HIGH-DEFINITION
VIDEO ASSIST

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"The only constant is change."
Heraclitus

For years the technology of video assist has centered on recording and playing back NTSC or PAL composite video signals, and moving those signals around the set through a coax cable that gets run over, twisted, pinched, spliced and otherwise abused like no other piece of your equipment. Since its inception, videotape recording technology has improved and become smaller and lighter, then tapeless digital recording systems replaced the VTR except for some back-up or extra camera recording. But through it all the composite analog video signal remained at the heart of our system and cart design as it continued to serve us with its very robust and unique forgiveness.

During the last several years as High Definition cameras have been moving further into the world of commercials, episodic and feature production to replace or coexist with film cameras the question comes up time and time again "Hey, can I see that back in High Def?"

The answer to that question is not a simple one and there is no one solution for every production.

Steven Soderbergh has used the RED camera on his last 3 movies and does not use video assist at all. On his latest project "*The Informant"* with Matt Damon there was not even a single on set monitor. The only image from the camera was what Steven saw or played back on the RED viewfinder. Contrast this to Michael Mann, who recently finished shooting "*Public Enemy*". After a test of an HD assist package, "Michael had to have it". While shooting in Wisconsin it took two days to get dailies back to the location, so the assist operator brought his HD recorder to the dailies trailer (and often a hotel room) where Michael screened selects with the DP and editor.

Here we are in the middle of 2009, and HD equipment, whether consumer, industrial, broadcast or professional, continues to evolve to a point where equipment price and capability make the prospect for a high definition video assist package a real possibility. Just as every video assist company or operator has a unique way they want their standard def composite video assist cart designed and arranged, the options for building a new HD assist cart are just as varied. I do not want to discuss assist cart build outs specifically in this paper, but talk about some general high def technology that every operator should have knowledge of and how it impacts equipment selection, video cable and cart design.

I am going to approach this paper from the aspect of a video assist technician and not from a Data Capture or Digital Imaging specialist. The technical level that a well qualified DIT or Data Capture engineer should be at is well beyond the normal demands of video assist although the fundamentals of

signal formats and distribution should be understood by anyone dealing with HD signals. This paper could also serve as a solid introduction to anyone approaching the Data Capture or DIT learning curve.

This paper is packed with practical information and is not going to be an overly technical journey, and important points to remember have been italicized.

Introduction and History

Let's begin our journey with a quick introduction to some basic definitions and differences in handling composite video vs. high definition digital signals through coax cable.

In the standard definition (SD) world of video, there are several types of formats that can represent a video signal. There is the ubiquitous composite video signal that is represented by an "analog" voltage that changes amplitude to recreate the image. Then there are other analog signal types still in use today such as Y/C and several component versions that require multiple coax cables to distribute. (Not very useful for most assist work!)

These component SD analog signal types are not normally dealt with in the assist world. Currently, one digital version of SD in widespread use today is known as "serial digital interface" (SDI). This term is often used to describe a whole family of digital video interfaces standardized by the SMPTE (Society Of Motion Picture And Television Engineers). Any time you see the acronym SDI it usually refers to a standard definition video format that could be NTSC or PAL. The acronym HD-SDI (High Definition Serial Digital Interface) standard refers to a high-definition digital signal.

HD-SDI is the most common high definition signal type used in production and post production for it easily travels over a single precision coax cable. HD-SDI is the signal you will use most of the time on an HD production. There are other high definition digital and analog formats that we will cover later in greater detail.

Whether SDI or HD-SDI, these digital video formats traveling through the coax cable are basically a high speed string of computer bit ones and zeroes used to represent the video and audio. The actual data transport speed of most HD-SDI formats is 1.5Gb/s (that's one and a half billion bits per second!). Another even faster HD digital format is now with us and referred to as 3G (that's 3 billion bits of information flowing through your coax every second!). Since I have mentioned that audio can be part of any SDI format, *the term for audio following along with the video in any SDI signal is referred to as "embedded audio"*. We will talk about this in more detail later.

For those real techies out there, you will often see digital video specified in equipment manuals and documentation referred to by its SMPTE standard designation. 259M refers to a standard definition serial digital signal at 270Mb/s. SMPTE 292M refers to HD-SDI signals at 1.5Gb/s and SMPTE 424M refers to HD-SDI signals at 3 Gb/s. These numeric designations only refer to the bit rates and tell you nothing about the resolution or frame rate. HD equipment is often specified by what "data rates" it is capable of handling along with specific resolutions and frame rates. *When selecting any equipment for use in an HD assist package pay very close attention that the device supports all the resolution and frame rates you*

need to work with. Consumer and Industrial products often do not support the 24 frame formats used in production.

Coax Cable and the HD-SDI Signal

One of the most important areas to fully understand is the more delicate care and handling that an HD-SDI signal traveling through a coax cable needs compared to an analog composite signal. Let's take a closer look at how the video assist industry handles and often unknowingly mistreats composite video.

In the familiar world of composite video, minor level changes, signal to noise ratios or other signal distortions encountered as the signal travels through coax cable, distribution amplifiers, tape decks, matrix switchers, etc., are usually of minimal concern to the video assist operator.

However, television studios, post houses and the like must carefully calibrate and monitor video and audio levels to ensure a very high level quality of service to a degree that the video assist industry has never needed to do. As we connect and route a composite video signal from the film camera to our cart and back out to various monitors, as long as there's a picture we pretty much just move on with our duties. For years I have seen camera crews and assist operators use a "T" connector to feed another monitor or piece of equipment with little regard to the fact the video signal might be double terminated and losing half level. No problem, just crank up the monitor's contrast and brightness! This general disregard or complacency for handling analog composite video has been prevalent for a long time in the world of video assist.

The important point to remember here is that composite video is very forgiving to both the type of coax cable you use and even how it is connected between multiple pieces of gear. Digital video signals whether high def or standard def will not accept this type of abuse and must be treated with the utmost of respect to be successfully moved around a film set. From the camera to your cart and back out again, following some simple rules and specific cable guidelines will help insure a successful migration to the world of HD assist.

As I mentioned earlier, the abuse that most coax cable suffers over time on a film set is pretty high. That poor old coax cable that distributes composite video has been trampled, twisted, crushed and pinched, yet the analog video signal, for the most part, just does not care. This is simply not the case when handling HD-SDI video.

The very first item you need to change when moving to high def is *all* your cable. The high speed digital signals that make up HD-SDI video require coax cable that is referred to as "precision video" or "digital spec'd" cable. Older RG-59 coax cable that is not specifically made for handling digital video signals will not successfully pass HD-SDI signals with a high degree of accuracy or repeatability. The longer the cable run the greater chance that your HD equipment will not "see" the HD-SDI video at the other end.

Belden, Canare, Gepco and other cable manufactures all make RG-59 and larger diameter RG-6 coax cable designed to "digital specifications". Belden has a flexible coax version in both RG-59 (1505F) and RG-6 (1694F) that coils very nicely. There are also sub miniature digital coax versions (Belden 1865A)

that can be used to wire your cart to keep weight down and cable bundle sizes very small. Always use high quality brand name connectors and be very diligent in terminating connectors properly with the recommended crimp tools. (If you want additional technical information on coax cable electrical properties I suggest reading Belden Technical Bulletin TB65 6th Edition.)

Before we move away from the subject of cable, it's important to understand another important point. *You can use an older analog cable to distribute HD-SDI, but the longer the run, the less likely you are to be successful*. A 100 ft. older coax may work on a set one day but that same cable may not work on the next job. Composite video is very forgiving to both the type of coax cable you use and will not noticeably deteriorate until it passes through several hundred feet of cable. Composite *analog video will always come out the other end of a cable (that's not chopped in half!)*

HD-SDI equipment can be very finicky about the signals they receive. HD-SDI signals are also somewhat dependant on the equipment it is coming from and going to. The way an analog signal deteriorates is gentle and soft. Analog may get a little noisy or experience a drop in level over a long cable run but an image will still be visible. However, when a HD-SDI signal deteriorates through a long or damaged cable run it may not be detected or recoverable by the receiving equipment or may even become intermittent and just seem to drop away randomly. *Analog video signal failures through coax cable are "soft" and digital signal failures are "hard" and can be difficult to troubleshoot*.

There are 2 basic types of HD-SDI distribution amplifiers, equalizing and reclocking made specifically to compensate for long cable runs and other induced signal errors known as "jitter." *Do not purchase any HD-SDI distribution amps that do not reclock. The AJA HD10DA is one example of an excellent reclocking DA. You should plan on having a few of these type of DA's as part of your standard package.*

The video monitoring output on most high-end production cameras will be an HD-SDI interface which is also found on the DIT's HD rack. Most professional production type LCD monitors used on set will also use the HD-SDI interface as at least one type of input. Let's talk some more about HD camera outputs and the various formats of HD, and then move on to monitors and other types of HD signals you need to know about.

HD Cameras & Formats (What The Shop Guys Did Not Tell You)

One of the most confusing areas for assist operators moving into HD is dealing with all the different formats and frame rates that can present themselves on a production. It is very common among both high end HD cameras (Genesis, Sony, Arri, RED) and smaller cameras (Sony EX3 and Panasonic HVX series) that often *the monitoring outputs on the camera body are not the same frame rate or resolution that the camera head is actually shooting.* Do not assume when you ask what format the camera is shooting that this is what you are getting from the camera head or DIT. This issue has been a stumbling block and learning curve for many assist operators new to HD cameras and workflows.

The signal format you are ultimately getting from the HD camera or DIT is what determines how you set up your HD assist recorder – whether it's an FFV HD Omega deck, Panasonic HPM110, Raptor HD or

other recorder. Most productions shooting HD and emulating a traditional episodic or feature workflow are going to shoot at one of the 1920 x 1080 @24psf formats.

Here is a list of the most common formats that you will likely record and playback:

- 1280 x 720p @ 59.94
- 1920 x 1080Psf @ 24.00
- 1920 x 1080Psf @ 23.98
- 1920 x 1080i @ 59.94

Now that we have introduced this alphabet soup of formats, let's explain some basics for understanding frame rates and resolutions. The HD rates listed above use a common short hand approach to represent resolution, frame rate and raster scanning format.

Let's take the example of 1280 x 720P @ 59.94. "1280" is the horizontal resolution, the second number "720" is the vertical resolution and the third number "59.94" is the exact frame rate. A letter "i" next to the vertical resolution means the signal is interlace scanned; a "p" is for progressive scanning, and the designation "Psf" stands for progressive segmented frame. The reason for the existence of the Psf format goes back many years when CRT based monitors were unable to display the high horizontal refresh rates of progressive scan HD signals. It has continued as a capture/record format supported by Sony and others ever since.

The other common signal description you will come across is the color encoding or sampling rate format. By now you have probably seen standard def and HD signals described in terms of 4:1:1, 4:2:2 or 4:4:4. These numbers represent ratios that describe the relationship between how the luminance and color components are digitally sampled inside of equipment and formatted into a serial digital stream. Larger numbers (4:2:2 vs 4:4:4) mean higher picture quality, but the additional bits to transport and record, generally translate into higher equipment costs.

Most current video assist formats you will record from the monitoring outputs of most HD cameras are going to be 4:2:2. Most lower-end products used to record HD for assist will only record video formatted to 4:2:2. Data Capture technicians and DIT's are more concerned about these signal parameters, which are part of the technical decisions made when determining a projects post production workflow and final distribution requirements.

The fact that you are usually dealing with some form of moderate compression to store all takes and perform a traditional film based video assist workflow precludes you from needing to record actual 4:4:4 signals. The quality of the compressed HD recordings is typically going to be very good for viewing on set and even for evaluating critical focus.

HD Component Video

The term "component video" will always refer to any type of SD or HD analog video that is made up of two or more signals used to recreate the image. In SD or HD, component video usually means the use of

three different signals used to represent the video image. There are two main types of component formats used in the production and post production workplace R,G,B and Y, Pb,Pr. You will primarily need to deal with the Y, Pb, Pb version in production. This variant reduces the signal duplication and bandwidth requirements inside digital equipment. The black and white or "luminance" (Y) signal information is made up of a combination of all three primary colors red, green and blue with a majority coming from the green signal. If the luminance signal is subtracted from red signal (R becomes Pr) and the blue signal (B becomes Pb) this will reduce signal duplication and we can recover the original full R,G,B signals by simple calculations inside equipment and monitors. The use of component analog signals and how their digital counterparts are created inside equipment is the reason we sometimes refer to them by their digitally sampled nomenclature. (Refer to the 4:2:2 and 4:4:4 discussion from the previous page).

Most of the sub $10K HD cameras traditionally have not had an HD-SDI output on the camera. This is slowly changing and two current examples are the addition of an HD-SDI output on the Panasonic HVX 170 and Sony EX3. HD Cameras in this price range will usually have either an analog component output or a HDMI output that is often used to connect to a larger on-camera monitor or connect to a full size HD monitor at video village. HD component analog is similar to standard def component and requires 3 coax cables to distribute. Many but not all HD recording devices will support this signal format as an input (all the Raptor HD products certainly do). Audio will never be part of an analog component video format like it can be with HD-SDI. You can distribute HD analog component video using the same coax that you use for standard def but most assist operators prefer to use "3 wire" bundled multichannel coax that's all in one jacket like the Canare V-3C series or Gepco RGB250.

When hooking up and troubleshooting component analog interfaces (Y,Pb,Pr) it's a good idea to always start with and connect the "Y" luminance signal first. The Y signal is usually the green colored connector/receptacle and carries the sync information. Monitors will always lock up and display an image with only the Y signal connected. *The picture will be black and white until the two color difference channels are connected but connecting the Y signal first confirms the sending and receiving equipment are set correctly*. If the coax carrying the "Y" signal fails, you can always patch around the bad cable at both ends and display a black and white image in an emergency! HD analog component video is very similar to composite video in the way it travels through and is treated by coax cable. You can go hundreds of feet with proper gauge high-quality cables. In fact any precision coax for digital use is able to handle analog signals just fine.

Literally every DVD player and consumer television has Y,Pb,Pr connections. Most professional and broadcast monitors will also support this type of component video input and the 3 input connectors will usually double as straight R,G,B inputs as well that can be switched via the monitors menu function to select the type of component input signal you are sending to the monitor.

HDMI Signals

The other type of HD signal you will encounter is HDMI (High Definition Multimedia Interface). The HDMI interface is an all digital type signal and is designed to carry uncompressed video and audio. This is

the same interface found on nearly every consumer HD LCD monitor and DVD player. HDMI is a high speed digital signal that also needs to be treated very carefully. It was originally designed for very short digital interconnects between consumer equipment and only recently have long distance cable options become available or affordable.

Since HDMI is used primarily for the consumer marketplace, the quality of construction and materials used in building HDMI cables vary greatly from off-shore manufacturers. Be aware of cable length and wire gauge used. Two 50 foot cables made by different companies may give different results. HDMI can fail like HD-SDI signals over long distances. In lower quality cables and/or long cable runs you may notice "digital snow" or "sparkles" before the signal drops out completely.

Many companies now make active repeaters, amplifiers and equalizers to allow HDMI to be used well over one hundred feet. *Be aware that most HDMI cable sold on-line and at retail stores is made with male to male ends*. You will need to buy barrels or couplers to extend most HDMI cable. HDMI is electrically backward compatible with the DVI (Digital Visual Interface) standard and small passive adaptors are available to convert between these two connector types. The DVI interface does not support any audio, while HDMI does. There are many HD-SDI to DVI conversion units available because of the early widespread use of standard computer monitors used on set as a low cost solution to monitoring HD signals. There are also HD-SDI to HDMI conversion tools to allow consumer and other monitors with HDMI inputs to be used in an HD-SDI production infrastructure.

You are probably not going to use HDMI as a capture/record signal to often but may utilize it for an assist cart monitor or large format client monitor if your HD assist recorder supports it. The Raptor HD DDR's all support HDMI in/out.

When you start selecting LCD monitors for the assist cart and client use remember HD-SDI inputs will not be found on consumer monitors and HDMI inputs will not be found on all professional monitors yet. The lowest common denominator input signal type that nearly all HD monitors have is component analog. There are devices available to convert HD signal formats to any other format, but this can be expensive and add a lot of complexity to a system if you do not plan accordingly. That being said, being "armed" with some of these format conversion tools can be a life-saver as you move from job-to-job and are asked to send signals to equipment you do not own.

Cat 5 Extension

One growing option for component analog and HDMI distribution to monitors on set is the use of Cat 5 type conversion devices. Cat 5 tools are a two-part solution: the "transmitter," which converts the digital or analog signal to a Cat 5 cable-friendly format, and a "receiver," that converts the Cat 5 cable signals back to the original input format.

These solutions are made by dozens of companies and quality does vary. You should not use these tools for original camera signal recording. The broadcast television and film production industry never uses devices like this during any original capture/record. Cat 5 tools should be used primarily for long

distance signal distribution to monitors. Cat 5 conversion tools are available from mainstream vendors like Altinex, Extron, Gefen and many home theatre equipment vendors.

HD-SDI signals are such delicate high speed data streams that they do not lend themselves to direct conversion to Cat 5 extension solutions. For extremely long cable runs in excess of 1000ft or more there are fiber optic cable solutions for long distance transmission of HD-SDI, but it would be extremely rare to require this in a production environment.

HD and Audio

Generally speaking, standard definition practices apply when it comes to handling audio for HD assist. There's going to be a production sound mixer that's recording "double system" and may or may not be sending audio to HD cameras that record on-board. This means you cannot count on audio being part of the HD-SDI signal (again, referred to as "embedded audio") you get from camera. Make sure your HD assist recorder supports separate analog audio inputs to efficiently emulate a standard assist workflow. *Many HD recorders do not have separate analog audio inputs or outputs, whether they are solid state or hard drive based!*

While there are devices to "embed" and "de-embed" analog audio in and out of a SDI video stream why add to the complexity and cost of a system if you do not have to. (All Raptor HD recorders support either separate balanced analog audio in & out or embedded audio.)

Down-Conversion and Assist Cart Design

Let's say you are considering a new cart design. Do you start from scratch? Every operator will answer that question in his or her own way. Upgrading from SD to HD does not mean you have to throw out the baby with the bath water. Your existing matrix switcher and signal routing infrastructure can still work to provide an assist feed to departments that only have a standard definition NTSC or PAL monitor. The answer is in the use of down converters. Down-conversion is a term used to describe a piece of equipment that converts a high definition signal to a standard definition signal.

If every HD recorder in your cart has an external HD to SD down converter, your signal distribution challenges are simplified. Adding down-converters is another expense that can cost several hundred dollars each. Some HD record/playback devices have built in down converters or may have an option to have one built-in. All Raptor HD products will support simultaneous down conversion when this feature is implemented in the summer of 2009. *Simultaneous down conversion is a huge problem solving feature and major cost savings for anyone trying to make the move to HD assist.* Adding a small 4x4 HD-SDI matrix switcher to an existing or new cart design means you can switch the few critical HD viewing monitors on set while using your standard def video matrix switcher for legacy composite monitors. Of course, if money is no object just add down converters to several outputs of a larger HD-SDI matrix switcher and you have the same solution.

Be careful when purchasing down converters. There are some in the marketplace that down convert to standard def- SDI only and not to composite video!

Most down converters will support aspect ratio conversion between HD and SD by allowing you to select a center crop, letterboxed or squeezed image.

HD Conversion Tools

There is an entire range of HD conversion equipment that is designed to down convert to SD, up convert SD to HD and even cross convert between HD standards. For example take a 1280x720p input and cross convert to 1920x 1080i. Some of this equipment is designed to be single purpose and perform one dedicated function while other equipment may perform up/down/cross conversion all in one unit. These tools can be very helpful to carry as "HD Swiss army knives" in your package. For instance Cobalt Digital has a multi-purpose HD/SD Up, Down Cross converter (model 8022) that's small, dc powered and easy to use. You will eventually run into situations where having this kind of advanced signal management capability will be very useful. You do not have to spend top dollar on the high end equipment found in most HD racks. There are several companies that make smaller, standalone, more affordable versions that provide excellent quality. AJA, Cobalt Digital, Blackmagic Design and Ensemble Designs all have great small products to choose from.

Effects and Editing

I am approaching this section based on the following premise. Your HD video assist package emulates a composite video cart with standalone video record/playback equipment. I am assuming you are not already using a NLE (non-linear editing) solution as a basic record playback device or a software application that may provide some vfx capability.

There are HD tools and equipment that can match any standard def equipment you have used for vfx assist or on-set editing. The biggest stumbling block for assist owner/operators is the cost of the equivalent HD solutions. Fortunately the cost vs. performance ratio is moving in our favor, literally every day. Final Cut Pro (FCP) properly configured on a laptop or tower, can handle many of the visual effects and on-set editing that productions have come to expect. For a versatile HD FCP package you should have some I/O device that will accept HD-SDI as an input and provide this signal as an output. Both AJA and Matrox offer excellent devices for this. The *AJA HD I/O* and the *Matrox MXO2* provide a full range of audio and video interfaces, but have some ideological differences in the way they "speak" to the computer. Study each one's "real time" capabilities and storage requirements very carefully before purchasing.

For real-time switcher effects, such as live green screen keying or effects plate "line ups," there are small HD switchers made by several companies including, Panasonic, Edirol, Datavideo, For-A, and Grass Valley, to name a few. Be very careful when researching switchers for vfx work. The lower cost units often do not have a chroma key function and will generally not support HD-SDI 24fps frame rates. (Remember the cross converters?…Hmmm.)

HD Recording Technology

There is a huge range of HD recording equipment used in the broadcast, professional and consumer marketplace, from tape, hard drive and solid state recorders designed for everything from HD camera master acquisition, to small palm-sized solid state capture devices. Prices range from $100,000 for a Sony SRW5000 mastering VTR; under $5,000 for several of the solid state recorders; and a large number of consumer hard drive based PVR's (Personal Video Recorders) that are well under $1000.

Just as with standard definition, selecting from such a wide range of equipment must be done carefully and intelligently while keeping in mind your exact goals.

The primary role of video assist has always been to record every rehearsal and every take on each day of production. From a one day commercial to an 100 day feature, takes are generally recorded and stored for immediate playback at any time and can be requested by any department. Playback Technologies has maintained this simple concept with all of our HD Raptor recorders: provide a video assist operator a tool that can record and organize all recorded footage for immediate playback.

Let's look at some of the HD recording options being used and considered for video assist work. I am not going to mention any tape based recorders since digital recording and instant cueing has been the mainstay of video assist for many years.

One of the first HD record/playback tools to be utilized by video assist operators was Final Cut Pro. For commercials and other short-form single-camera work, FCP and some type of video interface hardware like the AJA I/O HD can provide a very useful package. However, adding a second camera or being highly mobile for run-and-gun shooting can be problematic with this solution.

Fast Forward Video has a single and dual-channel HD Omega deck that is AC powered only and is a familiar device to many video assist users. The HD Omega deck does not support separate analog audio in and out, or provide video support for HDMI, component or composite video inputs or outputs, but will record a NTSC or PAL signal via SDI input only. The FFV Elite recorder can provide a small battery powered run-and-gun capture device, but again, has no provisions for handling analog audio in or out.

Sony , Panasonic and AJA all have solid state recorders in their professional video product lines. Sony has optical media-based recorders in their XDCAM product line, but these are priced above 15K each and do not all support the 24fps HD formats.

Sony's PMWEX30 is a XDCAM EX format recorder that uses the same SxS memory cards as the EX1 and Ex3 cameras. It's not very useful as a long form project recorder but is an example of one of the sub-$5000 DC powered HD recorders.

Panasonic has their portable AG-HPG20 and the larger AJ-HPM110 P2 recorders. The smaller HPG20 does not support 24fps formats or analog audio. The HPM110 provides much better I/O flexibility, with analog audio, component video interfaces and built-in monitor. The 110 has been popular for some commercials, camera car and location work. The 6 internal P2 card slots extend record times out to a

reasonable amount. Panasonic introduced a standalone palm sized AG-HMR10 SD card recorder at NAB 2009. The HMR10 has a built-in 3.5" LCD monitor and records in the highly efficient MPEG-4 AVCHD codec that is now becoming a widely used HD codec for consumer and low end HD gear. This device certainly can be used for run-and-gun capture with HD-SDI inputs only, but will not be suitable as a primary record/playback device.

AJA announced a tapeless recorder at NAB 2009 as well. The AJA Ki Pro recorder is a dc powered recorder that captures to the Apple ProRes codec only. A robust video and audio interface make this device another choice for portable run-and-gun capture but again, will have limited use for multi-day or long form productions.

Convergent Design has the Flash XDR ruggedized portable HD recorder/player. This recorder uses CF cards and can capture master quality, broadcast or proxy mode quality all using different data rates. The XDR supports only HD-SDI video inputs but has standard analog audio I/O. This recorder is popular with the camera rental houses for field recording POV camera set-ups. At NAB 2009 Convergent also introduced a smaller CF card recorder, the nano-Flash, with HD-SDI and HDMI video I/O, but it does not support analog audio like its big brother.

Doremi continues to build VTR replacement HD disk recorders with their V1-HD product. Doremi had some early acceptance by commercial video assist operators with their cost-effective SD recorders but since have moved ahead with units that basically price themselves out of being used for assist work.

I will only briefly mention there are US and European video assist application software vendors. For HD use these software only products require a user to assemble and build their own hardware compatible system generally using tower computers and one or more 3rd party capture cards. Definitely not for the faint of heart or for those that need small dc powered gear for fast moving location work.

This brief introduction into HD recording products is not meant to be a complete listing of devices but should serve as an introduction to the variety of tools out there and their wide operational and technical differences. Evaluate any device you plan to use very carefully and make sure its video, audio and operating efficiency fit the task at hand.

The Raptor HD product line are the only recorders made specifically for the video assist user. Our products have the internal and external storage options to keep all rehearsal and production takes available for an entire project - without having to swap media or hard drives. Included video assist software makes clip management simple and straight-forward. Now offered with true 12vdc battery operation you can record and playback from the front panel in an insert car and install the deck back in your cart and use the application software with an attached monitor, mouse and keyboard.

HD Wireless

The broadcast television industry along with their news gathering departments have been using HD microwave equipment for many years. The HD wireless gear used for broadcast news and sports is

licensed for use in specific frequency bands and is very expensive priced beyond most assist and steadicam users. Fortunately, there are a couple of affordable solutions, albeit with limited range.

The IDX CW-5HD "Cam-Wave" uses the low power 5Ghz unlicensed wi-fi band to transmit extremely low latency uncompressed HD-SDI signals over approximately 150ft line-of-sight, and roughly 40 to 100 ft between walls, depending on building or set wall materials. The transmitter and receiver are sold as a pair for about $5K.

Boxx TV has a similar HD transmitter system called the "Meridian", that also uses the unlicensed 5Ghz band. The Meridian system has different receivers to choose from, including one with a built-in down convertor and balanced audio out. Users report a little better range with the Boxx system primarily due to their external antenna design on the transmitter.

General Technical Notes

Another recommended piece of equipment that can help when troubleshooting cable, equipment and interfaces is a HD test signal generator (TSG). Traditionally, these have been very expensive, but prices are coming down and there are several battery powered versions out there. The reason I recommend an HD TSG is to allow you a means of generating a "known good" signal. When trying to troubleshoot HD gear, including monitors and cable having a portable signal, you can inject to confirm equipment operation or test a long cable that was intermittent. A TSG will provide you the peace of mind that you can confidently state a piece of gear or cable is good.

Manufactures of small HD TSG's include Harris, Doremi and Red Byte Technologies. There are probably going to be many new units introduced here at NAB 2009.

Despite all the talk about HD-SDI signals being sensitive to cable runs, do not be too worried about this. Just knowing about the sensitivity of these signals and their care and handling will help you avoid some of the common pitfalls.

Earlier I touched on a type of signal distortion that is a specific SDI signal error called "jitter." This is not a frequent problem, but has been experienced on set. To state it briefly, the extremely high-speed digital bits that make up the HD-SDI data stream can accumulate a phase error referred to as jitter that makes signal recovery by the receiving equipment difficult.

Jitter can be introduced by equipment circuitry design tolerances as well as by induced noise along cable runs. In one recent experience after some reported problems with recording the HD-SDI output from a new and popular camera manufacturer, excessive jitter was measured (with $30K test equipment) to be coming right out of the camera. The jitter from this camera caused HD recording devices from several manufactures to lock inconsistently to the incoming HD-SDI video. This difficult-to-troubleshoot and impossible-to-measure on set signal error is the reason we and other HD assist operators suggest always passing the HD-SDI signal through a reclocking DA right before the input to your primary HD recorder. This problem has been reported on sets with HD cameras and gear from many leading companies.

Why not design reclocking inputs to all HD gear? Parts and development costs for the manufactures translate to higher equipment costs. While these problems do not occur often, there have been enough reports that it is fast becoming a recommended practice to use reclocking DA's at the inputs to all HD recording devices used for assist.

We have covered a lot of ground in this paper and have only briefly introduced some key terms, technologies and equipment. When choosing any equipment for HD assist work explore all aspects of the gears application and technical specifications. Make sure it performs how you need it to and do not be impressed simply because it's the newest, cheapest or smallest piece of gear out there. There are no magic bullets that work for everybody.