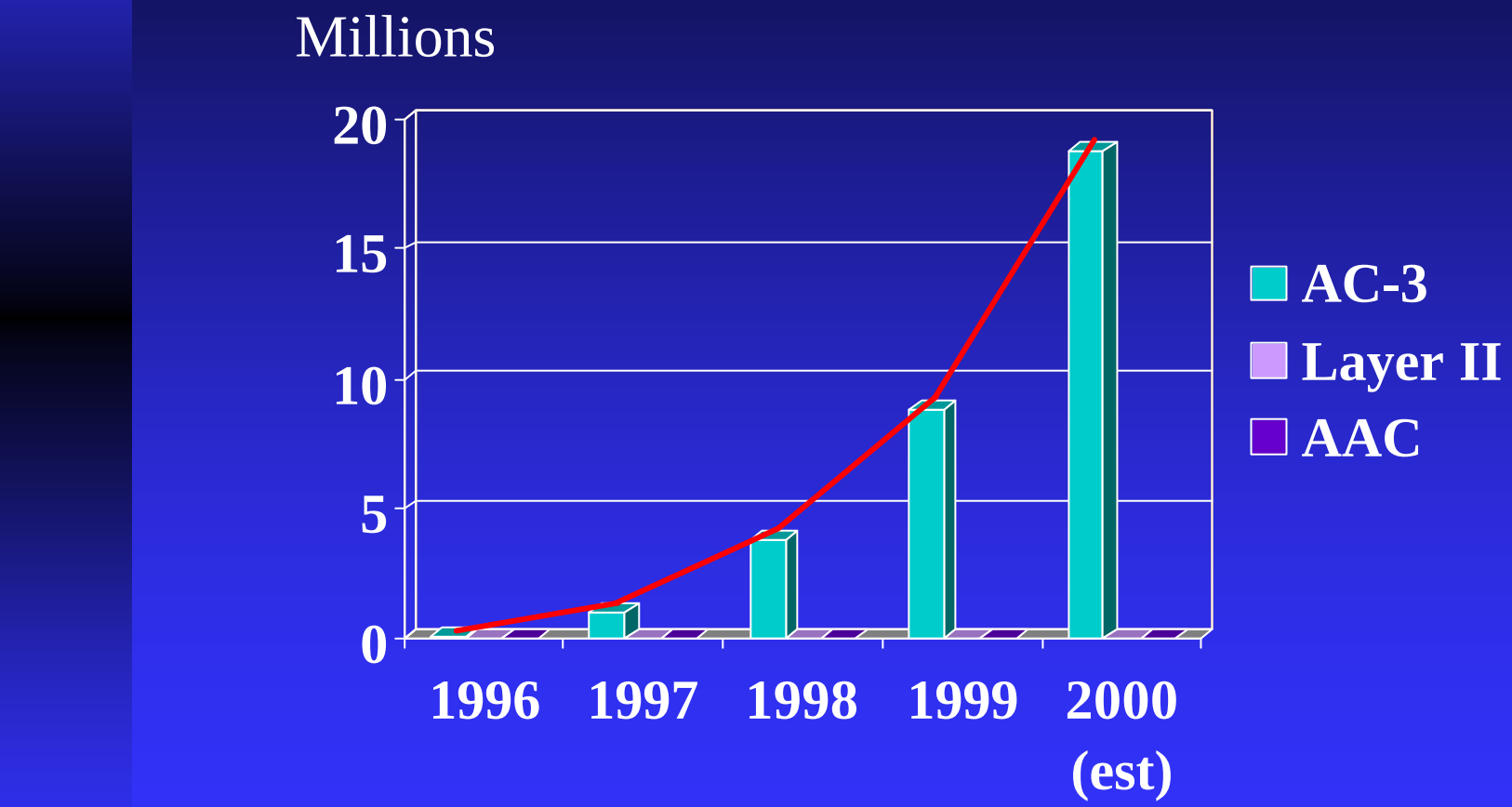
Dolby Digital Marketplace



Dolby Digital at home



Growth in 5.1 ch Dolby Digital A/V Receivers - Cumulative



DVD players with Dolby Digital

Full 5.1 ch Dolby Digital receiver

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Dolby Digital in a box

Major considerations for selection of audio coding for DTV

- 5.1 channel audio is ***very important***
  - the future of audio is surround
  - AAC and AC-3 score better than MPEG LII
    - Based on technical attributes and market success
- Compatibility with other 5.1 ch media (DVD)
  - AC-3 scores best
  - MPEG Layer II has failed in 5.1
  - AAC - ???? (perhaps)

Is AAC a viable 5.1 ch solution ?

- Only current likely application for 5.1 ch AAC is ISDB in Japan
- The market for 5.1 ch AAC products must be substantial before AAC is well supported
  - Limited application areas of 5.1 ch AAC
  - Subset of any market uses 5.1 ch vs 2ch
  - Unclear if 5.1ch AAC will reach ‘critical mass’
- Dolby will provide some support for AAC 5.1 ch
  - but much less than the support we give AC-3 (due to relative market sizes and generated revenue)

Logical Conclusions

- AAC is the best “technical solution”
  - Coding efficiency
- AC-3 offers best balance of all factors
  - Cost
  - Complexity
  - Support
  - Interoperability
  - Consumer recognition and acceptance

Audio in DTV Systems

- ATSC
  - Dolby Digital (AC-3) is sole audio solution
- DVB
  - Layer II 2ch stereo mandated
  - Option to include AC-3
- ISDB
  - AAC mandated
    - Could be modified to include AC-3 as alternative

Conclusions and Recommendations

- A DTV system should be able to offer 5.1 ch audio (even if transmissions start with stereo or mono)
- From a 5.1 ch audio viewpoint:
  - ATSC with AC-3 is a solid choice
  - DVB with the AC-3 option is a solid choice
    - Important to mandate this option in all receivers to avoid wasting bits on MPEG-1 simulcast
  - ISDB with AAC is a unknown
    - Risk could be eliminated by specifying ISDB with AC-3

Don’t forget the audio

Audio Systems for DTV

Thank You

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