An Advanced M/E Architecture for Today's Production Environment

By Mark A. Narveson

The paper looks at the traditional M/E architecture and discusses its limitations. It then proposes a new architecture with applications for today's complex production environment. The new architecture features four keyers, two completely independent background transitions, and up to four customized program outputs to meet these new requirements.

Traditional M/E (mix/effects) architecture found in production switchers generally limits on-air effects to two keys/graphics over a single background mix. Standard switcher effects include mixes, wipes, and the ability to fly one or more keyers via an effects send loop. Any effect more complex than these will generally require more than one M/E bank. As the on-air look of teleproduction increases in complexity, there is a desire to have more graphics on-air at the same time and more flexibility in integrating DVE moves into the switcher. This results in quickly consuming a large number of external DVE channels and M/E banks to perform a single complex effect.

For some productions, two graphics over a background is adequate. However, directors need the ability to preview several composites and take any of them to air instantly. In a news program, for example, the director may wish to see the two anchors, two remotes, the sports desk, the weather desk, and the chroma-key set, all with associated keys to ensure that graphics and DVE effects are positioned accurately and are ready for air. Using today's switchers, the director generally has simultaneous access to two or three composites via the M/E banks in addition to the program output. However, the scenario outlined here would require up to seven M/Es in addition to the program output.

Some productions require multiple feeds with separate graphics and logos sent to each feed. For example, a remote truck can be hired by a main client, but secondary clients want the same basic production with a set of custom graphics and camera sources suitable to their markets. Traditional clean feed systems allow the secondary client to remove one or more of the downstream keys (DSKs), but generally limit the ability to choose custom keys and camera sources for upstream M/E banks.

The complexity of the "on-air" look has increased dramatically over the years for programs that are produced live as well as elements and programs post-produced for later broadcast. In addition, local stations add their own elements and promos during the closing credits of national and local programs in order to maximize the time available for advertising.

There are numerous reasons why a producer may need two versions of the same show with separate graphics for each. These include live versus taped versions, local feed versus national version, and two clients for the same sports program or live event. All of these tax the capabilities of traditional production switchers and require additional people and equipment, which may or may not be available.

A Brief Look at a Traditional M/E Architecture

Traditional production switchers for live and post-production have a number of banks called M/Es or mix/effects banks. The mix/effects is so called because it can perform mixes (dissolves) on multiple video sources as well as other effects such as wipes (geometric patterns) and DVE style

Figure 1. Typical M/E composite.

Presented at the 34th SMPTE Advanced Motion Imaging Conference (paper no. 34-16), in San Francisco, CA, February 3-5, 2000. Mark A. Narveson is with Grass Valley Group, Nevada City, CA 95945.

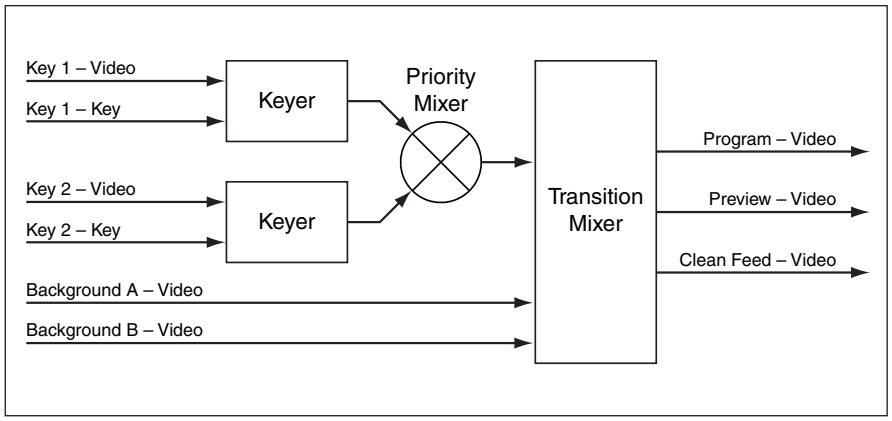

Figure 2. Traditional M/E architecture.

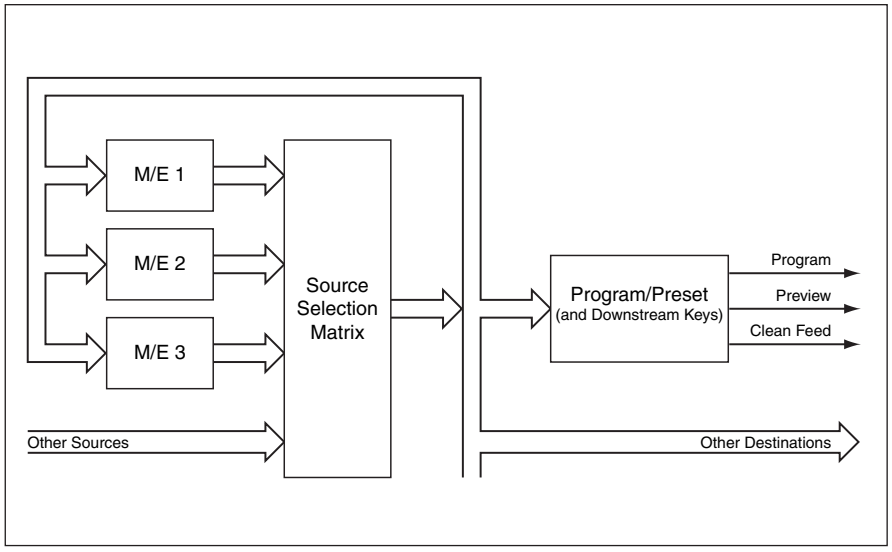

Figure 3. Multiple M/E switcher.

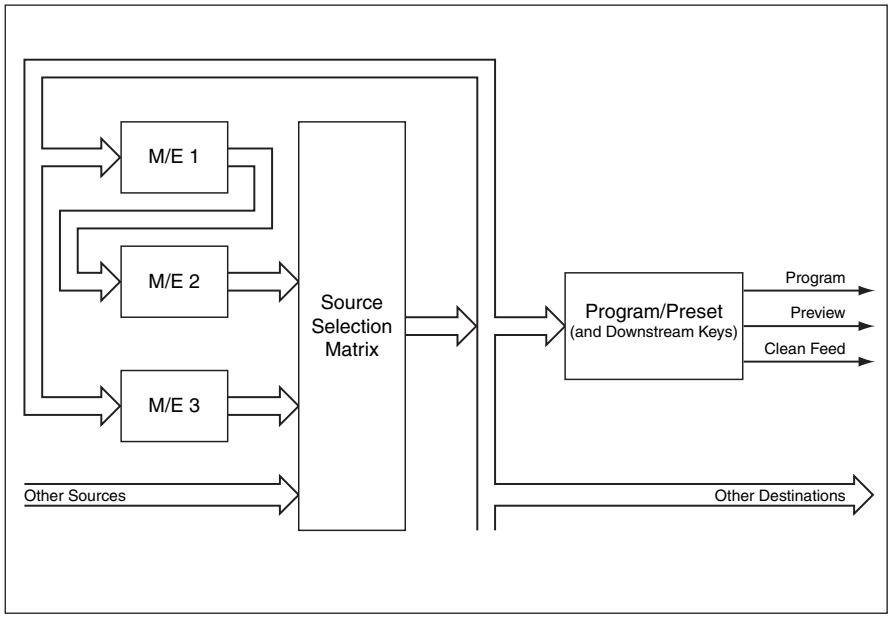

Figure 4. Cascading M/Es via re-entry.

effects (pushes or page turns). DVE effects have traditionally been performed by external standalone effects chassis, but increasingly, DVE channels are included internally to the switcher.

The M/E provides an easy way to "package" an on-air look for a particular camera shot. It typically has four video inputs and two key (or alpha channel) inputs. Two of the video inputs are used for full raster backgrounds and provide the means to cut, mix (dissolve), or wipe between two background sources. The remaining two video inputs plus the two key inputs allow the user to layer or "key" two additional partial screen video sources on top of the full raster background. For example, the background video might be a news anchor camera shot while the two keys might be a story graphic over the anchor's shoulder plus a "lower third" graphic with a tag line for the story.

Figure 1 shows this composite with the background wiping from the anchor to another camera shot. In addition, either one or both of the keyers may be used in conjunction with a chroma keyer, to do blue screen work such as placing the meteorologist in front of a computer-generated weather map.

A typical block diagram of an M/E which can perform the functions outlined above is shown in Fig. 2. Note the four video inputs and two key inputs as discussed previously. On the output side of the mix/effects bank, there are three separate video outputs typically called Program, Preview, and Clean Feed. Program is the main video output which is ready to take to air. The Preview output allows the user to see what the program output will look like after the next effect (e.g., background or key transition). Clean Feed is typically the background transition (mix, wipe, etc.) without any keys.

Most switchers have two, three, or four M/E banks stacked on top of each other like the ranks of an organ. The bottom M/E bank is called the "program/preset" bank and typically adds the last effects and keys before the video signal goes to master control/ transmission for broadcast. The program/preset can cut between cam-

era sources as well as prepackaged effects from other M/Es and can optionally add additional graphics such as station or network logos. The "upstream" M/Es package specific effects, which can be taken to air at the program/preset bank. This allows the live broadcast to progress through various stages such as news anchor, live remote, weather, sports, back to the anchor, and so on. Figure 3 shows how the various M/Es work together in a typical production switcher.

Limitations of the Traditional M/E Architecture

The M/E architecture outlined above has served the industry well, with occasional minor modifications such as the addition of a third keyer or an additional video input bus for such applications as placing video in a wipe border or using a video source as a key mask. However, in today's rich production environment, one finds that it is quite easy to run out of available resources rather quickly.

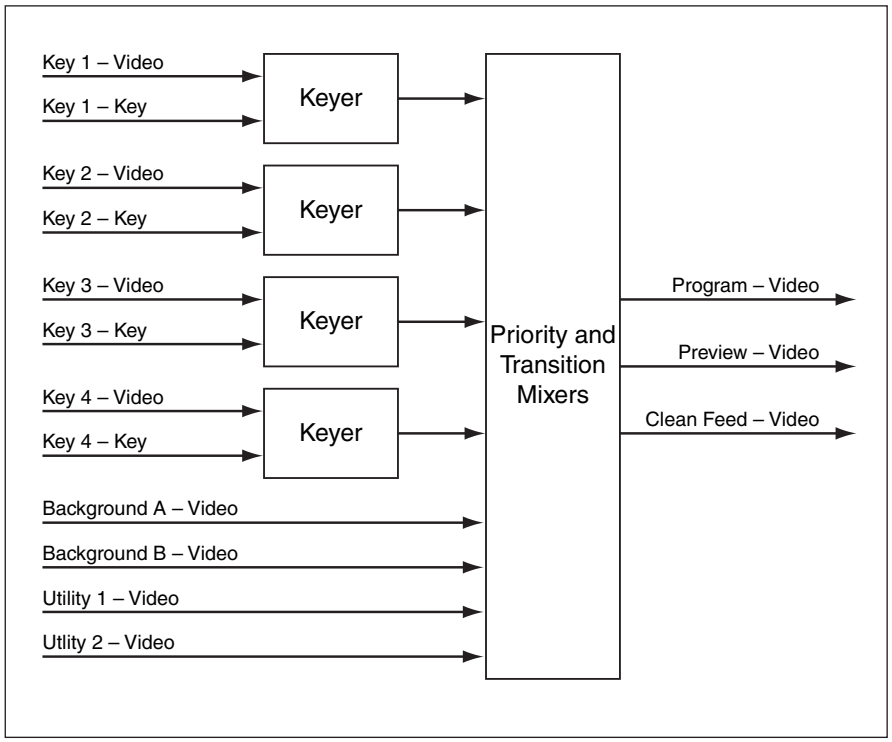

Figure 5. An advanced M/E architecture.

Limitation 1: The Need for More Keyers and Graphics at the Same Time

What if, for example, you wish to set up a mix/effects bank with more than two keys or graphics? One way to accomplish this is to "re-enter" one M/E into another to effectively cascade the resources of the two M/Es together (Fig. 4). In this case, M/E 1 provides the background video and the first two keys or graphics. This composite is reentered to the background bus of M/E 2 where two additional keys are added to the composite.

There are several limitations to this approach. The first is quite obvious from Fig. 4. M/E 1, M/E 2, and Program/Preset have been consumed just to set up this effect and take it to air: all that remains for the next effect is M/E 3. Note that you cannot set up two such effects at the same time in the traditional switcher; there are simply not enough M/Es.

There are operational challenges to

Figure 6. Compositing using the advanced M/E architecture.

this approach as well. Some transitions of keys and backgrounds will involve controlling the transition of two separate M/Es in lockstep fashion—an exercise not easily done during live operation unless all the various transition combinations are programmed in advance. This is both complex and limiting.

Solution: An advanced M/E architecture with more graphics, more effects

The proposed M/E architecture has a total of eight video inputs and four key (alpha) inputs. Two of the video inputs are used for full raster backgrounds just as with traditional mix/effects. Four video and four key inputs are used to key four separate graphics over background video. The remaining two inputs are called "utility buses" and may be used for other effects such as placing video in a wipe border or using a video source as a key mask. Figure 5 shows a block diagram of this architecture.

Thus, in a four M/E switcher, one is able to present four keys over a background in every M/E without reentry and still have two additional video sources for wipe borders, key masking, etc. This is more than double the flexibility of the traditional M/E without the operational challenges of cascading M/Es. The composite in Fig. 6 shows what can be done in a single advanced mix/effects bank.

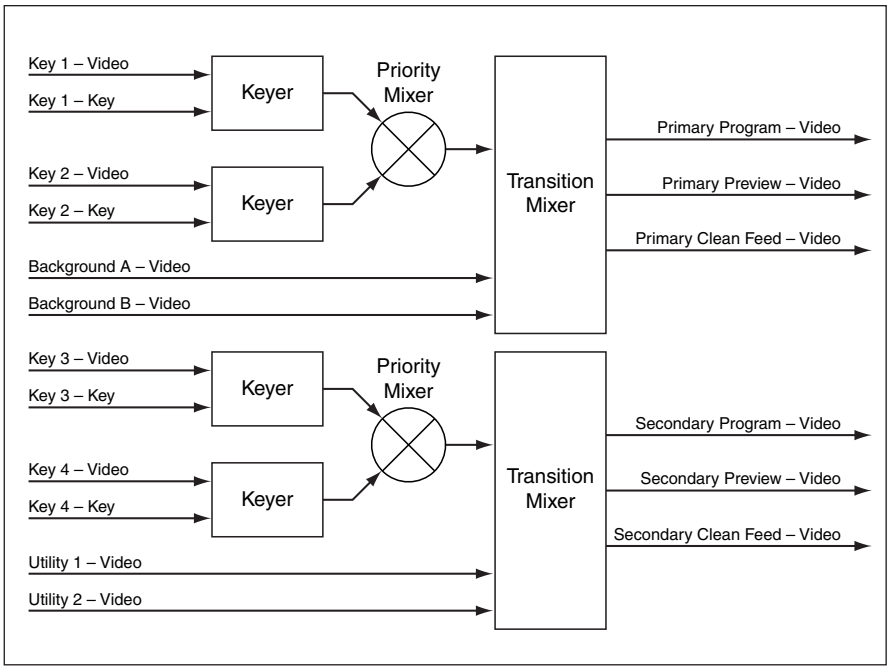

Figure 7. Advanced M/E architecture with splittable M/Es.

Limitation 2: The Need for More than Three Upstream M/Es

As mentioned, the largest production switchers today have four M/E banks—three for upstream effects setups and one called program/preset for taking sources and upstream M/E banks to air. In many live broadcasts this is quite sufficient, since it allows, say, M/E 1 to be on air while M/E 2 and M/E 3 are being preset for the next two effects to take to air. One

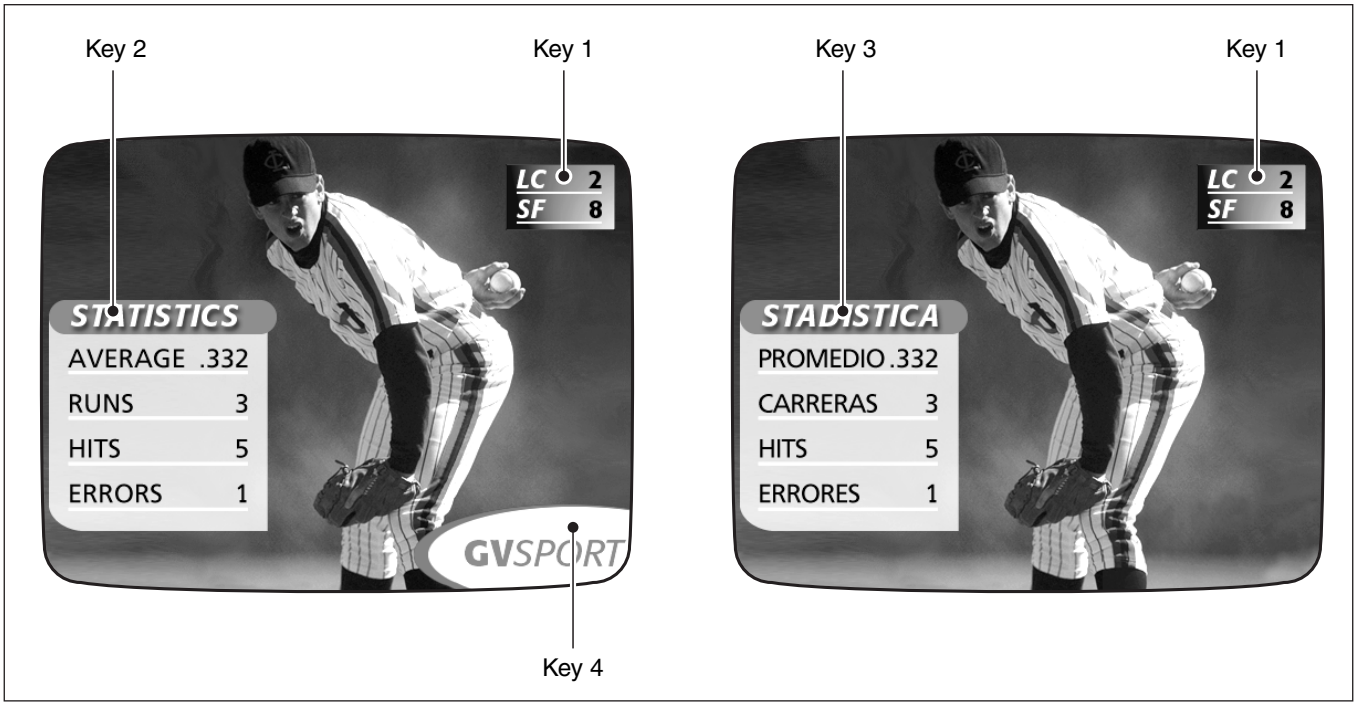

Figure 8. An example of programmable clean feed.

effect is on-air while another two are "waiting in the wings."

However, in some productions, such as many sports events, there is a significant degree of uncertainty as to which event should go to air first. Even in heavily scripted news programs or awards ceremonies, technical difficulties or other problems may cause sudden deviations in the script where the technical director has to recall a different set of effects and jump to another place later in the program.

In addition, programs which require rapid fire of several effects in sequence or have multiple branch point may necessitate the need to preview four or five "next effects" while one effect is on-air. The only way to do this on today's switchers is to recall different setups (or effects memories) and sequence through several possible next effects. However, even this does not allow more than two or three effects to be ready to go to air at any given time.

Splittable M/Es—twice the amount of effective M/Es

The advanced M/E architecture outlined above has all the inputs required for two complete "traditional" M/Es. There are four full raster video inputs (the two backgrounds plus the two utility buses) and four videos plus four key (alpha) inputs to serve as four keyers. All that is missing is a separate mixer to provide a second set of outputs (let's call these Secondary Program, Secondary Preview, and Secondary Clean Feed). Adding this separate mixer to the M/E produces an M/E architecture that looks like the one in Fig. 7.

Note that M/Es 1 to 3 are in split mode while the program/preset is not. The architecture should provide the capability of independently choosing the mode on each M/E (including program/preset) so that any M/E can be dynamically set to normal mode or split mode depending on the needs of the specific production.

In addition, Fig. 7 shows that keys 1 and 2 are part of the primary mixer while keys 3 and 4 contribute to the secondary mixer. For maximum flexibility, the M/E should be designed so that any subgroup of keyers (including none or all) can be attached to the primary mixer while the remaining keyers are attached to the secondary mixer. Operationally, one can use a simple button press to switch the physical control buttons associated with a specific M/E between control of primary versus secondary outputs. In addition, the effects memory system should accommodate separate memories for the primary mixer versus the secondary mixer in order to provide the true flexibility of two separate M/Es in a single bank.

Limitation 3: Complete Customization of Graphics for More than One Client or Purpose

There are numerous occasions where a broadcaster or production

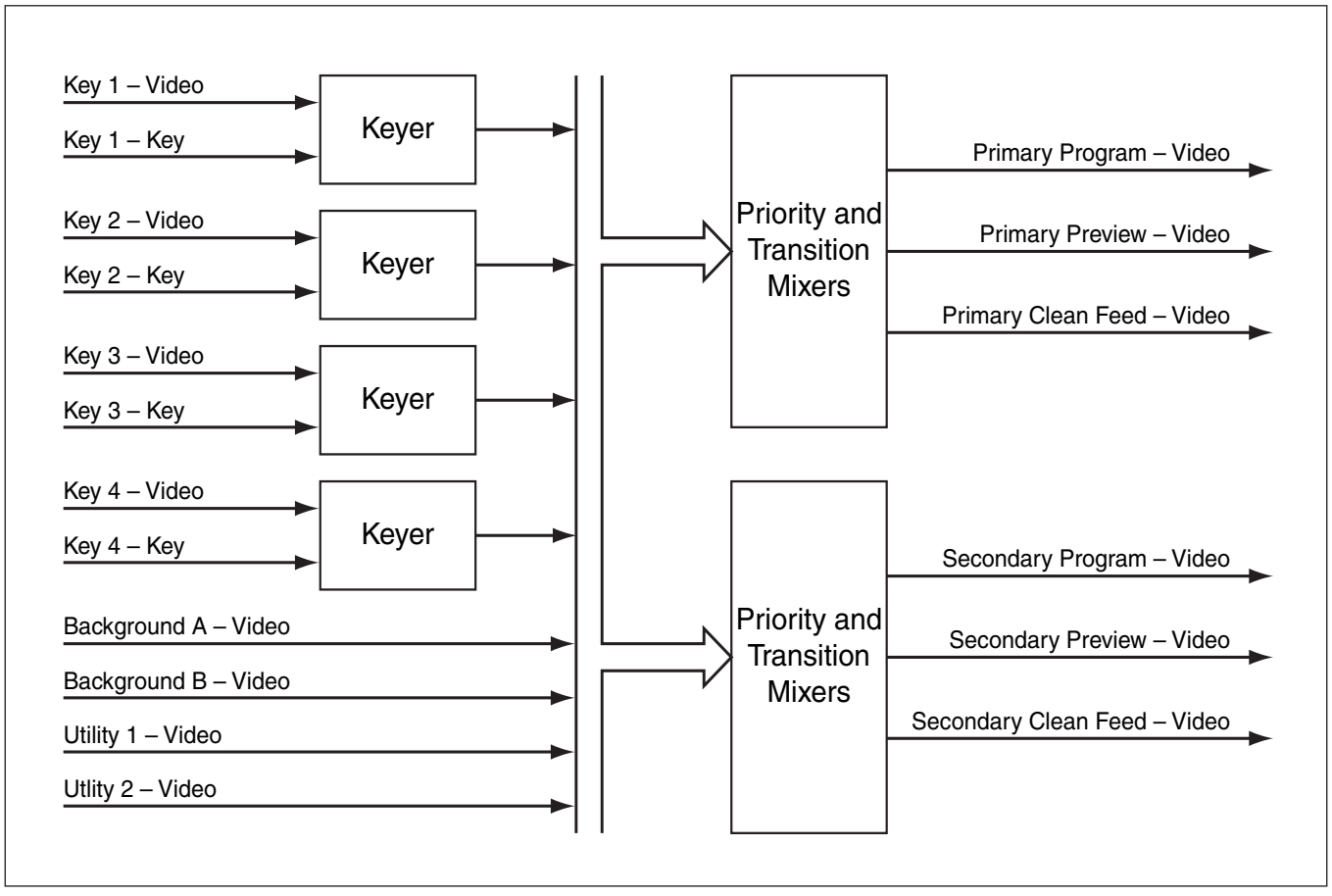

Figure 9. Advanced M/E architecture with programmable clean feed.

facility desires two different versions of the same production. This can be the case when a live production is also being taped for rebroadcast or when one sports event is being produced simultaneously for two teams or two networks. Typically, this is handled through a clean feed signal which consists of the background video without added graphics or keys. In a typical case, the clean feed output from the program/preset includes keys and graphics inserted by the upstream M/Es, but does not include any keys or graphics being applied by the program/preset bank itself. (The keys added by the program/preset bank are often called downstream keys.)

This clean feed is then recorded by a VTR or sent to the second client for the addition of more keys, such as the other network logo or other client specific graphics. However, in some cases, objectionable graphics are inserted by upstream M/Es and cannot be removed from the clean feed output. In other cases, some desired downstream (and upstream) keys are not available from the clean feed output, so the second client cannot get all the graphics needed for production. Finally, the secondary client may like an alternative version, in Spanish or French, for example, rather than English, of some graphics.

In these cases, the second client must make some compromise such as accepting a feed that does not have the exact set of desired graphics and keys. Some problems can be solved by the addition of one or more standalone keyers. The worst case is that the second client accepts a clean feed free of all graphics and hires a second switcher, remote truck, and crew to add the exact set of desired graphics and effects.

Solution: Programmable Clean Feed

With one additional enhancement to the advanced M/E architecture, the problem of customization of graphics for multiple clients or purposes can be readily resolved. In this case, it is desirable to utilize the two independent mixers from split M/E mode, but each mixer should be able to see any or all keyers. Thus, any set of graphics may be added to the primary set of outputs and any alternative set of graphics may be added to the secondary set of outputs. In general, the background video will be the same for the primary and secondary outputs, but it is possible to automatically substitute some camera shots so when the primary output goes to the camera shot of the talent, the secondary output may choose a wide shot of the stadium instead.

Operationally, the keyers may be preprogrammed so that the correct graphics are chosen for the secondary output automatically while the technical director is creating the primary production. Thus, when key 1 is taken to air on the primary, the secondary may also want to see this graphic. However, key 2 might be specific to the primary client and can thus be automatically suppressed from the secondary output. Where alternative graphics are available for both clients (in the case of multilanguage programming, for example), taking key 3 (an English graphic) to air on the primary may automatically bring key 4 (a corresponding Spanish graphic) to air on the secondary output (Fig. 8).

Note how one M/E is reentered into the next so that two completely independent production streams flow through the entire switcher. Thus any subset of available graphics/keys may contribute to the primary output while any alternative subset may contribute to the secondary output. Figure 9 shows the block diagram for this mode of operation. Again, the system should allow each M/E to be set to a specific mode (normal, split M/E, programmable clean feed) independent of the other M/Es.

Even with two independent production streams throughout the switcher, there are still two clean feed outputs available. If these clean feed outputs can apply one or more keyers over the background video, further customization is possible in those cases where there are more than two clients or purposes for the same production.

Conclusion

The complexity of current teleproduction environments places heavy demands on today's production switchers. The result is added operational complexity or the requirement for additional equipment and personnel in order to achieve increasingly enhanced production value in the future. The alternative is to accept the limitations of current equipment and the level of production value that can be achieved. An advanced M/E architecture can readily double the flexibility and power of today's production systems and provide an enhanced capability to add graphics and effects and/or serve additional clients without adding significantly to the production costs or equipment requirements.

THE AUTHOR

Mark Narveson is a product marketing manager for digital production systems at Grass Valley Group. He has been involved in the development of computer graphics and digital video effects products for more than 15 years, acquiring experience in electrical/computer engineering and program management.

Narveson worked in a variety of engineering and marketing positions at Grass Valley Group when the business unit was part of Tektronix. From 1991 to 1997, he helped develop several products including Model 1200 and Model 4000 digital production switchers. His current focus is the Kalypso Video Production Center product family. Narveson received an M.S. in computer engineering from Santa Clara University in 1991 and an MBA from the University of California-Davis in 1999. A member of SMPTE, he has served as Section Manager for the Sacramento Section.