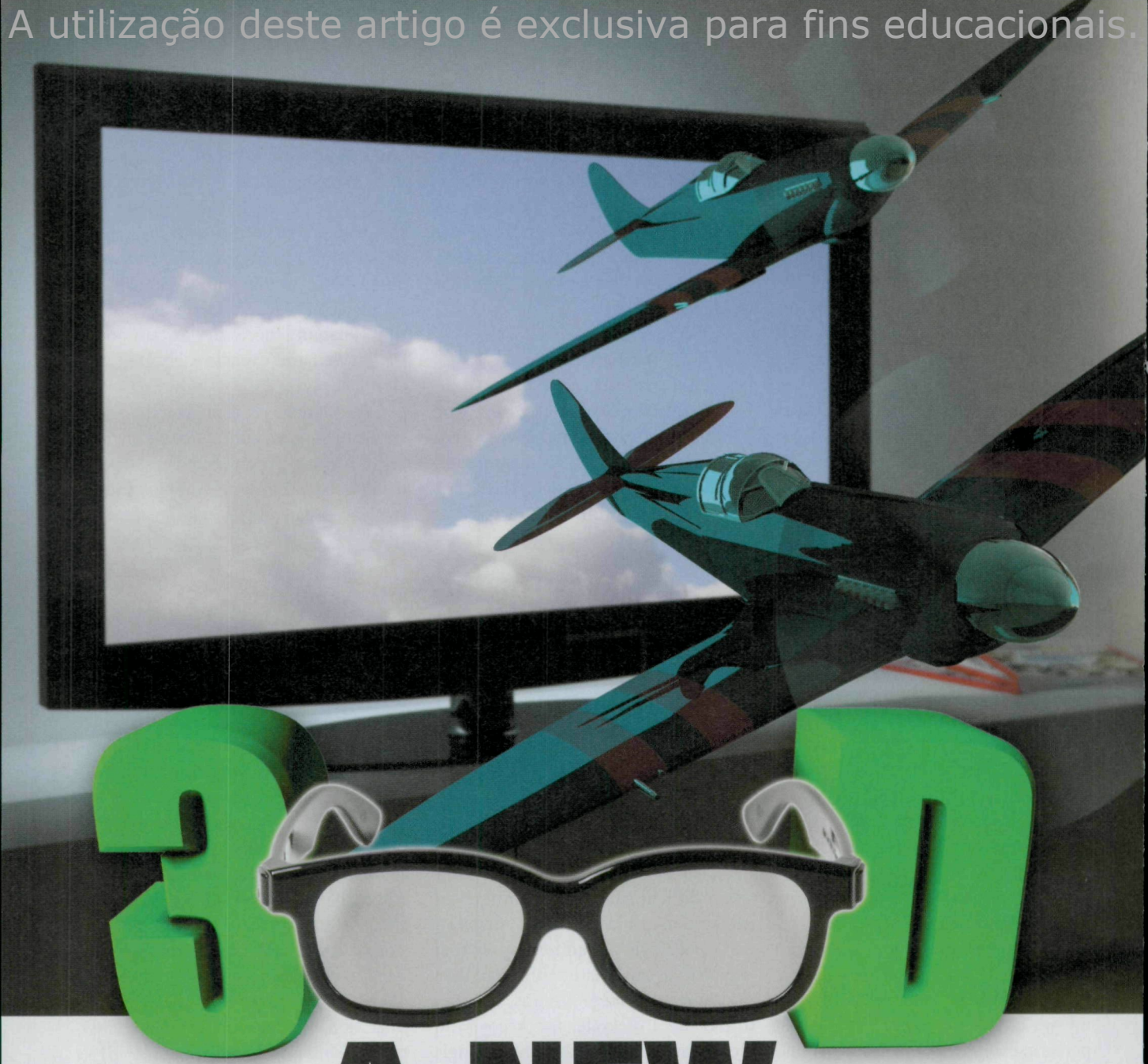

A NEW dimension in broadcast facility planning

BY CHRIS LENNON WITH STAN MOOTE

It's hard to think of an industry development that has generated as much excitement as 3-D television. The rise of 3-D in terms of industry buzz has been quick and all-inclusive, touching every corner of the broadcast world. We have been bombarded by this on a global level: helping broadcasters get on the air, speaking about the topic (individually and on panels) and participating in 3-D standards efforts.

When planning a new channel launch, the wealth of detail can overwhelm even the most knowledgeable engineering staff without even putting 3-D into the equation.

As the ESPNs and Discovery Networks of the world bring their 3-D channel visions to life, engineers across the industry need to start

planning their own 3-D strategies. The reality is that management could come calling any day with a 3-D agenda and a launch plan.

When learning about 3-D, don't get caught in the loop of how 3-D production and distribution is accomplished today. This will come back and bite you. 3-D is now far different than it's likely to be in the near future. The cool thing is that planning for the near future now will allow for future 3-D developments. The 3-D craze took everyone by surprise, and everyone scrambled to get on-air. Some of the shortcuts taken will definitely hurt later.

The first step is to understand 3-D visually, whether doing a simple pass-through or adding some production. 3-D is an illusion, and it clearly has drawbacks. A logo insertion could look great on one size screen and completely fall apart on a smaller screen. How do you account for this? Keep it simple. Don't try to be fancy, and don't exaggerate the 3-D illusion.

In terms of setting up your facility to handle 3-D, distill the pertinent details from a very deep well. It all starts with one question: How do I get on the air with 3-D? It is entirely possible that there is gear in place, notably in the infrastructure, that can accommodate 3-D signals as-is or with a simple upgrade. In other cases, some existing equipment may require replacement.

The good news is that this can be done without breaking the bank or creating a technology dead end. 3-D-capable gear doubles as HD gear, so the risk factor is generally low if the decision is made to upgrade certain components to handle 3-D. They will serve HD needs well, even if 3-D plans don't develop as expected.

3-D workflow

As engineers, we want to maintain the highest quality. Certainly this isn't being done now for 3-D, not because we can't, but because of the need to get on-air quickly. Reality often hits hard when dealing with one-off events and the need to maintain compatibility with existing infrastructure.

A survey of products and vendors is likely to result in some confusion and intimidation. There will certainly be mixed messages when disparate voices speak to 3-D requirements.

This is not to say that talking to different sources is a bad idea. However, it is a better idea to first understand the 3-D workflow from production through to broadcast. A broad view of the workflow and equipment interoperability will provide a clearer frame of reference moving forward.

The cleanest and highest-quality approach to 3-D television starts with true image preservation. Most broadcasters will opt to maintain full-resolution HD images for each eye through the production and air chain.

The camera remains the starting point. There are a number of 3-D camera options from multiple vendors, including side-by-side dual camera rigs, beam-splitter rigs, and single camera units with single or dual lens options. Developments in fiber-optic systems have made this the ideal method to transport left and right images to the router as two distinct, full-resolution pictures.

The router presents the first technical challenge in the chain. In a 1.5Gb/s infrastructure, a full-resolution 3-D environment requires two feeds for every source at the input and output. The router must treat L/R dual-link signals as a 3-D pair and frame-accurately route them to dual-link destinations in single control transactions.

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A frame-compatible approach will degrade the resolution by half in the case of side-by-side. Storing the images in this format for later conversion to another format, such as over-under, will potentially lower the resolution by half. The result is quarter-resolution images, which are not a pretty sight.

The following overview will consider deployments for full-resolution 3-D broadcasts, focused on content and production, facility infrastructure and workflows, post production, and external networking and distribution. Figure 1 on page 42 outlines the various stages and specific components in the end-to-end chain.

Production

The large orange box represents the first stage: mobile content acquisition. This is particularly crucial in remote and outside broadcast applications such as sports and live event production.

(See Figure 2 on page 44.) A typical HD-capable router may not be large enough to accommodate 3-D production due to this doubling of inputs and outputs.

A 3Gb/s-capable router and infrastructure ensures that full-resolution signals are transported on a single wire. This supports routing two full-resolution 3-D signals to multiple points, including storage platforms, multiviewers, production graphics and networking systems. In this environment, only half the inputs and outputs that would have been required for full-resolution 3-D in a 1.5Gb/s infrastructure are needed.

In the area of production storage platforms, 3-D-capable servers must be able to handle synchronized dual ingest and playout. Editing systems present a larger challenge, as some are not capable of supporting 3-D. A talented editor working on a capable system must be able to edit the two eyes as if working with a single

video source.

Graphics adapt far easier in the 3-D television universe. 3-D modeling has long been in the picture for many vendors. Applying currently-available graphics systems to the 3-D environment is less of a challenge based on existing capabilities, but it's still an important (and highly visible) portion of the 3-D picture.

The multiviewer, once somewhat overlooked, has become a significant consideration in the digital TV space. Multidisplay systems continue to evolve with richer features and better interoperability with other components in the workflow. Technical operations staff will benefit from a multiviewer that can produce separate left and right feeds, while creative staff will need to see the 3-D image. This means that the ideal multiviewer for this environment will be capable of displaying both HD and 3-D feeds.

Contribution is the final stage of the mobile production environment. Video networking systems exist to manage and transport contributed signals into the broadcast facility. The ideal 3-D-ready system can accommodate standards-compliant audio, video and data into the plant while supporting the left- and right-eye feeds together.

Broadcast facility

3-D contribution feeds come in and are handled in much the same way as they were on the way out of the mobile content acquisition environment. Fiber management and video networking systems handle the two signals together as a related pair.

Frame synchronizers and converters can recover phase errors that can adversely affect the signal while using traditional contribution solutions for separate signals. This is especially true when working with long links. A routing switcher will pick up the signal once synchronization for the two eyes is confirmed.

A storage system within the broadcast facility will surely be one important destination. As in the acquisition and production phase, its ability to handle coordinated ingest and playout of the L/R pair is pertinent. Digital asset management systems tied to storage must be able to distinguish 3-D from HD content and accommodate unique metadata requirements for 3-D content.

The master control switcher should be configured in a L/R slaved configuration to support dual-link, full master control processing in a 3-D environment. This allows the operator to switch both eyes simultaneously with the press of a button. Nonsynchronized switching can ruin the 3-D experience, which would be unfortunate at this stage of the workflow. A reliable multiviewer, similar in capability to the produc-

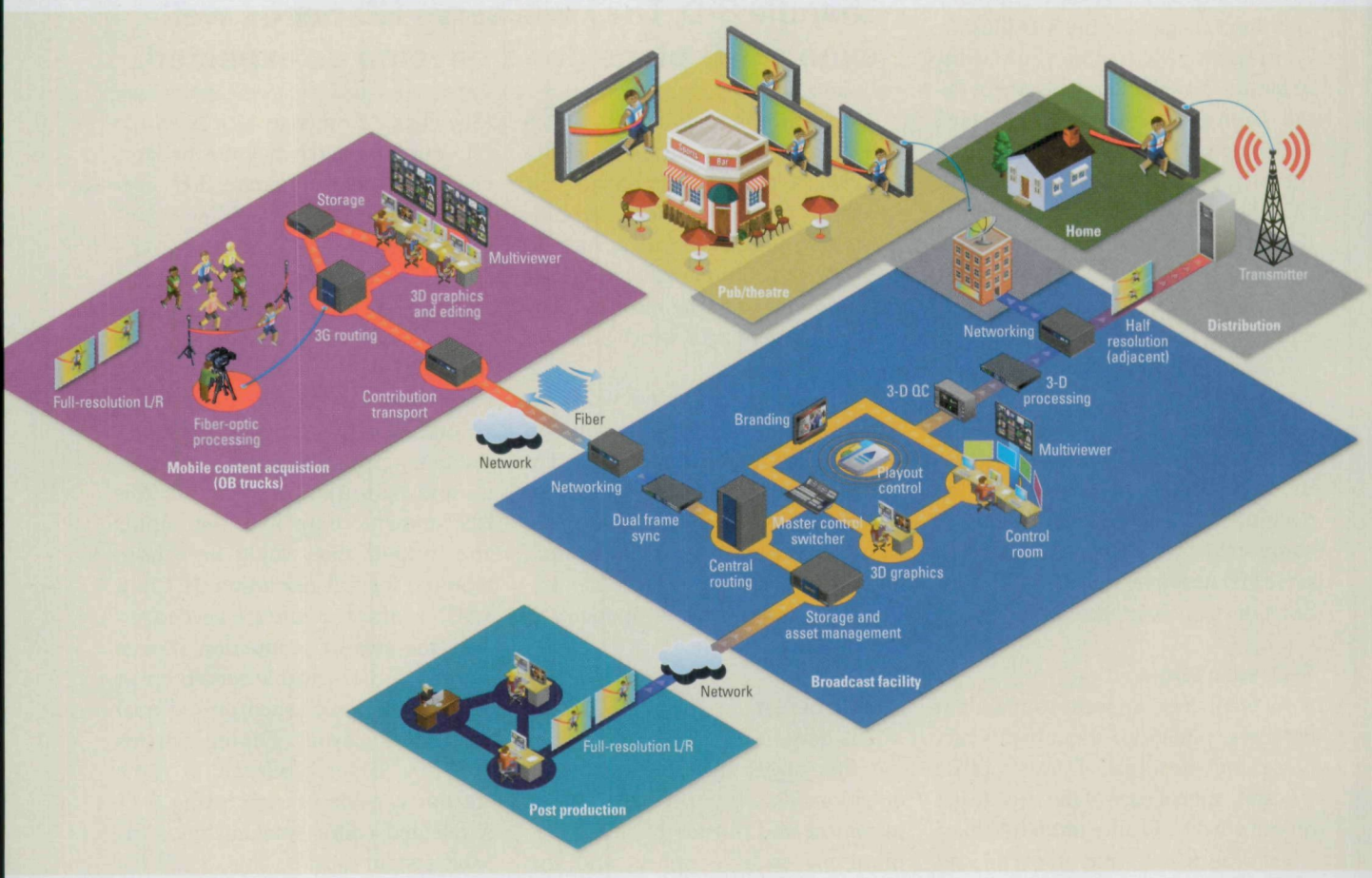

Figure 1. 3-D end-to-end workflow

tion environment, will provide the appropriate level of master control confidence monitoring.

The master control operation incorporates the channel branding elements. This is an extension of on-air graphics, and should offer 3-D compliance for appropriate placement of logos, bugs and promos. Often viewed as a nuisance in traditional viewing, 3-D channel branding can actually enhance the viewer experience if done properly. Alternatively, it can make for a miserable viewing experience if not applied correctly.

	Frame-compatible on single HD-SDI feed	L/R full-res two HD-HDSI feeds	L/R full-res single 3Gb/s feeds
Routing	Same as 2-D	Tie two 2-D feeds together with the router control system. (See Figure 2.)	Same as 2-D 3G
Backhaul	For side-by-side or over-under, same as 2-D. Other compatible systems may require a special compressor.	Dual 2-D backhaul feeds required with frame syncs	Dual 2-D backhaul feeds required with frame syncs
Servers	Same as 2-D	Two 2-D feeds slaved together on ingest and playout	Two 2-D feeds slaved together on ingest and playout on single 3G BNC
Graphics	3-D graphics system with special software for side-by-side or over-under. Not typically possible with other frame-compatible systems	3D graphics system	3D graphics system
Automation	Same as 2-D	Slaves two channels	Same as 2-D
Multiviewers	Typically will only display the frame-compatible picture	2-D units will properly display left and right pictures. 3-D units will display 3-D and left with right channels.	2-D units will properly display left and right pictures. 3-D units will display 3-D and left with right channels.
NLE	2-D NLE works for basic cuts/mixes for side-by-side or over-under. Not possible with other frame-compatible systems	3-D NLE gives full features.	3-D NLE gives full features.
Processing/frame syncs	Standard 2-D system for side-by-side or over-under. Other frame-compatible systems may have horrible results.	Dual proc/frame sync. Some procs have this as standard in 2-D models.	Dual proc/frame sync. Some procs have this as standard in 2-D models.
Switching	2-D switcher works for basic cuts/mixes for side-by-side or over-under. Not possible with other frame-compatible systems	Slave two switchers together or 3-D switcher	3-D switcher
Test and measurement	Frame-compatible 3-D test and measurement product is available now.	Dual-channel 2-D test sets provide limited functions; 3-D sets are available.	Dual-channel 2-D test sets provide limited functions; 3-D sets are available.

Table 1. Infrastructure effects

Automation systems can be tricky in the 3-D environment as virtually everything tied to the system is doubled. The deployment grows in complexity as the playout automation operation expands. At its core, the playout element must control two signals simultaneously in a frame-accurate manner. This translates to dual, synchronized playlists. Secondary events related to channel branding elements must also be properly supported across the two playlists.

3-D test and measurement has come a long way in a short period of time. An array of reliable tools and solutions exist to help the 3-D broadcaster identify signal quality issues. Scopes with left and right waveform displays, and performance tests for luminance/chrominance and position measurement, will ensure that viewers receive the best possible 3-D picture.

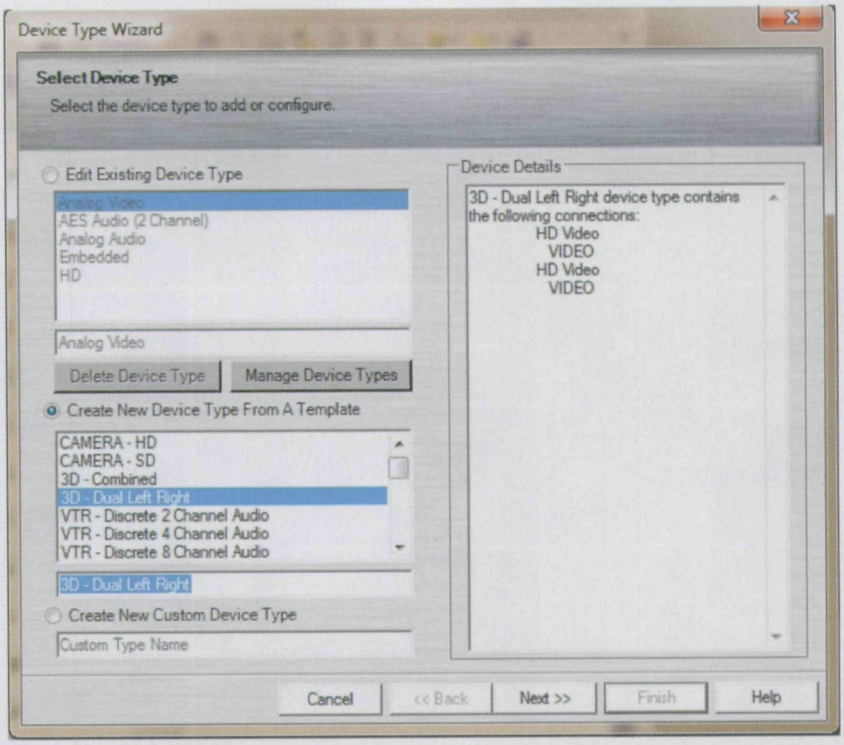

Figure 2. Router control system selecting 3-D modes for simultaneous L/R switching

Format considerations represent the final stage in the broadcast facility. Every destination needs to be considered (typically cable and satellite at this point). The system requesting two full HD streams makes life easier for the broadcaster as it is simply a continuation of the process that has worked its way through the broadcast facility.

A more significant challenge is presented when the operator requires an encoded signal in a frame-compatible format, such as side-by-side or over-under. This requires an additional synchronizer and/or converter to perform the task. If required, it makes sense to integrate a unit that can output the 3-D signal over HDMI. This provides a final QC stage, enabling display on 3-D television sets similar to those the end user would be using.

It makes sense to look at the complete picture from acquisition to transmission instead of addressing single point products one at a time.

Effects of various approaches to 3-D

The ideal approach is to feed two full-resolution images as far through the chain as possible. Unfortunately, this is not always practical. Since there are three primary approaches to implementing 3-D in the plant (frame-compatible, two full-res feeds over 1.5Gb/s and two full-res feeds over a single 3Gb/s), it's helpful to understand the effects of each.

Table 1 on page 43 serves as a quick reference guide regarding the effects of each approach that can be used.

Conclusion

The 3-D television workflow is essentially an ecosystem — a suite of interoperable components that complete a cycle for advanced broadcasting. It makes sense to look at the complete picture from acquisition to transmission instead of addressing single point products one at a time. This strategy will minimize problems as you move forward with a 3-D channel launch. BE

Chris Lennon, CTO Group, and Stan Moote is vice president of corporate development for Harris Broadcast Communications.

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