



Requirements Specification for HD DVD Video Application

**Functional & Performance
Requirements**

Version 1.0

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1. General

1.1 Scope

Ad Hoc 0-10 (AH0-10) was established under the Technical Coordination Group (TCG) of the DVD Forum to study the requirements for the HD DVD Video application. The output of AH0-10, namely this document, will be reported to the TCG and subsequently on to Working Group 1 (WG-1) for use in creating the HD DVD Video Specifications version 1.0.

This document defines functional and performance requirements for HD DVD Video. These requirements are expressed in terms of the desired end-user experience that should be achievable with content that complies with the HD DVD Video Specifications version 1.0.

The usage scenarios and functional requirements disclosed in this document were created by utilizing input from a variety of motion picture studios and entertainment companies. Subsequently, the performance requirements were derived through consultation with both consumer electronics manufacturers and information technology companies.

1.2 Target Audience

This document is intended to be used by the DVD Forum Working Group 1 (WG-1) to assist in the creation of the HD DVD Video Specifications version 1.0. From time to time this document discusses other topics not strictly within the scope of WG-1's work (e.g. content management, authoring). In each instance the purpose is to give context to the overall application model and is not meant to be an exhaustive discussion or complete input on the topic.

1.3 Informative References

Throughout this document there are informative references to various specifications. These informative references are meant to provide background and/or example specifications to be considered by WG-1. Normative references will be defined by Working Group 1 in the HD DVD Video Specifications.

2. Technical Elements

2.1 Symbols

==	Equal to
≠ or !=	Not equal to
≥ or >=	Greater than or equal to
>	Greater than
≤ or <=	Less than or equal to
<	Less than

2.2 Notations

Numbers in decimal notation are represented by decimal digits, namely 0 to 9.

1 M bytes represents 10^6 bytes

1 G bytes represents 10^9 bytes

1 kB represents 2^{10} bytes

1 MB represents 2^{20} bytes

1 GB represents 2^{30} bytes

1 kbps represents 10^3 bits per second

1 Mbps represents 10^6 bits per second

1 kHz represent 10^3 periods per second

2.3 Terminology

The terms included here are used in various places in this document to describe content providers creative intent. More technical definitions may be defined by WG-1.

Activate	To actuate an interactive graphic element (button is activated or triggered) signifying the user's desire to execute the operation offered by the graphic.
Application Data	Advanced content which controls the player behavior as well as the aural and visual user experience (e.g. Playlist, Manifest, Mark-up, Script).
Key	To create an overlay effect in which portions of an image that are over (or under) a set brightness level is "keyed" out (i.e. removed) and replaced by either another image (graphic or video), or a color.
Composite	To layer graphic objects and video resulting in a single image for presentation.
Highlight	An attribute of an interactive graphic object that changes to signify that it is available for activation. The highlight could also be an audible attribute like a sound that is generated when the cursor is moved over the graphic object.
Interactive Object	An object that can be manipulated through user input (e.g. remote control) or application data (e.g. script) to trigger subsequent events.
Mask	A defined area of an image used to key specific hue, saturation, and luminance values in the image (see definition for Key).
Menu Interface	An interactive object or group of objects (e.g. graphics) that allows the user to change the presentation. A menu interface can be presented either full-screen or non-full-screen. In addition, a menu interface can be presented concurrent with video presentation if desired by the content author.
Mix Down	The final aural presentation as heard by the user when the audio provided on the disc has a greater number of channels than the player can support. In such a case the audio is mixed down to the essential number of channels supported by the player (e.g. 5.1 channels on disc is mixed down to 2.0 channels output from the player).
Picture In Picture	The final visual presentation as seen by the user that gives the appearance of a video picture "floating" on top of another video picture.
Presentation	The final aural/visual information as perceived by the user.
Presentation Data	Files or data used by an application (e.g. images, fonts, video, audio)
Programmatically Determine	To dynamically (as opposed to statically) determine the timing and placement of interactive objects and events in the final presentation.
Quality of Service (QOS)	A measure of performance for a transmission system that reflects its transmission quality, speed, and availability of service.

Render	To combine graphic objects and video with any applied effects, such as transitions or scaling, one frame at a time. Once rendered, the final presentation is ready for display. (See definition for Composite)
Streaming Objects	Audio, video, graphics, subtitles, text and/or metadata that are delivered as a flow of data rather than in a complete package.
User Operation	The action of a user when pressing buttons on a remote control, front panel controls of the player, or other input device.
Static Scaling	To scale an object to a specific scaling ratio instantaneously (e.g. does not scale over time).
Animated Scaling	To scale an object to a specific scaling ratio over time (e.g. scales a graphic from 100% to 200% over 3 seconds).
Zoom	See Animated Scaling
Clip	To remove or hide a portion of a graphic object or video. (See also Mask and Key)

2.4 Abbreviations

CSS	Cascading Style Sheets
DOM	Document Object Model
DRM	Digital Rights Management
DSL	Digital Subscriber Line
DTCP	Digital Transmission Content Protection
HD	High Definition
HDMI	High Definition Multimedia Interface
LAN	Local Area Network
NTSC	National Television System Committee
PAL	Phase Alternating Line
PIP	Picture In Picture
PSTN	Public Switched Telephone Network
QOS	Quality Of Service
REL	Rights Expression Language
SD	Standard Definition
S/PDIF	Sony/Philips Digital Interface
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
URN	Uniform Resource Name

3. Introduction

3.1 Purpose of the Requirements Specification

The purpose of this document is to provide a basis for technical discussion within the WG-1 working group as it defines the HD DVD Video format. These requirements have been defined in accordance with the activities of the Ad Hoc 0-10 group, which has included input from several motion picture studios and others with the intention of identifying those features that are considered necessary in order to ensure the long-term success of the HD DVD Video format. The purpose of this document is to provide a basis for technical discussion within the Working Group 1 (WG-1) as it defines the HD DVD Video format.

This document provides three primary types of information: usage scenarios, functional requirements, and performance requirements.

3.2 Use Cases and Usage Scenarios

The use cases described in this specification are intended to provide tangible examples of the functionality that is being defined in the requirements. Underneath each use case are specific usage scenarios. These are meant to demonstrate real-world examples of how the functionality would be used. They are informative, not normative. These applications should be considered representative of the types of content expected to be delivered on HD DVD Video, but it should not be considered an exhaustive list. Each individual requirement will refer to one or more of these applications as an example embodiment of the feature in order to help clearly describe the requirement.

3.3 Functional Requirements

The functional requirements describe the specific capabilities that should be supported by the format. These requirements are specified in terms of end-user experience. The technical discussion regarding how such features may be implemented is left to Working Group 1. Although an effort has been made to ensure that the functional requirements are, in fact, technically feasible, it is understood that some of the specific requirements may present significant technical challenges. Therefore, a designation accompanies each requirement in order to ensure appropriate dedication of resources to each feature.

3.4 Performance Requirements

The performance requirements describe minimum and recommended values for key performance issues regarding each functional requirement. In some instances recommended values are not given to allow for further study be undertaken in Working Group 1 to determine the actual values. In all cases the values are intended to address the need for reasonably consistent presentation of content across multiple HD DVD Video player implementations, while also helping to further clarify the functional requirements themselves.

4. Use Cases and Usage Scenarios

4.1 Menu Interfaces during Video Playback

4.1.1 Graphic menus over video

Interactive graphical menus appear seamlessly over video at programmatically determined times or in response to a user operation and present the user with the ability to navigate to any point within the video (user defined or programmatically defined) without any interruption in audio or video.

- Menu interfaces may be full screen or non-full screen.
- Menu interfaces may be any size or shape and can be positioned anywhere on the screen.
- Menu interfaces or portions of menu interfaces may utilize effects such as fade, scroll, wipe, expand, or scale (i.e. thumbnail images of chapter menu expand/grow upon user selection).

4.1.2 Button sounds

Button responses to a user operation

- The user may be able to 'highlight' a button and subsequently can 'activate' the button.
- When the user highlights or activates a button an audio effect (sound) may be heard.
- When the user highlights or activates a button the button's image/animation may be replaced by a different image/animation (i.e. rollover).

4.2 Interactive Content during Video Playback

4.2.1 Viewer's Wish List

Items in main video are visually highlighted programmatically during playback and may be activated by the user. The highlights match the image in the video and are synchronized with the video. When the user activates the highlight it is stored in persistent memory for later access. In addition, the activation may later link to an e-commerce site for product purchase.

4.2.2 Collecting Objects for Later Use

While the movie is playing the user periodically saves clues (graphics) by highlighting and activating them in the video. The collected clues are stored for later use (used to solve the mystery at the end of the movie).

- The clues are stored in temporary storage for this disc session.
- Additionally, the clues may be stored persistently for future disc sessions.

4.2.3 What's wrong with this Picture

The user must highlight and activate the subtle errors in the film (i.e. a black bird is flying upside down). A score is tabulated every time the user makes a correct selection. The user can play alone or compete against a friend from another location (via a network connection).

4.2.4 Context-sensitive user input

As directed by the disc instructions, the user can press a particular button on the remote control (i.e. "info" button, "A" button) during playback in order to display additional information about the main program. No interruption in the audio or video occurs.

- In a subsequent scenario the content can react differently to the same button.

4.2.5 Audio prompted user input

An audio message plays over video at programmatically determined times, requesting the user to press a button on their remote control (i.e. 'A' button) to learn more about the current video topic.

4.2.6 Sports play maker

At predetermined times drawing appears on top of the video to emphasize certain parts of the video without interruption of the audio/video playback. The drawing resides on the disc or can be access via a network.

4.2.7 Sports play maker alternative

In addition to user scenario 6 above, a user can generate their own drawing that will play back with the video and can be shared with other networked users.

4.2.8 Trivia interaction

The user interacts with trivia questions in the form of graphics and/or text that displays along the bottom of the video (in ticker tape fashion). The user can play alone or compete against a friend from another location via a network connection (cf. Online Content).

4.2.9 Storyboard & Screenplay Sync

User views storyboards, script, and movie simultaneously in separate windows (“windowed” mode). Video may be resized to full screen. The user can toggle back and forth between “windowed” mode and full screen without any interruption in audio or video. Storyboard images and script text automatically update and synchronize with the movie. The user can manually scroll the script text as well.

4.2.10 Multiple user interactive graphics

In a two player game each user is simultaneously controlling an alpha blended graphic on the screen (e.g. crosshairs graphic). At some point those graphic objects may overlap with each other or other graphics on the screen (e.g. Crosshairs overlap with each other and explosions). When overlapping, graphic objects maintain alpha blending and layer ordering defined by content without visual distortion.

4.3 Non-Interactive Objects over Video

4.3.1 Masked video

Video is masked with graphic overlays (example: Mystery Science Theater). User can switch in and out of this “masked” mode at any time.

- As the user switches in and out of “masked” mode the graphic objects gracefully fade in and out utilizing multiple levels of opacity.
- Graphic objects can come from a server or the disc.

4.3.2 Director’s highlight

While a director’s commentary is playing the director “highlights” areas of interest in the scene and makes remarks about it. The director jokes about how an actor spilled a glass of soda 3 times requiring lots of retakes. During this comment the soda glass is highlighted and tracked within the scene.

- “Pixie Dust” outlining areas of interest in main video, synchronized to main video.
- Irregular shaped mask with alpha blending over video. Mask moves with each frame of video.

4.3.3 Video transition to menu

While the movie is playing full screen the user presses the “Menu” button on the remote control activating a transition (scroll, wipe, fade, etc.) of the on-screen video to a full screen menu interface.

4.3.4 Zoom menu

While viewing a menu interface the user presses the “Zoom” button on the remote control, thereby zooming in on the menu to make it larger for better readability. Any video playing concurrent with this menu interface is not affected.

4.3.5 Zoom subtitles

While viewing subtitles during movie playback the user presses the “Zoom” button on the remote control, thereby increasing the size of the subtitles for better readability. Any video playing concurrent with the subtitles is not affected.

4.3.6 Zoom and pan video

While viewing the movie the user presses the “Zoom” button on the remote control, thereby zooming in on the video. The user can subsequently use buttons on the remote control to pan around the zoomed video.

4.3.7 Capture video frame

While viewing the movie a menu interface appears seamlessly over video in the form of a menu bar along the bottom portion of the screen. When the user activates the “capture” button a frame from the video is captured and immediately shown as a thumbnail image within the menu interface. The user can save the captured images for later viewing in a slideshow.

4.4 Audio Objects

4.4.1 Streamed audio from network

An alternative audio stream is streamed over the network and synchronized frame accurately to the primary video. The user has the ability to switch between the streamed audio and the other audio streams that reside on the disc.

4.4.2 New commentary alert

While the movie is playing an on-screen message appears alerting the user of a new director's commentary that is available. The director's commentary audio stream is streamed over the network and mixed with the main audio stream according to provided metadata (e.g. stereo director's commentary is mapped to the left and right channels). The resultant composite audio stream is synchronized with the primary video.

- Additionally, the alert could be an audible sound instead of visual.

4.4.3 Home network audio

An alternate audio stream (e.g. director's commentary) which has been previously downloaded and cached on the user's home network is listed on the audio menu along with all of the on-disc audio streams. When selected, the commentary is synchronized with the primary video and automatically mixed according to provided metadata.

- The user can toggle between the cached audio stream and the disc based audio streams via the remote control without interrupting the video.

4.4.4 Independent volume control of alternate audio

User adjusts the volume control of the alternate audio stream (e.g. director's commentary) and feature film separately. The control can be via the remote control or via an interactive graphical controller (which overrides the predefined volume levels).

- The user saves this information for subsequent playback.

4.4.5 Independent volume control of dialog audio

While playing the movie the user adjusts the volume of the dialog stream separately from the music and effects stream.

- The user saves the volume settings for future use.

4.4.6 Button audio response

An audio response is heard when an interactive button is highlighted/activated or when a remote control button is depressed by the user. The audio response is mixed with all other audio currently being presented.

4.4.7 Auxiliary audio (Karaoke)

While playing a music video the user plugs a musical instrument into the player. During playback the sound from the musical instrument is mixed in with the music video across desired channels.

- Auxiliary audio could be a microphone or instrument

4.4.8 Independent audio control of individual channels

From within a mixing application the user controls the audio levels of each individual channel of one or more streams to create a unique mix.

4.4.9 Automatic playback when no display is available

When playing an HD-DVD disc in a car player with no user display interface the player automatically plays the music or other alternate play list.

4.4.10 Audible Menu Pages

As the user navigates to each button on a menu interface, the button text (or description of the button) is read to the user (e.g. children, visually-impaired) for ease of use. Alternatively, the audible sound could be a sound effect (e.g. click, pop, beep). In addition, the menu narration stream can be streamed and/or downloaded from a network.

4.4.11 Audio Assistant for Visually Impaired

While viewing the movie the user presses the “Info” button on the remote control, triggering an “audio assistant” stream to fade in and mix with all other audio currently being presented. The audio assistant directs the user how to access additional content or features (Example; “Hello, how can I help you? Please press the right arrow button to access the deleted scenes”).

4.4.12 Audio Jukebox

The user is presented with a menu interface that lists various songs that are available for playback. The user can either choose a predefined play list to listen to or can select the individual songs to listen to.

4.5 Picture in Picture (multiple simultaneous video streams)

4.5.1 Documentary video as PIP

While playing the movie, a user opts to see a documentary about the making of a particular scene in the movie. A documentary video plays in a smaller PIP window on top of the movie at a location programmatically controlled by the content. The documentary is synchronized with what is being viewed/described in the movie. The location of the PIP window is updated programmatically based on content, device state, and user preferences.

- Example: Location is changed based on what the directors are talking about as well as to avoid conflict with the position of the subtitles.

4.5.2 PIP transition

While watching a bonus video overlaid as PIP on the feature film, the user presses a remote control button to transition the PIP to become full screen and the feature film to become PIP.

- The PIP video can reside on the disc, home network server, other local cache, or internet server.

4.5.3 Keyed supplemental video

A director's audio/video commentary plays during playback of the main movie. The directors are displayed in the form of a video that is keyed (e.g. chroma-keyed) over the movie (i.e. not a fixed shape, size, or location).

4.5.4 Multiple PIP videos

When the user selects the "multi-scene" mode from a menu interface the user is presented with other scenes (behind the scenes, storyboards) that can be viewed in two PIP windows while the movie continues to play. The user can highlight each PIP window individually and resize it on the fly.

4.6 Alternative Subtitles

4.6.1 Alternate subtitle stream

An alternate subtitle stream which has been previously downloaded and cached on the user's home network is listed on the subtitle menu along with all of the on-disc subtitle streams. When selected the alternate subtitle stream is synchronized to the feature film.

- The user can toggle between the cached subtitle stream and the disc based subtitle streams via the remote control without interrupting the video.

4.6.2 Graphical commentary

A director's graphical commentary stream which has been previously downloaded and cached on the user's home network is selected by the user from a menu interface for playback. When selected, the graphical commentary is synchronized with and overlaid onto the primary video.

4.6.3 Selectable words in subtitles

While viewing the movie the user highlights and activates a particular word or sentence in the subtitle stream to learn more. The words that are selectable by the user are defined by the content (i.e. not all words are selectable).

4.7 Alternate Playback Order & Play Lists

4.7.1 Parental control-based play lists

The movie is automatically “scripted” based on parental control levels and can be controlled in all of the following ways:

- Scenes of a mature nature are automatically skipped. This process does not require any re-editing of the movie, as the selected scenes are automatically skipped as defined in the “script.”
- Scenes of a mature nature are replaced with alternative segments of audio/video/subtitles.
- Scenes of a mature nature are muted/blocked (i.e. audio is muted, subtitles are blocked, offensive portions of the video screen are masked).

4.7.2 Scene Medleys

A user makes a selection in a menu interface to retrieve all the music videos used in a movie. The various music videos are indexed into a play list for selection by the user. The user selects the individual music videos to be played back or activates a “Play All” button in sequential, random or shuffle mode to play all of the videos in the play list. The transition between each video in the play list is seamless.

4.7.3 Shared scene medleys

A user creates a personal “Scene Medley” of his/her favorite scenes in a movie. The scenes are scripted to play in the order as determined by the user. In addition, the user has the option to record and mix their own audio commentary with the various scenes. The resulting scene medley (script and audio commentary) can be posted to an internet server and shared with friends.

- The posted scene medley can only be accessed by a user that has the disc in the drive.

4.7.4 User search

A user searches the disc/movie for his/her favorite scenes or actors. Based on the search criteria, each scene containing the selection is presented to the user in a menu interface. The users can either select individual scenes or play all the scenes.

4.7.5 Browse-able slide show

The user browses a set of slides (slide show) wherein the user controls the presentation (i.e., changing of slides) without affecting the audio playing in the background.

4.7.6 Multi-Story

While viewing, the user selects a particular character in order to see unique angles and a unique playback sequence. The selections are made during video playback.

4.7.7 Seamless multi-angle

A multi-angle presentation is playing with different menu options for each angle (e.g. different number of buttons, different navigation commands). As the user changes angles via the remote control or menu interface buttons the angle switching is seamless.

4.7.8 Stored multi-angle play list

The user plays through a seamless multi-angle sequence and change angles at various times using the remote control. The locations and angle numbers viewed are stored into memory. The user can subsequently play back the stored angle sequence seamlessly.

4.7.9 Seamless multi-angle with multiple audio streams

The user plays through a seamless multi-angle sequence in which each angle has its own unique audio and video stream (e.g. concert video where each angle features a certain musician and whose audio emphasizes that particular musician). The user can toggle through the various angles using the remote control without interruption in the audio or video.

4.7.10 Alternate dialog segments

The user makes one or more selections for alternate dialog segments (e.g. to replace the word “apples” with the word “oranges”). While viewing the main program audio is periodically replaced according to the user’s previous selection.

4.8 Updateable Content

4.8.1 Seamless presentation and notification of updated content

Upon start of playing a disc, the disc automatically determines if additional content is available in the local cache (hard drive), on the home network or on the internet and then either (1) notifies the user such additional content is available (via button, or overlay graphic), or (2) seamlessly presents the additional content as if it was authored onto the DVD itself.

4.8.2 Updated actor biography

A user selects to view the actor biography for a specific movie. The player connects to a content-owner-authorized location and determines that updated actor biography information is available for the currently played disc. The updated content is downloaded resulting in an updated actor biography menu that is presented to the user. In addition, the buttons can link to additional on-disc or cached information, or link to additional biographical data online.

4.8.3 Updated trailers

Based on the user profile and the disc in the player/drive, updated trailers for that studio are automatically downloaded and cached. The next time a disc from that studio is played, the trailers are automatically played before playing the movie. The trailers are presented to the consumer just as if they were on the disc. The disc's navigation is automatically updated and gives the consumer the ability to "skip" the trailers, as is already possible if the trailers are on the disc.

4.8.4 Automatic Update

New content is automatically downloaded and merged into the on-disc menu navigation as if the downloaded content were originally part of the disc. Likewise, when certain data is unavailable (e.g. has not finished downloading) the user interface handles this situation gracefully.

4.8.5 Manual Update

The menu interface contains a button, which if selected by the user, checks for updated content on the server. The user is presented with a list of the available content from which the user can select. The selected content is downloaded and merged into the on-disc menu navigation as if the downloaded content were originally part of the disc.

4.9 Online Content & Events

4.9.1 Disc-based user chat

While connected to the internet and with a specific disc loaded in the player the user chats with other users and/or cast and crew. While chatting the user can post a bookmark to a specific scene in the disc.

- While engaging in the chat the user utilizes a wired or wireless keyboard.
- If a keyboard is not available the user is presented with an onscreen “virtual” keyboard.

4.9.2 Disc-based synchronized event

While connected to the internet the user creates or joins an event that automatically synchronizes the playback of the movie in each user’s player. If the user joins the event prior to the event starting, a timer graphic appears that indicates the amount of time until the event starts (a similar timer graphic could be displayed during the event indicating time remaining). While the movie plays back various events that may take place include:

- Chat event in which each user can post and read messages.
- Streaming director’s commentary while movie plays.
- Network based interactive challenge.

4.9.3 e-Commerce

When a user selects an item to purchase the user enters billing/address/shipping information via a keyboard or a “virtual keyboard” that appears on the screen. The user submits the information (to the server) which completes the transaction

- User’s billing information can be saved in their user profile for future use.

4.9.4 Messaging

While playing a disc the user joins a club associated with that disc. Once a member of the club and while playing back the disc the user receives messages from the server which give links to content on a network server or the disc. In addition, the user sends/receives messages to/from other members of the club (e.g. invitation to watch a different movie).

4.10 Interactive Challenges & Activities

4.10.1 Multi-player games

Users play a game that allows up to two simultaneous players (via multiple remote controls or other input devices).

4.10.2 Game synchronized to video

User plays a game that is synchronized to video.

- Sound effects associated with actions in the game are mixed with all other audio currently being presented.

4.10.3 Programmatic graphic control

User plays a game in which a target is positioned on the screen designating where the user wants to fire their weapon (e.g. at an alien). The user utilizes a remote control or other input device to play. The positioning of the target is determined solely by the user's input.

4.10.4 Collision detection

User is playing the same game as in scenario 3 above. When the user hits a button on the remote control (e.g. enter) a laser shoots from the weapon towards the alien designated by the target position. If the laser hits the alien an explosion animation is visible on the screen.

4.10.5 Scoring

While playing a game a score is tabulated for each 'hit' the user makes. After the game is finished the score (if high enough) is added to a high scores list which is stored persistently for future use.

4.10.6 Timer

While playing a game a timer is visible on the screen showing how much time is remaining in the level.

4.10.7 Score-based links

Upon achieving a high enough score, the user is presented with a link to download/stream content from an internet server or access additional content on the disc.

4.10.8 Fantasy team updates

User can pick a 'fantasy team' for a particular sport while connected to the network. While making player selections updated content is streamed from an internet server to assist the user in making the selection.

4.10.9 Children's tracer tool

Child plays "learning to draw" game. The game features a trace mode where the child can freeze a frame of the video and trace over the video frame. While tracing the child can toggle the reference video frame on/off. Once the trace is complete the child can color/fill the drawing, save it locally or to a home network, and print it out.

4.10.10 Interactive coloring game

Presented with a still image the user can choose from a predefined palette of colors and can actively color in the image. The resultant colored image can be saved locally or to a home network and printed.

4.10.11 Photo scrapbook

The user captures a frame of video without audio/video interruption and saves it to local storage or on the home network. Using the various frames captured the user makes a scrapbook and can add text, draw on each image, or post the scrapbook to an internet site.

4.11 Personalization

4.11.1 Personal commentary

A consumer creates their own audio commentary, synchronized with a selected portion of the movie (or a studio predefined portion), and then posts the new commentary to the network for other users to hear and enjoy. Example: User records their own sports commentary for a football game.

4.11.2 Personalized video masking

A user imports or downloads a photo of his/herself and then overlays this image over a character's face. As the camera point of view changes the image tracks accordingly.

4.11.3 Bookmarks

The user ejects the disc from the player and the current playback location of the disc is automatically saved, so that the next time the disc is played it can resume from its last playback location.

4.11.4 Personalized game clues

The portions of the disc that have been played by a user are stored (such as finding items for a Treasure Hunt) in persistent memory, so that next time the disc is played, all the "clues" found from a prior viewing can be used in a subsequent viewing.

4.11.5 Personalized play list

A user desires to create a play list of all their favorite fighting scenes across the episodes of a movie, and then shares this play list with their friends. The user tags the entry and exit points for each scene (annotates with text, audio, or other information), and then sends to their friends.

- Friends can only access if they have an "authenticated" version of the movie (disc or otherwise).

4.11.6 User profile-based play list

A studio provides the "best-of" scenes for a user based on their preferences. A movie's scenes are indexed in a variety of ways (by actor, action, location, etc.). Those scenes that most closely match a user's profile are listed in a menu interface for the user to select.

4.11.7 Personalized viewing experience

Customized or personalized displays are overlaid to customize a consumer's viewing experience:

- Sports team
- Your face
- Favorite Soda (Coca Cola versus Pepsi)

4.11.8 Customized playback experience

Upon insertion of an HD-DVD disc in a particular player the user is presented with customized content based on the playback system resources, device state, and available input devices. For example, if the player currently has only one remote control then the user will not have access to a game on the disc which requires multiple remote controls.

4.11.9 Personalized pause frame

Parents are watching a movie which contains sexual content. When children enter the room the parents press the “pause” button on the remote control, at which point the image on the video screen is replaced with an alternate image (e.g. box art) instead of the frame from the movie (which is sexually explicit).

- This feature can be activated or deactivated by user preference.

4.11.10 Personalized player preferences

The user sets the player preferences which may include:

- Output device resolution and aspect ratio
- Display state (enabled/disabled)
- Parental Control state (on/off)
- Network connection type
- Time Zone
- Geographic Location
- Household location (e.g. den, bedroom)

4.11.11 User profiles

The user creates a user profile that is stored persistently in the player and can personalize it with criteria that may include:

- Allowed rating or parental level
- Age
- Male vs. Female
- Basic vs. Advanced content modes
- Content genre preferences (e.g. Western, Sports)
- Playback preferences (e.g. display mode, text size)
- E-Commerce information (e.g. billing address, credit card number)
- Preferred input device (Basic remote, Remote with diagonal keys, Remote with pointer capability, mouse, keyboard, etc.)

4.11.12 Profile-based playback

Parents want limited control access for their child. The parents create a user profile for the child and set the player to that particular profile. The player stays in the child’s profile until it is actively changed. When the child inserts the disc the subsequent options shown are based on that profile (e.g. does not show audio setup, online content, etc).

4.11.13 Multi-Disc User Experience

A user is playing the first disc of a multi-disc set. At a pre-defined or programmatically determined time the user is prompted to eject the first disc and insert the second disc. Upon inserting the second disc the user experience continues on where the first disc left off (e.g. game continues, user history from first disc is retained).

5. Requirements

Apart from the requirements listed in this document it is required that the HD DVD Video application layer will support and improve upon features offered in DVD such as regional coding, multiple menu languages, soundtracks, subtitles, and angles that can be selected programmatically, by player default settings, or user input.

Each functional requirement has been assigned a designation of 1, 2, or 3, defined as follows:

1 = An AH0-10 defined Feature and its associated Performance Level shall be mandatory and implemented as intended in AH0-10 documents.

2 = An AH0-10 defined Feature shall be mandatory at a minimum Performance Level as defined in the AH0-10 documents. Implementing higher Performance Levels is considered a player implementation and differentiation issue.

3 = Provided by AH0-10 as important requirements that may be out of scope of HD DVD Video Specifications 1.0, however are integral to developing a successful next generation packaged media format and should not be precluded by the HD DVD Video Specifications 1.0.

5.1 A Single Format

A single format and file system for CE and PC devices.

5.1.1 Operating System Independent

Designation:	1
Example Applications:	N/A
Functional Requirements: Application format and subsequent user experience should not depend on the operating system of the playback device (e.g. Windows, Linux, Mac OS).	
Key Performance Requirements: N/A	

5.1.2 Consistent Experience

Designation:	1
Example Applications:	N/A
Functional Requirements: Application should deliver a consistent experience in both CE and PC devices.	
Key Performance Requirements: N/A	

5.2 Picture Quality

Picture quality should be equal to or better than other sources of consumer HD content and should support multiple TV standards and aspect ratios.

5.2.1 Video Source Standards and Resolutions

Designation:	1
Example Applications:	N/A
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Source content including film/telecine content, progressive video, or interlaced video in native format, frame rate, and aspect ratio. 2) Support for video source resolutions up to 1920x1080 and frame rates up to 60p. 3) Support for lower resolutions (e.g. SD, SIF, CIF). <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) In the case of 60 Hz region, 3:2 pull down flag is mandatory for movie (film content), which means that synchronization between video, audio, sub-picture, and advanced objects follows 60 Hz vertical synchronization signal. 2) In the case of 24p source content, when the 3:2 pull down flag is used for 60 Hz region, picture level encoding is performed on a frame-basis. In addition, such 24p elementary video streams can be converted during content creation (authoring) to corresponding 50 Hz elementary video streams. 3) The encoded frame rate of primary video and secondary video shall be 60 Hz for 60 Hz region and 50 Hz for 50 Hz region. 	

Key Performance Requirements (5.2.1):

- 4) Source picture resolutions, frame rates, and aspect ratios for 60 Hz Regions:

Table 5.2.1.1

Horizontal	Vertical	Encoded Frame Rate	Aspect Ratio
1920	1080	29.97 (*Note 1)	16:9
1440	1080	29.97 (*Note 1)	16:9
1280	1080	29.97 (*Note 1)	16:9
960	1080	29.97 (*Note 1)	16:9
1280	720	59.94 (*Note 2)	16:9
720	480	59.94 (*Note 2)	16:9
704	480	59.94 (*Note 2)	16:9
720	480	29.97 (*Note 1)	16:9/4:3
704	480	29.97 (*Note 1)	16:9/4:3
544	480	29.97 (*Note 1)	16:9/4:3
480	480	29.97 (*Note 1)	16:9/4:3
352	480	29.97 (*Note 1)	16:9/4:3
352	240	29.97 (*Note 1)	16:9/4:3

*Note 1: 59.94i, 29.97p, and 23.976p with 3:2 pull-down

*Note 2: 59/94p and 23.976p with 3:2 pull-down

Key Performance Requirements (5.2.1):

- 5) Source picture resolutions, frame rates, and aspect ratios for 50 Hz Regions:

Table 5.2.1.2

Horizontal	Vertical	Encoded Frame Rate	Aspect Ratio
1920	1080	25 (*Note 1)	16:9
1440	1080	25 (*Note 1)	16:9
1280	1080	25 (*Note 1)	16:9
960	1080	25 (*Note 1)	16:9
1280	720	50 (*Note 2)	16:9
720	576	50 (*Note 2)	16:9
704	576	50 (*Note 2)	16:9
720	576	25 (*Note 1)	16:9/4:3
704	576	25 (*Note 1)	16:9/4:3
544	576	25 (*Note 1)	16:9/4:3
480	576	25 (*Note 1)	16:9/4:3
352	576	25 (*Note 1)	16:9/4:3
352	288	25 (*Note 1)	16:9/4:3

*Note 1: 50i and 25p

*Note 2: 50p and 25p with 2:2 pull-down

5.2.2 Video Rendering and Compositing

Designation:	1
Example Applications:	4.1.1 , 4.3 , 4.5 , 4.8.2 , 4.8.3 , 4.10.3 , 4.10.9 , 4.11.2
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Ability to scale and crop individual visual objects (e.g. video, graphics, text, subtitles). 2) Ability to position, composite, and render video, graphics, text, and subtitles into a final presentation. 3) Ability to render content in appropriate aspect ratio according to the aspect ratio of the display device via player set-up (e.g. 16x9 content on 4x3 display and vice versa). 4) Ability to decode and present two video streams simultaneously. <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Legacy subtitles shall at a minimum support the functionality specified in DVD Video 1.1. 2) Static scaling of video shall support at least a finite set of scaling ratios <ul style="list-style-type: none"> • Ratios to be determined by WG-1. • Behaviours should be defined for the case that the mark-up requests the video to scale outside the allowed scaling ratios. • Behaviours should be defined to handle square pixel and non-square pixel video. 3) Animated scaling (zooming) of video should be treated as follows: <ul style="list-style-type: none"> • The start and end points of the animated scaling should conform to the same scaling ratios defined above (see 2 above). 4) Players should support smooth scaling of bitmap graphic objects and vector graphic objects (including text). 5) Graphic objects can be clipped pixel accurately. <ul style="list-style-type: none"> • Specifically, graphics can appear to reside between the primary video and secondary video. 6) It should be possible to clip objects (including secondary video) according to layout information. 7) Player should be capable of drawing full-screen HD resolution graphics (1920x1080) plus some additional amount of overlaid graphics with alpha blending. These graphics should be capable of being updated each frame. WG-1 should conduct the necessary study to determine the actual values. Decoding overhead should be considered while conducting this study. 8) The maximum on-screen positioning range for objects shall be up to 1920x1080 (as defined by content). Further restrictions should be defined by WG-1. 9) The minimum number of graphic objects to be supported simultaneously by the player is 512. 10) The minimum number of overlapping layers to be supported simultaneously by the player is 99. 11) Graphics may overlap over secondary video. 	

5.2.3 Video Output Resolution

Designation:	2
Example Applications:	N/A
<p>Functional Requirements: Ability to convert the resolution of rendered content for output to accommodate all HD displays as well as SD displays.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Players shall have the capability of one of the following: <ol style="list-style-type: none"> a. HD-50 output and PAL SD output b. HD-60 output and NTSC SD output c. HD-50/HD-60 output and PAL/NTSC SD output 2) Players should effectively handle conversion of progressive source for interlaced display and vice versa. 3) When source content is progressive, players that support progressive output should output full vertical resolution without filtering for interlace. 4) Players shall have the ability to maintain a fixed output scan rate and resolution regardless of changes in the source content (e.g. 1080p to 480i). 	

5.2.4 Video Output Frame Rate

Designation:	2
Example Applications:	N/A
<p>Functional Requirements: Ability to adjust output frame rate to accommodate HD displays as well as PAL and NTSC SD displays.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Players shall have the capability of one of the following: <ol style="list-style-type: none"> a. HD-50 output and PAL SD output b. HD-60 output and NTSC SD output c. HD-50/HD-60 output and PAL/NTSC SD output 2) It is not required for players to convert 50 Hz content to 60 Hz output and vice versa. 	

5.2.5 Disc Playtime

Designation:	1
Example Applications:	N/A
Functional Requirements: Capacity on a single optical disc for feature-length motion picture and bonus material typical for DVD with picture quality as defined above.	
Key Performance Requirements: N/A	

5.3 SD and HD Content

Support for both SD and HD content on the same disc.

5.3.1 Switching Between Different Resolutions and Codecs

Designation:	2
Example Applications:	N/A
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Ability to switch between different video source resolutions. 2) Ability to switch between different video codecs. <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) The maximum pause duration during resolution change shall be specified by WG-1. 2) The maximum pause duration during video codec change shall be specified by WG-1. 3) When a pause occurs the player shall display the last frame of the previous resolution/codec until playback continues (i.e. there should not be a black frame displayed). 4) When a pause occurs the player shall mute the audio; when playback continues the audio will continue playing in sync (no frames of audio are lost). 	

5.4 Audio

Support for multi-channel lossy and lossless audio.

5.4.1 Lossy Audio Codec

Designation:	1
Example Applications:	4.4.1 , 4.4.10 , etc.
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) At least one codec should be optimized for movie soundtracks. 2) At least one codec should be optimized for Internet delivery. 3) Support for up to 8 channels (e.g. 7.1) source audio. 4) Support for 2 channel output when source audio is greater than 2 channels. 5) Support for 6 channel output when source audio is greater than or equal to 6 channels. (e.g. 7.1 to 5.1 channels). 6) Support for a minimum of 2 channel analog output. <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) A maximum of 8 channels (8.0 or 7.1) shall be supported for primary video. 2) A minimum of a 2 channel output shall be supported by the player. <ol style="list-style-type: none"> a. Player shall support mix down to 2 channel output when source is greater than two channels (e.g. 7.1, 5.1). b. Mix down shall be done in accordance with provided metadata in the audio elementary stream. 3) When the player has a 6 channel output, the player shall support the 6 channel output when the source is equal to or greater than 6 channels (e.g. 7.1). 4) Switching between audio streams within the primary video should occur within a maximum time frame specified by WG-1. <ol style="list-style-type: none"> a. Switching between disc based audio and network based is subject to network QOS. 5) Audio for secondary video shall be constrained as follows: <ol style="list-style-type: none"> a. Source audio shall be one or two channels. b. Source audio sampling rate shall be 12 kHz, 24 kHz and 48 kHz. 	

5.4.2 Lossless Audio Codec

Designation:	1
Example Applications:	N/A
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Lossless codec should be mathematically lossless. 2) Support for up to 8 channels (7.1) source audio. 3) Support for stereo output. 4) Support for 6 channel output when source audio is greater than or equal to 6 channels. (e.g. 7.1 to 5.1 channels). 5) Support for a minimum of 2 channel analog output. 6) Support for protected digital outputs with bandwidth greater than S/PDIF (e.g. HDMI). 7) Ability to integrate with lossy codecs to support legacy devices. <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Lossless audio should be mathematically lossless (bit-for-bit accurate to the source). 2) A maximum of 8 channels (8.0 or 7.1) shall be supported for primary video. 3) A minimum of 2 channel output shall be supported by the player. <ol style="list-style-type: none"> a. Player shall support 2 channel output when source is greater than or equal to two channels (e.g. 7.1, 5.1). b. 2 channel output should be lossless or controlled by metadata provided in the audio stream (i.e. controlled by content owner). 4) Switching between audio streams within the primary video should occur within a maximum time frame specified by WG-1. <ol style="list-style-type: none"> a. Switching between disc based audio and network based audio is subject to network QOS. 5) Support for protected digital outputs is optional and/or may be determined by the copy protection license. However, when a digital output is used it shall be protected and have a bandwidth greater than S/PDIF. 	

5.4.3 Uncompressed Audio (LPCM)

Designation:	1
Example Applications:	N/A
Functional Requirements: <ol style="list-style-type: none">1) Support for uncompressed LPCM source audio.2) Support for sampling rates equal to that of DVD Audio for LPCM audio.3) Support of mix down of LPCM source audio equal to that of DVD Audio.	
Key Performance Requirements: <ol style="list-style-type: none">1) A maximum sampling rate of 192 kHz shall be supported for LPCM audio.<ol style="list-style-type: none">a. Note for 192 kHz sampling rate only stereo LPCM should be supported.2) Mix down shall be performed in accordance with the audio attribute information provided by the content provider.3) Audio for sound effects shall be constrained as follows:<ol style="list-style-type: none">a. Source audio shall be one or two channels.b. Source audio sampling rate shall be between 12 kHz, 24 kHz, and 48 kHz.	

5.4.4 Audio Mixing

Designation:	2
Example Applications:	4.2.5 , 4.4.2 -4.4.8 , 4.7.1 , 4.7.3 , 4.7.10 , 4.10.2
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Ability to dynamically mix multiple audio streams from non-volatile memory, volatile memory, disc, or network, based on metadata, user input, or other application logic. 2) Audio streams should be accessible from different sources including the disc, internet, network, or persistent storage. 3) Ability to mix audio streams relative to video, metadata, and graphics regardless of source (e.g. disc, website, or local network). 4) Ability to mix audio streams of different types, including codecs (whether lossless or lossy), sampling rate, or bit depth. 5) Support for delivery of audio files much larger than buffer memory. 6) Support for graceful resynchronization of video and audio following user navigation, Pause, Rewind, Chapter Play, or network drop-out, etc. 	

Key Performance Requirements (5.4.4) :

- 1) A maximum of three audio streams can be mixed simultaneously:
 - a. Audio for primary video
 - b. Audio for secondary video
 - c. Audio for sound effect
- 2) Metadata can be provided with the audio for the secondary video and/or sound effect audio which contains mixing information:
 - a. Channels in the audio of primary video that the audio shall be mixed to.
 - b. Mix levels for each audio stream (primary, secondary, and/or sound effects).
 - c. Content providers should take care when mixing audio for secondary video or sound effect audio so that the mixed audio is not lost when output as stereo (e.g. In the case where audio for primary video is 7.1 channels and audio for a sound effect is 2.0, if the sound effect is mixed into the rear channels then the sound effects may be lost when the player output is stereo).
- 3) Mixing metadata can be provided in the navigation information. Mixing metadata can be dynamically changed via navigation information.
- 4) In the absence of metadata the mixing shall be controlled by the player. In this case the player shall not allow the amplitude of the mixed audio to exceed the peak level (0 dB fs).
- 5) All audio shall be synchronized to the audio of the primary video.
 - a. WG-1 should study how to handle the case when primary video does not exist for an application.

5.4.5 Audio Output

Designation:	1
Example Applications:	N/A
<p>Functional Requirements: Support for speaker mapping for multi-channel output.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Each source audio channel should be associated with an audio channel identification tag indicating which channel it represents (Center, Left, Left Surround, etc.). <ul style="list-style-type: none"> • The player should be capable of using the audio channel identification tags to send the appropriate audio to the appropriate audio output (speaker). • Identification tags should be determined by WG-1. 2) Applications should be capable of querying the player's audio output settings (e.g. S/PDIF, HDMI) <ul style="list-style-type: none"> • An appropriate memory register (e.g. SPRM) should be identified by WG-1. 3) Players which choose to add an S/PDIF output should be capable of being triggered by content to send legacy streams to the output (rather than the output of the audio mixer) as follows: <ul style="list-style-type: none"> • Dolby: Multi-channel Dolby AC3 streams • DTS: Multi-channel DTS Core streams • MLP: Lossless stereo sub-streams (PCM) 	

5.5 Authoring

Format should support an efficient authoring process.

5.5.1 Authoring Tools

Designation:	3
Example Applications:	N/A
Functional Requirements: <ol style="list-style-type: none"> 1) Authoring tools should support all functions of the specifications (e.g. seamless branching). 2) In addition to audio/video encoding, application authoring, multiplexing, and premastering tools, applications should be available that provide for the simulation (prior to multiplexing) and emulation (after multiplexing) of the final authored data. 	
Key Performance Requirements: N/A	

5.5.2 Authoring Verification

Designation:	3
Example Applications:	N/A
Functional Requirements: <ol style="list-style-type: none"> 1) DVD Forum should provide verification tool that confirms authored data complies with the DVD specifications. 2) DVD Forum should provide a verification process for authoring tools to ensure compliance with the DVD specifications. 	
Key Performance Requirements: N/A	

5.6 Graphics

Format should support advanced graphics including images, animation, and rendered text.

5.6.1 Graphic Object Properties

Designation:	1
Example Applications:	4.1 , 4.2.1 -4.2.4 , 4.2.6 -4.2.10 , 4.3 , 4.5 , 4.6 , 4.7.1 , 4.8.4 , 4.8.5 , 4.10.3 , 4.10.4 , 4.10.6 , 4.10.9 -4.10.11 , 4.11.7
<p>Functional Requirements: Ability to dynamically change the properties of all graphics objects (e.g. position, opacity, color, behaviours, size).</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Graphic objects can be clipped pixel accurately. <ul style="list-style-type: none"> • Specifically, graphics can appear to reside between the primary video and secondary video. 2) It should be possible to clip objects according to layout information. 3) The maximum on-screen positioning range for graphic objects shall be up to 1920x1080 (as defined by content). Further restrictions should be defined by WG-1. 4) The frequency with which graphic object properties can be changed shall be specified by WG-1. 5) The complexity limit for the graphics plane should be measured by the number of pixel updates per second: <ol style="list-style-type: none"> a. Pixel updates per second is calculated by using the total number of layers (z-order), number of objects, screen area, number of pixels changing per frame (e.g. via animation or opacity change) and multiplying by the output frame rate. 	

5.6.2 Animation

Designation:	1
Example Applications:	4.1.1 , 4.1.2 , 4.2.1 , 4.2.10 , 4.3.1 -4.3.3 , 4.10.4 , 4.11.2
<p>Functional Requirements: Support for advanced animation with programmatic control.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) The minimum animation frame rate displayed by the player is 15 frames/sec at a bit depth of 24 bits per pixel plus 8-bit alpha channel. 2) WG-1 should provide a matrix of achievable combinations of resolution and frame rate. 	

5.6.3 Text

Designation:	1
Example Applications:	4.2.9 , 4.9 , 4.10.5
<p>Functional Requirements: Support for dynamically rendered text using content provided fonts.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Font data shall be loaded into volatile storage (e.g. data cache) before rendering the text. 2) At least a subset of OpenType format fonts shall be supported. 3) Player should be capable of rendering a full screen of text in a reasonable amount of time. 4) Fonts should be provided from application data either from disc or network. 5) In the case fonts are not provided by the application data, the player should provide a default resident font. 6) Text should support the same effects as other graphic objects (e.g. fade, scroll, scale). 	

5.6.4 Relation of Graphics to other Content Objects

Designation:	2
Example Applications:	4.1 , 4.2.1 -4.2.4 , 4.2.6 -4.2.10 , 4.3 , 4.5 , 4.6 , 4.7.1 , 4.8.4 , 4.8.5 , 4.10.3 , 4.10.4 , 4.10.6 , 4.10.9 -4.10.11 , 4.11.7
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Ability to scale, crop, overlay and position graphics based on Cartesian coordinate system. 2) Ability to synchronize presentation of graphics relative to video, audio, and text regardless of source (e.g. disc, website, or local network). 3) Support of alpha blended graphics over video (e.g. by object, by layer). 4) Ability to deliver multiple streams of graphics from disc or network. 5) Ability for the content to update visual presentation to overlay graphics in relation to other content (c.f. 5.9.1). <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Regarding scaling and cropping, see section 5.2.2. 2) Alpha blending of graphics should offer pixel level and object level blending. 3) When playing a disc, graphic objects can be updated without interrupting primary video playback. 	

5.6.5 Pointer/Cursor

Designation:	1
Example Applications:	4.2.10 , 4.10.3 , 4.10.9 , 4.10.10
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Support for pointer/cursor with its appearance controlled by content. Cursor graphic would be provided and capable of being updated by content owner. 2) Pointer/cursor can be positioned by the user based on content rules. <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) The minimum size of a cursor graphic object that should be supported by the player is 200 x 200 pixels. 2) At a minimum cursor images should support at least 256 colors. 3) Support for arbitrary cursor movement controlled by content. 4) Application data should be capable of dynamically changing the cursor image based on layout information. <ol style="list-style-type: none"> a. A minimum of four cursor images should be available to an application. 5) As with other graphic objects, cursor images should support pixel level or object level alpha blending. 	

5.7 Streaming Objects

Format should support the playback and integration of streaming objects from a network.

5.7.1 Support for Streaming Objects

Designation:	2
Example Applications:	4.4 , 4.5.2 , 4.6.1 , 4.6.2 , 4.8 , 4.9.2 , 4.10.7 , 4.10.8

Functional Requirements:

- 1) Streaming objects include audio, video, graphics, subtitles, text and metadata.
- 2) Support for both broadcast (unicast) and on-demand types of streaming objects.
- 3) Support for multiple simultaneous streaming objects (e.g. multiple audio streams, audio with graphics).
- 4) Support for trick play of streaming objects (e.g. fast forward, rewind).
- 5) Support for random access of streaming objects (e.g. chapter navigation).
- 6) Ability to switch between multiple streaming objects (e.g. multiple audio streams) on the fly via remote control or user interface.
- 7) Ability to switch between streaming objects and disc-based objects on the fly via remote control or user interface (e.g. streaming audio streams with disc-based audio streams).
- 8) Ability to synchronize downloaded and/or streaming objects relative to disc based content and vice versa (c.f. 5.13.4).

Key Performance Requirements:

- 1) The assumed network throughput is at least 512 kbps.
- 2) The player should support streaming of a combined audio/video/subtitle stream.
- 3) Player should support pre-buffering of streaming content. Applications can change the size of the stream buffer to optimize performance.
- 4) Applications can query the network capabilities and either the application or the server may select the appropriate stream bitrate available.
- 5) While player is receiving streaming content the player should be able to support additional network connected activities (e.g. e-commerce, content management) without interrupting the streaming content.
 - a. It is understood that content provider needs to manage the user's experience based on the network conditions.
- 6) While player is receiving streaming content the application should be able to send data back to the server.
 - a. This data could be used to affect the playback of the application.

5.8 Navigation

Format should support advanced navigation capabilities.

5.8.1 Presentation of Graphics

Designation:	1
Example Applications:	4.1.1 , 4.2.1 -4.2.4 , 4.2.6 -4.2.9 , 4.3.4 , 4.3.5 , 4.5.4 , 4.7.5 , 4.8.1 , 4.9.2 , 4.10.2 , 4.11.2 , 4.11.7
<p>Functional Requirements: Capability of graphics to be user accessed and presented without audio/video playback interruption, (e.g. non-modal menus).</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Content such as graphics, navigation menus, commentary tracks, theatrical trailers, deleted scenes, documentaries, and DVD-ROM features like scripts, web links, games, and screen savers are retrieved, rendered, and presented in real time, at the frame rate or sample rate of the master content. 2) Access, decoding and presentation of objects must occur without interruption of primary audio/video while source files are prepared for presentation. 3) Content on an HD DVD is accessed, buffered and rendered such that user navigational input does not cause a pause or any objectionable delay or interruption in the video, audio, subtitles and other graphics. 	

5.8.2 Interactive Objects

An object may be acted upon by a user (i.e. user interaction) or acted upon by another object (i.e. object interaction).

Designation:	1
Example Applications:	4.1 , 4.2 , 4.3.1 , 4.3.4 -4.3.7 , 4.4.10 , 4.4.11 , 4.5.2 , 4.5.4 , 4.6.3 , 4.7.4 , 4.7.8 , 4.8.5 , 4.10.3 , 4.10.4 , 4.10.8 -4.10.11 , 4.11.5

Functional Requirements:

- 1) Interactive objects can include any content object (e.g. graphic, group of graphics, streaming object, audio or video).
- 2) Interactive objects may include other types of objects (e.g. buffer manager, network manager).
- 3) Interactive objects respond in real time and are capable of being manipulated by the advanced content (e.g. rollover effects, drag and drop, collision detection).

Key Performance Requirements:

- 1) Each object may be assigned a unique identifier.
- 2) Content should be capable of controlling the loading and unloading priority of each object.
- 3) No two objects, based on the same type, can have the same values for the properties of its Unique ID.
- 4) An application can arbitrarily show/hide or enable/disable interactive objects.

5.8.3 Random Access

Designation:	1
Example Applications:	4.1.1 , 4.3.3 , 4.4.1 , 4.4.3 , 4.4.11 , 4.4.12 , 4.6.1 , 4.7 , 4.8.2 , 4.8.3 , 4.8.5 , 4.9.2 , 4.10.9 , 4.10.11 , 4.11.3 , 4.11.5 , 4.11.6 , 4.11.8 , 4.11.12
<p>Functional Requirements: Ability to navigate and randomly access content (either programmatically and/or by user operation) by timecode as well as Title, Chapter, Program, Song and other logical divisions.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Content should be able to specify that an animation should begin or end either by API call or mark-up. 2) The content should be able to manage system resources (e.g. cache, network, disc access) in order to preload content such that the user perceives the interactive experience as spontaneous and non-linear. 3) Timecode format should be video frame accurate. 	

5.8.4 Content Referencing

Designation:	1
Example Applications:	N/A
<p>Functional Requirements: Ability to reference resources and/or content based on URI (not physical file path).</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Official registration of URI scheme names is maintained by IANA. The URI scheme can accommodate existing identifiers from well established namespaces and must be in compliance with generally accepted practices and all applicable URI schemes (e.g. IETF RFC 3305, RFC 2838, RFC 3861, RFC 1630, RFC 2396, RFC 3120, RFC 2276, RFC 3187, RFC2616, RFC 2717 at http://www.ietf.org/rfc). 2) The URI scheme for HD DVD shall be a subset of those maintained by IANA. 3) Scheme allows access to objects available using existing protocols, and may be extended. The scheme must be extensible so that new naming schemes may be added later. The URI scheme must be complete so that it is possible to encode any naming scheme. 4) URIs, URLs, and URNs shall be implemented so as to be consistent with the "Contemporary View" described in RFC3305 section 1, and which consider the additional URI issues listed or alluded to in RFC3305 section 3. 	

5.8.5 Relation of Programming Events to other Content Objects

Designation:	2
Example Applications:	4.2.1 , 4.2.5 , 4.2.9 , 4.5.1 , 4.7.6 , 4.7.8 , 4.7.10 , 4.9.2 , 4.10.2 , 4.10.4 , 4.11.2 , 4.11.4 , 4.11.7 , 4.11.8
<p>Functional Requirements: Ability to synchronize programming events relative to video, audio, subtitles and graphics regardless of source.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Based on a master clock (content or system) programming events and objects can be initialized, started, and restarted at the precisely the same time. 	

5.8.6 User Navigation and Accessibility Without Visual Display

Designation:	2
Example Applications:	4.2.5 , 4.4.6 , 4.4.9 -4.4.11 , 4.11.8 , 4.11.10
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Playback device shall have device display state information which indicates whether the player has its video output enabled or not. 2) The device state is stored in the player and configured either by the manufacturer of the device (e.g. preset) or the user. 3) Ability for the content to query the device display state and trigger the playback of an alternate playlist. <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) The configuration of the display state (enabled/disabled) should not be changeable during playback of a disc. 	

5.9 User Interaction and Display/Image Space

Details on user interaction and control of display/image space are described here.

5.9.1 Control of display/image space

Designation:	1
Example Applications:	4.2.4 , 4.7.4 , 4.7.7 , 4.8.1 , 4.8.5 , 4.9.1 , 4.9.3 , 4.9.4 , 4.11.3 , 4.11.8 , 4.11.9 , 4.11.13
Functional Requirements: User interface and display/image space is controlled by content once content is loaded.	
Key Performance Requirements: n/a	

5.9.2 Application Start-up and Presentation

Designation:	1
Example Applications:	4.1.1 , 4.2.1 -4.2.4 , 4.2.6 -4.2.9 , 4.3.4 , 4.3.5 , 4.5.4 , 4.7.5 , 4.8.1 , 4.9.2 , 4.10.2 , 4.11.2 , 4.11.7
Functional Requirements: <ol style="list-style-type: none"> 1) Rapid application startup of initial application segment and basic video playback. 2) Content and applications can be seamlessly loaded, presented, and updated without interrupting the aural/visual presentation. 	
Key Performance Requirements: <ol style="list-style-type: none"> 1) As the content indicates, applications on the disc may be launched without explicit intervention of the user. 2) Usability guidelines suggest no more than a 10 second delay between user action (insertion of a disc into a player) and reaction (content is presented). 	

5.9.3 Data Access

Designation:	1
Example Applications:	4.2.2 -4.2.4 , 4.2.7 , 4.2.8 , 4.4.2 , 4.4.3 , 4.7.3 , 4.7.8 , 4.7.10 , 4.8.3 , 4.9.3 , 4.10.4 , 4.10.7 , 4.11.1 , 4.11.5 , 4.11.7
Functional Requirements: <ol style="list-style-type: none">1) Ability to randomly access application data during playback of audio/video.2) Priority of access to presentation data, application data, and/or system resources should be dynamically defined by content.	
Key Performance Requirements: <ol style="list-style-type: none">1) For each application being presented its associated application data should be available for presentation when needed, and the data access should not interrupt audio/video playback.	

5.9.4 User Input Devices

Designation:	2
Example Applications:	4.9.1 , 4.9.3 , 4.10.1 , 4.11.8
<p>Functional Requirements: Support for multiple and varied controllers, e.g. keyboard, mouse, game controllers, remote control.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1. The player should support a wired or wireless remote control that supports all mandatory HD DVD playback functions and user operations. <ol style="list-style-type: none"> a. In addition to the user operations specified in Annex J of DVD Video Specifications 1.13, the following additional user operations should be supported as mandatory <ul style="list-style-type: none"> • Diagonal navigation keys or equivalent • Four (4) generic navigation keys or equivalent whose actions can be defined by advanced navigation. 2. A set of API's should exist for accessing standard controllers (optionally supported by player). <ol style="list-style-type: none"> a. Examples of standard controllers are: <ul style="list-style-type: none"> • IR remote controller • Keyboard • Joystick/game controller • Mouse 3. An API should exist to enable currently unspecified controllers to be connected to devices (optionally supported by player). <ol style="list-style-type: none"> a. Such an API should allow low-level communication with the controller. b. An example of a currently unspecified controller might be an advanced remote control with additional functions that can be used by content. 4. Content shall be able to query the player to determine what types of controllers are supported and connected at time of playback. 	

5.10 Player Storage

Details regarding application access to temporary and persistent storage are described here.

5.10.1 Volatile Memory

Designation:	1
Example Applications:	4.2.2 , 4.2.3 , 4.3.7 , 4.4.12 , 4.7.3 , 4.7.8 , 4.10.5 , 4.10.7 , 4.10.9 -4.10.11 , 4.11.1 , 4.11.10 -4.11.12
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Ability to securely store and retrieve device state information by application programming. 2) Ability to securely store and retrieve application data (e.g. temporary user selection). <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) The minimum capacity of the volatile memory (a.k.a. data cache) in the player is 64 Mbytes. 2) The volatile memory can only be accessed by the advanced navigation of the currently loaded disc. 3) The advanced navigation should be capable of moving content from the volatile memory to non-volatile memory and vice versa. 4) Regarding access rules, see 5.10.3. 	

5.10.2 Non-Volatile Memory

Designation:	1
Example Applications:	4.2.1 , 4.2.2 , 4.3.7 , 4.4.4 , 4.4.5 , 4.8.3 , 4.9.3 , 4.10.9 -4.10.11 , 4.11.3 , 4.11.4 , 4.11.13

Functional Requirements:

- 1) Ability to securely and persistently store designated information after application termination, disc eject, power cycle, or long term power loss (e.g. game scores, cookies).
- 2) Ability to securely and persistently store content regardless of source (e.g. disc, network).

Key Performance Requirements:

- 1) At a minimum the non-volatile memory (a.k.a. storage device) in the player should be capable of storing 2 ½ minutes of high definition resolution (1920x1080) audio/video encoded at an average data rate of 7.5 Mbps.
- 2) The minimum capacity should be provided as fixed (i.e. not removable) non-volatile memory that is located in the player.
 - Optionally, the player may support additional fixed or removable non-volatile memory.
- 3) Applications can read from and write to non-volatile memory.
- 4) Applications should be capable of moving data from fixed non-volatile memory to removable non-volatile memory or vice versa.
- 5) The sustained transfer rate of data that is retrieved from non-volatile memory should be 33 Mbps at a minimum.
- 6) Regarding access rules, see 5.10.3.

5.10.3 Storage Access and Rules

Designation:	1
Example Applications:	4.2.1 , 4.2.2 , 4.3.7 , 4.4.4 , 4.4.5 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9.3 , 4.10.9 -4.10.11 , 4.11.3 , 4.11.4 , 4.11.13
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Ability for applications to control rules for caching and storage of content (e.g. persistence, expiration). 2) Support for tiered access to storage by content (e.g. specific to content owner or current user). <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Access rules should be defined by WG-1, but should not conflict with content protection systems adopted by the DVD Forum. 2) At a minimum a content owner may limit read or write access to its data in non-volatile memory by other content owners. 3) At a minimum a content owner may limit read or write access to its data in non-volatile memory by another disc. 4) At a minimum players should provide a storage management mechanism that users can use to delete files and allocate storage. The specific mechanism should be defined by WG-1. 	

5.11 Network Connectivity

Playback devices must be capable of network connectivity. If unconnected, playback devices must allow playback of basic content features at a minimum.

5.11.1 Connection to a Home Network and the Internet

Designation:	1
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5 , 4.11.10 , 4.11.11
Functional Requirements:	
<ol style="list-style-type: none"> 1) Ability to connect and communicate with a home network environment consistent with open industry standards (non-proprietary). 2) Ability to connect and communicate with the Internet consistent with open industry standards (non-proprietary). 	

Key Performance Requirements (5.11.1):

- 1) Suggest WG-1 consider compliance with
 - a. DLNA (UPnP AV)
 - b. Rendezvous
- 2) For internet connectivity, WG-1 should consider compliance with:

Table 5.11.1.1

DNS	Domain Name Server, RFC 1034 and 1035, IETF
DHCP	Dynamic Host Configuration Protocol, RFC 2131, IETF
IPv4	Internet Protocol, RFC 791, IETF
UDP	User Datagram Protocol, RFC 768, IETF
TCP	Transmission Control Protocol, RFC 793, IETF
SSL	Secure Sockets Layer
TLS	The TLS Protocol version 1.0, RFC 2246, IETF
HTTP1.1	Hypertext Transfer Protocol – HTTP/1.1, RFC 2616, IETF
HTTP-AUTH	HTTP Authentication Basic and Digest Access Authentication, RFC 2617, IETF
HTTP-STATE	HTTP State Management Mechanism, RFC 2965 & 2109, IETF
HTTPS	HTTP over TLS, RFC 2818, IETF
ICMP	Internet Control Message Protocol
HOST-REQ	Requirements for Internet Hosts – Application and Support, RFC 1123, IETF
MIME	Multipurpose Internet Mail Extensions, RFC 2045 Part 1 Section 5, IETF
PKIX	Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile, RFC 2459, IETF
URI	Uniform Resource Identifiers (URI), RFC 2396, IETF. Generic Syntax. 1998.
UTF-8	UTF-8, A Transformation Format of ISO 10646, RFC 2279, IETF
UTF-16	UTF-16, An Encoding of ISO 10646, RFC 2781, IETF
IGMP	Internet Group Management Protocol, Version 3, RFC 3376, IETF

Key Performance Requirements (5.11.1):

3) For home network connectivity, WG-1 should consider compliance with:

Table 5.11.1.2

DNS	Domain Name Server, RFC 1034 and 1035, IETF
DHCP	Dynamic Host Configuration Protocol, RFC 2131, IETF
IPv4	Internet Protocol, RFC 791, IETF
UDP	User Datagram Protocol, RFC 768, IETF
TCP	Transmission Control Protocol, RFC 793, IETF
SSL	Secure Sockets Layer
TLS	The TLS Protocol version 1.0, RFC 2246, IETF
HTTP1.1	Hypertext Transfer Protocol – HTTP/1.1, RFC 2616, IETF
HTTP-AUTH	HTTP Authentication Basic and Digest Access Authentication, RFC 2617, IETF
HTTP-STATE	HTTP State Management Mechanism, RFC 2965 & 2109, IETF
HTTPS	HTTP over TLS, RFC 2818, IETF
ICMP	Internet Control Message Protocol
HOST-REQ	Requirements for Internet Hosts – Application and Support, RFC 1123, IETF
MIME	Multipurpose Internet Mail Extensions, RFC 2045 Part 1 Section 5, IETF
PKIX	Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile, RFC 2459, IETF
URI	Uniform Resource Identifiers (URI), RFC 2396, IETF. Generic Syntax. 1998.
UTF-8	UTF-8, A Transformation Format of ISO 10646, RFC 2279, IETF
UTF-16	UTF-16, An Encoding of ISO 10646, RFC 2781, IETF
IGMP	Internet Group Management Protocol, Version 3, RFC 3376, IETF

Key Performance Requirements (5.11.1):

- 4) Capability for multiple simultaneous connections (e.g. sockets) should be supported by players. Minimum number of simultaneous connections should be determined by WG-1.
- 5) Capability to support multi-player games via a network connection with acceptable latency.
 - a. A minimum of two players should be capable of playing the game.
 - b. Minimum value of latency should be determined by WG-1.
 - c. Content should be able to distinguish between reliable transfer (e.g. TCP/IP) and time-critical transfer of information (e.g. UDP).
- 6) Ability for either the content or the server to redirect users (e.g. if resources are not available an alternative URI will be presented).
 - a. Specific HTTP response status codes should be determined by WG-1.
 - b. Some response status codes should automatically be handled by the player network manager (e.g. 301).
 - c. Some response status codes should be handled by the application (e.g. 404).

5.11.2 Network State Query

Designation:	1
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5 , 4.11.10 , 4.11.11

Functional Requirements:

Ability for application to query current network state.

Key Performance Requirements:

- 1) Connection status should be available to the content (connected or not connected).
- 2) Relative throughput performance should be available to the content with configuration based information (e.g. user specifies connection quality/speed) such as
 - a. PSTN (dial-up <100 kbps)
 - b. DSL (100 – 500 kbps)
 - c. Cable (500 – 5,000 kbps)
 - d. LAN (5,000 – 10,000 kbps)
 - e. Fiber (>10,000 kbps)
- 3) WG-1 should consider support of the following network status and metrics of the current network connection:
 - a. Round trip time (RTT)
 - b. IP address assigned to the player
 - c. Physical address of the player (e.g. MAC address)

5.11.3 Network Transmission

Designation:	1
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5

Functional Requirements:

- 1) Ability to securely send and receive content and application data from a network.
- 2) Ability to provide alternate or updated navigation indices that allow for the remote discovery of content and which indicates relevant content types currently available, regardless of source.

Key Performance Requirements:

- 1) Suggest WG-1 consider compliance with
 - a. DTCP over 1394 and IP
 - b. SSL2 (OpenVPN)
 - c. IPsec VPN
 - d. PPTP
- 2) Support for content to choose either of:
 - a. User prompting (to access the alternate/updated content)
 - b. Seamless integration of the alternate/updated content
- 3) Playback should be authenticated by verifying which disc is in the drive to ensure that they merit access to this alternate/updated content.
- 4) Suggest WG-1 consider the following mechanisms to securely send and receive content:
 - a. Source and endpoint authentication.
 - b. Obfuscation of private information (e.g. cookies).
 - c. Verification that sent content has not been tampered with (e.g. signed hash).
 - d. Persistent protection of content and information that resides in persistent storage.
 - e. Coordinates with and does not conflict with any DVD Forum authorized content protection scheme.

5.11.4 Consideration of Intermittent Network Conditions

Designation:	1
Example Applications:	4.2.6 , 4.2.7 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.8 , 4.10.7 , 4.11.1
<p>Functional Requirements:</p> <p>Resilience from intermittent network transmission conditions during progressive downloading or streaming for all linear content types (audio, video, subtitles, animation, etc.) with relevant and similar functionalities as “complete download” case (e.g. trick play).</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Content should be capable of setting the player buffer size for streaming content. <ol style="list-style-type: none"> a. Expected range of the buffer size that is sufficient is 1 second to 60 seconds (depending on content type and length). 2) Trick play functionality of streaming content should at a minimum include arbitrary stream re-entry (e.g. chapter jump, time jump), slow play, step-frame, and pause. 3) Trick play functionality of downloaded content should at a minimum include arbitrary stream re-entry, fast forward, rewind, slow play, step-frame and pause. 4) In the case where streaming content is synchronized with primary video, and during interruption of the streaming content (e.g. due to packet loss) streamed audio is muted, streamed video is paused, and streamed subtitles would not be presented, until resynchronization occurs. <ol style="list-style-type: none"> a. During such a case primary video should continue to play. 	

5.12 Content Management

The goal of providing content management is to enable content providers to extend copyright, contract and license terms for the purposes of authorized viewing, copying, and distribution of content.

5.12.1 Licenses

Designation:	3
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5
Functional Requirements: <ol style="list-style-type: none"> 1) Provide both human-readable and machine-readable (actionable) licenses. 2) Support the ability to dynamically re-license, update and store licenses independent of the content and transport mechanism (cf. 5.9.2). 	
Key Performance Requirements: N/A	

5.12.2 Rights Expression Language

Designation:	3
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5
Functional Requirements: <ol style="list-style-type: none"> 1) Provide methods to securely extend content usage and access rights to end users that are defined and expressed in a Rights Expression Language (REL) that is bound to content or a class of devices. 2) Enable the delivery of a REL separately from content in the form of a license (key) that is linked to content, a class of devices or a specific DRM system. 3) The REL is intended to be unambiguous, with the goal that disparate systems will recognize and implement the license with the same results, even if the disparate systems approach the processing differently. 	
Key Performance Requirements: N/A	

5.12.3 Content Access Control

Designation:	3
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5
Functional Requirements: Provide machine-actionable access control of content and device resources for the purpose of authorized rendering, display, copying, and distribution of content.	
Key Performance Requirements: N/A	

5.12.4 Content Usage Control

Designation:	3
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5
Functional Requirements: <ol style="list-style-type: none"> 1) Provide machine-actionable usage control of content and device resources for the purpose of authorized rendering, display, copying, and distribution of content. 2) Control content application, navigation and portability within a domain of trusted devices (e.g. home network, portable device). 	
Key Performance Requirements: N/A	

5.12.5 Authorization and Content Delivery Over Networks

Designation:	3
Example Applications:	4.2.1 , 4.2.3 , 4.2.6 -4.2.8 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.7.3 , 4.8 , 4.9 , 4.10.7 -4.10.11 , 4.11.1 , 4.11.2 , 4.11.5
Functional Requirements: <ol style="list-style-type: none"> 1) Support realtime authorization and secure delivery of content and rights over networks (cf. 5.10.3). 2) Ability to integrate with e-commerce standards and transaction initiatives (e.g. electronic rental, sell-through). 	
Key Performance Requirements: N/A	

5.12.6 Device Constraints and Usage Rules

Designation:	3
Example Applications:	N/A
Functional Requirements: <ol style="list-style-type: none"> 1) Support device constraints conditioned by rules such as number of views, time interval, payment, geographic location, disc or device serial number, resolution, level of security and trust extended to signal transport and display devices, revocation of devices, individual user, or content, etc. 2) Support location/date/time constrained playback based on a secure clock. 	
Key Performance Requirements: N/A	

5.12.7 Video Output Interfaces

Designation:	3
Example Applications:	N/A
Functional Requirements: Video should be output over protected analog and digital outputs.	
Key Performance Requirements: N/A	

5.13 Seamless Stream Integration

This section provides requirements in regards to performance of asset/stream retrieval and integration of multiple asset types.

5.13.1 Content Retrieval and Presentation

Designation:	1
Example Applications:	4.1.1 , 4.2.1 -4.2.4 , 4.2.6 -4.2.9 , 4.3.4 , 4.3.5 , 4.5.4 , 4.7.5 , 4.8.1 , 4.9.2 , 4.10.2 , 4.11.2 , 4.11.7
<p>Functional Requirements:</p> <ol style="list-style-type: none"> 1) Ability to rapidly fetch and present application content from the disc in response to user navigation without interrupting the aural/visual presentation. 2) Ability for content to define rules per asset that determine how the assets are loaded and presented (e.g. buffer priority). <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) At a minimum playback of content that is located in the data cache or persistent storage of the player should not be interrupted while loading application content from the disc. 2) While primary video is played back from the disc, application content can be loaded from the disc. Restrictions should be determined by WG-1. 	

5.13.2 Seamless Branching

Designation:	1
Example Applications:	4.7.5 -4.7.10
<p>Functional Requirements:</p> <p>Support for seamless playback between non-contiguous audio/video segments including but not limited to:</p> <ul style="list-style-type: none"> • Segments within a play list • Playback across a layer transition • Transition between downloaded content and disc content • Playback of multi-story content (story selection made before and/or during playback) <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) When the segments within a playlist are allocated contiguously on the disc, the presentation is able to be seamless. 2) In the case where segments within a playlist are not allocated contiguously on the disc, some rules should be defined by WG-1 which allow for seamless playback. 3) In the case where a new audio/video segment (e.g. alternate ending) has been downloaded to the player, it should be possible to transition seamlessly between the primary video (from the disc) and the new audio/video segment (from persistent storage). 	

5.13.3 Multi-Angle

Designation:	1
Example Applications:	4.7.5 -4.7.10
<p>Functional Requirements: Support for seamless playback of multiple video angles.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) At a minimum, players should support the playback of 9 angles in a single playlist. 2) Video angles may be presented seamlessly with the same audio streams across all angles. <ul style="list-style-type: none"> • Audio streams may consist of main audio, sub-audio, and secondary audio streams. 3) When each video angle is accompanied by its own audio stream and there is a transition between one audio/video angle to another audio/video angle, the new video frame and the new audio frame should be presented within one video frame of each other. <ul style="list-style-type: none"> • Synchronization between audio/video streams should always be maintained. • The video angle transition should be seamless while the audio transition should have a minimized mute duration. 	

5.13.4 Relation of Streaming Objects to Other Content Objects

Designation:	2
Example Applications:	4.2.6 , 4.2.7 , 4.3.1 , 4.4.1 -4.4.3 , 4.4.10 , 4.5.2 , 4.6.1 , 4.11.1
<p>Functional Requirements: Ability to synchronize downloaded and/or streaming objects relative to disc based content and vice versa.</p> <p>Key Performance Requirements:</p> <ol style="list-style-type: none"> 1) Downloaded audio/video objects, graphics objects, and effect audio should be capable of synchronizing frame accurately with content that is presented from the disc. 2) Streaming audio/video objects should be capable of synchronizing frame accurately with content that is presented from the disc except during trick play navigation. <ul style="list-style-type: none"> • When trick play navigation occurs (if allowed by content authoring) resynchronization should occur within 3 seconds for audio only (e.g. streaming director's commentary audio) and within 6 seconds for audio/video. WG-1 should use these values as target guidelines for the specifications and should create restrictions as necessary. 	