

Technology
Overview



DVCPRO P2:

*A No-Nonsense Explanation
of its Workflow Advantages*



Panasonic ideas for life



Inside . . .

Introduction	02
From Whence Cometh P2?	03
Where Can P2 Take Us?	03
The Benefits of P2	04
The Bottom Line: Memory Based Acquisition Is Here! ...	05
Structure of P2 Card	05
The P2 Card DVCPRO System	05
What Is It Like To Work With A P2 Camcorder?	06
Working In The Field	07
Shooting Scenarios With P2	07
The Television Commercial	08
The Independent Feature Film	08
The News Shoot	09
So What About The Archive?	09
Options For The Smart Archive	10
Data Tape and Tape-less Storage Solutions	10
DVD-R/DVD-ROM	11
Blu-ray Disks (BD)	11
HD DVD	11
Holographic Blue Laser	12
Metadata: What Is It and How Can It Help Me?	12
Content File Structure	12
MXF Essence File	12
Examples of Structural Metadata Elements	13
Examples of Descriptive Metadata Elements	13
Summary	14

Video production professionals are sometimes compelled by shifts in technology to stop for a moment and reassess how these changes in technology could alter the way they work and the way they conduct business. Panasonic P2 (Professional Plug-in) memory based acquisition is one of those enabling technologies that is bringing about a revolution. These same video professionals have said repeatedly that they want to move away from the linear, longitudinal nature of tape, reduce the time it takes to digitize from tape, and eliminate the frustration of just trying to find the scene they want on that tape. P2 allows users to break free from

DVCPRO P2 Introduction

the constraints of tape and adopt a new workflow. While at first blush it may seem too revolutionary and impractical, but, to paraphrase Albert Einstein, you never get to anyplace new by thinking the same old way.

This paper describes some of the background and rationale for the selection of memory for acquisition, the benefits, including a quick review of the new P2 HD hand-held camcorder, and an overview of the workflow paradigm shift needed to make the transition to Media-less Acquisition painless.



When Panasonic introduced DVCPRO in 1995, few could have foreseen that DV based algorithms, rather than MPEG, would become the de-facto ENG/Production standard. Production professionals have adopted DVCPRO and DV compression across the country and around the world as their format of choice. No one could have predicted the expansion to higher formats. The 50 Mbps format, DVCPRO50, came into its own as a production format starting with the Winter Olympic Games in Salt Lake and a "no-brainer" success story with the introduction of the AJ-SDX900, which has become the high-end production camera of choice for Standard Definition. DVCPRO HD, the 100 Mbps format, has helped make real world professional HD production viable. With its unique ability to shoot variable frame rates, its film inspired gamma curves and an ergonomic approach designed to be intuitive to both film shooters and videographers, the AJ-HDC27V HD Cinema Camera, the VariCam,

has made digital cinematography possible for shooters and producers. VariCam has evolved from an independent production favorite to an industry workhorse, and when DVCPRO HD became the only professional HD format compatible with IEEE 1394, a mainstream cost-efficient HD post-production environment became a reality. This advancement has truly set the stage for future expectations.

A DVCPRO HD camcorder has 16 recording heads that writes 40 tracks on tape to record each frame of video, and this requires a very robust and precise mechanism. As a result of P2 technology, professional video cameras no longer need that complicated tape drive with its expensive recording heads and mechanisms. Since there are no moving parts in a P2 camcorder, Panasonic has been able to bring to the market a small, easily affordable DVCPRO HD camcorder, and since there is no physical tape footprint or format, that camera can be switchable between all DVCPRO formats, SD and HD, making it the most flexible camera in our ever-evolving marketplace.



The AG-HVX200 DVCPRO HD P2 Camcorder

The AG-HVX200 is the latest addition to the P2 family of products, and with switchable operation and a native 16:9 chipset it can be virtually any camera the video production professional needs it to be. Shooting in DVCPRO HD it can be a primary camera for an independent feature film, or a secondary camera on a VariCam project. It can be working on an SDX900 program in Standard Definition using the high performance DVCPRO50 Codec, or it could be the lead camera in a shoot with Panasonic's popular AG-DVX100A. It can easily be part of a News Crew shoot since so many Broadcasters work in DVCPRO for news acquisition and have started their P2 migration.

From whence cometh P2?

Central to the realization of P2 is the growing use of Information Technology (IT) elements to transform the workflow, especially for newsgathering and



post-production. IT infrastructure and components have brought network connectivity and ever-larger storage – especially hard disk drive storage - to what was once called “broadcast.” In addition, computer memory elements are now found in consumer devices like cell phones, PDAs and digital still cameras, and with ever-wider application capacity is growing and prices falling. Taken together, one can see that these generic and ubiquitous elements can revolutionize television..

Where can P2 take us?

If we leave tape acquisition behind, where do we go? When Panasonic set out to develop the next-generation digital video recording system, we reviewed all the current and emerging technologies such as tape, hard disk, optical disc and solid-state memory, and sought development advice from companies representing a broad cross section of digital acquisition users and post-production workflow vendors. Panasonic heard customers say that they wanted to move away from tape and from transports and mechanisms that break down. Our decision to introduce P2 took into account two fundamental market conditions. The first is that DV, rather than MPEG, is the de-facto compression standard utilized in the overwhelming majority of digital cameras and recorder products. Available in several forms from several manufacturers, it is clearly the optimum selection of data rate, picture quality, and editability for newsgathering and production. Whatever we chose, it needed to work with the DVCPRO family of codecs. All needed to be recordable on the same device. And second, through the combined efforts of Panasonic and our DVCPRO Technology Partners, DV 25 Mbps and 50 Mbps compression have migrated widely to non-tape recording, editing, playout and computer network systems; and DV 100 Mbps (high definition / DVCPRO HD) is following suit.

Panasonic meticulously analyzed the merits of each of the available recording technologies and selected Solid-State memory. To eliminate the mechanism, memory-based storage like that in digital still cameras was selected. Since Panasonic is one of the world's leading suppliers of SD Memory - the same SD memory that is now in use by more than 500 companies in a wide variety of products was selected for its base. The SD Memory card has quickly become the world's leading standard for compact, portable, high-capacity storage. It is impervious to almost all environmental conditions; it is capable of very fast signal transfer, and should function indefinitely.

When one considers a memory-based camcorder, the immediate inclination is to compare the cost of the memory to the cost of tape under the understandable but erroneous assumption that it is just another form of media. It is far more appropriate to think of the memory-based camcorder as part of a media-less system in which the budget for consumable media decreases dramatically, as does the one for maintenance.



The Benefits of P2

Because the P2 card stores audio and video as data it's capable of doing things that tape never could. For example, a P2 card can be set to continually buffer record, recording the full capacity of the card as a "pre-roll" buffer. This can be incredibly useful for sports, news, and event coverage. Here's how it works: Assume there's a 4 GB P2 card installed, and the camera is shooting DVCPRO50. That card has a capacity of about 8 minutes, so with the pre-roll buffer on, the card will be holding the last 8 minutes BEFORE you press the record button! If you were waiting for the whales to breach the surface of the

water, you have the shot in memory, just push record and it will keep all that before the breach, the breach and what followed. And because P2 is solid-state memory with no moving parts, there's no headwear, or spinning parts and no reason not to take advantage of features such as continuous recording.

Silent operation is probably one of the first things a new user notices. The higher capacity the tape drive in a camera, and the more heads in the tape mechanism (as well as the faster the heads spin and the tape moves), the more noise a camera makes. But with the P2 camera recording to P2 memory, there are no moving parts – the camera is utterly silent.

Then there's reliability – P2 is a solid-state, basically indestructible memory card. It's practically impervious to temperature, weather, condensation, dew, heat, vibration, magnets, x-rays, dust, dirt, or any of the other potential hazards that can affect tape (or hard disk or optical disk) recording methods. A P2 recording will never have a dropout, dropped frames, or media errors, a claim that no hard disk, no tape, and no optical disk recording mechanism can make.

Infinite record times become possible with P2 as well. Because P2 cards are hot swappable, and because all P2 cameras include multiple card slots, one could theoretically record perpetually on a P2 camera. As cards are filled, they can be pulled out, empty cards can be inserted and recording continues. The camera knows to roll over from a full card to an empty one and the Metadata links the footage together so that it can be reassembled into one long continuous clip in the edit bay. This is something that tape could never do; with P2, you never have to stop recording, as long as cards can be swapped.

While a P2 card may appear to initially be somewhat expensive, one needs to consider that a P2 card is a one-time purchase. It is infinitely reusable (up to 100,000 times), with no moving parts to wear out, and no worries about taping over the footage. It's not like tape; you don't need buy new tapes for every event. With a P2 card, you shoot with the cards that you have, and offload the data to another storage device or drive to free up the card for more shooting (just like with a digital still camera).

THE BOTTOM LINE: Memory Based Acquisition is Here!

In order to have a highly reliable P2 system, the P2 card itself must be engineered to withstand the physical wear and tear, and even abuse it will receive in its lifetime of use.

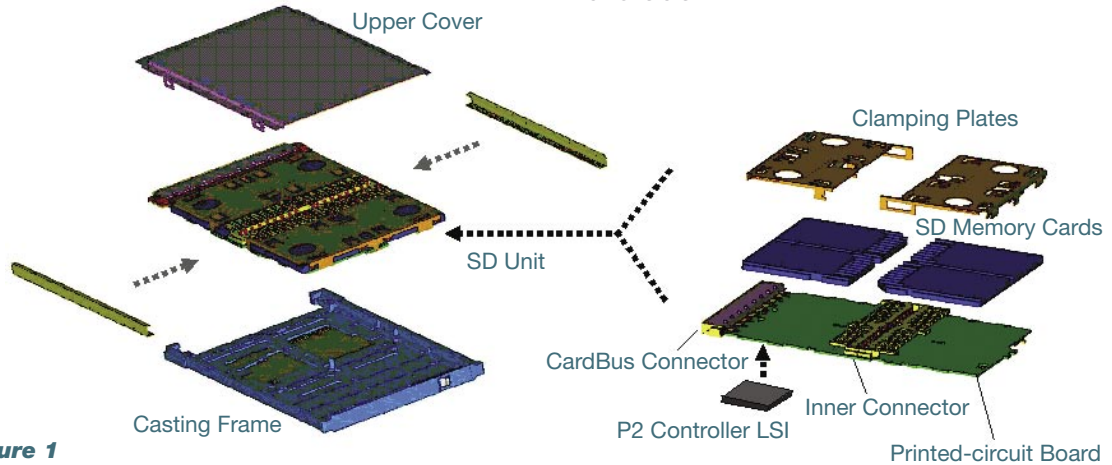


Figure 1

Structure of P2 Card

The PCMCIA assembly consists of a rigid aluminum die-cast frame, a printed-circuit board, the P2 control LSI, four SD memory cards, the connectors for those SD cards, two clamping plates, and the CardBus connector (see Figure 1). The clamping plates form a retainer mechanism that holds the four SD memory cards very precisely in the specially developed inner connectors so that reliable contact is maintained within the P2 card even under severe accidental shock or vibration. Taken together, this forms a mechanical structure that allows P2 cards to be guaranteed to endure shock up to 1500 G of Gravitational Force, and vibration up to 15 G.

Structured in a Raid 0 array, the capacity of the SD memory in the P2 card is multiplied by a factor of 4 and so is the basic interface speed. This is the job of the P2 controller LSI. A 4 GB P2 card will have four 1 GB SD cards inside, and since each one has an interface speed of 20 Mbps, the combination has an interface speed of 80 Mbps or 640 Mbps. This may seem like “over-kill” but recall that P2 has been designed to allow HD acquisition with no modification, and even in HD users will expect faster than real time transfers.

The P2 Card DVCPRO System

A critical advantage of P2 Card recording is instant connection with the IT universe. For example, when the P2 Card is inserted into a laptop computer it can be instantly recognized as a mounted drive. This permits immediate editing since there is no need to “digitize” prior to editing.



P2 offers speed advantages for news coverage



P2 cards mount and allow almost instant editing

Once the footage is transferred, the P2 memory card may be reused. The fast transfer advantage is coupled with the elimination of all moving parts (i.e. tape or disk transport) and field media, meaning that significant operating cost reductions can be realized, especially in maintenance costs and consumed media.

Full compatibility with DVCPRO, the industry's standard for digital news gathering, high performance DVCPRO50, the new standard for SD production, and now, DVCPRO HD for production represents investment protection for current systems with a built-in future proof scenario. Since it is not based on tape or transports, the card is totally agnostic to which format is recorded; it allows Panasonic engineering to bring to the market a camera that just was not possible until now.

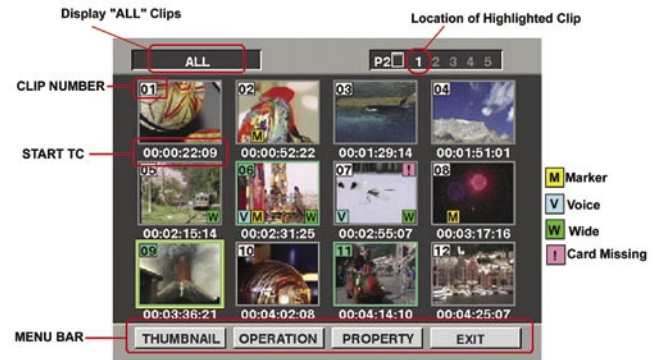
One of the most interesting impacts for the production industry is that, while vast amounts of money was being spent on talent, gear rental, lighting, sets, DPs, camera assistants and many others in the production crew, it has always relied on the video tape to capture the images. Ironically, this is the least expensive item on the set, and the most vulnerable. As just one of its first benefits, P2 technology allows the production community to move away from the weakest product in the production chain.

Many producers have sat in the edit suite wondering how to get past the drop outs, to get past the little sparklies that happen on ingest with DV video, to get past the audio drift, which has been a part of the DV production arena. They have had to sit in that same chair setting up the batch capture EDL from tape and found the pain of broken time code, and mismanaged media. In general, the time that has to be taken to do this, under the Tape Acquisition paradigm, has to be during the most time-sensitive constraint, before one can even start to edit. It adds a layer of stress that no one appreciates. P2 brings an end to all of these problems and offers reliability unforeseen in the tape-based acquisition and production arena. Under the P2 workflow, the careful cataloging of shots can be done after the show has been cut and is billed.



What is it like to work with a P2 camcorder?

Acquiring video content with a P2 camera is much like working with a conventional camera with the additional flexibility afforded by the clip management functions inherent in an Information Technology (IT) centric device. Each time the camera enters the record function, a thumbnail picture that identifies the first frame of the clip is created, it is stored and represented in the "bin." This bin shown below is a snapshot of the LCD viewfinder on the side of the camera.



The indicators shown on the right of the photo illustrate the various ways users can identify clips recorded. These capabilities include a Marker that is the indicator for the best shot, which have a voice memo marker, which have been shot with 16:9 aspect ratio and which shot has the root card (the card where the clip was recorded) missing. This Screen shot is from the AJ-SPX800 full size camera hence the indication for 5 card slots at the top.

Once recorded in memory, acquired material can be transferred to the computer and edited or it can be edited right from/on the P2 card. The clips are the clips; there is no digitizing necessary. The footage can also be previewed and selected for the NLE phase. This is somewhat analogous to the digitizing process, except that you just review the material that was shot, but it is already digitized. You can immediately start to make post production decisions.

Working in the field

So how does one work in the field when there are hours of shooting to be done and the P2 cards fill up? It isn't exactly like tape, where you would just pop in another tape. While there are a number of strategies, the first presented is the P2 Store Drive. It is a 60 GB drive that will hold an hour of DVCPRO HD, 2 hours of DVCPRO50 and 4 hours of DVCPRO. All you need to do is to place the P2 Card into the P2 Store and it automatically moves the data to the hard drive. It actually will check to make sure that you have not transferred that same card earlier. For convenience, it is small enough to be worn on your belt.



P2 Store Drive

Of course over time and during a long enough shoot, this too will fill up, so it could be handed off to a Production Assistant to offload to the computer and the larger hard drive that would be used in production. The transfer from this device is similar in speed to any other USB port device.

The P2 Store is an ideal production tool for the news reporter that has to roam and meet photographers at the story location. When finished with the shooting of the piece the reporter simply off loads the scene footage and standup on to his/her P2 Store and moves onto the next story. After finishing the days on-the-scene reporting the reporter returns to the station to edit. Since all of the footage for all the stories is in the P2 Store, editing can be very efficiently finished in time for the Early Edition News. Of course there are other strategies that one could use in the field for managing the data. Content could simply be loaded to the computer through the PCMCIA slot. It has been a common practice within the production circles to be able to hand over to the Producer at the end of a shoot the tapes recorded that day. As P2 is essentially a "media-less" system, it is more practical to transfer the footage to a hard drive that the producer can use back in the edit suite. This concept would mean that it is no longer

necessary to digitize this footage, saving them hours of tedious mark-in and mark-out work. They could easily go back to the edit suite and just review the footage for final edit.



Let's examine the economics of this new workflow for a minute. DVCPRO HD tape cost is about \$120 per hour. On an average shoot, one might expect to go through 15 hours of tape. When doing the math, $15 \times \$120 = \1800 . It will take a similar amount of time to digitize this into an editing system. Instead of delivering \$1800 worth of tape, why not deliver to the producer the footage on one of the many new compact, high capacity hard drives that are currently available. Obviously, this is less than tape and the time saved in not having to digitize is a bonus. So both time and money are saved over tape acquisition.

It should be noted that these hard drives represent temporary storage, hard drives may not be the best for long-term storage. They are, however, certainly viable in the near term for applications such as the monthly storage needs of a news or production department. In either case the price of digital storage has fallen so that it is less than tape. The beauty of it is that it costs you and the producer less than DVCPRO HD tape. So instead of being handed a tape at the end of the shoot, the producer gets his footage already to edit on a hard drive for less than what it would cost to do the same thing on tape.

Another idea is that if it is a shorter shoot, footage could be transferred via the computer to an iPod, a popular device in the production marketplace. They are small and the latest one, the iPod Photo has 30 GB of storage, certainly enough for a small commercial shoot in DVCPRO HD or in DVCPRO50. Alternatively, direct recording to the computer is also viable.

Shooting Scenarios with P2

How would P2 recording work in a real production environment? Let's examine several typical P2 production scenarios: the television commercial, the independent feature film, and the news photographer.



The Television Commercial

P2 recording works ideally for television commercial production. The P2 card and its capacity bears a striking resemblance to the film workflow employed on high-end television commercials. On film shoots, the film camera may come with perhaps three film magazines and an Assistant Cameraman is usually assigned the job of loading the magazines with film, and unloading them when the film has been shot. The magazines are typically kept loaded with film, so that the movie camera can quickly swap out a full magazine for a fresh one.

These 35 mm film magazines typically come in two sizes, 400-foot and 1,000-foot. A 400-foot magazine lasts for approximately four and a half minutes of shooting; and a 1,000-foot magazine lasts for approximately 11 minutes. With P2, a single 4 GB card can store approximately 11 minutes of high-definition 720/24p footage, so a 4 GB card can be thought of as roughly equivalent to a 1,000-ft load of film. Financially 1,000 feet of film will cost about \$600, processing adds about \$200 and it will cost about \$200 more to transfer it to video so it can be edited. In contrast to that expense the P2 card incurs no additional cost, is immediately edit-ready, and the P2 card is re-usable, something that can't be said for film.

As you can see, the P2 comparison directly mimics the film comparison: a P2 shooter would have two or three empty P2 cards at the start of the shoot, similar to freshly-loaded, unshot film magazines. As a card gets filled up, it would be handed over to an assistant who would "unload" the data (by copying it to hard disk, to a P2 Store, or some archival domain). The assistant would then erase the card (which is similar to loading it with fresh, unshot film) and stand ready to load it back in the camera. It's a very traditional, well-established workflow, and P2 fits very neatly into it, all the while optimizing costs and providing tremendous workflow benefits.



The Independent Feature Film

Once again, P2 fits in perfectly with the film workflow. On a 16 mm independent feature film shoot, a 100-foot spool of 16 mm film

captures about 2:45 of shooting, and a 400' load will last for 11 minutes - again, about the same as a 4 GB P2 card shooting 720/24p. When shooting film, long record times are never an issue, since the longest conventional film magazine only allows for 22 minutes of record time. Magazine changeovers are directly comparable to the P2 offload/erase cycle, with the main differences being seamless transition to the next P2 card, an incredible savings in money, plus immediate access to the footage. The P2 workflow is ideal for independent feature film production.



The News Shoot

Despite the fact that film hasn't been used for news for decades, here too P2 recording is unparalleled. For news, the overriding consideration is immediate turnaround. News shooters need to get the shot, get it to the editor, and get it on the air. P2 provides for instantaneous edit. The shooter could actually edit the spot right on a laptop during the ride back to the station, or even edit it in the truck and uplink right in the field. There's no need to digitize, or even to transfer the footage, footage can be edited directly from the card or directly from the camera. Selecting the marked good shots and hitting Play creates a package. News shooters find themselves in all sorts of inhospitable conditions – weather (tornado, hurricane, earthquake etc), disaster (flood, fire, etc), civil unrest, etc. The indestructible, dropout-proof, heatproof, vibration-proof, weatherproof P2 recording system guarantees that the news shooter WILL get the shot, the recording will be clear and usable, and the footage will be instantly accessible. P2 is the ultimate news gathering recording device.

As users consider whether the P2 workflow satisfies their production flow, they should ponder this example: When shooting in the popular "Run and Gun" style, with lots of things to shoot, the need

might be to shoot on DVCPRO or DVCPRO50 depending on the client. The project could be a Documentary or a Reality TV series or corporate work. Using the new AG-HVX200, users can shoot in the format suited the client and the budget, all recording to the P2 cards. Occasionally footage can be offloaded to the computer or the P2 Store. Because of the Hot Swap capability of the cards, one card can offload while recording on the other. Because of the transfer speed of the card, it is empty before the other card is full. If time is critical, start editing while the shoot is continuing or just move the footage to a portable Hard Drive for the producer to take back to the edit suite.



When inserted into a computer the P2 card "mounts" as a virtual drive. This is the elegance of an IT workflow; since it is possible to edit directly from the drive, so things can be done quickly. However if the program is long form, then it is quick and easy to slide the data to the hard drive even more than one, if warranted. Once back in the edit suite, a quick review in the P2 viewer shows, the bad shots, blown lines, and so on and unusable footage can be easily identified and dumped, thus beginning the Smart Archive.

So What about the Archive?

Since the introduction of P2, earnest objections have been made to the P2 media-less workflow based on its very concept. In heated discussions, critics would hold up an imaginary tape or disc and saying "I have my content, I digitize my content into the NLE, I put my content archive on the shelf. I always have my content. I know how to find it." While this is consistent with

today's production workflow and it affords users a comfort factor that is hard to deny, those same users want to move away from the shortcomings of tape or disk-based acquisition.

Consider the Albert Einstein quote referenced at the beginning, "Problems cannot be solved by the same level of thinking that created them." The problem is that users say they want to move away from tape, but they also want to have their archive and to keep the same comfortable workflow. If we want to change the paradigm, we must learn to think differently.

In the past, producers have happily brought footage back into the edit suite and spent inordinate amounts of time making their selections from piles of tapes, building an edit decision list, doing an off-line edit, then repeating the process in an on-line edit. There's also direct tape-to-tape editing where users searched for the right cut by reviewing and searching the tapes, knowing it was there somewhere.

If the time that used to be spent in the beginning of the production to log, capture and review the footage was time-shifted to the end of the process, wouldn't that be an advantage? There would still need to be some review at the front end, but no log and capture. By time shifting the process, one can build what we term a "Smart Archive." Within the old production framework the entire tape would be saved, despite the fact that there were many shots that just were not worth saving. In the new intelligent or smart archive, one doesn't save the garbage - the blown lines, the microphone boom in the shot, the badly framed or the out of focus shots - only the good takes are kept. In addition, one doesn't have to save a 30 or 60 minute tape with only 10 minutes of content recorded. Furthermore, this activity can be done during your edit session or after the session is over and you have billed the client.

Options for the Smart Archive

There are a variety of solutions for the Smart Archive, and they range from simple to complex, and from traditional to cutting edge. Each solution has positives and negatives, and in many cases "archive" means immediate access to the footage. Of course, the archive also needs to be cost effective and that too is a factor.



Tape

Obviously the first archive candidate is tape. Every one is familiar with videotape, feels comfortable with it and it is fairly inexpensive. There is no transformation required to retrieve the content, and developing the Smart Archive around video tape could still save users money since they would not be saving all of the bad takes with the good. That is to say, if tape were used, users could still realize a significant decrease in their tape budget, since only the important footage would be saved. Should users want to save everything, that's obviously possible, as well. Simply set it up to record to tape, get up and go to lunch.

What is the better, smarter way to work under this new paradigm? Taking the archive back to videotape is questionable because much of the benefit has been lost. If the footage is ever used again, it would have to be digitized, which is time consuming, and all the metadata would be lost, that may not be interesting today but in three years may be important.

Data Tape and Tape-less Storage Solutions

How to preserve the footage and maintain ease of access in the data domain in a way that best suits the user and their organization? There are a number of choices available for digital storage and each will be discussed briefly. However, for a full review of these storage technologies, one should contact the various manufacturers for a more in depth discussion. These can be broken down into Tape based, Disk based, and Optical/Holographic Technologies.

Data tape based technologies are available from Quantum, Exabyte and others. The solutions shown are from Quantum, and they say DLTtape Technology provides a family of proven, highly reliable, and cost-effective tape storage solutions. Based on a rigorous tape drive platform, the DLTtape product line allows scalable performance and backward-read compatibility to protect the investment in existing DLTtape media. They also manufacture a line of LTO back up drives as well.

An Array of Quantum DLT Solutions



Superloader



SDLT 320



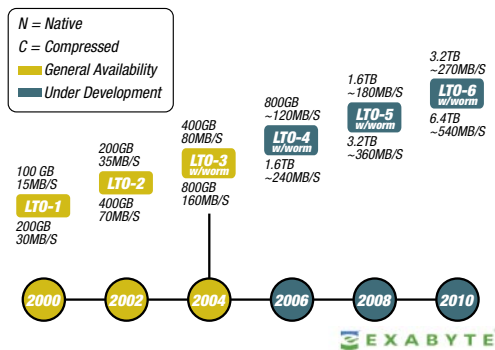
M2500



P7000

Another example is Exabyte Corporation, who manufactures data drives in a variety of shapes and sizes from which they claim there is probably one ideally suited to the users situation. Exabyte makes a series of LTO Data Tape Storage devices that operate at 93 GB an hour (slowest point) and hold over 200 GB with a secure shelf life of 30 years. With the 7 tape autoloader one could archive 1.4 terabytes (TB) with total “fire and forget.” Currently each tape costs around \$62.00 each for 200 GB or 31 cents per GigaByte. Keep in mind that in comparison to video tape this is much less expensive. DVCPRO HD tape costs about \$2.00 per GigaByte. As shown in the following chart, as the products achieve denser data packs the future is very aggressive for Data Tape Storage.

LTO Tape Drive RoadMap



Blu-ray Disks (BD)

This solution is a disk format that has many manufacturers in its coalition and is similar to DVD's but with considerably more storage time. Blu-ray, also known as Blu-ray Disc (BD) is the name of a next-generation optical disc format jointly developed by the Blu-ray Disc Association (BDA), a group of leading consumer electronics and PC companies (including Dell, Hitachi, HP, JVC, LG, Mitsubishi, Panasonic, Pioneer, Philips, Samsung, Sharp, Sony, TDK and Thomson). The format was developed to enable recording, rewriting and playback of high-definition video (HD), as well as storing large amounts of data. A single-layer Blu-ray Disc can hold 25 GB, which can be used to record about 2 hour of DVCPRO HD data or about 2 hours of Standard DV25 data. This might be suitable for commercials and short form work. There are also dual-layer versions of the discs that can hold 50 GB.



HD DVD

The DVD Forum has approved an alternative High Def/High Density Disk version has been developed by Toshiba and NEC and a specification for the pre-recorded version. The original name was AOD (Advanced Optical Disc). There are three versions in development.

1. **HD DVD-ROM** discs are pre-recorded and offer a capacity of 15 GB per layer per side, offering capacities up to 30 GB per side or 60 GB per disc. These can be used for distributing HD movies.
2. **HD DVD-RW** discs are re-writable and can be used to record 20 GB per side for re-writable versions.
3. **HD DVD-R** discs are write-once recordable discs with a capacity of 15 GB per side.

Like Blu-ray discs they use a blue-violet laser of 405 nm wavelength, but are physically similar to DVD discs. Since they use a cover layer of 0.6 mm HD DVD discs can be manufactured

Disk Based Technologies

DVD-R/DVD-ROM

While everyone is familiar with these technologies, they can sometimes be over looked as a viable storage for video as data. The downside of this technology is that it is limited to 4.7 GBs on a single side or just 9 GB on a double or dual layer.

using existing DVD lines, and existing UV mastering equipment.



Holographic Blue Laser

There are new optical technologies emerging that offer ways to efficiently and effectively store the Smart Archive in an accessible data file on optical media. One of these is the Holographic Blue Laser being introduced by InPhase Technologies, and Optware offers a competitive but very similar technology. These drives will store 200 gigabytes of data on a single disk or cartridge, and this is expected to rapidly increase to 1 TB or more. In addition, InPhase claims that their patented Zerowave manufacturing process enables record-breaking savings on media cost, saying that at \$.25 per gigabyte there is no other tape or optical media that can compete against this price and performance combination.

InPhase also says the 50-year archive life of the media keeps assets safe long after they have been archived. In addition, no special media handling, such as tape re-tensioning or temperature and humidity controls, is required to keep the content safe and secure.

All of the Video as Data solutions have the same downside, the footage cannot be directly viewed until it is loaded back into the system, but again, the right implementation that uses the metadata stored with each clip, could make the thumbnail viewable as well as a number of other pieces of information. Metadata could be the valuable key to your Smart Archive.

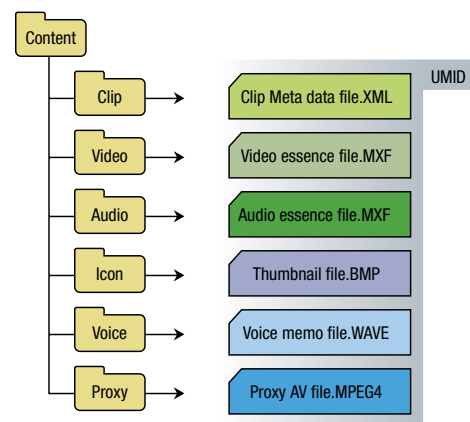
Metadata: What is it and how can it help me?

Simply put, Metadata is data about the content data, frequently called essence. The more data or information one has about the content, the more easily it can be found or filed.

Content File Structure

A globally unique ID for AV material called a Unique Material Identifier (UMID), is generated each time video/content is recorded on the P2 card, and is given to the clip - the video and audio essence and the proxy (if present), as well as the markers as described in the Working with P2 Section of this paper. If the content is moved or copied from the P2 card to another media that has a different directory structure where the link between the files of a given clip could be lost, it is possible to re-associate the essence and its related metadata using the UMID.

The structure of the P2 card content consists of these logical "clips" that each contain a video MXF file, one or more related audio MXF files, an XML clip metadata file as well as implementation dependent optional files, i.e. a Bitmap thumbnail file, a WAVE voice memo file, and an MPEG 4 proxy file. These files are stored under directories within the P2 card as shown below.



Content Structure on P2 card

MXF Essence File

MXF (Material eXchange Format) is a standardized (by SMPTE) file exchange format that assures interoperability with other devices and systems. P2 uses MXF, and more specifically uses Operational Pattern (OP) Atom, one of several file configurations within the MXF standard. OP-Atom was selected as the data structure because the video essence and the audio essence are wrapped independently and stored in separated files, making them immediately accessible and suitable for the independent (split) audio or video editing after recording.

The P2 system has two types of Metadata: Structural Metadata and Descriptive Metadata. Structural metadata is the metadata required for full-featured use of the video and audio essence stored in the MXF file, such as the parameters of the essence. On the other hand, the descriptive metadata represents additional

information about the video and audio essence that adds functionality and efficiency.

The Structural Metadata is recorded in both the Header Metadata section of the MXF files and the clip metadata XML file. While it is expected that the metadata structure and information carried in the MXF file will be popular and useful in the future, having a separate XML metadata file that also carries the structural metadata enables easy conversion of P2 content to a different data structure. This is useful in viewing applications and it also allows editing using the Clip metadata and the Proxy data without using the essence file. Users that have decided to use the optional proxy and low resolution editing to augment the direct editing features of P2 will find their requirements facilitated by this structure. Descriptive metadata is the information about the production

aspects of the clip. For any given shot it can contain the time, date, location, shooter, talent, person interviewed, and even GPS data, should that be supported on the camera, and can be used, modified, or updated in the editing and post production process. Descriptive metadata is required for content management, and is used as a key to search a specific content. Therefore, this data is best held in the XML layer, which has PC compatibility, visibility, and extensibility. In addition, when content that has been recorded with this additional shooting information is ingested to a production system, the XML metadata can be parsed and the appropriate metadata elements can be registered in the database of the production system. As one might imagine, a subject as broad as the application of descriptive metadata makes further discussion beyond the scope of this paper.

Examples of Structural Metadata Elements

Element	Description
<ClipContent>	Clip name, Global clip ID (UMID), Edit unit, Duration
<Relation>	Relation between Clips stored in multiple P2 cards
<Video>	Codec, Frame rate, Aspect ratio
<Audio>	Sampling rate, Quantization bits

Examples of Descriptive Metadata Elements

Element	Description
<Device>	Manufacturer, Model Name. Serial. No.
<Shoot>	Shooter (person's name), Start/End Date, Location(GPS)
<Scenario>	Program name, Scene No. Take No.
<News>	Reporter, Purpose, Object
<Access>	Last update: Person, Date
<Memo>	Relation between Clips stored in multiple P2 cards
<Thumbnail>	Information about a Thumbnail



Summary

Media-less recording has finally become possible, and it simplifies cameras, and liberates shooters by removing both the limitations of fixed video formats and the mechanical recording functions that wear out over time. It allows a scalable camcorder like the AG-HVX200 to be born – a camera that is small yet feature rich and that records a very high-quality DVCPRO HD, DVCPRO50 or DVCPRO signal.

As stated at the beginning of this paper, P2 is an enabling technology. It enables random access to your footage. It enables having metadata about each clip that can be used in cataloging the archive and improving the workflow further as the NLE manufacturers integrate this feature into their workstations. It enables the editor to start editing immediately so that the production finishes in a more timely fashion. It enables the creation of a

Smart Archive, where just the best and most viable footage is stored in a comprehensive and organized fashion. That Smart Archive allows for the immediate editing; meaning there is never any need to redigitize the footage as it always stays in the digital data domain. It enables the technology of a scalable format such as DVCPRO to DVCPRO HD to be executed in a small hand-held camcorder. P2 enables you to work smarter, faster and more effectively in the production of content, whatever that might be; a feature film, a news story, a commercial, or a documentary.



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