

DOING DVD RIGHT!

A Producer, Distributor and Content Provider Guide to DVD Development

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This document outlines the steps needed to create DVD-Video, DVD-ROM or DVD-Hybrid programs and discs. While applying to all DVD discs, the primary context is re-purposing existing linear programming. It's for the content provider, producer or distributor. It's designed to give enough detailed information of the DVD development and authoring process to enable the producer or distributor, be they corporate or entertainment, to take full advantage of DVD's immense power in a cost-effective and timely manner.

While the process is described as essentially a straight line, it is itself an interactive process with subsequent steps causing us to go back and refine earlier steps. For example, we may find new material that requires a change in the bit budget or disc type; or conversely the video material does not compress as much as anticipated and disc resources must be reallocated or features dropped. New footage is found or ideas hatched. They demand to be included, even at the last minute.

We make the process sound planned and orderly when in fact many times a DVD starts with a pile of elements. Here are the ingredients. Make a great soufflé. The beauty of DVD is you can do just that. You can make a great soufflé. Each title is different and requires a slightly different approach.

DVD titles can occupy large amounts of disc space during the development and authoring process. Ideally all elements needed for any title, from flowchart to audio files are in hand before any DVD title begins production. In reality it doesn't work that way. It is very useful for the authoring and development facility you work with to have sufficient hard disc space to "park" a project while the last few pieces come in.

I. Define Scale, Look, Features of Program

DVD's greatest strength is its versatility. That's why it's called "Digital Versatile Disc (DVD)". DVD can be almost anything we want it to be from big movies to little sales films, from simple video to highly complex, Web-based interactive entertainment and learning programs. This very strength in turn, presents us with DVD's greatest challenge: What of all DVD attributes and features are best suited for this particular project?

- A. **Scale:** This is fundamentally a budget and effort question. There is no sense in devoting major resources to a title expected to sell only a few thousand pieces.

On the other hand, even a title with limited content source material may be worth the effort to create DVD features from whole cloth to add value.

- B. **Look:** Each program has an overall feel based on audience and content. It determines the initial impression the audience and market has of the program, and serves as a yardstick to measure program and its DVD attributes. Is it young and hip, male or female, family or single? Is it soft and romantic? Is the audience technologically savvy or even frightened of technology they don't understand? Menu graphics and navigation flow from this key backdrop.
- C. **Features:** Specific DVD features require both source material and appropriateness to the title. Start with a list of desired features such as Surround Sound, DVD-ROM applications, "Making of...." video, blooper outtakes or product follow-on information. The list should be driven by the title's scale and look. It's a wish list that will be limited soon enough by availability of material. DVD features and issues to be decided include:
1. Value-added content
 - a. Biographies
 - b. Filmographies
 - c. "Making of..."
 - d. Director, other commentary
 - e. Star interviews
 - f. Interactive games, quizzes
 2. DVD-ROM
 - a. Screen savers
 - b. Internet links
 - c. Web interface
 - d. Title-specific Calendar
 - e. Photo gallery
 - f. Downloadable/printable information
 - g. Interactive games, quizzes

II. Identify and Collect All Source Material

Video, film, audio and other materials form the heart of DVD. Even before getting your hands on it, you need to know if it exists so that the total program can be planned. Often the most elusive elements are things not included in the original video program. This can be everything from trailers to bloopers, cast interviews, production stills and production notes to footage that simply had to be sacrificed for time.

- A. **Video:** It is essential that all video or film elements be the highest quality available. The better the video, the more it can be compressed while maintaining high image quality. It is worth getting dubs as close to the master as possible.

Even if the nature of the content is less than studio quality, the technical quality of the dub should be high. While VHS tends to mask picture weaknesses, DVD actually enhances errors and problems. The DVD compression algorithm focuses on changes from frame to frame. It wants to highlight single-frame events, such as noise. If the original program source was film, it is essential that the video be continuous timecode if reverse telecine (highly recommended) is to be used. If multiple aspect ratio video (4:3, 16:9, letterbox) is to be used, careful timecode matching and space allocation is required.

- B. **Audio:** DVD supports a wide variety of audio formats and options. If the audio is stereo and on the video master, there is nothing special to do other than look for clean sound. All other audio sources must meet strict DVD specifications. Whether Dolby 5.1 Surround Sound, DTS or language tracks, all must be DVD timecode compliant. Surround Sound should follow DVD track allocation specifications. This is the responsibility of producer. Meeting DVD requirements adds no cost to the producer. It costs no more to have continuous timecode than breaks in timecode.
- C. **Graphics:** Prints, chromes, production stills and package art are all useful grist for the DVD mill. DVD directly supports .TIF and .TGA graphic files. There is little need to worry about file size, though we should keep in mind the video resolution is only 72 dpi, and anything higher is wasted. Photoshop files are great sources of graphics. Sub-picture, sub-title and close-caption require very precise DVD standards, but are quite simple if all source material meets spec.

III. Bit Budget and Design Constraints

While DVD discs offer immense capacity, there is a finite limit. A DVD-5 is 4.7 gigabytes (GB), a DVD-9 is 8.5GB. In addition, the bit rate at which DVD can be read or played is limited. For DVD-Video it is about 10 megabits per seconds (Mb/sec). For DVD computer disc drives, the read speed is problematic. You cannot count on speeds as high as DVD-Video players.

In any event, DVD disc and bit rate resources must be budgeted. In its final form, bit budgeting is done by the DVD author, but it is important that the constraints of a bit budget be recognized in the early planning to forestall unpleasant surprises later, and to provide time to create encoding options, feature editing, workarounds and solutions.

- A. **Video:** By far and away the largest user of space and bandwidth is video. Typically video will constitute 75% of disc space. The amount of space to budget is driven primarily by content, including the runtime, nature and quality of the video. Obviously longer runtimes require more space. But, certain kinds of content, such as high-speed action, rain or 3-D animation, demand higher encoding bit rates and therefore more disc space. The lower the quality of the master, the more bandwidth required to achieve an acceptable picture. Multi-

pass variable bit rate encoding (VBR) can go a long way toward placing more material on a disc without sacrificing quality or interactive features. A good rule of thumb is that video should be 4.5 Mb/sec to 6.0 Mb/sec for multi-pass VBR.

- B. **Audio:** Each Dolby Digital audio track, be it stereo or 5.1, is .384 Mb/sec. This is a fraction of video, but there can be many audio tracks on a single disc. DTS 5.1 audio requires 1.5 Mb/sec or .784 Mb/sec of bandwidth with corresponding disc space.
- C. **Sub-title/Sub-picture/Closed-caption:** These require only tiny amounts of space and virtually no bandwidth, though with 32 channels it can add up. Allow .10 Mb/sec per channel. Sub-picture elements are usually .TIFF files linked to timecode. Closed-caption is usually Line 21 compliant.
- D. **Multi-angle:** Each angle is separate piece of video for budgeting purposes, and must meet very specific timecode requirements.
- E. **Regional Coding:** Requires no disc space or bandwidth.
- F. **Parental Management:** Requires no disc space or bandwidth when applied to an entire disc or segment. If different versions (PG-13 and R) are to be contained within the same program, very complex and stringent specifications need to be met. Some additional disc space for alternate scenes, but no more bandwidth, may be required.
- G. **Aspect Ratio:** All aspect ratios use the same bandwidth parameters. In current practice, each aspect ratio version is its own program. Most widescreen versions are already letterboxed on the video master. If a 16:9 anamorphic widescreen master is used, the DVD player will letterbox in on a standard TV screen. In any event, usually only one version can fit on a side or layer. When creating 16:9 product that also can be pan and scan, it is important to design separate menus or menus that function in both environments. True DVD pan and scan is very rare. The pan and scan must done at the time of encoding, and it is even more complex than optical pan and scan done at the time of film-to-tape transfer for television.
- H. **Graphics/Menus:** Most graphic items take little bandwidth or disc space, with the possible exception of motion menus and motion picons. Motion menus require video, so the same rules of bandwidth and disc space apply. In other words, a 1:00 minute motion menu loop requires normal video bandwidth. If a dozen such menus are used, the disc space can add up.

Photoshop is the most common design tool used. Client supplied finished graphic files (background images) can be used if they are DVD compliant at 720 x 540 pixels with TV safe areas. Remember, for the most part DVD is played on NTSC

composite video television sets. TV safe parameters are critical when creating DVD graphics. Color pallets can be the full 16.2-million colors. All buttons and highlights, however, must be created within DVD authoring to meet DVD specifications, which can severely limit the number of colors available at any one time.

Motion menus and motion picons are only video, essentially running in the background under the active button interface. All the issues of bandwidth and disc space apply. Usually this is not a major concern because most menu motion is looped, but navigation-rich titles can easily add 10:00 minutes of video runtime.

- I. **Copy Protection:** Analog copy protection to prevent users from making VHS or other analog dubs takes no disc space or bandwidth. It does require a contract between Macrovision, or other copy protection vendor and the content provider or distributor. The authoring house also must be licensed.
- J. **Encryption:** Encryption is designed to prevent digital copies from being made, mostly to prevent larger scale piracy. The content scrambling system (CSS) is free, takes no bandwidth or disc space and is done at the replication facility. The DVD author must flag the DLT for CSS inclusion.
- K. **Multiple Language:** Multiple language tracks function like any other audio track and have the same timecode constraints. When set up properly, however, the DVD player is smart enough to know which language is its default language and will automatically begin playing that language. When using multiple languages, it is important to consider multiple language menus as well.
- L. **DVD-ROM Features:** A DVD-Hybrid disc (information and control in both the Video Header and the Other Header) usually allows the program to share the high disc space assets such as video. Therefore, only the bandwidth and disc space required for the DVD-ROM features need to be considered in the bit budget. Generally speaking, DVD-ROM features require relatively lower bandwidth and usually do not take up large amounts of disc space. A complete feature set of screen savers, calendar, Web links, photo gallery and text information usually takes about 300 MB of disc space.

DVD discs contain navigation and other information in disc segments called "headers". There are two different headers: the "video header" and the "other header". DVD-Video set top players can only read the video header. If no information is in the video header (DVD-ROM disc), the set top player says, "I don't know what this is", and shuts down. If that same disc is placed in DVD-ROM drive, the DVD-ROM drives first looks at the other header. If it finds nothing, it is smart enough to look at the video header. If it finds information in the video header, it re-configures itself to behave like is set top DVD-Video player, and proceeds to play the disc with all the video header navigation.

If the DVD-ROM drives does find information in the other header, it simply begins following those instructions. This opens up the whole world of computer-based features, such as screen savers, databases, downloadable and printable information and Web links. The most universal DVD discs with DVD-ROM features are DVD-Hybrid discs with information in both the video and the other header. While the DVD set top viewer might miss some features, the disc still is fully functional.

- M. **Disc Type:** The final option involves disc type. The most common dilemma occurs when the content won't fit comfortably on a single side, single layer DVD-5. The options are cutting the content of the program through lower bit rates, or simply eliminating elements. Moving to a DVD-9 or DVD-10 can add both authoring and replication costs. Authoring can add between 10% and 25% to the cost of a single title that needs some more room. Keep in mind that squeezing a title onto a DVD-5 may also add encoding costs, since there will need to be some experimentation to see how low you can go in bit rate. Replication of DVD-9 can cost up to 100% more, though the cost differential is falling. Unless there are two separate titles or versions, most consumers prefer DVD-9 to the two-sided, single layer DVD-10 because they do not have to flip the disc.

IV. Video and Audio Encoding

Encoding is the technology and quality core of DVD. It demands the greatest amount of disc space and bandwidth. Poorly encoded video and sound means a weak program, no matter how great the graphics or value-added features. Encoding is part science and part art, not unlike film-to-tape color correction and transfer. It takes the highest technology encoding boards and a practiced eye.

- A. **Video:** Encoding video to MPEG2 must take into account a multitude of factors, especially disc space and bandwidth. It can be significantly affected by image content. Because of the fundamental MPEG2 algorithm, some programs or scenes compress more, and more easily than others. In an overly simplified view, MPEG2 is only really concerned about what is different in one frame from the preceding frame because it "remembers" what was in the preceding frame. Therefore, the more things change from one frame to the next, the less MPEG2 can use of the previous frame and the less it can compress the image. This means it requires more bandwidth and more disc space. A wild action scene with multiple explosions during a rainstorm seen with quick camera moves and cuts takes a lot of DVD resources to look good. On the other hand, a soft romantic scene with static camera and out-of-focus background changes little from frame to frame, and can be highly compressed and still look great.

Since most programs and movies contain all kinds of scene, the key is to get the right resources to the right scene. There are two fundamental encoding schemes to do this:

- a. **Constant bit rate (CBR) encoding:** With the rate of encoding remaining constant, the quality of image from scene to scene can vary. Encoding resources are insufficient for some scenes resources and being wasted on others. CBR encoding is done in one pass. It is usually used for short, often corporate programs. Its continuous high rate can present problems for DVD-ROM drives. CBR's primary advantage is lower cost, and it takes less facility time.
- b. **Variable bit rate (VBR) encoding:** The basic concept of VBR is to maintain constant image quality from scene to scene by using as much or as little bandwidth as needed to create a high quality image. Each encoding board or system uses its own algorithms to encode video. Some are better than others. The best encoding utilizes multiple passes of the video source (up to five times) to analyze each frame to determine the best encoding parameters, including bit rate, color telemetry and motion vectors. It, in effect, attacks each scene and frame differently. In the hands of an experienced and aesthetic encoder, more imagery at higher quality can be placed on a DVD disc.

- B. **Audio:** Audio encoding has been around longer than video encoding and is less demanding of bandwidth and disc space. DVD supports two official audio encoding systems, meaning every DVD player must be capable of playing back audio stream: PCM and Dolby Digital AC3.

PCM audio is the standard used on normal CD-Audio discs. It has a high bandwidth (1.5 Mb/sec) compared to Dolby AC3 (.384 Mb/sec). The quality is not any higher; rather the compression scheme is less sophisticated. Most DVD uses AC3 compression. The bandwidth is the same for all modes from stereo to 5.1 Surround Sound. PCM is not widely used anymore in DVD because it provides no observable increase in audio quality while using almost four times the bandwidth and disc space.

Included in the Dolby family of audio standards is Pro Logic. It's a Surround Sound format, also, and most DVD players will decode it. Pro Logic requires a separate (.384 Mb/sec) audio track.

Another audio standard that many DVD players support is DTS. DTS is also a 5.1 Surround Sound standard. It has a higher sampling rate and thus claims a higher quality sound. Its bandwidth is 1.5 Mb/sec, the same as PCM. There also is a DTS audio stream at half the sampling at .784 Mb/sec.

V. Graphics, Menus and Navigation

Overall graphics flow from the total look and feel of title based on content and audience. Menus encompass the graphic look while executing all the DVD features to be incorporated into the title through its navigation scheme.

- A. **Graphics:** DVD graphics, especially background images, can be with a full 16.2-million color palette with high resolution, and are supported in several formats: .TIF, .TGA and SGI files. While basic DVD video has an equivalent of only 72 dpi resolution, the graphics usually want to be higher resolution because they are often static and remain on the screen for prolonged periods. It is essential to remember TV safe when creating graphics and menus since most consumers will be viewing on NTSC TV sets.

- B. **Menus:** DVD menus can be created with a wide range of functionality and looks. Each menu button needs a "select" feedback or highlight. That highlight may be any color, but there are severe restrictions. Only a limited sized palette may be used at any given time. Common buttons include:
 - 1. Text - A simple word that highlights when selected. Useful when a very large number of selections must fit on one page.
 - 2. Icon - From a simple circle button to a graphic representation of the menu selection. It can also have text with it, which may or may not be highlighted.
 - 3. Picon - A picture icon, often an image grab from the program itself.
 - 4. Motion Picon - Usually a short segment of video from the program itself. If live video, it will not loop seamlessly and usually needs to fade to black briefly before running again. If an animated picon, it should have matched open and closing frames so it can loop seamlessly.
 - 5. Context Menus - Since the DVD system is only looking at the placement of pixels, a menu can be anything that makes sense to the viewer. For example, on a golfing DVD the menu could be a typical golf hole. The viewer simply clicks on the appropriate segment of the course to access the information he or she wants, i.e. the green for putting, just off the green for pitching.

- C. **Navigation:** While navigation is most commonly associated with the actual authoring of a DVD, it must be worked out in exquisite detail before menu design can be completed. As with so much in DVD, navigation is part science and part art executed in a series of trade-offs. For example, the more that can be placed on a single menu, the easier it is to find your way around. On the other hand, the

first criterion of a menu is that it must be readable. Sometimes text is not the best way to communicate. Graphic symbols, icons, still frame images and picons may tell the viewer much more than words. Again, remember that most DVD will be viewed on an ordinary NTSC composite TV set. Small text and fine fonts will become lost and very hard to read.

Navigation, and hence menus, should be intuitive. It should not require an instruction manual to understand. Each navigation scheme and menu set should have a single visual "grammar", not unlike a good software program. A given symbol, such as an arrow, should have the same meaning on all menus. These conventions can greatly ease use of the title.

Content and feature sets should be grouped in a logical form and sub-sets of information or options need a logical cohesion. For example, a program and its chapters belong together, while bios and other background can share a menu.

Simple navigation can be outlined on a scratchpad, but most DVD navigation design should include a flowchart of all menus and options. In many cases, a series of titles built around similar or linked content or distribution will follow the same navigation and graphic pattern. Each DVD becomes a template for subsequent titles. This can improve efficiency and ease use by viewers as they learn the conventions.

When creating navigation, it is as important to design where the viewer goes after the selection is completed as it is getting to the right segment in the first place. Does the viewer return to the last menu? If so, where on the menu? Generally speaking the viewer wants to go back to his or her last point of departure.

VI. Authoring

Authoring, while a very broad term, has two very specific functions. First, authoring interconnects all video, audio, graphic and other elements to provide the viewer or end-user with an enjoyable and intuitive experience.

Second, it ensures that all elements and functions are DVD compliant. While DVD offers amazing flexibility in functionality, it is very demanding when it comes to specifications. A simple misplaced command can shut down an entire disc.

Authoring is where player anomalies and control are dealt with. While DVD-Video players must meet strict performance specifications, each manufacturer has considerable leeway in how to accomplish it. No player will play every single disc ever created, and no single disc will play and fully function on every player ever made. With some functions it is necessary for the disc to take control of player settings through the player's memory registers to ensure performance.

VII. Emulation

The more sophisticated DVD development systems allow developers and authors to perform all navigation and playback of a DVD disc image from a hard drive before any DVD-R or DLT is created. This is in addition to the normal interactive simulation that higher-end development systems support during the actual authoring process.

Emulation creates an exact replica or disc image of the final DVD disc. Through a software remote control the disc will perform and function as if it were a finished DVD disc in a DVD-Video player. Mistakes and problems are caught here before the costs of mastering are incurred, and before the program has widespread internal exposure.

VIII. DVD-R

A one-off or recordable DVD disc (DVD-R) serves several purposes. First, it can be played in a DVD-Video player or DVD-ROM drive for testing in a real-world environment. This is especially useful for DVD-ROM or DVD-Hybrid titles, since there is so much variation in computer-based playback.

Second, DVD-R discs allow a wider number of people to simultaneously review a disc for final approval.

Third, DVD-R's can be used as early preview copies for both reviewers and major customers.

Finally, for many corporate or business applications only a few copies are needed. DVD-R's become the finished product while lowering cost and reducing turnaround time.

It is essential that the DVD-R being used fully comply with all DVD specifications. There are a growing number of recordable formats that use DVD in their name. Not all are DVD-Video and DVD-ROM compliant, and are designed for other uses such as data backup.

It should be noted that there remain compatibility issues even with fully compliant DVD-R discs. Some consumer DVD set top players have difficulty reading DVD-R discs. This does not mean there will be any problem with the finished DVD disc made from a glass master.

There are currently two types or sizes of DVD-R disc: 3.95 GB and 4.77 GB. Both function exactly the same. The 3.95 GB disc has fewer compatibility issues. The 4.77 GB allows a full DVD-5 disc to be written.

VIX. Re-author

If problems are discovered or changes need to be made, the disc is re-authored. In some cases re-encoding is necessary. However, with sophisticated systems only the affected areas or functions need to be worked on.

The entire project should have been parked on a hard drive during the DVD-R review process. Segment re-encoding allows only the affected video to be changed. Navigation errors, the most common problem, are essentially handled as simple editing.

Even though only certain segments or functions are being changed, it is important that the entire emulation process be repeated to ensure that no inadvertent changes were made or that the law of unintended consequences comes into play. Another DVD-R should be burned for final testing, though the number and distribution usually can be much smaller.

X. DLT/DVD-R Pre-master

A DVD pre-master is traditionally a digital linear tape (DLT) with a complete disc image and a DDP file. The DVD replicator creates a glass master from the DLT and then a metal stamper from which the actual DVD disc is made. When writing a DLT, it is important that the system perform an automated sector check to verify that the data on the disc image is all transferred and is transferred to the correct sector.

More and more DVD replicators are accepting DVD-R's as a pre-master format. This can save time and money for the content owner. Usually the check disc step can be eliminated.

It is essential that each pre-master, be it DLT or DVD-R, be accompanied by a detailed and accurate technical and data sheet containing all critical information on the pre-master, especially flags and authoring software.

DVD compliance is absolutely mandatory on DLT's. Mastering and replication facilities cannot deviate from specifications and their systems are designed to detect compliance.

XI. Check Disc

In most cases check discs will be made, usually 10 will be stamped by the replicator and sent to the authoring house, content provider or both. A check disc is the actual finished disc. It is the last opportunity to catch errors or make any improvements. The check is made from the glass master and stamper that will be used in bulk duplication. When the pre-master is a DVD-R, the replicator usually will warrant that the final disc is an exact duplicate of the DVD-R pre-master.

The fact is that everything should have been caught before. Since the master has already been made, there is usually a charge for another master, in addition to the cost of making the change under rush circumstances and the time lost.

Check discs should be reviewed with care. The expanded pace and scale of DVD replication can and has created instances where a piece of one disc's program ends up on your disc.

XII. Replication

In many ways replication has become the easier and most reliable part of the entire equation, especially for DVD-5 and DVD-10 discs. Even DVD-9 discs are reliable and commonplace, though not all replicators do DVD-9's.

DVD-18 remains somewhat problematic. There have been relatively few DVD-18 discs created, and at the present time only one company is replicating them.

A word of caution: Know your replicator. There are new people with great prices entering the market every day. It may take them awhile to get the process down to an art.

Many of the companies offering DVD replication are actually brokers and are not replication facilities themselves. While most brokers are very good companies and often can obtain good prices, they do not have ultimate control of the replication process.

The minimum replication order for waiving a mastering charge is usually 1,000 to 1,500 discs. Mastering charges are usually about \$1,000.00 for a DVD-5 and double that for a DVD-9 or DVD-10. The typical independent distributor initial run is usually 2,500 to 5,000. The studios can have initial runs of up to 500,000 discs. Corporate applications needing as few as 25 discs may well find it less costly to master and replicate 1,000 stamped discs than burn 25 DVD-R's.

XIII. Packaging

DVD can be packaged in a variety of forms, very similar to CD's. Cost varies from a few cents to slip cases to over \$.50 for Amaray cases. The cost of printed inserts and shrink-pack needs to be included.

For many corporate applications, it may be more cost-effective to package only the number of discs needed for the immediate project and save the rest of spindles. They can always be packaged at any CD-ROM replicator.

Other than making sure the packaging matches the content, features and requirements of the disc, the most important thing about the package is making sure the printed

material is ready when the replication is ready. Often the critical path goes through the paper, not the DVD.

IX. Timetable

Some DVD projects (5:00 existing video for tradeshow loop) can be done in a day or two. Others (highly interactive DVD-Hybrid with multiple DVD and value-added features) can take several months.

A more typical feature film, or corporate communications DVD would fall within the following time frames:

<u>Description</u>	<u>Low</u>	<u>High</u>
Design, Collect Resources	1 week	8 weeks
Encode and Author	2 weeks	4 weeks
Review/Re-author	1 week	3 weeks
Check Disc	1 week	2 weeks
Replication	3 weeks	5 weeks
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Total	8 weeks	22 weeks

As you would expect, the most difficult to predict and potentially time-consuming element is the collection and organization of all the disparate elements needed to create a successful and entertaining DVD program. DVD rewards the truly compulsive organizer. Once all the material is accounted for, the process can be fairly predictable.

Most authoring and replication facilities try to have an orderly stack of projects on hand. This is especially true during busy times of the year, like third and fourth quarter. It is useful and helpful to the authoring house if the content owner can provide advance notice of timing for a title. This allows the authoring house to hold capability for the project. The worst time spent by a content owner is waiting in line for authoring.

The authoring house can keep the replicator informed of DLT delivery schedules so the replicator can have needed capacity available for the title.

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