Postprint: Exploring Live Broadcasting Solutions for Converged Media in HD OB Van Video Systems

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Abstract

This paper introduces a general live broadcast solution for HD OB van video systems when completing important program converged media live broadcast tasks, using as a case study a successful converged media live broadcast by the 7-channel HD OB van of Anhui Radio and Television Station at the Hefei Grand Theatre. This live broadcast solution focuses on on-site television production, live broadcasting, and transmission, coordinated with converged media live broadcast methods such as Internet streaming, and is suitable for converged media live broadcast tasks for most conferences, opening ceremonies, and small-to-medium-sized events. Both system scheme design and emergency planning prioritize live broadcast safety.

Full Text

A Discussion on Converged Media Live Streaming Solutions for HD Broadcast Truck Video Systems

Abstract: This paper introduces a general live streaming solution for HD broadcast truck video systems when executing important program converged media live streaming tasks, using as a case study a successful converged media live broadcast completed by Anhui Broadcasting and Television Station' s 7-channel HD broadcast truck at the Hefei Grand Theatre. This solution focuses primarily on on-site television production, live broadcasting, and transmission, supplemented by converged media live streaming methods such as internet broadcasting. It is applicable to converged media live streaming tasks for most conferences, opening ceremonies, and small-to-medium-sized events, with live broadcasting safety being the top priority in both system design and emergency planning.

Keywords: HD broadcast truck; video system; converged media live streaming

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Live programs cannot afford any mistakes; therefore, the focus of designing the live streaming solution is to ensure the normal output of the broadcast signal. Anhui Broadcasting and Television Station' s 7-channel HD broadcast truck is equipped with a complete audio-visual system capable of producing and broadcasting live programs, and has successfully completed numerous field live broadcasting missions. This paper uses a field event' s converged media live broadcast as an example to introduce the HD broadcast truck converged media live streaming solution. We expanded the backup system to make the entire solution more reliable.

1. Overview of HD Broadcast Truck Live Streaming Plan

The HD broadcast truck is equipped with one Snell Kahuna video production switcher and one Evertz XE4 video routing matrix. The switcher and matrix serve as the core equipment for the broadcast truck' s primary and backup production paths, providing mutual backup. If the switcher fails, the 2$×$1 emergency switch at the director' s position can immediately transfer signal switching control to the emergency switching matrix panel at the director' s position to complete the switching. At this point, the matrix replaces the switcher for switching operations. If the switcher fault cannot be resolved in time, the emergency matrix completes the switching work, and the signals output to various terminals are also taken from the backup path. The block diagram of the broadcast truck' s primary and backup video system paths is shown in Figure 1 [Figure 1: see original paper].

This live broadcast utilized a 7-channel HD broadcast truck. Seven Fujinon HDK-79EXIIIα HD cameras were deployed at the event site (six cameras were actually required, with the seventh serving as backup; see Section 3.5), equipped with three 18× Fujinon HA18$×7.6$BERD - S58Bstandardlenses, two13×$ Fujinon HA13$×4.5$BERM - M58Bwide - anglelenses, andtwo66×$ Ikegami XA66$×$9.3BESM box-type telephoto lenses, complemented by a Jixun 8-meter jib arm to create a comprehensive three-dimensional live broadcasting environment at the venue. The 7-channel HD broadcast truck served as the core system for on-site program production and real-time signal transmission. Additionally, one HD satellite truck and one SD satellite truck from the broadcasting department received the HD/SD PGM signals (program signals) switched by the director and embedded with subtitles from the broadcast truck, and transmitted these HD/SD live signals via satellite channels to Anhui Broadcasting and Television Station' s broadcasting department for distribution. A Clear-Com intercom system was installed on-site, consisting of one Clear-Com CCT-RT wireless beltpack antenna and four Clear-Com CP-222 wireless beltpacks for communication between the broadcast truck and the live event site. The three vehicles were parked in an open area at the side entrance of the venue, with cable routing avoiding the main entrance with heavy foot traffic, and security personnel were stationed along the path from the site to the broadcast trucks

to ensure the safety of on-site cabling and equipment.

Camera signals entered the broadcast truck' s switcher and matrix via fiber optic cables. After director processing, audio signals were embedded, followed by subtitle CG insertion at the backend. The signals were then distributed and down-converted before being sent to HD/SD video recorders and HD/SD satellite trucks.

Figure 1. Block diagram of the broadcast truck' s primary and backup video system paths

2. Key Design Points of HD Broadcast Truck Live Streaming Solution

The production environment of an HD broadcast truck is complex, and live programs cannot afford any mistakes. Therefore, the focus of designing the live streaming solution is to ensure the normal output of the broadcast signal. Consequently, we implemented primary and backup path designs when configuring the 7-channel HD broadcast truck. Additionally, for this particular live broadcast, we expanded the backup system to make the entire solution more reliable.

2.2 Triple Backup for Down-Conversion Modules

The broadcast truck is equipped with two Evertz 7700R 2$×$1 emergency switching units and down-conversion video signal processing cards Evertz 7714HDC. If either the primary or backup down-conversion card fails, only one signal path is affected while the other continues to output normally. The faulty card can be bypassed using patch cables to maintain two-channel output. Given the importance and sensitivity of this live broadcast, a third down-conversion card was temporarily installed and connected to the patch panel as a cold backup that could be activated when necessary.

2.3 Dual Backup for Final Stage Signal Output

The final stage signal output at the rear of the broadcast truck employs dual-channel backup. Both HD video output signals and SD video signals are output in primary and backup pairs, with the two satellite trucks switching as needed. Primary and backup HD Evertz 7721AE4-B-HD embedding cards output two channels of HD-SDI signals with embedded audio to the HD satellite truck. Simultaneously, the primary and backup HD signals are distributed to primary and backup down-conversion cards, which output two channels of SD-SDI video signals with embedded audio to the SD satellite truck. This ensures that each satellite truck receives two video signals from different system routes from the broadcast truck, achieving redundancy at the transmission end.

2.4 Signal Source System Backup Design

The seven camera channels deployed on-site can serve as backups for each other. Additionally, to ensure uninterrupted video signals for the live broadcast, the broadcast truck prepared one extra camera beyond the normal six-camera setup, complete with fiber optic cables, tripods, pan-tilt heads, and other peripheral equipment as a backup camera. To prevent unforeseen broadcast truck failures, the backup camera' s CCU (camera control unit) was powered through the UPS emergency power supply plan, with one signal path directly to the HD satellite truck to ensure continuous picture transmission from the site. Furthermore, the HD satellite truck' s built-in camera could be used as an external backup signal source for the broadcast truck video system. The live signal routing diagram is shown in Figure 2 [Figure 2: see original paper].

2.5 Subtitle System Backup

The subtitle system was also an important signal source for this live broadcast. Two NewAuto subtitle machines were deployed to ensure normal operation of the subtitle system during the broadcast. The switcher prepared two keyer channels to complete primary and backup subtitle inputs. If one subtitle system failed, the switcher's keyer could be toggled to the backup subtitle machine to maintain subtitle insertion. Both key signals also entered the downstream keyer boards of the matrix channels to complete backup for the emergency switching system, allowing downstream keying to be loaded when the emergency switching system had to be used for the live broadcast.

2.6 Intercom System Backup

To prevent communication interruption caused by wireless intercom system failures or camera intercom module malfunctions, we added eight Motorola GP328 wireless walkie-talkies that could communicate in real-time with the Motorola GR1225B wireless walkie-talkie repeater station on the broadcast truck. If the walkie-talkie repeater station also failed, we could bypass it and communicate directly using the walkie-talkies. These walkie-talkies served as a backup communication system for the wireless beltpacks and camera base station communications, providing reliable real-time communication assurance during the live broadcast.

2.7 UPS Emergency Power Supply for Power System

We connected a power supply line (40KW capacity) from the distribution room on the north side of the venue for the broadcast truck. If municipal power failed, the UPS emergency power supply equipped on the broadcast truck could ensure critical routing equipment continued operating for 30 minutes, providing time for system emergency adjustments and safeguarding the live broadcast. The UPS emergency power supply should be tested at least one day before the live broadcast. During testing, power both circuits simultaneously, operate all

broadcast truck equipment for more than five minutes, then cut the power supply and observe whether system equipment operates normally during the automatic UPS switchover. Continue monitoring whether the UPS output voltage and current remain stable. If all indicators are normal and can be sustained for more than 30 minutes, the test is qualified.

3. Emergency Plans for HD Broadcast Truck Live Broadcasting

With comprehensive preliminary system design and technical preparations for live broadcasting, this alone cannot guarantee flawless execution, as focusing solely on equipment, systems, and hardware is insufficient—these are only objective factors. The decisive factor for broadcast safety is human. To ensure video technicians are fully prepared and can respond quickly during the live broadcast, we also developed a set of emergency plans and conducted drills before the broadcast. Any staff member discovering a problem during the broadcast must immediately report it to the on-duty technician, who should prioritize broadcast safety and handle the incident promptly.

3.1 Emergency Response for Common Switcher Failures

If the switcher path fails, immediately use the 2$\times$1 emergency switch to switch to the matrix path (the backup path must be tested before the broadcast). Simultaneously notify the live event site, then troubleshoot the primary path. If the primary path fault is resolved within the broadcast duration, switch back to the primary path without affecting the ongoing broadcast. If the primary path fault cannot be resolved during the broadcast, complete the broadcast using the backup path.

3.2 Emergency Response for Common Matrix Failures

If matrix problems cause partial or complete matrix panel failure, troubleshoot the matrix fault while ensuring the switcher operates normally. If the matrix fault cannot be resolved immediately, use patch cables to route signals. If the matrix failure causes the video wall to lose signal, use patch cables to directly route CCU monitoring output signals to each monitor input in the director' s area. For monitoring screens required at other positions, use patch cables to route monitoring signals to the interface panel below the video wall, then connect the corresponding display inputs to the interface panel using video cables.

3.3 Emergency Response for Camera and Fiber Optic Cable Failures

If camera or fiber optic cable failures cause picture abnormalities, immediately notify the director to temporarily avoid the faulty camera position and dispatch technicians to the site for troubleshooting and resolution as appropriate. For example, if the fiber optic signal is weak, attempt to clean the fiber optic connec-

tors using professional cleaning tools to ensure optical path clarity, and replace the backup camera and fiber optic cable if necessary.

3.4 Emergency Response for Broadcast Truck Final Output Signal Failures

If the broadcast truck' s final output signal is abnormal, immediately check the relevant boards and communicate with the signal receiving party. The down-conversion card 7714HDC is a board prone to failure in this truck; the fault can often be resolved by reseating and restarting the board after communicating with the receiving party' s technical staff.

3.5 Emergency Response for Common Tally System Failures

If the Tally system fails, the Tally host can be restarted without affecting the normal broadcast. Since the Tally host and system monitoring share one display output, care must be taken to switch between the two when using them.

3.6 Emergency Response for Other Failures

If the intercom system, subtitle machines, video recorders, or other equipment fail, backup path switching operations should be considered first, and on-site relevant professionals should immediately address the issue.

4. Overview of Converged Media Live Streaming Plan and Emergency Plans

Benefiting from the rapid development of media convergence technology, this live broadcast incorporated converged media live streaming for the first time. A converged media live streaming workstation was set up at the live event site, staffed by personnel from Anhui Network Television for full-process internet live broadcasting. The core equipment for internet live streaming consisted of two Naga direct-broadcast all-in-one units. Each unit can input four SDI signals with HD/SD auto-sensing and includes built-in video frame storage functionality, connecting to the internet via Ethernet interfaces. The direct-broadcast all-in-one units can perform HD internet video live streaming or function as small switchers to switch and process input signal sources before broadcasting, supporting up to 12 video signal sources. The switcher bus is a single-level bus that, while lacking multi-level switching capabilities, is sufficiently functional for small-to-medium-sized event online live streaming. The two direct-broadcast all-in-one units serve as backups for each other.

The internet live streaming signal format was HD 1080p with eight embedded audio tracks. The broadcast truck directly transmitted primary and backup dual-channel HD PGM signals to the primary and backup direct-broadcast all-in-one units. Two network cables were connected from the venue to ensure primary and backup dual internet pathways, and with the two direct-broadcast

all-in-one units backing each other up, this achieved two complete primary and backup paths for internet live streaming, ensuring broadcast safety. The direct-broadcast all-in-one units were configured with a 700-second broadcast delay, allowing emergency handling within this timeframe if any broadcast accidents occurred.

The delayed HD live streaming signals were transmitted via the internet to websites, mobile APP clients, forums, WeChat official accounts, and other online platforms, thereby achieving converged media live streaming.

Due to the strong real-time interactivity of internet live streaming, the converged media live streaming workstation was arranged inside the venue rather than outside, enabling staff to conduct graphic live streaming using mobile phones and upload live event graphics and text to corresponding online platforms. Graphic live streaming, as a complementary form to internet video live streaming, offers strong interactivity that enhances the viewing experience and provides audiences with more exciting on-site content and an immersive viewing experience.

Since internet live streaming only used two direct-broadcast all-in-one units as primary and backup paths to directly receive the broadcast truck' s primary and backup PGM signals, the system had fewer nodes. Additionally, with internet server sites simultaneously recording both primary and backup signals without requiring emergency switching, the emergency plan primarily focused on timely fault detection and resolution for the primary and backup signal paths, particularly paying close attention to network interface stability.

Anhui Broadcasting and Television Station' s 7-channel HD broadcast truck has undertaken numerous field live broadcasting tasks since being put into service. We have continuously learned lessons and accumulated experience from these many years of work, gradually forming this complete set of HD broadcast truck video system live streaming solutions and emergency plans. However, as our experience with converged media live streaming is still limited due to its relatively short implementation time, we need to continue exploring in future work, constantly improving, refining, and innovating broadcast truck live streaming solutions and converged media live streaming plans and related emergency plans according to the development trends of broadcasting technology and new technological directions, striving to present more exciting live programs to audiences.

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Note: Figure translations are in progress. See original paper for figures.