

Submission by:

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**Digital Terrestrial Broadcasting in Hong Kong
A Consultation Paper**

Submitted to:

Information Technology and Broadcasting Bureau

The Government of the Hong Kong Special Administrative Region

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Prologue

- 1.1 Dolby Laboratories welcome the proposal of Dolby AC-3 as the chosen audio format for digital terrestrial television in Hong Kong.
- 1.2 Dolby Laboratories support the view that the correct selection of an audio format is important for the future of digital television.
- 1.3 Dolby Laboratories support the view that multichannel, 5.1-channel sound is a requirement for any digital television system.
- 1.4 Dolby Laboratories welcome the opportunity provided by the Information Technology and Broadcasting Bureau to file information to support the proposal of Dolby AC-3 and demonstrate the benefits of the Dolby AC-3 system.
- 1.5 Dolby Laboratories has been involved in many decisions regarding digital television worldwide and welcome the opportunity to address key issues in light of these experiences. We would therefore like to examine aspects of the AC-3 technology which may be misunderstood by various sectors of the industry that have interests in digital television legislation.

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2. Preface

- 2.1 Dolby AC-3 technology is currently used in over 84 Million consumer products. This includes over 16 Million set top boxes for digital television applications, and over 25 Million DVD players¹.
- 2.2 Dolby AC-3 (consumer name Dolby Digital) is a 5.1-channel² discrete audio encoding/decoding technology, developed by Dolby Laboratories. It has become the sound standard for virtually every new digital consumer format, including Digital Versatile Disc (DVD), digital cable, and digital broadcast television. Dolby AC-3 sound technology allows six discrete channels of audio to be stored or transported with lower data rate than a single channel of audio found on traditional compact discs.
- 2.3 Dolby Laboratories firmly believes that the future of the audio portion of the “entertainment” package is surround sound - there is no other direction for audio to go from here. The first generation was the Dolby Surround system that continues to be a commercial success³. The next generation of surround sound is Dolby AC-3 as used in DVD, PC computers, games consoles and digital television (DTV). Dolby multichannel sound is helping to sell DTV.

*"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 multichannel surround sound (said by more than a few experts to have been responsible for selling more large-screen televisions than any other technological advance since colour)."*⁴

- 2.4 Dolby Laboratories firmly believes that provision for 5.1-channel audio is essential in any new audio consumer delivery format. The broad consumer acceptance of 5.1-channel audio in DVD-Video, DVD-Audio, Games Consoles and PC's means that new technologies without 5.1 audio will be perceived as lower quality. This perception will slow the consumer acceptance of that technology.
- 2.5 The AC-3 technology was first standardized by the ATSC. Since then, AC-3 technology has become an international ITU-R standard, and Dolby has made the customary commitment to ATSC, ITU-R and DVB concerning open and fair licensing. At the request of broadcasters in Australia and other countries, the DVB Project incorporated AC-3 technology into the DVB Standard. Equipment with AC-3 decoders and DTV transmissions with AC-3 audio (including transmissions without MPEG audio) are fully DVB compliant.⁵ The cost of AC-3 decoder circuit implementations is currently low, and is rapidly becoming negligible as decoder chips become more highly integrated. The royalty cost of AC-3 decoders is modest. Product manufacturers (Dolby licensees) and

¹ Source <http://www.dolby.com/stats>

² 5.1 audio provides for five full range audio channels, designated as left, center and right front channels and left and right surround channels. A sixth channel, known as the “.1” carries dedicated low frequency information.

³ Currently over 52 Million products have been sold that incorporate Dolby Surround technology. Source <http://www.dolby.com/stats>

⁴ Quote from The Business Of Digital Television by Chris Forrester, the noted analyst on DTV:

This is taken from page 7 of chapter , sample chapter at <http://www.bh.com/bookscat/samples/0240516060/0240516060.pdf>

⁵ Section 5 of this document explains this in more detail

consumers using end products with AC-3 technology receive good value for the modest royalty expense.⁶

- 2.6 Dolby Laboratories conceives, designs, develops and deploys audio signal processing products and technologies. The company manufactures professional audio equipment for the motion picture, broadcasting, and music recording industries. Dolby also licenses audio signal processing technologies for a wide variety of entertainment applications in the consumer electronics and computer industries. Providing the best possible audio for any entertainment environment, including music, movies, television and multimedia, is Dolby Laboratories' principal mission. The privately held company is headquartered in San Francisco, with offices in New York, Los Angeles, Shanghai, Beijing, Tokyo, and European headquarters in England.

⁶ Section 6 of this document explains this in more detail

3. Comments on the Consultation Paper

- 3.1 **Section 4.13** As discussed in section four of this submission, the Dolby AC-3 system was designed to delivery stereo and mono sound as well as 5.1 multichannel sound. Whereas the most impressive audio experience comes from 5.1 channels, there are no limitations or compromises within the Dolby AC-3 system when transmitting stereo or mono. Out of any audio system in use today for terrestrial digital television, AC-3 provides the best performance when transmitting stereo or mono signals. Dolby AC-3 is also the only format used for 5.1-channel audio broadcast worldwide.
- 3.2 **Section 4.14** As discussed in section six of this submission, the growth of Dolby AC-3 technology in broadcasting and consumer applications has increased the numbers of chipsets supporting Dolby AC-3 audio decoding. Most new receiver designs incorporate these chipsets so there has been an increase in the number of DVB receivers incorporating AC-3 audio decoding. Consumer demand in DVB regions has further stimulated demand for DVB receivers with Dolby AC-3 decoding. For example, following the launch of a DVB-S service in Germany (ProSieben), DVB-S receivers incorporating Dolby AC-3 decoding have been developed.⁷
- 3.3 In 525 line DVD players and US terrestrial and cable television AC-3 audio decoders are used, leading to an even greater assortment of chipsets capable of supporting MPEG-2 video and Dolby AC-3 audio. Since all applications of HDTV specify the use of AC-3 (e.g. ATSC, DVB-T in Australia), all chipsets designed to decode MPEG-2 MPHL video include AC-3 audio.
- 3.4 **Section 4.15** Dolby Laboratories agrees with the conclusion that to transmit both Dolby AC-3 and MPEG-2 formats is not a favorable option. However, we respectfully submit that it is not *'a more flexible option... to require that audio signals are encoded in both Dolby AC-3 and MPEG-2 formats'*. Our experience has shown that it is more complex for the broadcaster to transmit both audio formats due to the increase in spectrum required for audio broadcast (as written in section 4.15). The consequence is that the broadcaster loses flexibility in their usage of that spectrum. The broadcaster will also require additional transmission equipment at additional cost.
- 3.5 Spectrum inefficiency increases as more audio services are included, for example multiple languages or services for disabled viewers.
- 3.6 The consumer can suffer if both audio formats are required for transmission. There is the danger that receiver products could enter the marketplace with only one audio coding technology included, causing confusion, and receivers that include two audio formats will incur additional and unnecessary patent royalty costs that must be borne by the consumer.
- 3.7 Dolby Laboratories also contend that the choice of audio system is not influenced by the use of *'television programs originally encoded in the MPEG-2 format'*. The final transmission audio format is not dependent on any preceding audio coding system. Normal television practice is to decode any encoded audio when it is received at the television station. For subsequent transmission the appropriate audio encoder is used depending on whether the signal is transferred to analogue television transmitters, digital

⁷ Attachment 1 describes the launch of the ProSieben service. An example receiver can be found at, http://www.panasonic.de/produkte/de/download/features_30.pdf

television transmitters, for contribution to another network provider or even streaming through the Internet.

- 3.8 **Section 4.16** This option replicates the audio decoding requirement of DVD players in 625 line (PAL) countries. Whilst providing the most flexible system for broadcasters, history shows that the marketplace, both consumers and content providers, have chosen to use Dolby AC-3 sound where possible. The consequence for the DVD player, for example, is that the MPEG decoder, though fully implemented, is not used.

4. AC-3 Multichannel Audio Technology

4.1 Dolby AC-3 as used in DTV applications has been designed as a *delivery system* for audio to the consumer's home. As a result certain key features were designed into the system.⁸

- High sound quality
- Ability to carry multichannel audio
- Superior delivery of mono and stereo audio
- Scalable receiver design using a feature called downmixing⁹
- Low cost receiver implementations for stereo and mono receivers
- Simple upgrade path from mono and stereo to multichannel audio for consumer and broadcaster, creating a future proof system
- Guaranteed performance of consumer equipment through Dolby Laboratories testing program
- Optimization of audio presentation for each consumer receiver
- Control of loudness of programs in the consumer decoder
- Ability to improve audio quality through upgrades to the encoder whilst retaining compatibility with all existing decoders

4.2 Therefore, Dolby AC-3 is not simply a delivery "pipe" for audio signals: it is a comprehensive audio entertainment delivery system wherein one encoded bit stream simultaneously provides for optimized audio reproduction in listening scenarios that span the range from the monophonic television receiver to the multichannel home theatre. The AC-3 system includes an extensive set of sound control features that constitute solutions to the real problems of optimal sound reproduction in diverse consumer listening environments. The system features provide the means to normalize variations in loudness between programs, to optimize reproduced dynamic range e.g., in quiet versus somewhat noisy listening environments, and to optimize reproduction with different configurations of loudspeakers (e.g., from mono to multichannel sound). These features provide solutions to practical problems such as the "loud commercial" problem, so that objectionable variations in loudness when changing programs will no longer occur.

4.3 These features allow for the superior delivery of stereo and mono audio. Some receiver products may include both RF and line level audio outputs. The dynamic range¹⁰ available via the RF output is small. Audio systems without AC-3's control features require that all broadcast audio be tailored to this reduced quality output, limiting the dynamic range that can be broadcast for all listeners. However, the dynamic range control in Dolby AC-3 allows a wider dynamic range to be transmitted suitable for the line level outputs and the decoder will reduce the dynamic as required for the RF output. This idea has not been implemented in any other audio coding system.

⁸ Dolby Digital: Audio Coding for Digital Television and Storage Applications by Steve Vernon presented at the AES 17th International Conference on High Quality Audio Coding provides an in-depth overview of these features.

⁹ Downmixing involves reproduction of *all* of the artistic content of the "N" channels in the transmitted multichannel program, where N for a modern motion picture film might include five full-bandwidth audio channels, using just two (stereo) or one (mono) loudspeaker.

¹⁰ Dynamic range describes the difference between the loudest and quietest sounds.

Low cost 2-channel receiving products

- 4.4 Dolby AC-3 is not just for the home theater enthusiast! The scalable design of Dolby AC-3 allows a cost effective, high quality mono and stereo presentation from consumer product whilst providing the ability for the consumer to upgrade to 5.1 channels in the future. As a result, these products, known as 2-channel products make up a large proportion of Dolby AC-3 consumer products.
- 4.5 These products provide wider dynamic range than conventional TV sound as well as the normalized loudness level through the use of the system features described previously.
- 4.6 A digital output is included for connection to a home theater system to allow the consumer to upgrade to a home theater system in the future. Importantly this output is compatible with the 8 Million home theater decoders¹¹ that exist today without requiring any changes to the transmitted audio or the receiving product (such as a set top box).
- 4.7 The alternative proposal for DVB audio is the MPEG-1 audio technology which was originally designed to provide a pipe for two audio channels. With MPEG-2 audio, this pipe was extended to be multichannel, but with the constraint of backwards compatibility with the earlier 2-channel MPEG-1 system. This restriction imposes a devastating compromise in performance that prevents MPEG-2 audio from matching the audio performance of AC-3 audio at comparable, practical bit rates. The performance benefits of AC-3 have been underscored in every critical listening test of the two systems—this includes comparisons performed by the U.S. Grand Alliance, MPEG, ARIB (Japan, formerly BTA), the European Broadcasting Union (EBU), and the Canadian Research Center (CRC).

Worldwide Trends

- 4.8 The audio quality delivered by AC-3, the compelling feature set, the availability of a multitude of cost-effective consumer decoders, and the high level of applications engineering support provided by Dolby Laboratories to build a robust, supporting infrastructure have led to widespread adoption of AC-3 for applications including:
- DVB¹²
 - DVB-T Digital television in Australia and Singapore¹³
 - DVB-S and DVB-T Digital television in Europe
 - DVD in all regions
 - ATSC digital television in the US, Taiwan and Korea
 - U.S. digital cable television
 - Computers and games consoles (e.g. Sony PS2)
 - LaserDisc
 - U.S. direct broadcast satellite including DirecTV, and Echostar
- 4.9 The decision to use AC-3 audio by the Information Technology and Broadcasting Bureau should not be dependent on the choice of digital TV system as AC-3 is standardized in both the DVB and ATSC specifications.
- 4.10 Dolby AC-3 is suitable for both high definition (HD) and standard definition (SD) video applications. AC-3 is the only audio format that has been paired with high definition

¹¹ Source <http://www.dolby.com/stats>

¹² Attachment 2 describes the adoption of Dolby AC-3 within the DVB standard.

¹³ Attachment 3 describes the adoption of Dolby AC-3 for digital broadcasting on Singapore.

(HD) video. The majority of applications using AC-3, however, have been with SD video for example DVD, DVB, U.S. digital cable, Laser Disc.

- 4.11 The adoption of AC-3 for DVD applications *worldwide* is an interesting case to explore further. Initially it was thought that the NTSC television world would adopt AC-3, while the PAL television world would select MPEG audio. The initial DVD specification specified AC-3 for the NTSC (525-line/60 Hz) versions of DVD players, while MPEG audio was specified for PAL (625-line/50 Hz) players. However, multichannel audio became a “must-have” feature for DVD, and the overwhelming advantages of the AC-3 system (i.e., the combination of audio performance, availability of professional encoders, consumer integrated circuit decoders, reference designs and technical support) led to a change in the DVD specification to include AC-3 in the PAL version. This is a good example of the free market choosing the very slight increase in cost/complexity of dual decoding in order to gain the compelling benefits delivered by AC-3 technology.¹⁴ Note that dual decoding was required for the DVD-PAL specification since the initial specification mandated MPEG audio and this created a legacy problem for those few discs that had been issued with only 2-channel MPEG audio. By specifying AC-3 in its initial specification, Hong Kong can avoid the need for dual decoding and the unnecessary expense and complication that this entails.
- 4.12 The adoption of AC-3 within DVB applications *worldwide*, is following a similar pattern to DVD. The DVB standard as originally conceived did not include the possibility of AC-3 audio. Since the standard was revised in July 1999, to include Dolby AC-3, every decision to use DVB for terrestrial broadcast has included Dolby AC-3 audio. This includes Asian markets such as Australia, Singapore and India. As a consequence markets that had already started to use DVB prior to June 1999 have begun the painful process of adding AC-3 to their existing services. Unfortunately for these European countries legacy non-AC-3 capable receivers owned by consumer’s forces broadcasters to continue to provide MPEG-1 audio wasting valuable spectrum.

¹⁴ Excerpts of relevant industry news items (attachment 4) describe then current developments in DVD audio specifications and market reactions.

5. AC-3 Technology – An Open International Standard

- 5.1 AC-3 is an internationally recognized sound coding standard fully documented in ITU-R Recommendation BS.1196¹⁵. The AC-3 technology is readily accessible to product manufacturers worldwide under license, and is widely acknowledged as the pragmatic solution for a host of consumer applications including sound services for digital television.
- 5.2 Dolby Laboratories as a member of DVB agrees to the DVB directive that:
- DVB systems are developed through consensus in the working groups of the Technical Module. Members of the groups are drawn from the general assembly of the project. Once standards have been published, through ETSI, they are available at a nominal cost for anyone, world-wide. Open standards free manufacturers to implement innovative and value added services. It doesn't matter where DVB technology is developed. It is available world-wide*¹⁶.
- 5.3 Dolby Laboratories as a full member of DVB worked within the technical module to add the relative sections to standards to enable the use of AC-3. This work is published by ETSI in TR 101 154¹⁷.
- 5.4 Dolby Laboratories agreed to open and fair licensing policy as required by the ITU (International Telecommunications Union).
- 5.5 Dolby Laboratories as a member of ATSC made the AC-3 specification publicly available and agreed to an open and fair licensing policy as required by that organization.
- 5.6 Dolby Laboratories as a member of the DVD forum made the AC-3 specification publicly available and agreed to an open and fair licensing policy as required by that organization.
- 5.7 As part of the commitment to open and fair licensing of the AC-3 technology, Dolby Laboratories has also publicly stated that there will be no charge to broadcasters, network operators or program suppliers when using signals which correspond to the AC-3 specification.¹⁸
- 5.8 Examples of regulatory and standards setting bodies that have embraced or adopted AC-3 technology for professional and consumer applications in digital television include:
- The International Telecommunications Union (ITU-R)
 - The Digital Video Broadcast Consortium (DVB)
 - The Digital Versatile Disc (DVD) Forum
 - The Digital Audio-Visual Council (DAVIC)
 - The Advanced Television Systems Committee (ATSC)
 - The FCC Advisory Committee on Advanced Television Services (ACATS)
 - The U.S. Federal Communications Commission (FCC)
- 5.9 Effective standards efforts often benefit from creative technical contributions from commercial enterprises. For example, MPEG Layer II audio was largely developed

¹⁵ Available at <http://www.itu.int/itudoc/itu-r/rec/bs/1196.html>

¹⁶ Source is <http://www.dvb.org/about>

¹⁷ Available at <http://www.etsi.org>

¹⁸ Attachment 5 gives evidence of this statement.

through the efforts of three research organizations including Philips (Netherlands), CCETT (France) and the IRT (Germany). In the case of AC-3, Dolby Laboratories was responsible for the research and development efforts. In both instances, however, the technologies were discussed and debated in open standards processes before being finalized, documented and ratified.

5.10 MPEG-2 and AC-3 audio technologies are the subject of international patents held by their respective developers. In both cases royalty-bearing patent licenses are required to practice either of the respective technologies in the marketplace.¹⁹

¹⁹ A copy of the letter from Dolby that underscores Dolby's willingness to license AC-3 patent rights to enable widespread use of the technology in reference to the ITU-R BS.1196 Recommendation is also provided (attachment 5).

6. The Cost of AC-3 Technology

6.1 As is the case with any technology, the substantial benefits of AC-3 are accompanied by some costs. These costs are

- a) the circuitry required in the receiver to decode the AC-3 encoded signal,
 - either as a dedicated audio processing IC,
 - or software code embedded in a single IC capable of audio and video processing
- b) patent royalties paid to the owners of the intellectual property (IP)

Hardware Costs

6.2 Current consumer retail prices for products in Hong Kong which includes the cost of Dolby AC-3 are as low as: DVD players HK\$1000²⁰.

6.3 Like most modern technologies, the cost of AC-3 circuitry started out high, has fallen to moderate levels, and is rapidly trending towards insignificance due to advances in semiconductor technology, increases in production volumes, and the high level of system integration in consumer products. The initial implementation (circa 1991) employed a set of five expensive digital signal processing (DSP) chips in a professional product that initially sold for nearly \$20,000 U.S. Within a few years the AC-3 decoder was implemented on a single DSP chip, and began to penetrate the high-end consumer marketplace in products selling for a couple of thousand dollars. Today there are numerous AC-3 decoder chips in products which themselves sell for less than \$100.²¹

6.4 The results of a study of the basic silicon cost of the AC-3 decoding function are captured in a document originally submitted to the ITU-R²². This study—based on the results of actual chip designs—illustrates that the true silicon cost of a combined an AC-3 audio decoder included on an MPEG-2 video MPML decoder chip is on the order of \$0.24 U.S. today. More importantly, the cost is already trending downward toward a cost of <\$0.10 in the not too distant future.

6.5 Therefore the cost of embedded AC-3 decoders in audio-visual (A/V) and television receiver products, DVD players, and set-top boxes is negligible. Continued systems integration has led to inclusion of the AC-3 decoder function on the same chip as the MPEG-2 video decoder creating ‘one chip solutions’ for DVB receivers and DVD players.²³

6.6 High profile companies Panasonic and Philips, along with other manufacturers, have DVB products containing AC-3 audio chips for use in the European and U.S. markets. These designs would be adaptable for use in Hong Kong.

6.7 As AC-3 is included in the standard for all DVD players and Digital TV systems in use today the growth of AC-3 decoders is expected to continue to rise, with the consequent reduction in cost.

²⁰ Source <http://www.shinco.com>

²¹ Currently over 70 Dolby AC-3 chips have been certified.

²² Document 10C/25-E submitted 14 May 1999 to the ITU and to the DVB technical module.

²³ Attachment 6 reproduces a press release from C-Cube announcing the use of Dolby AC-3 capable silicon in set top boxes. Attachment 7 is a list of some of the available single chip solutions for DTV applications.

Intellectual Property Costs

- 6.8 The other cost issue is that of intellectual property. As with other audio decoders (for example MPEG-2 which is licensed by Philips), there are modest IP costs associated with AC-3 audio. Dolby's license is a comprehensive hybrid license comprising a variety of intellectual property, such as patents, know-how, trademarks, copyrighted works and trade secrets. The licensing program includes an extensive technical support element, including product verification and testing.
- 6.9 Implementations (integrated circuits or software code) are fully tested and verified by Dolby before being released for sale. There are no royalty payments associated with implementations.
- 6.10 Dolby Laboratories as the licensor of Dolby AC-3 have established a sliding scale where royalty payments are based on volume: as production volume increases, the per unit royalty cost decreases. As AC-3 products have reached a high volume of production, manufacturers of mass-market receiving equipment will be paying relatively low incremental royalty costs.
- 6.11 The table below shows the average royalty rate versus volume for a manufacturer who builds only a single type of product: a 2channel decoder.

Table 1: 2-channel products only

Total number of 2ch products per quarter	2 ch product royalty in US\$
5k	4.29
50k	1.72
125k	1.20
250k	0.97
500k	0.86

- 6.12 The major manufacturers of consumer products for the Hong Kong marketplace are already building large quantities of products which include the Dolby AC-3 technology. Since the royalty scale drops with quantity, it is more realistic to consider the incremental royalties due for the incremental increase in quantities resulting from products manufactured by these licensees.

Table 2: Incremental product royalties

2ch products per quarter	2ch product royalty in US\$
25k-125k	0.86
125k-500k	0.74
>500k	0.64

- 6.13 There is no charge for products to provide the Dolby AC-3 digital output for use by external decoders. The royalty charges are only for actual decoding circuits.

Licensing Dolby AC-3

- 6.14 As part of the product royalty Dolby Laboratories provides comprehensive know-how and substantial support to its licensees and the industry²⁴. It is undoubtedly best for all if, with the knowledge Dolby have as the technology developer, Dolby helps the licensee implement the technology quickly, efficiently and correctly. Dolby also test the finished product to ensure that it complies with specifications: the aim is that the product should work as intended and be compatible with everything else that provides or replays Dolby AC-3 audio. An additional and important consequence of this approach is that helps manufacturers get product into the market faster.
- 6.15 There already are 9 licensees based in Hong Kong manufacturing DVD, TV and home theatre products incorporating Dolby AC-3 technology. In addition many international companies whom also hold licenses for Dolby AC-3, such as Philips and Thomson manufacture in Hong Kong. All of these companies are able to utilize the engineering resources of Dolby Laboratories to construct DTV products.
- 6.16 The proposal to include only AC-3 audio benefits the consumer as the royalty burden of MPEG audio is eliminated.

²⁴ An example of this support is Dolby Laboratories Reference Design Qualification Program, more information can be found at <http://www.dolby.com/trademark/co.ot.0012.refdsnqual.pdf>

7. Spectrum Efficiency

- 7.1 Dolby AC-3 operates with superior spectrum efficiency compared to MPEG audio. AC-3 delivers near-transparent stereo audio at a bit rate of 192 kb/s. The MPEG audio coder requires a bit rate of 256 kb/s—33 percent higher bit rate (i.e., poorer spectrum efficiency)—to deliver audio of similar quality²⁵. The spectrum efficiency advantage of AC-3 technology can be leveraged to economic advantage (e.g., data broadcasting). This is especially true if broadcasters are permitted to transmit only AC-3 audio without a requirement to transmit the less spectrum efficient MPEG audio.
- 7.2 While AC-3 delivers a useful gain in spectrum efficiency for stereo audio transmission, the spectrum efficiency of an AC-3 mono-cast (no MPEG audio) becomes overwhelming when multichannel audio is broadcast. Multichannel AC-3 bit streams serve those listening in mono and stereo via downmixing; i.e., there is no need to transmit a separate bitstream for those listeners. If an additional MPEG mono or stereo audio bitstream is also included it wastes spectrum.
- 7.3 In situations where alternative audio services are required, such as multiple languages or services for the disabled, the spectrum inefficiency of transmitting MPEG audio is increased.
- 7.4 Direct broadcast satellite (DBS) services in the U.S. and many of the digital video broadcast (DVB) services in Europe started before AC-3 was available. These broadcast services, of necessity, began with the older MPEG stereo audio. Now that multichannel audio is becoming an important feature,²⁶ these services are adding AC-3 audio in a simulcast mode. Existing services are, perhaps forever, saddled with the efficiency-robbing requirement to simulcast stereo with multichannel sound, because they began operation with MPEG stereo and must keep that original stereo service active so as not to silence early receivers.

²⁵ Source Canadian Research Center (CRC) tests published in the AES Journal

²⁶ The importance of multichannel sound is increasing in the minds of consumers driven by the growth in surround sound systems, home theater and new multichannel delivery formats such as DVD.

8. The Benefits to Hong Kong for Dolby AC-3 as the Audio Encoding Standard

For the Consumer

- 8.1 A high quality sound system comparable to current technology such as DVD. It would not be advisable to offer the consumer inferior performance and feature set compared to DVD. To do so would fail to stimulate as much consumer interest.²⁷
- 8.2 A range of consumer product at a range of prices, due to the scalable properties of the AC-3 system.
- 8.3 Low cost consumer products due to the high volumes of AC-3 products.
- 8.4 Compatibility with existing home theater and TV equipment that already contain multichannel Dolby AC-3 decoders.
- 8.5 A recognizable brand name that provides an assurance of quality supported by an extensive engineering and testing program for consumer electronics manufacturers.
- 8.6 Certainty for the consumer as there is only one, fixed audio format. Therefore, receivers will not be obsolete in the future.
- 8.7 A future proof system with the ability to choose multichannel sound equipment when required.

For the Broadcaster

- 8.8 Superior spectrum efficiency allowing data to be used for applications such as multiple languages, data transmissions and the Internet.
- 8.9 Superior stereo performance. Current television receiver products often utilize both line level connections and an RF modulated interface to connect to televisions or home audio systems. The RF interface can only match the performance of current analogue television practice in terms of levels and the small amount of dynamic range. In MPEG-2 audio broadcasts the line level outputs from the receiver product are also constrained to this small dynamic range as the transmitted audio must also fit the RF output. Dolby AC-3 includes control of the dynamic range in all receivers. This allows a wider dynamic range to be broadcast suitable for the higher quality line level outputs. The decoder uses the dynamic control feature to provide a signal suitable for the RF interface, if required, without compromising the stereo line level outputs. These controls are not available within current MPEG-2 audio encoders and decoders. Consequently MPEG-2 audio must be broadcast pre-compressed, limiting the dynamics to that of existing analogue television, or FM.
- 8.10 A future proof system that can be used for mono and stereo broadcast today and be expanded to multichannel audio as required without needing to upgrade consumers receivers.
- 8.11 When broadcasting multichannel audio there will be no requirement to carry a separate stereo program.

²⁷ Examples of consumer websites supporting multichannel audio can be seen at <http://www.hifistudio17.fi/hifipalsta/cinemasounddigitv.html> and <http://home.online.no/~espen-b/mpeg/audio.html>

- 8.12 Simplicity of transmission and program preparation leading to lower costs, as only one audio service need be provided.
- 8.13 Support from Dolby Laboratories to assist in the production of program material for digital television. For example, Dolby has been providing engineering support for the production of multichannel audio with film in Hong Kong since 1990.
- 8.14 Existing Dolby Digital feature film²⁸ provides a large amount of 5.1 channel audio programming. This allows the broadcaster to begin broadcasting 5.1 content quickly and cheaply.
- 8.15 Support from professional broadcasting technologies such as Dolby E, integrating with Dolby AC-3 transmissions. Major equipment manufacturers such as Panasonic, Sony, Grass Valley Group, Philips, and Tandberg Television all support Dolby E²⁹.

For the uptake of Digital Television

- 8.16 Dolby AC-3 provides high quality multichannel audio, a fundamental requirement of any DTV system.
- 8.17 The flexible nature of AC-3 allows the industry to grow towards multichannel without fear of legacy systems or high cost.
- 8.18 The Dolby brand name provides a known level of quality assurance for the broadcaster and consumer. This is valuable to encourage consumers to realize that digital TV is a better quality service than its analogue cousin
- 8.19 The Dolby AC-3 standard is a major part of the DVD specification (which is predicted to be in 87% of households in Hong Kong by 2005³⁰); failing to meet that specification would not be acceptable for the consumer.
- 8.20 Putting out a confused message by accepting other audio formats would also be unacceptable for the consumer.
- 8.21 Existing feature film allows the broadcaster to begin broadcasting 5.1 content quickly and cheaply, so creating real consumer benefit to digital television early in its development. The ability of DVD video to provide 5.1 channel AC-3 was a major factor in the very rapid adoption of DVD-V by early adopters.
- 8.22 A decision to utilize Dolby AC-3 technology within Hong Kong would be a driver for the local consumer electronics industry. The growth of DTV would promote the sale of televisions and home theater products stimulating local manufacturing.
- 8.23 The use of Dolby AC-3 in products manufactured in Hong Kong allows the use of the Dolby trademark on these products. This is valuable when looking to export these products.

²⁸ To date 3,520 films have been released or announced in the Dolby Digital format. Source <http://www.dolby.com/stats>

²⁹ Source: <http://www.dolby.com/news/dolbynews/0009/m.nw.0009.fallnews.html>

³⁰ Source: Understanding and Solutions, UK

9. Conclusion

- 9.1 Dolby Laboratories welcome and fully support the proposal from the Information Technology and Broadcasting Bureau of the Government of the Hong Kong Special Administrative Region to use Dolby AC-3 as the audio encoding standard.
- 9.2 Dolby Laboratories believes the Hong Kong authorities have, in their proposal, looked to the future by selecting and leveraging the substantial and compelling benefits of AC-3 technology to the greatest economic and technological advantage of the Hong Kong population. AC-3 technology is the ideal choice for Hong Kong terrestrial digital television where a new transmission standard must withstand the test of time by simultaneously serving a broad cross section of evolving consumer and commercial market interests.
- 9.3 The overall implementation cost of AC-3 technology is modest today, and will have a nearly negligible impact on prices of consumer DTV receivers in the long run. AC-3 multichannel audio can benefit those listening with stereo speakers or headphones by use of the system features. AC-3 technology is fully supported by both the DVB and ATSC standards. AC-3 technology delivers improved spectrum efficiency for mono or stereo audio, and significantly improved spectrum efficiency when multichannel sound is broadcast. AC-3 technology offers a valuable, future-proof feature set to consumers and broadcasters alike. And finally, AC-3 technology is the subject of international standards, publicly available and subject to a fair and open licensing policy.
- 9.4 AC-3 is the best audio technology choice for Hong Kong.

10. List of Attachments

No.	Attachment Title/Description	Pages
1	Dolby Press Release: "Pro Seiben is first broadcaster in Europe to transmit Dolby Digital 5.1-channel sound," July 1999.	2
2	Dolby Press Release: "DVB Project Recognizes Dolby Digital as a Digital Audio Standard," July 1999.	2
3	Dolby Press Release: "Dolby Digital selected as a key factor in Singapore's DVB future," June 1999.	2
4	News letters: DVD Intelligence, Feb. 1998, July 1998	1
5	Dolby Letter to ITU-R, patent statement, June, 1995.	1
6	Press Release: "C-Cube Wins With Motorola for European Set-top Box Deployment," May 2000.	2
7	An Example of Single Chip Solutions available for Set Top Boxes including Dolby AC-3 decoding.	1