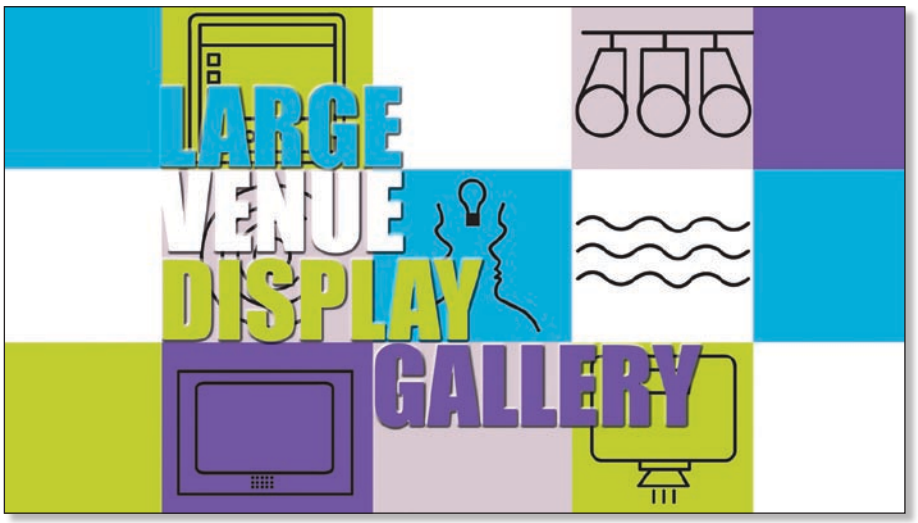
By Steve Somers, Vice President of Engineering

Distributing High Definition, High Performance Imagery for InfoComm's Large Venue Display Gallery – How We Do It

If you attended the 2005 InfoComm, I hope you had an opportunity to visit the third annual Large Venue Display Gallery event that Extron supported and managed, and will continue to do so for InfoComm 2006. This ubiquitous display of some of the industry's pre-eminent high definition large venue projectors resided within the north hall, next to the registration area. The larger-than-life high resolution image delivered by each projector enticed viewers into each of the dedicated cinema-like theaters. Now for the third year since the demise of the Shoot-Out, the Large Venue Display Gallery fills a void. Or more accurately, it appeases our hunger for huge, high definition imaging technology prowess. This issue of Technically Speaking recaps how we ensured the "high" in high performance video distribution for the 2005 LVDG event.



No, it was not a "shoot-out." I discouraged the use of the "S-word" on several occasions. Admittedly, its roots are from the Shoot-Out days. I've been to more than 20 InfoComms when you include its international reach of more recent years. What I love most about this trade show is big, big electronic images. Isn't that what all of us expect to see at InfoComm? Producing large-scale presentation images is a hallmark of our industry; besides, it's really cool. Since the demise of the Shoot-Out, an essential show display element such as the LVDG has been wanting.

Setting up and operating the LVDG is much more simplistic than a projection shoot-out. There are considerably fewer rules. Software display and operation within the event is more freeform. The focus is on big, beautiful, high quality, high definition imagery. The goals of the LVDG are:

- To produce a high quality InfoComm event for attendees centered on its core business: large-scale presentation, high definition imaging and imaging technology
- To simulate a cinema theater environment for attendees
- To distribute both static and moving image sources at the highest HD resolution in common use – 1920x1080
- Display only progressive scan, not interlaced, materials

History Lesson

The 2003 and 2004 LVDG events utilized four video (with audio) sources. Each of the sources along with its audio track could be selected by viewers from a dedicated touch screen control panel in each theater. For one moving video source, we employed the high definition video material, 1080/24p, used to master the Shoot-Out Software DVD release. A 10-bit disk server delivered this HD-SDI - high definition serial digital - feed from our control room via Extron's HDSDI-ACR 100, HD-SDI to Analog Component and RGB Converter - and RG6 Super High Resolution cable. The HD-SDI feed was not converted to RGB by the HDSDI-ACR100. We used its active HD-SDI loop-through to buffer and drive the long RG6 cable runs. We calculated that runs to about 300 feet would be attainable. After installation, we did not exceed 200 feet; so, there was a comfortable safety margin. See the sidebar on calculating HD-SDI signal loss for cable runs. Balanced-line stereo audio feeds were managed through a portion of a 16x16 Crosspoint Matrix router.

Technically Speaking — continued

Due to variation in native resolution employed by the various projectors in the event, distribution from the control room of multiple resolution RGB sources would be unduly complicated. To simplify the distribution system, individual computer systems were co-located at each projector position to support high definition static image material as well as Windows Media HD movie trailers running in 1080p. Therefore, each theater required one to three local computers for still imagery and WMV-HD.

In each theater, we used an Extron MLS 506 switcher to manage the RGB imagery and audio delivery from the graphics sources. The HD-SDI feed from the control room disk server connected directly to the projector; however, its separate balanced-line audio feed routed through the MLS 506 for management with the other audio sources before hand-off to the theater's audio power amplifier. This topology worked well, but required a considerable number of computer systems to support the variety of image resolutions needed.

If It Ain't Broke...

Signal distribution planning for the 2005 LVDG certainly began with the same approach in my mind. Need I say: "If it ain't broke, don't fix it." But, Sony's Gary Mandle asked me a provoking question: "Could you supply ALL the source feeds in HD-SDI format?" Hmmmm. Sony had interest in using our graphics imagery, but needed all feeds in HD-SDI format for compatibility with their planned video delivery system. Additionally, Gary expressed strong interest in utilizing the HD video material in progressive scan format. Further discussion with other LVDG participants yielded an overwhelming interest in 1080/24p HD delivery of all material. For the HD video, this would certainly make for cleaner transfer to the video server along with potentially higher quality.

The request for progressive scan doesn't sound particularly significant on the surface; but, in previous years the HD video format supplied from the digital server was 1080i. Ironically, the master tape is recorded in 1080/24p, or 24 frame progressive. For the first two LVDG events, we had to scan convert it from 1080/24p to 1080/60i. Things have since progressed. Most projectors having HD-SDI inputs today are operational at all rates covered within the serial digital specification, SMPTE 274M. Therefore, supporting the 24p request is straightforward.

A New Distribution Paradigm

But, delivering ALL sources in HD-SDI format creates a real kink in our distribution pipe, so to speak. How would that be accomplished? In the course of a talk with my good friend Rod Sterling at JVC, I found that JVC has been utilizing a particular model NVIDIA graphics card to deliver all their demo material to their flagship projector in HD-SDI as well as dual-link DVI format. As it turns out, the broadcast and production communities already utilize graphics cards equipped with serial digital support for direct transfer of high definition graphics to online HD television production in real time. This is particularly attractive for local news graphics and editing where the production cycle is only hours or minutes. In that environment, whatever may be displayed on your computer desktop is auto-magically outputted in HD-SDI format; assuming, of course that your native desktop is 1920x1080, or higher, resolution. Thank you, Rod, for your suggestions and connecting me with NVIDIA. NVIDIA supplied us with a Quadro FX-4000SDI graphics card test sample that supports both DVI and SDI/HD-SDI output.

Calculating SDI/HD-SDI Cable Loss

Cable loss specifications for standard SDI, SDTI, and uncompressed SDTV are addressed in SMPTE 259M and ITU-R BT.601. In these standards, the maximum recommended cable length equals 30 dB loss at one-half the clock frequency. Note that this high loss value does not correlate with normally acceptable loss for analog video and graphics signals. SDI signals are nominally 800 millivolts… not much different in level from analog video signals. However, the 30 dB loss level is acceptable due to the serial digital receiver having a signal amplifier and an equalization recovery system.

For HD-SDI running at 1.485 Gbps, SMPTE 292M governs cable loss calculations. In that standard, maximum cable length equals 20 dB loss at one-half the clock frequency (743 MHz). Due to the data coding scheme, the bit rate is effectively the same as the clock frequency in MHz. Similarly, high definition serial digital receivers have equalization and gain recovery. See Table 1 for some examples of cable length calculations. The "one-half clock frequency" calculation point accounts for those odd frequencies listed in many cable attenuation specification tables.

This provides leeway for cable variations, connector loss, patching equipment, etc. Table 1 includes this 10% allowance. In all cases, your system must operate solidly before the "cliff region" where sudden signal dropout occurs. Final performance rests with the cable and the type receiver used. The bottom line in these systems is maintaining low BER - bit error rate. Bit errors may manifest as random horizontal line noise bursts within the image. When these random noise events are seen, the system is at the edge of transmission failure.

	SMPTE 259								SMPTE 292	
	Level A		Level B		Level C		Level D			
Application	NTSC 4fsc Composite		PAL 4fsc Composite		525/625 Component		525/625 Component		HDTV	
Data Rate in Mbps (clock)	143		177		270		360		1485	
1/2 Clock Rate in MHz	72		89		135		180		743	
Extron Cable Product	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters
MHR 26 AWG (22-020-xx)	583	178	531	162	428	130	365	111	94	29
M59, 24 AWG (22-127-xx)	813	248	736	224	600	183	519	158	150	46
RG59, 20 AWG (22-124-xx)	1034	315	944	288	801	244	687	209	188	57
RG6 18 AWG (22-098-xx)	1406	429	1274	388	1067	325	915	279	285	87

Table 1

That graphics card solves a significant problem. With one of those cards in each of three PCs, both high definition graphics sources and the WMV-HD video source could be located in the LVDG control room and operate at the same 24p rate; but, we needed a way to manage selection between four sources for the single HD-SDI input on each projector with the idea that only one RG6 coax cable need be distributed to each projector. With this scheme no local computers would be necessary; thus, greatly simplifying the distribution design and installation. The MLS 506 switcher does not support HD-SDI sources, which operate at 1.5 Gbps. While the HD-SDI graphics card is a revolutionary breakthrough for high definition graphics generation and delivery, there was another essential ingredient missing for this project: an HD-SDI matrix router.

The Skunk Works

Here's a little-known fact: many new Extron products, and some unreleased products, were designed and field-tested in the InfoComm Projection Shoot-Out® event to gain experience and/or provide a needed solution to an anticipated technical problem. This is not unusual. Many companies have some projects developed outside the regular product development plan because of a rogue engineer with a unique vision. Some companies designate special secret project groups. They coined Skunk Works at Lockheed Martin for the motivated, free-thinking group that developed secret aircraft projects during World War II. There are several theories as to the origin of this moniker. In any case, rogue products and the Shoot-Out venue became a kind of "skunk works" for us at Extron.

For example, my anxiety level peaked in early 1992 with our first experience supporting the Shoot-Out. Prior to that time, I was an attendee of the first three Shoot-Outs and, while they were cutting-edge then, I recall seeing instances of faint AC hum bars on some of the screens. In large venue signal distributions, we all fear the inevitable ground loop experience.

As we planned for the 1992 show, discussions with Shoot-Out participants inevitably led to questions pointed at our stance on addressing and solving ground loop issues. You know as well as I that it's not a matter of 'if', it's a matter of 'when' and 'where'. I was determined to beat the odds. Within only two weeks time before our departure for the show, one of our engineers designed and built the first prototype of the GLI - active ground loop isolator. We hurriedly built twelve units in unpainted aluminum boxes, packed up, and left for the show. We used three of them. The show was flawless where ground loops were concerned. Good insurance. The GLI became a hit product.

Fast-forward to the spring prior to InfoComm 2005. Development of an HD-SDI matrix router was on the near-term backburner. One of our engineers was actively pursuing it partly as an undefined project and partly because he thought we should have one. He had investigated available components, technology, pitfalls, and performance requirements. Only a prototype board existed upon which he had been running his own tests. He had some questions about features and implementation which he brought to me.

In a few minutes it became obvious that we could really use his design for the LVDG but it wouldn't be ready as a released product in time. Enter the skunk works. While product management had some festering notions and concerns about the final configuration and scheduling of this product, all I needed was a basic working prototype that delivered a pristine 1.5 Gbps signal up to 300 feet on RG6 cable. The design was a 16 input by 16 output implementation, which seemed like overkill since we had only six customers. But more is better; and, the prototype had two dead outputs for some yet to be determined reason. What if more outputs failed? What if the whole unit failed? Since our whole distribution would be built on HD-SDI delivery, failure of this prototype router would bring down the entire event. We never operated any Shoot-Out event with that level of risk. Back then, source materials were duplicated and every installation had a backup plan. Sometimes our backups had backups. We had only one HD-SDI router prototype.

Most products fail because of power supply issues. So, we took two backup power supplies and planned to duplicate our traditional system design in case this non-sanctioned matrix router didn't work out. No one at Extron besides me and the LVDG engineering team knew about the router's role at InfoComm. The design engineer packaged the prototype router in a, you guessed it, plain aluminum cabinet. There was a possibility of obtaining a reasonably good approximation of an enclosure later, maybe during show setup. Less probable was the availability of a second router main board assembly. We'd see.

HDXP 3216

The Show Always Goes On

By the time setup day arrived at InfoComm, we focused on making the HD-SDI distribution work. We had six of the seven theater customers requesting our signal feed and the necessity for only one video cable along with the balanced stereo audio cable for this installation became a really attractive goal. We set up all four sources in the control room along with the prototype Extron HD-SDI matrix router. The HD video server main output feed is HD-SDI. Each of the HD-SDI graphics cards were installed into a dual-processor PC. Each graphics card output was connected to a separate router input. Never had an installation been so simple.

The prototype router worked perfectly. By the time all equipment was placed and operational, we noted that the main equipment rack in the control room was noticeably warm due to the high equipment density. We employed two small muffin fans that we found among our crates of miscellaneous hardware and equipment items. Both were suspended and wired just inside the rear rack opening and trained onto the router. Minutes later, we noted a reasonable temperature drop within the rack. But, this left us a bit nervous.

We knew that we could repair the power supply in the new matrix router in about 15 minutes should it fail. But, if the router circuits failed, we would be in dire straits. It would take too long to reinstall the older system approach. With that realization, we called back the Extron engineering department. As it turned out, there existed one additional blank prototype circuit board. If enough components could be found to populate it, we could possibly have a backup router board assembly.

Thanks to some dedicated people in our engineering department, the task of building another router board began and we were going to have a backup board. The only catch: it would not arrive until the morning of the first day of the show. This, we could live with.

See the Large Venue Display Gallery at INFOCOMM 2006

Once again, Extron will be providing high definition signal distribution cabling and equipment for the LVDG. Steve Somers will produce image content and manage all technical operations of the LVDG. Don't miss this unique opportunity to see Extron's HD-SDI products in action and view the latest projection technology for D-Cinema and large venue applications.

Sony entered the event with their new SRXR110 SXRD 4K cinema-grade projector. At 4096x2160 resolution, it is capable of displaying all four of our 1920x1080 HD sources simultaneously. Sony masked the output to 3840x2160, which exactly matches a 4:1 tiling of four HD images. As details of their equipment install unfolded, we found that it would be interesting to provide them with not one, but four HD feed lines so that they could show all four of our sources on their screen simultaneously. By the time we installed all feeds which now numbered ten, then added one output feed to our local monitor, we used 11 of the 14 good feeds. That 16x16 router suddenly seemed not so large after all.

Installation was straightforward. With all HD sources located in the control room, short lengths of RG6 coax interconnected the server and each HD card-equipped computer to the Extron prototype HD-SDI matrix router. Router outputs were fed via Extron's RG6 coax to the projector platform in each theater. These cable runs were 100 to 200 feet.

A Really Really Good Show...

For those of you who may also be in "show business," here's another bit of good insurance: once the video distribution system is operational, keep it operating continuously until the final close of the show. We do not shut down our video/audio sources each evening. In this way, the mechanical stress of temperature variation is avoided. Continuous operation has always been my approach for sourcing signals at large-scale events such as this one.

The performance of the HD-SDI router and all components of the show were flawless. Via a local touch screen, attendees selected at their option any of the four sources while viewing them in the theater of their choice. Switching and presentation performed perfectly. Distributing in HD-SDI format was simple and reliable. By the way, the format is not limited to supporting only high definition video. HD-SDI can be used as a high speed transport for a variety of data. Today's digital data delivery tools are unconcerned with the content being transmitted.

Since InfoComm 2005, the new HD-SDI matrix router has taken form as a real product. The new HDXP Plus Series routers support both SDI and HD-SDI in 32x16 and 32x32 configurations, and offer some really interesting features yet to be seen on this type of router technology - see the new product announcement on page 19. I expect to be routing much more HD-SDI supported data into the future. How about you?

HDXP 3232