DTS-HD Audio

Consumer White Paper for Blu-ray Disc and HD DVD Applications

Summary and overview of DTS-HD Audio: data rates, sampling frequencies, speaker configurations, low bit rate and lossless extensions to DTS Coherent Acoustics

Includes Component Connection Diagrams, Logo identification for hardware and media and Professional Audio Features

November, 2006

High Definition Audio

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1.0 Introduction and Overview

This paper is a summary of the current DTS Coherent Acoustics coding system and an overview of the new DTS-HD Audio coding system, a multichannel audio codec optimized for new HD DVD and Blu-ray Disc High Definition optical disc media. DTS-HD Audio is made possible by the emergence of higher-capacity media and higher-performance DSPs, and exceeds the original specification of DTS Coherent Acoustics.

DTS-HD Audio is a scalable audio format with constant and variable bit rates, higher sampling frequencies, additional channels, lossless audio capability, quality-optimized low bit rate operation and a core decoder that is backward compatible with all DTS decoders in use today.

The DTS-HD Audio coding system offers many new features and benefits to consumers, content creators and the professional audio community. For consumers, DTS-HD Audio provides the highest quality audio ever available for home theater, with lossless audio, a bit for bit recreation of the original master recording. It is also the most flexible format, providing compatibility with consumers' existing equipment. In addition, DTS-HD Audio features quality optimized, low bit rate audio decoding for emerging consumer media, such as Internet, satellite and wireless transmission of audio programming.

DTS-HD Audio is an elegant encoding solution that gives content creators and audio professionals a multitude of scalable options to deliver the best possible audio quality every time. It is a flexible audio format that takes full advantage of the available "bit budget", allowing the most efficient use of available disc space. With constant and variable bit rate encoding, DTS-HD Audio maximizes audio quality and allows precise and intelligent control of the bit budget. Professionals will also benefit from the archiving capabilities of DTS-HD, which permits large numbers of lossless audio tracks to be stored as bit for bit retrievable.

2.0 Background

The DTS Coherent Acoustics coding system was introduced in 1996 with the philosophy that coding efficiency can be used to improve quality, and that major parameters should be widely scalable to accommodate almost any application, consumer or professional, with the maximum audio quality possible.

The principles of DTS Coherent Acoustics are described in detail in a White Paper, prepared in June 1999, available at:

www.dts.com/media/uploads/pdfs/whitepaper.pdf

Historically, the first application of Coherent Acoustics on optical disc media was as a 5.1-channel system operating at 44.1 or 48 kHz, 16 - 24 bits, at a 1.5 Mbps data rate. These were the data rates in use for two channels of 16-bit PCM, within which bandwidth DTS was able to offer marked sound quality improvements of 5.1 discrete channels at 20 or 24 bits. Later, in addition to a 1.5 Mbps data rate, a 768 kbps data rate was offered on DVD, the system was extended to include discrete 6.1 capability and a 96 kHz sampling rate, and applications grew to include games and broadcast.

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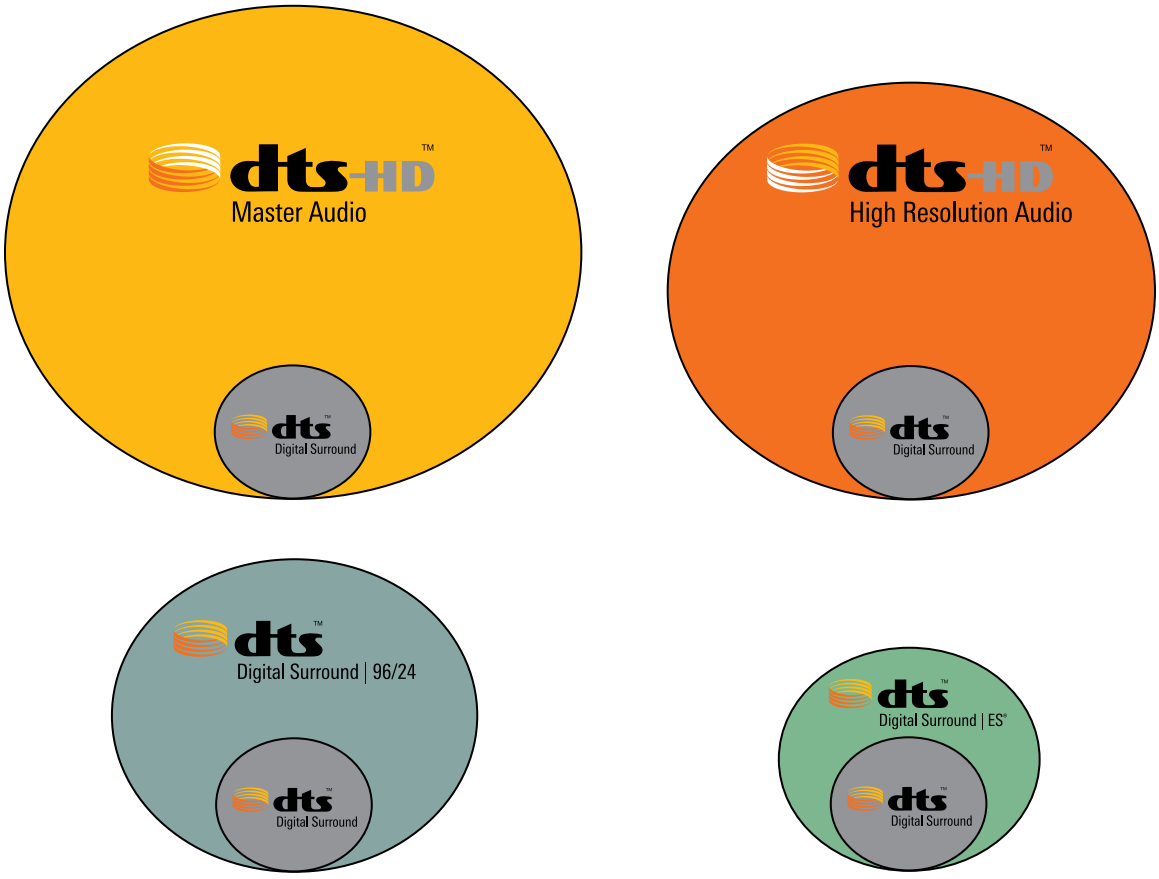
3.0 DTS Core Plus Extension Data Structure

Fundamental to the original DTS Coherent Acoustics system is the core + extension architecture, shown below. It is this structure that ensures full backward compatibility with all decoders, no matter the enhancement, present, or future. Simply stated, the core contains the Coherent Acoustics 5.1-channel 44.1 or 48 kHz data stream, which any DTS decoder can process. Extensions to the core contain other data: additional channels, data for higher sampling rates or enhancements not yet devised. All decoders make use of the core. Advanced decoders make use of the core plus the extension data, which is simply ignored by decoders that cannot use it. Current extensions to the DTS core decoder include DTS-ES and DTS 96/24. DTS-HD Audio adds new extensions to the DTS core, specifically DTS-HD High Resolution Audio and DTS-HD Master Audio, which offer substantially improved audio quality and new features.



4.0 DTS-HD Audio Core and Extension Elements

DTS-HD Audio consists of a backwards-compatible 5.1-channel core (44.1 kHz or 48 kHz sampling frequency) and new coding extensions for improved audio performance and features to support new high definition HD DVD and Blu-ray Disc optical disc formats. The new extensions are as follows:

- XLL Extension for Lossless Audio coding, a bit-for-bit recreation of the original master recording using variable bit rate encoding as high as 24.5 Mbps for Blu-ray Disc and 18.0 Mbps for HD DVD formats

- XXCH Extension for additional channels, beyond 6.1

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- XBR Extension for higher constant data rates, up to 6.0 Mbps for Blu-ray Disc and 3.0 Mbps for HD DVD formats.

- XSA Extension for Secondary Audio/Sub Audio Content, also known as DTS-HD LBR (low bit rate).

The DTS-HD Audio format also supports higher sampling frequencies (up to 192 kHz for DTS-HD Master Audio), multiple bit depths (16, 20 and 24 bits) and various speaker playback configurations, known as speaker re-mapping. (see section 5.2.).

The DTS-HD Master Audio stream can consist of the core decoder plus the lossless audio extension if backwards compatibility is desired. If backward compatibility is not necessary the lossless audio extension can be used with no core. Operation with no core maximizes the efficiency of the stream and minimizes decoder complexity and is appropriate where no backwards compatibility is necessary, such as in professional audio archiving or cinema exhibition. In most cases, however, backwards compatibility with the core and lossless extension is the preferred option.

4.1 DTS Core Only or Core Plus Lossless Extension Encoding Process

In the case of core plus lossless audio extension in a single stream, the audio signal is split into two paths at the input to the encoder. One path goes to the core encoder for backwards compatibility and is then decoded. The other path compares the original audio to the decoded core signal and generates residuals, which are data over and above what the core contains that is needed to restore the original audio as bit-for-bit identical to the original. The residual data is then encoded by a lossless encoder and packed together with the core. The decoding process is simply the reverse. Lossless audio coding is always variable bit rate.

4.2 DTS-HD Audio: Core and Extension Elements in a Single Data Stream

The DTS-HD Audio format consists of a single data stream that carries both core and extension data. A single data stream has many advantages:

1. The first and most important advantage is backwards compatibility with existing DTS decoders. All decoders make use of the core, while advanced decoders make use of extension data, which is simply ignored by decoders that cannot use it.

2. A second advantage is that the encoding workflow is simplified because only one encoding pass is required to generate both core data and lossless extensions, saving time and expense during the encoding process as compared with competing audio formats.

3. A third advantage is that the size of the core + extension data is generally smaller than the combination of a standalone legacy audio track and standalone lossless audio track offered by competing audio formats. With DTS-HD, content creators can encode a lossless encode and a compatible core in a single data stream with very efficient use of disc space.

4. A fourth advantage is that the DTS core itself is capable of very high performance in comparison with competing coding systems.

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5.0 Overview of DTS-HD Audio Technology for Consumers

DTS Coherent Acoustics 5.1-channel surround sound decoding (with two-channel analog output) is a required audio format and DTS-HD Audio is supported as an optional format for both HD DVD and Blu-ray Disc players. Signifying "best in class" technology, DTS-HD Audio supports additional channels, higher data rates and sampling frequencies, multiple speaker configurations and full lossless audio reproduction, a bit for bit reproduction of the original master recording. DTS-HD Audio provides the highest quality audio ever available to consumers, while maintaining backwards compatibility with existing home theater systems.

5.1 DTS-HD Audio Performance

DTS-HD Audio supports three levels of performance based on the capabilities of the home audio equipment used for playback: DTS-HD Master Audio, DTS-HD High Resolution Audio and DTS Digital Surround.

5.1.1 DTS-HD Master Audio Features and Benefits

dts-HD™ Master Audio

DTS-HD Master Audio Features

- Lossless Audio with variable data rates up to 24.5 Mbps for Blu-ray Disc and up to 18.0 Mbps for the HD DVD format
- Up to 7.1 discrete channels with a sampling frequency of 96 kHz and 24 bits of signal resolution
- Up to 192 kHz sampling frequency and 24 bits of signal resolution for 2.0 channels
- Speaker Re-mapping with multiple speaker playback configurations for 7.1 channel systems
- Secondary Audio/Sub Audio Stream for supplemental audio content*

DTS-HD Master Audio Benefits

- Sound Quality Indistinguishable from the Studio Master

New optical discs have far more storage capacity than standard DVDs. This allowed DTS to develop a surround sound format with data rates from 768 kbps to 18.0 or 24.5 Mbps (depending on format) compared to the current highest data rate of 1.5 Mbps on standard DVD discs. This high capacity data stream can deliver Lossless Audio, a "bit-for-bit" recreation of the original recording. The result is 7.1 channels of audio that is identical to the studio master. With DTS-HD Master Audio you will experience movies and music exactly as the artist intended.

- Delivers High-Definition Sound to Match the Picture

DTS-HD Master Audio delivers sound quality that matches the clear and vivid images of high-definition video. New high-definition optical discs deliver five times the resolution of standard DVD and produce images with stunning realism. Incredible sound is needed to complete the high definition experience and DTS-HD Master Audio provides the highest quality multichannel sound possible. Films come alive with sound as lifelike as the picture, and music sounds as real as a live performance.

*Secondary Audio (Blu-ray Disc) and Sub-Audio (HD DVD) is an optional, high-quality, low bit rate format designed for network streaming, broadcast and Internet applications.

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- DTS-HD Master Audio Puts the Listener in the Action

With 7.1 channels of sound, DTS-HD Master Audio immerses the listener in sound and creates a "you are there" listening experience. Using additional left and right side surround channels, it goes far beyond traditional surround sound to create an amazingly realistic and dynamic sound environment that radiates near perfect sound coverage throughout the listening room. Everyone gets a good seat, not just the person in the "sweet spot". With DTS-HD Master Audio, you'll feel like you're in the middle of the movie action or in the studio with your favorite recording artist.

- DTS-HD Master Audio: The Audio Format for Today and Tomorrow

To play the new high definition discs, consumers will need to purchase a Blu-ray Disc or HD DVD player. However, since all DTS products are based on the same core technology, current A/V receivers and home theater systems can decode DTS-HD encoded content. Consumers can confidently play new content with DTS-HD on current DTS capable audio equipment and enjoy high quality DTS Digital Surround, resulting in an immediate improvement in sound quality.

5.1.2 DTS-HD High Resolution Audio Features and Benefits

dts-HD™
High Resolution Audio

DTS-HD High Resolution Audio Features

- Extended High Resolution Audio with constant data rates from 1.5 Mbps to 6.0 Mbps for Blu-ray Disc and from 1.5 Mbps to 3.0 Mbps for HD DVD
- Up to 7.1 channels with a sampling frequency of 96 kHz and 24 bits of signal resolution
- Speaker remapping for 7.1 channel systems
- Secondary Audio/Sub Audio streams for supplemental audio content

DTS-HD High Resolution Audio Benefits

- Sound quality Significantly Better than Current DVD Discs

DTS-HD High Resolution Audio takes advantage of the increased storage capacity of new optical discs to provide sound quality that is virtually indistinguishable from the original. DTS-HD High Resolution Audio is a giant step forward in home audio with constant data rates from above 1.509 Mbps up to 3.0 Mbps (HD DVD) or from above 1.509 Mbps up to 6.0 Mbps (Blu-ray Disc). The result is better dynamic range and wider frequency response so more of the subtle details in a recording can be heard with much greater clarity, accuracy and realism.

- High Resolution Audio for High Definition Video

High definition video is only part of the home theater experience. With DTS-HD High Resolution Audio, the listener is drawn into the movie or concert and becomes part of the experience. You're not just watching the movie or concert, you're in the action, the best seat in the house.

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- Higher Audio Resolution for 5.1 channels and beyond

DTS-HD High Resolution Audio is capable of 5.1, 6.1 or 7.1 channels of audio at much higher data rates than are currently available on standard DVD. Content creators with a limited audio bit budget can select DTS-HD High Resolution Audio to provide very high quality surround sound with constant data rates. Multichannel movie and music discs will deliver sound with much greater detail, clarity and realism than current DVDs in DTS-HD High Resolution Audio and consume less disc space than DTS-HD Master Audio.

• DTS-HD discs are Fully Backward Compatible with all DTS Decoders

With a new HD DVD or Blu-ray Disc player, you can play DTS-HD discs on your existing DTS capable audio system. An existing A/V receiver or system with DTS decoding can play back DTS-HD Master Audio at 1.5 Mbps, nearly twice the data rate of other formats. Legacy audio components will decode DTS-HD encoded content in full DTS Digital Surround at 1.5 Mbps for a compelling surround sound experience.

Due to space limitations of the current DVD format, many DVD movies with DTS sound were encoded at 768 kbps. However, with the introduction of new higher capacity high definition optical disc media, consumers will be able to hear the DTS Digital Surround core at up to 1.5 Mbps, resulting in an immediate and dramatic improvement in sound quality; clearer, fuller and more dynamic sound. DTS-HD audio lets consumers enjoy high-definition audio today, getting the best performance possible from their existing home theater system.

5.1.3 DTS Digital Surround Features and Benefits

dts™
Digital Surround

DTS Digital Surround Audio Features

- The original DTS Coherent Acoustics core decoder with a full bit rate of 1.5 Mbps, nearly twice the bit rate of competing DVD audio technologies.
- Up to 6.1 channels with a sampling frequency of 48 kHz and 24 bits of signal resolution or 5.1 channels at 96 kHz sampling frequency and 24 bits

DTS Digital Surround Audio Benefits

- A Compelling Surround Sound Experience

DTS Digital Surround is the original DTS decoding format that revolutionized home theater audio. Enhanced dynamic range and improved frequency response combine to create an enveloping surround sound experience for movies and music when compared to competing audio decoding technologies available at the time.

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- DTS Digital Surround offers Twice the Data rate of competing DVD audio technologies

Although originally introduced with a data rate of 1.5 Mbps, a 768 kbps data rate was later used to conserve space on many standard DVD movies. With DTS Digital Surround you can enjoy exciting surround sound again at the full data rate of 1.5 Mbps. An increased data rate gives you the best performance from your existing DTS capable home entertainment system.

- Full Backward Compatibility with existing DTS Capable Audio Systems

With a new Blu-ray Disc or HD DVD optical disc player you can enjoy DTS-HD discs on your existing DTS capable audio or home theater system. The new discs will be decoded in DTS Digital Surround at data rates up to 1.5 Mbps data rate for extraordinary surround sound quality.

5.1.4 DTS-HD Audio: Mandatory and Optional Status

		Blu-ray Disc™				HD DVD™			
Logo	Codec Type	Status	Max Channels	Outputs	Audio Max Bitrate	Status	Max Channels	Outputs	Audio Max Bitrate
dts-HD Master Audio	Coherent Acoustics plus HD Bit-for-bit Extensions	Optional	8	8	24.5 Mbps	Optional	8	8	18 Mbps
dts-HD High Resolution Audio	Coherent Acoustics plus HD Extensions	Optional	8	8	6.0 Mbps	Optional	8	8	3.0 Mbps
dts Digital Surround | 96/24	Coherent Acoustics plus 96/24 Extensions	Optional	5.1	5.1	1.509 Mbps	Optional	5.1	5.1	1.509 Mbps
dts Digital Surround | ES™	Coherent Acoustics plus ES Extensions	Optional	6.1	6.1	1.509 Mbps	Optional	6.1	6.1	1.509 Mbps
dts Digital Surround	Coherent Acoustics	Optional	5.1	5.1	1.509 Mbps	Optional	5.1	5.1	1.509 Mbps
dts Digital Surround	Coherent Acoustics	Mandatory	5.1	2 ch analog	1.509 Mbps	Mandatory	5.1	2 ch analog	1.509 Mbps

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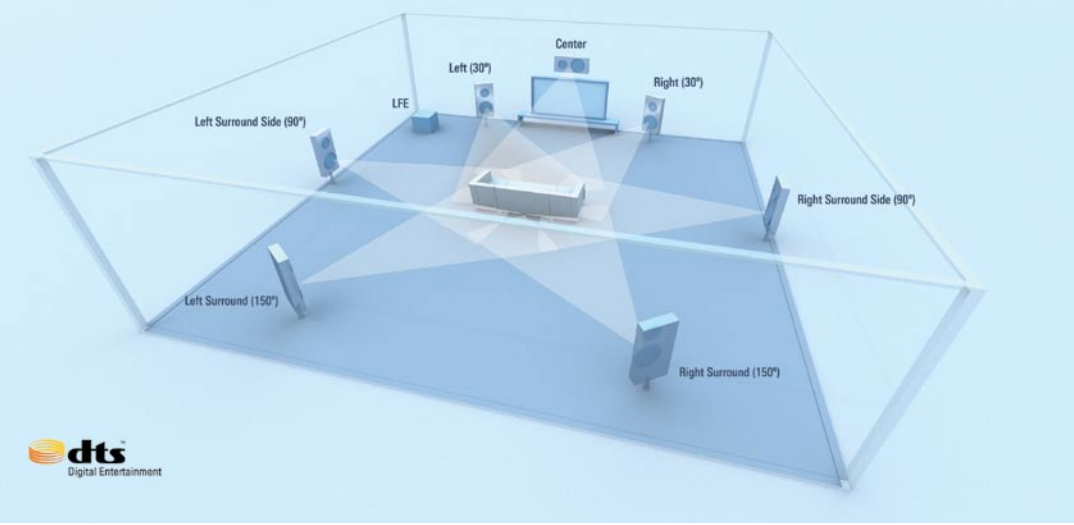
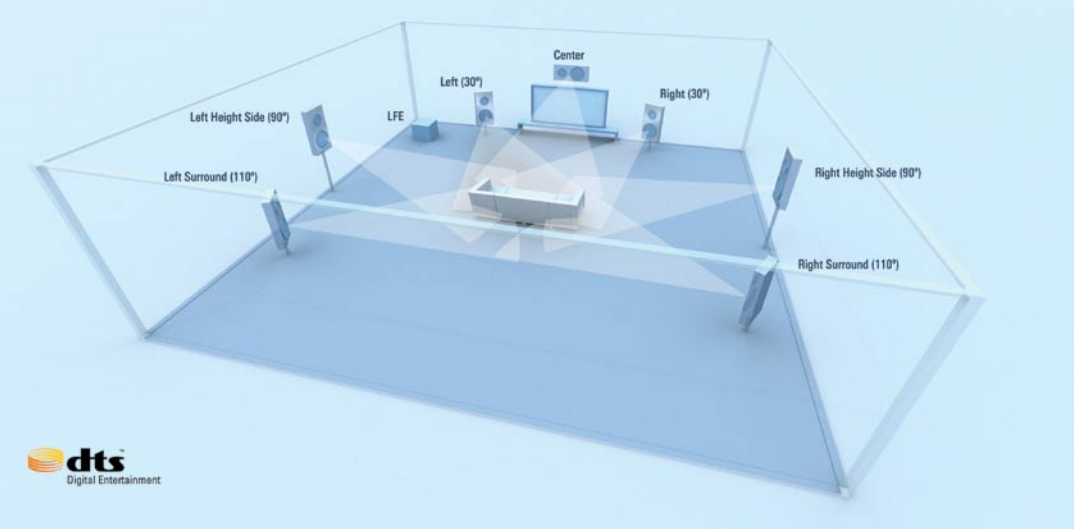
5.2 Speaker Re-Mapping: Multiple Speaker Playback Configurations

Home theater systems are often set up with speaker layouts that differ from the layouts used during recording, sometimes dictated by room dimensions or furniture placement. DTS-HD Master Audio and DTS High Resolution Audio include a speaker re-mapping feature, which allows the user to select from seven different speaker layouts. Speaker remapping ensures that if the sound mixer is using a different speaker layout during audio creation and mixing, the consumer gets the best possible sound quality and spatial characteristics based on their home speaker layout. Speaker re-mapping uses sophisticated algorithms to electronically reposition speakers in the listening room, and is designed for 7.1 channel systems as shown in the speaker re-mapping configurations below:

Configuration 1 | 7.1 channels: L, C, R, LFE, Lss, Rss, Lsr, Rsr



Configuration 2 | 7.1 channels: L, C, R, LFE, Ls, Rs, Lhs, Rhs



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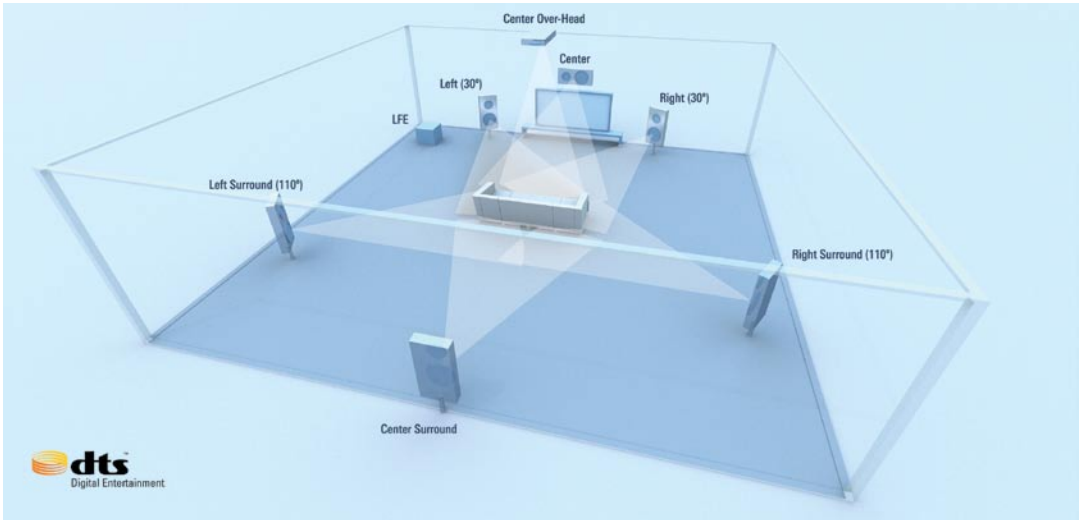
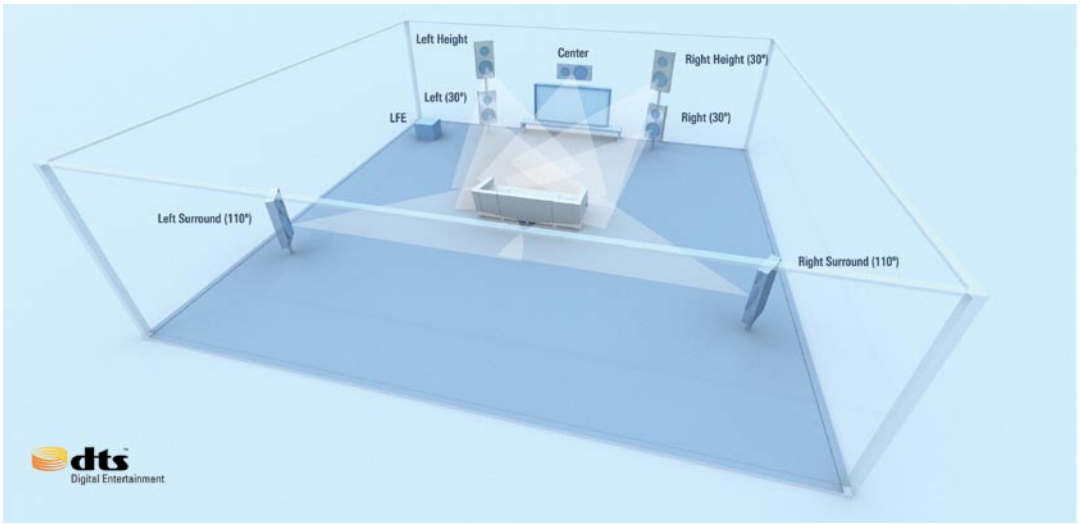
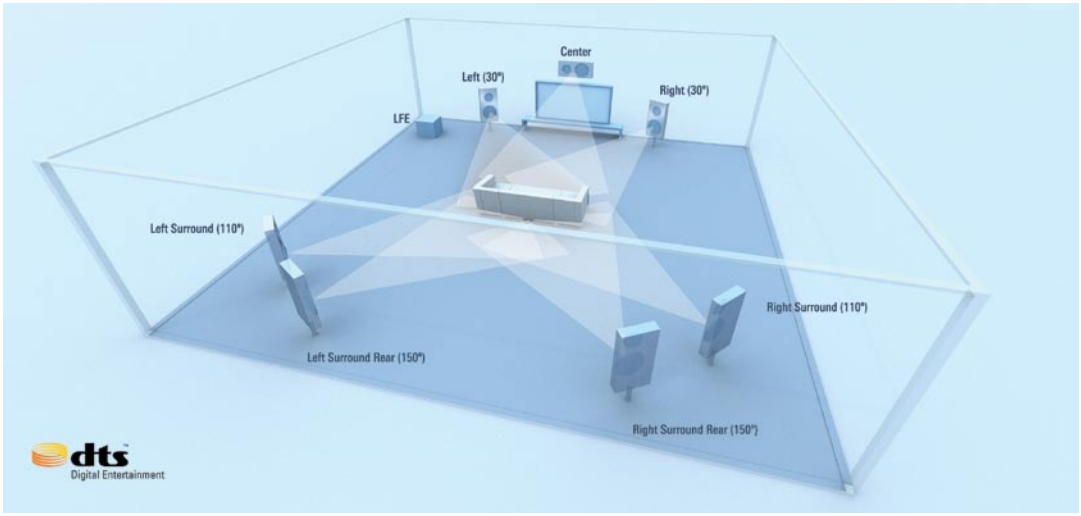
Configuration 3 | 7.1 channels: L, C, R, LFE, Ls, Rs, Cs, Oh



Configuration 4 | 7.1 channels: L, C, R, LFE, Ls, Rs, Lh, Rh



Configuration 5 | 7.1 channels: L, C, R, LFE, Ls, Rs, Lsr, Rsr



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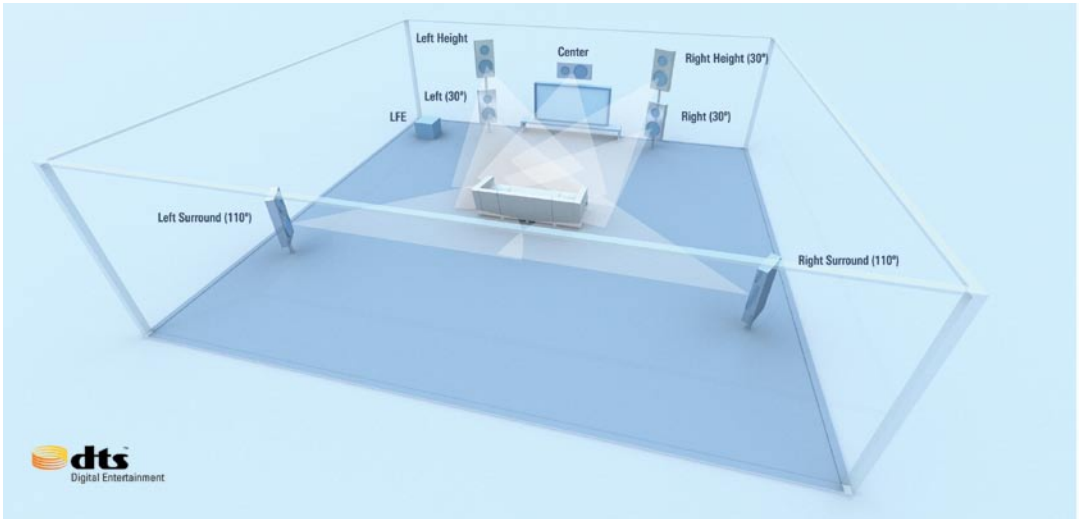
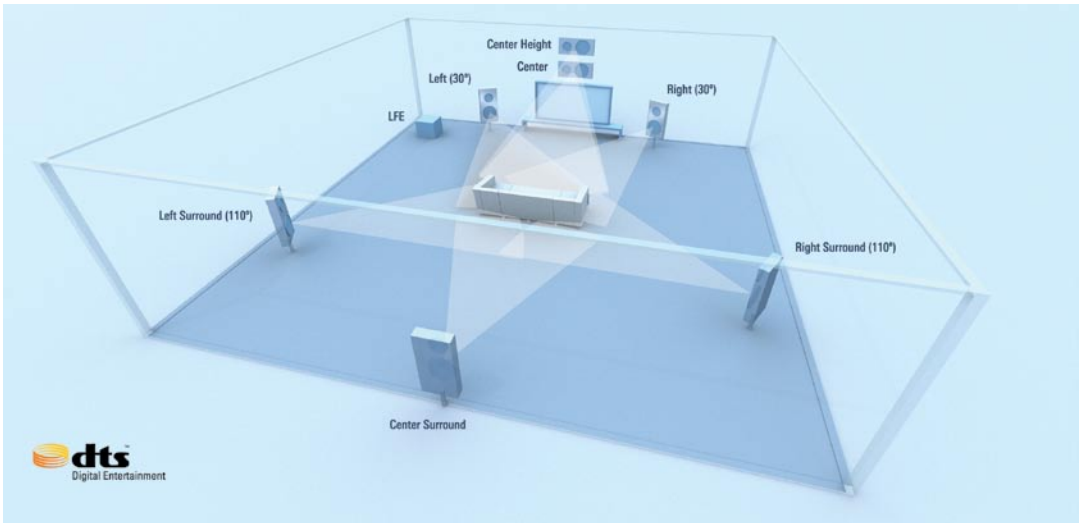
Configuration 6 | 7.1 channels: L, C, R, LFE, Ls, Rs, Lw, Rw



Configuration 7 | 7.1 channels: L, C, R, LFE, Ls, Rs, Ch, Cs



5.3 DTS-HD Technology: Audio Performance of Blu-ray Disc and HD DVD Formats

DTS-HD Master Audio is an optional feature on both new high-definition DVD disc formats, Blu-ray Disc and HD DVD. Both formats offer exceptional audio performance, but there are technical differences, explained below.

5.3.1 DTS-HD Technology: Blu-ray Disc Format

- DTS-HD Master Audio for Blu-ray Disc offers Lossless Audio, the highest quality available for movies and music. Lossless audio is a "bit-for-bit" identical recreation of the original studio master recording, free from loss. In the Blu-ray Disc format, DTS-HD is capable of up to 24.5 Mbps variable data rate, 7.1 discrete channels, with a sampling frequency up to 96 kHz and 24-bits of signal resolution, and 192 kHz / 24 bits in 2-channel.

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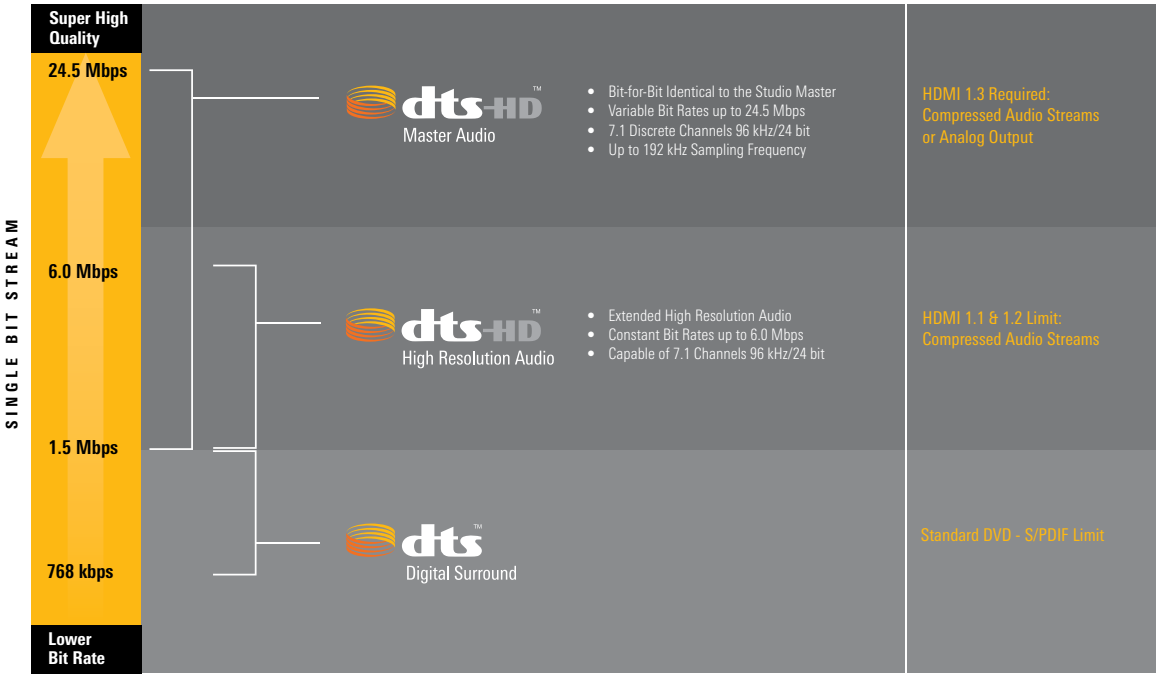
- DTS-HD High Resolution Audio is capable of delivering 7.1 channels of sound with a sampling frequency of 96 kHz and 24-bits of resolution, with a data rate up to 6 Mbps constant bit rate in a "lossy audio stream".

- DTS-HD Secondary Audio is an optional feature on Blu-ray Disc, which offers high-quality, low bit rate audio designed for network streaming, broadcast and Internet applications. DTS-HD Secondary Audio can provide high quality multichannel sound in a low bit rate, scalable format with data rates ranging from 24 kbps per channel and sampling rates of 48 khz for Blu-ray Disc and 44.1 kHz and 48 kHz for HD DVD, and up to 24-bits of signal resolution.

DTS-HD Technology: Primary Audio for Blu-ray Disc



DTS-HD data rates for Blu-ray Disc

5.3.2 DTS-HD Technology: HD DVD Format

- DTS-HD Master Audio for HD DVD also offers Lossless Audio, a "bit-for-bit" recreation of the original studio master recording with a variable data rate from 768 kbps to 18.0 Mbps, 7.1 discrete channels with a sampling frequency up to 96 kHz and 24-bits of signal resolution and 192 kHz / 24 bit in 2-channel.

- DTS-HD High Resolution Audio offers a "lossy audio stream" with 7.1 channels and a sampling frequency of 96 kHz and 24-bit signal resolution. DTS-HD High Resolution audio is capable of up to 3 Mbps constant data rate in a lossy audio stream.

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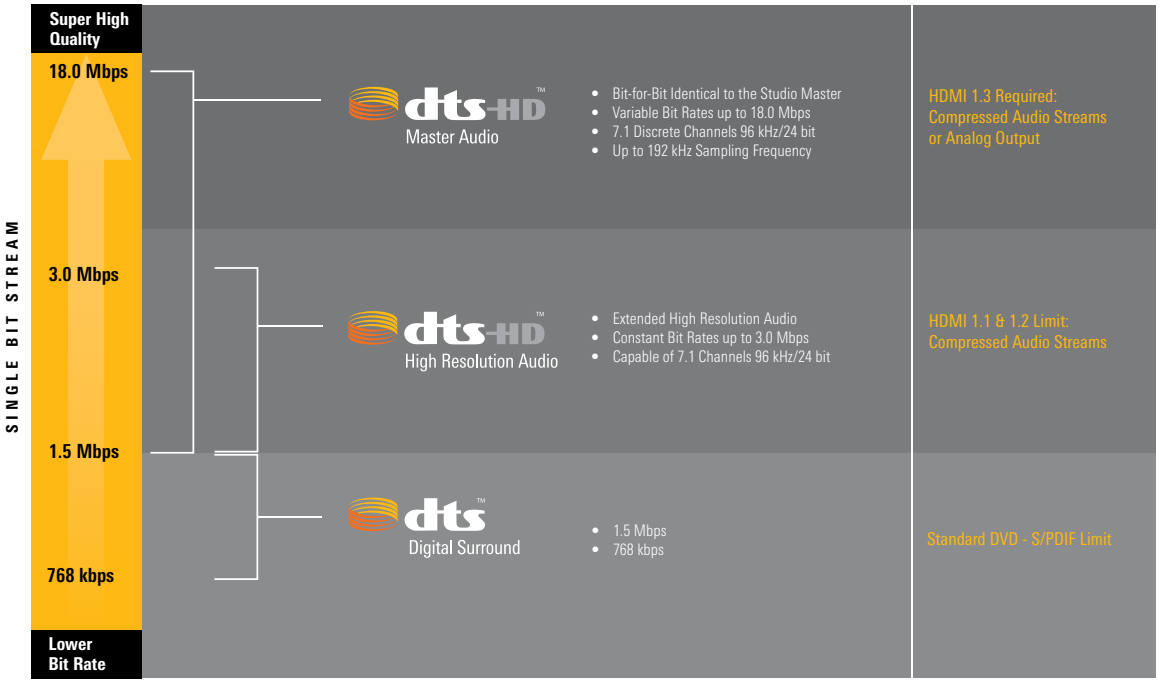
- DTS Sub Audio is an optional format on HD DVD discs, which offers high-quality, low bit rate audio designed for network streaming, broadcast and Internet applications. DTS Sub Audio can provide high quality two-channel (2.0) sound in a low bit rate, scalable format with data rates ranging from 64 to 192 kbps and sampling rates from 8 kHz to 96 kHz with 24-bits of signal resolution.

DTS-HD Technology: HD DVD



DTS-HD data rates for HD DVD discs

5.4 DTS-HD Audio Bass Management Systems

Bass Management is used in AV components to correctly control and direct bass signals to the most appropriate speakers or subwoofer(s) in the system. Some new DVD players may include Bass Management, however, it is generally best performed in an AV Receiver or home theater system in the digital domain. Bass Management is usually operable only when a DVD player and AV Receiver are connected digitally, because these circuits are bypassed when the DVD player and receiver are connected via analog cables (see connection diagrams, section 5.5.). Some AV Receivers incorporate Bass Management for analog sources by adding an analog to digital conversion circuit. Since there are many variations in the implementation of Bass Management, please check with the manufacturer of the component to determine the features and operation of Bass Management control.

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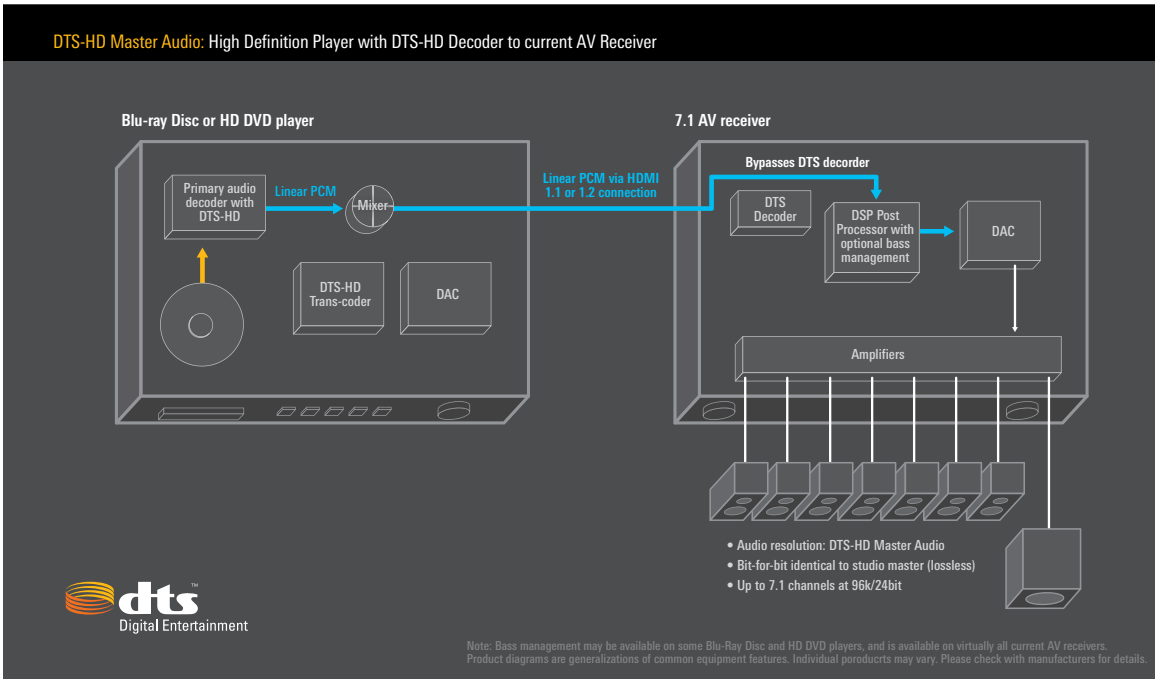
5.5 Components and Connections for DTS-HD Audio

5.5.1 DTS-HD Master Audio and High Resolution Audio via HDMI 1.1 or 1.2* Connection using a High Definition Player with DTS-HD Master Audio Decoder to Current AV Receiver

You can enjoy DTS-HD Master Audio and DTS-HD High Resolution Audio if you have a new Blu-ray Disc or HD DVD player with a DTS-HD Audio decoder built into the player. The audio is decoded inside the player and passed to the receiver in two different ways, a single HDMI cable or multichannel analog connections. The high definition player outputs DTS-HD Master Audio or DTS-HD High Resolution Audio as an uncompressed 6 to 8 channel linear PCM digital audio stream. You need a player with a built-in DTS-HD Master Audio decoder, and both player and AV Receiver must have HDMI version 1.1 or 1.2* outputs/inputs. HDMI stands for High Definition Multimedia Interface, and is a single-cable connection that carries video and digital multi channel audio signals. Connect the HDMI output of the player to the HDMI input of the AV Receiver. The DTS decoder inside the AV Receiver "ignores" the Linear PCM stream and passes the audio stream on to your receiver's digital-to-analog converters and then on to the 5.1 or 7.1 amplifiers. This way you can enjoy DTS-HD Master Audio that is bit-for-bit identical to the studio master.

*Note: HDMI Versions 1.1 and 1.2 standards have been revised to include high resolution compressed digital audio streams at up to 6.0 Mbps constant bit rate. HDMI Versions 1.1 and 1.2 outputs are unable to pass DTS-HD Master Audio compressed digital bit streams. For more information about HDMI, visit www.hdmi.org/consumer.



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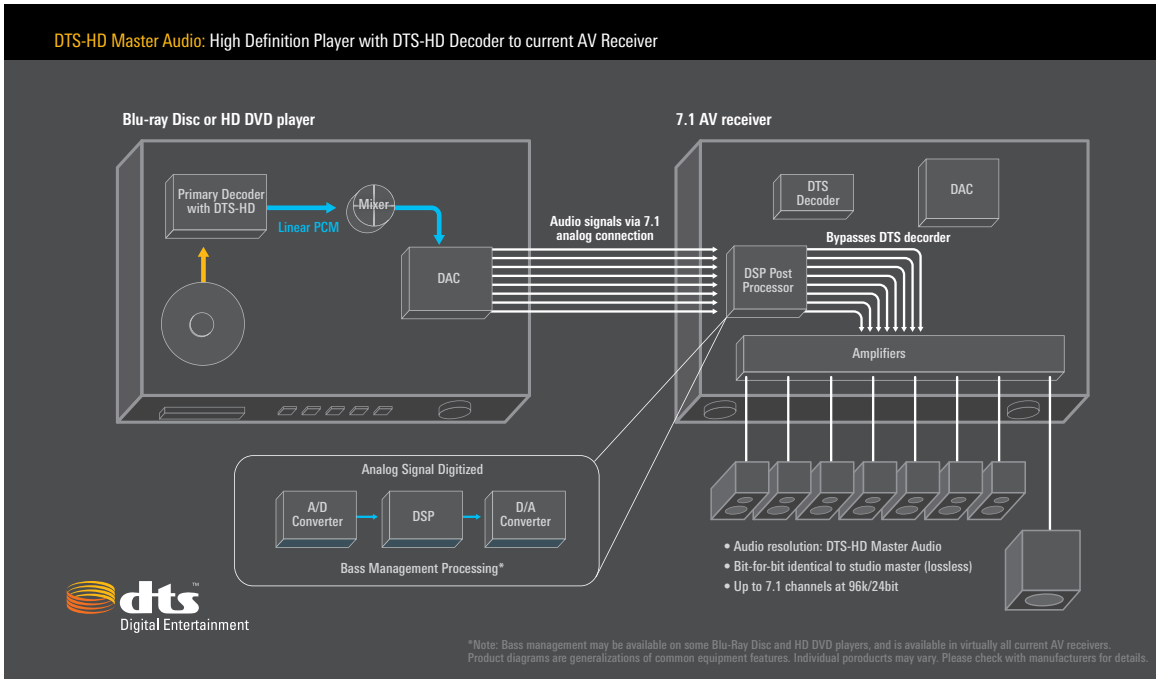
5.5.2 DTS-HD Master Audio / High Resolution Audio via 6 to 8 Channel Analog Connections

The high definition player outputs DTS-HD Master Audio or DTS-HD High Resolution Audio through the analog outputs of the player to the AV Receiver. The audio is decoded by the player and sent out as analog audio to the multichannel analog inputs on the AV Receiver. The number of analog output/inputs on the player and receiver determines the number of analog cables needed. Connect 6, 7, or 8 RCA cables from the analog outputs of the player to the analog inputs on the AV Receiver. The analog signals will go directly to the receiver's amplifier section. In this way you can enjoy DTS-HD Master Audio that is bit-for-bit identical to the studio master recording.



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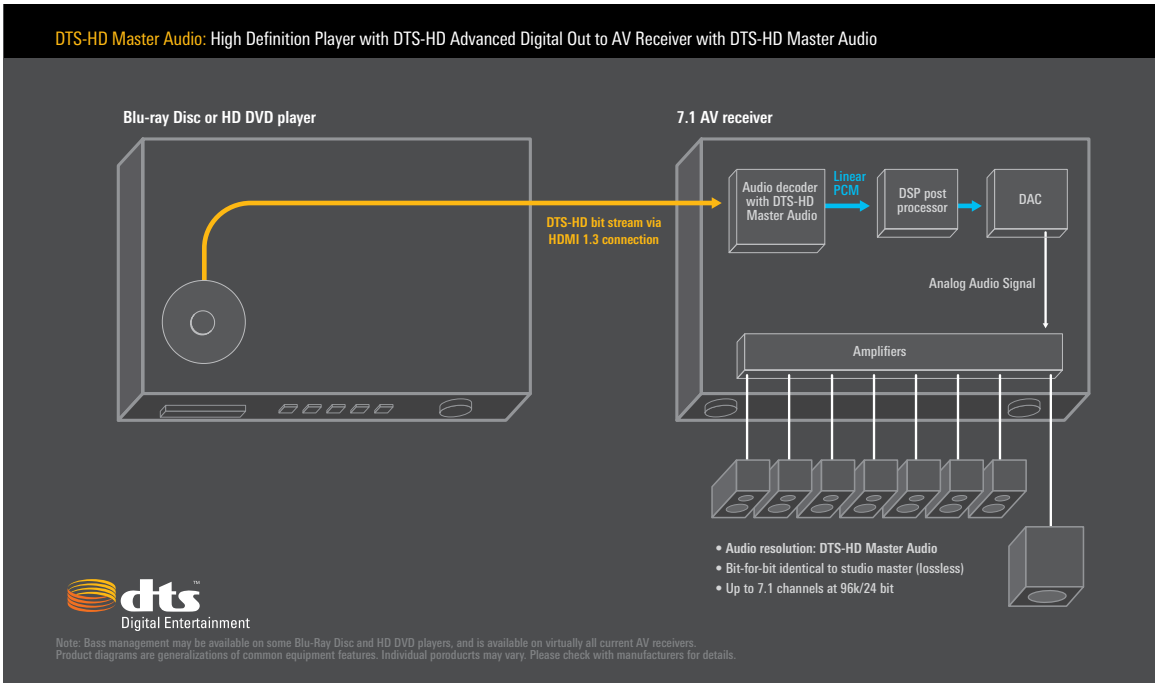
5.5.3 High Definition Player with DTS-HD Advanced Digital Out to New AV Receiver with DTS-HD Master Audio Decoding

You can enjoy DTS-HD Master audio by upgrading to a Blu-ray Disc or HD DVD player with DTS-HD Advanced Digital Out and new AV Receiver with DTS-HD Master Audio decoding. Both player and AV receiver will need to be equipped with new HDMI Version 1.3 outputs and inputs. Connect the player and receiver with an HDMI cable. The DTS-HD bit stream will pass through the player and HDMI cable to be decoded by the AV receiver. This way you can enjoy DTS-HD Master Audio at up to 7.1 channels at 96 kHz/24 bit sound that is bit-for-bit identical to the studio master.



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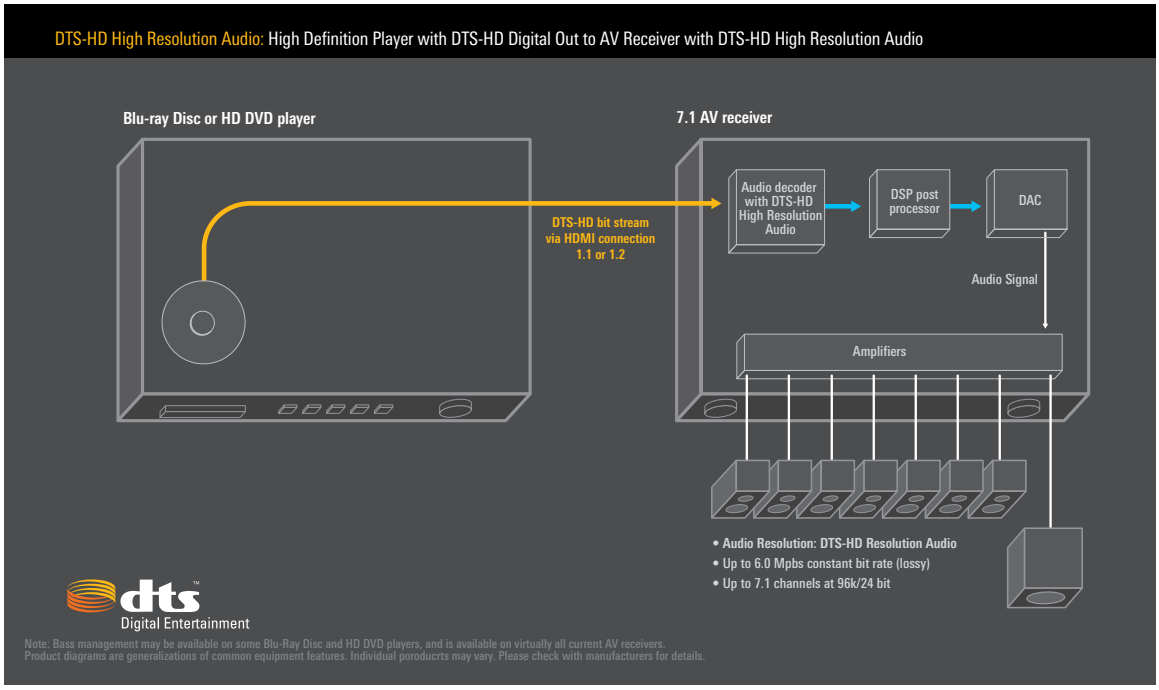
5.5.4 High Definition Player with DTS-HD Digital Out to New AV Receiver with DTS-HD High Resolution Audio Decoding

You can enjoy DTS-HD High Resolution audio by upgrading to a Blu-ray Disc or HD DVD player with DTS-HD Digital Out and new AV Receiver with DTS-HD High Resolution Audio decoding built-in. Connect an HDMI version 1.1 or 1.2 cable to the HDMI outputs and inputs of the player and receiver. Both the player and receiver must have HDMI version 1.1 or 1.2 capability. The DTS-HD bit stream will pass through the player and HDMI cable to be decoded by the AV receiver. This way you can enjoy DTS-HD High Resolution Audio with up to 7.1 channels at 96 kHz sampling frequency and 24-bit signal resolution.



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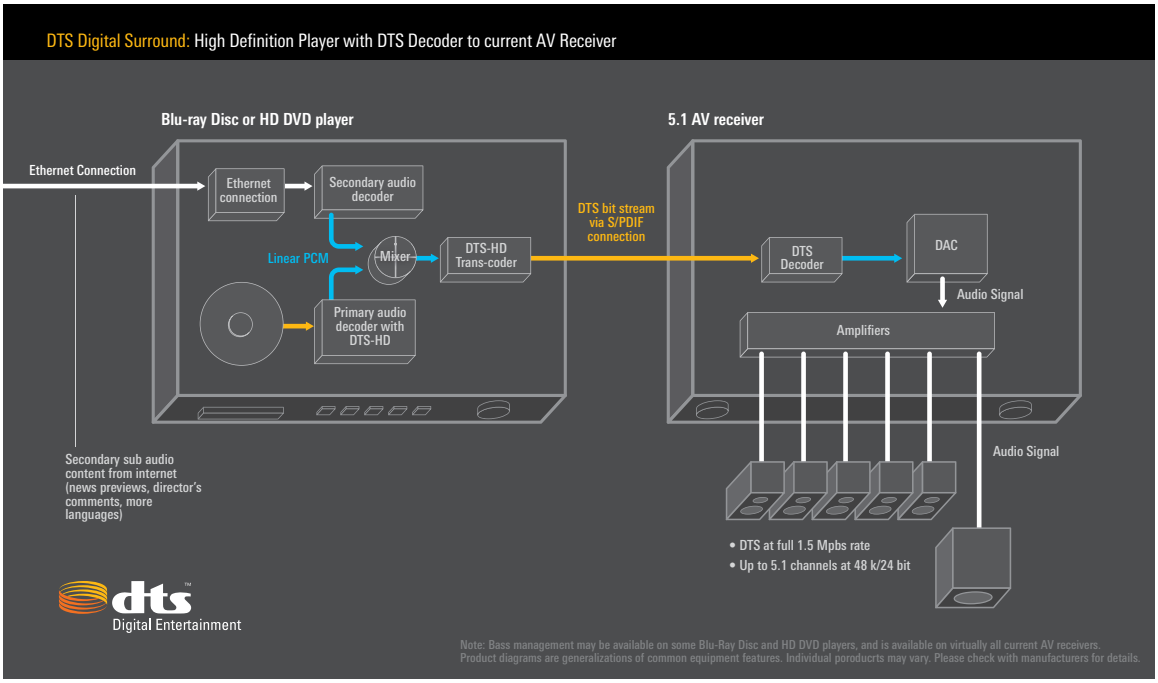
5.5.5 High Definition Player with DTS Digital Out to Current AV Receiver

You can enjoy DTS Digital Surround by hooking up a Blu-ray Disc or HD DVD player with DTS Digital Out to your existing AV Receiver with DTS Digital Surround decoding. Connect a digital audio cable to the S/PDIF outputs and inputs of your player and receiver. S/PDIF is a universal digital audio connection found on nearly all digital home entertainment components and is usually available with optical and coaxial type connectors. This connection will allow DTS Digital Surround at the full 1.5 Mbps data rate, which can deliver 5.1 channel surround sound at over twice the bit rate of other formats found on most standard DVDs.



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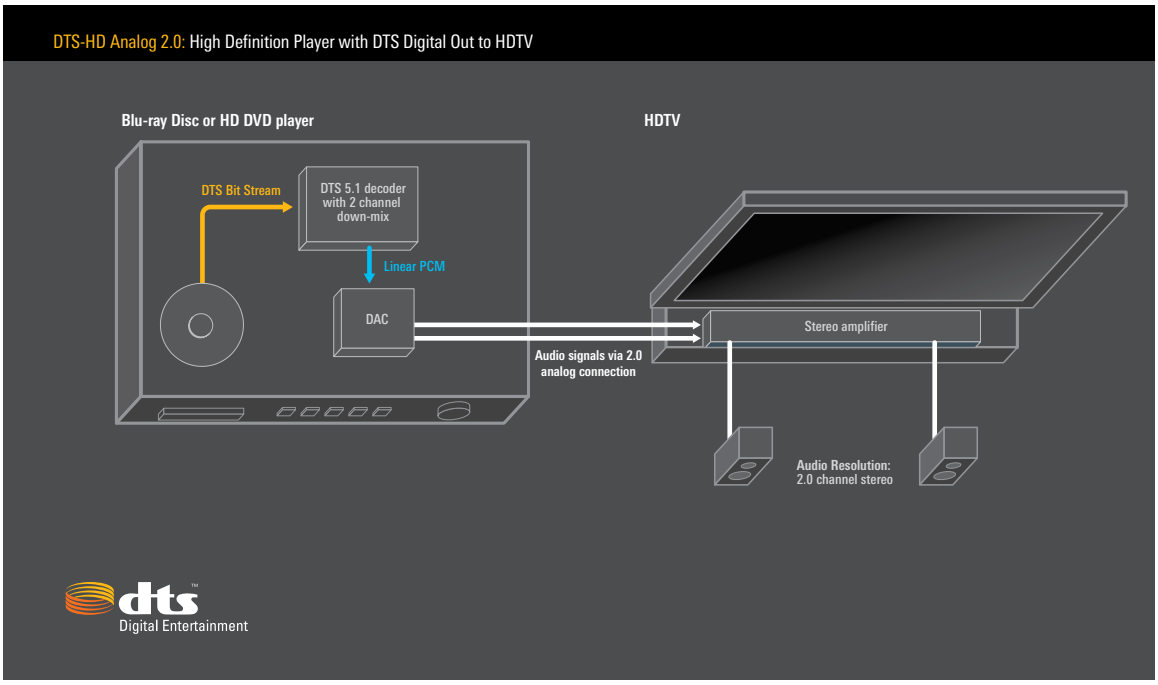
5.5.6 High Definition Player with DTS Digital Out to HDTV display or to External A/V Receiver or Amplifier

As part of the Blu-ray Disc and HD DVD standards, all players are required to down-mix DTS encoded multichannel soundtracks to 2.0 channel stereo. Connect the stereo analog outputs of the player to the stereo analog inputs of an HDTV display, A/V receiver, amplifier, or television.



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5.6 DTS Logos on Hardware Products

Hardware products that include DTS-HD Audio decoding will feature logos that identify the decoding capabilities. The following chart describes the logos and their meaning:

Hardware Products	Logos	Description
DTS-HD Master Audio	dts-HD Master Audio	DTS-HD Master Audio is capable of decoding all DTS formats up to and including DTS-HD Master Audio streams. For A/V receivers or external decoders without a Blu-ray Disc or HD DVD drive, they must be connected by a compatible HDMI or equivalent, high speed digital interface.
DTS-HD High Resolution Audio	dts-HD High Resolution Audio	DTS-HD High Resolution Audio is capable of decoding all DTS formats up to and including DTS-HD High Resolution Audio streams. For A/V receivers or external decoders without a Blu-ray Disc or HD DVD drive, they must be connected by a compatible HDMI or equivalent, high speed digital interface.
DTS-HD 2.0+Advanced Digital Out	dts-HD 2.0+Advanced Digital Out	DTS-HD 2.0 + Advanced Digital Out denotes the capability of outputting DTS-HD Master Audio 2.0 Lossless channels directly to a TV or external amplifier through analog outputs. Also capable of outputting DTS-HD Master Audio streams to an external decoder such as an A/V receiver or pre-amp/processor.
DTS-HD Advanced Digital Out	dts-HD Advanced Digital Out	DTS-HD Advanced Digital Out denotes the capability of outputting DTS-HD Master Audio streams to an external decoder such as an A/V receiver or pre-amp/processor.
DTS-HD 2.0+Digital Out	dts-HD 2.0+Digital Out	DTS-HD 2.0 + Digital Out denotes the ability of outputting DTS-HD High Resolution Audio 2.0 Lossy channels directly to a TV or external amplifier through analog outputs. Also capable of outputting DTS-HD High Resolution Audio streams to an external decoder such as an A/V receiver or pre-amp/processor.
DTS-HD Digital Out	dts-HD Digital Out	DTS-HD Digital Out denotes the ability of outputting DTS-HD High Resolution Audio streams to an external decoder such as an A/V receiver or pre-amp/processor.

5.7 DTS Logos on Software Products

Software products that feature DTS sound will display logos that identify the format encoded on the disc. The following chart describes the logos and their meaning:

Software Products	Logos	Description
DTS-HD Master Audio	dts-HD Master Audio	Content encoded in DTS-HD Master Audio with up to 7.1 channels at 96 k/24 bit audio bit-for-bit identical to the studio master. Encoded at variable bit rates above 1.509 Mbps up to 18.0 Mbps (HD DVD) and 24.5 Mbps (Blu-ray Disc).
DTS-HD High Resolution Audio	dts-HD High Resolution Audio	Content encoded in DTS-HD High Resolution Audio with up to 7.1 channels at 96 k/24 bit. Encoded at constant bit rates above 1.509 Mbps to 3.0 Mbps (HD DVD) or 6.0 Mbps (Blu-ray Disc).
DTS Digital Surround | 96/24	dts Digital Surround | 96/24	Content encoded in DTS 96/24 with 5.1 channels at 96 k/24 bit. Encoded at constant bit rates up to 1.509 Mbps.
DTS Digital Surround | ES (Extended Surround)	dts Digital Surround | ES	Content encoded in DTS-ES with 6.1 channels at 48 k/24 bit. Encoded at constant bit rates up to 1.509 Mbps.
DTS Digital Surround	dts Digital Surround	Content encoded in DTS Digital Surround with 5.1 channels at 48 k/24. Encoded at constant bit rates up to 1.509 Mbps.

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6.0 DTS-HD Audio for Content Creators and the Professional Audio Community

In addition to consumer and home theater applications, DTS-HD offers a wide range of features useful to content creators and the professional audio community.

6.1 DTS-HD Audio: Multiple Presentations and Audio Assets

In addition to new coding features, a single DTS-HD Audio stream can carry multiple audio presentations. A presentation is a set of playback instructions and each presentation consists of audio assets that are combined to create various playback conditions. For example, the data stream could carry audio assets designating a particular speaker layout, various data rates or sampling frequencies, multiple languages and other presentations.

The DTS-HD Audio stream is organized into five substreams, a core substream and four extension substreams. The core substream represents a single audio asset and each extension substream contains up to eight audio assets. The audio assets within the extension substreams can be mixed and combined to create a number of different audio presentations. Not all of the audio assets in the DTS-HD extension substream have to be active at the same time. Different audio presentations are defined by the stream metadata, which activates specific assets. Metadata is defined as data about data; for example, a library catalog is metadata because it describes information about publications in the library.

6.2 Multiple Presentations Provide Flexibility and Scalability

An important feature of the DTS-HD Audio format is flexibility and scalability. Multiple presentations and audio assets gives content creators a multitude of scalable options to deliver the best possible audio quality depending on the available "bit-budget". The bit-budget determines the amount of disc space allocated to audio, video and other disc features. A larger bit-budget for audio would allow higher data rates, sampling frequencies and bit depths, with the benefit of better sound quality. For example, a generous audio bit budget would allow a lossless DTS-HD Master Audio stream with 24.5 Mbps variable data rate, and 7.1 channels sampled at 96 kHz with 24-bits of signal resolution. A more restrained audio bit-budget would allow a lossy DTS-HD Audio stream with a 6.0 Mbps data rate, and 6.1 channels sampled at 96 kHz and 24-bits of signal resolution. The DTS-HD Audio system allows the content creator flexibility to make the decision based on the available audio bit budget.

Most important, DTS-HD always delivers the maximum quality to all listeners, whether their equipment is new or old, advanced or simple, and this optimum delivery is automatic within a single data stream. Simply stated, the DTS decoder used in a home theater system determines the level of audio performance, always defaulting to the highest possible level. DTS-HD Audio decoders will always deliver the maximum performance possible because the complexity is built into the encoder, not the decoder. This architecture permits a simpler decoder design and provides format scalability that always delivers the highest possible sound quality.

6.2.1 DTS-HD Encoding Options for Content Creators

Thus far, three options have been presented for DTS-HD Audio: Master Audio, High-Resolution Audio and Digital Surround. Because DTS-HD Audio is based on the core plus extension architecture, there are additional encoding options available to content creators and audio professionals. The encoding options provide additional audio capabilities and flexible playback configurations as shown below:

- The DTS core can be encoded with a scalable data rate of 768, 960, 1,152, 1,344 or 1,509 kbps, plus a DTS-HD Master Audio extension for higher data rates up to 18.0 Mbps for HD DVD and 24.5 Mbps for Blu-ray Disc.

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- The DTS core can be encoded with a scalable data rate of 768 kbps or 1,509 kbps, plus a DTS-HD High Resolution Audio extension for higher data rates up to 3.0 Mbps for HD DVD and 6.0 Mbps for Blu-ray Disc.

- The DTS core can be encoded with a data rate of 768 kbps or 1,509 kbps with 6.1 channel 48 kHz/24 bit playback, plus a DTS-HD High Resolution Audio extension for higher data rates up to 3.0 Mbps for HD DVD and 6.0 Mbps for Blu-ray Disc.

- The DTS core can be encoded with a data rate of 768 kbps or 1,509 kbps with 5.1 channels, 96 kHz/24-bit playback, plus a DTS-HD High Resolution Audio extension for higher data rates up to 3.0 Mbps for HD DVD and 6.0 Mbps for Blu-ray Disc.

- The DTS core can be encoded at a data rate of 768 kbps or 1,509 kbps with 6.1 channels, 48 kHz/24 bit playback, plus a DTS-HD Master Audio extension for higher data rates up to 18.0 Mbps for HD DVD and 24.5 Mbps for Blu-ray Disc.

6.3 Lossless Audio Archiving

For consumer applications the DTS-HD format is capable of channel configurations ranging from 2.0 up to 7.1 channels. However, a prime application for lossless audio coding is the archiving of audio for the recording industry. Lossless coding preserves the full original master as bit-for-bit retrievable and substantially reduces storage requirements. In professional applications, there are large numbers of tracks to store. The structure of the DTS-HD format affords a convenient and efficient method of storing large numbers of tracks, up to 2048.

7.0 Summary and Contact Information

The introduction of DTS Coherent Acoustics helped launch the discrete surround sound era for movies and music in the home and demonstrated that not just additional channels, but unprecedented sound quality could be delivered into the home. The DTS-HD extensions make full use of emerging consumer media broadening the capability of Coherent Acoustics into additional channels, a wider range of data rates and lossless audio operation. Perhaps most importantly, DTS-HD delivers maximum audio quality to all listeners, whether their equipment is old or new, simple or advanced. This optimum delivery is automatic within a single, efficient data stream.

Contact Information:

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