Postprint: Exploration and Practice of Several Common Types of Converged Media Live Streaming Applications in Radio and Television Stations

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Abstract

In recent years, self-media and third-party live streaming platforms have undergone rapid development, leading to corresponding changes in audience information acquisition methods and viewing habits. To meet evolving demands, traditional radio and television stations should, while preserving their inherent advantages, actively respond to new media challenges, innovate communication approaches, implement multi-screen integration, and produce more high-quality content products favored by audiences. This paper will introduce several types of converged media live streaming applications commonly employed by Anhui Network Radio and Television Station, based on practical cases, and provide a comprehensive summary.

Full Text

Preamble

Exploration and Practice of Several Common Types of Converged Media Live Streaming Applications in Radio and Television Stations

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Abstract: In recent years, the rapid development of self-media and third-party live streaming platforms has fundamentally transformed how audiences access information and their viewing habits. To adapt to these evolving needs, traditional radio and television stations must maintain their existing strengths while actively embracing the challenges posed by new media, innovating communication methods, and coordinating large and small screens to produce more high-quality, audience-centric content. This paper introduces and summarizes

several common types of converged media live streaming applications regularly employed by Anhui Network Radio and Television Station.

Keywords: Converged media; Radio and television stations; Live streaming types; Considerations; Converged media live streaming applications

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Converged media live streaming is not simply the direct transfer of traditional radio and television broadcasts to internet platforms. It can involve adapting large-screen content for small screens, while small screens can also provide high-quality content resources for large screens, enabling interaction between the two. Moreover, radio broadcasts can incorporate visual elements. The essence of converged media live streaming lies in the "convergence" itself—leveraging high-quality resources from traditional radio and television broadcasting, production, and planning within the broader framework of media convergence, while harnessing the advantages of new media: unlimited space, timelessness, unlimited authorship, and unlimited audiences. By integrating traditional and new media live streaming, single-platform radio and television broadcasts are transformed into multi-platform, multi-terminal converged media live streams, achieving resource integration, promotional synergy, and shared benefits [1].

In 2020, Anhui Network Radio and Television Station established a dedicated broadcast team to provide new media transmission services for various channels and frequencies, as well as to undertake commercial live streaming events. Throughout the year, the team completed over 400 live streams, including television program small-screen adaptation broadcasts, broadcast visualization live streams, multi-camera event broadcasts, cross-regional multi-person interactive connection live streams, and converged media large-screen/small-screen interactive broadcasts. All live streams were built on new media streaming technologies, primarily utilizing three protocols: RTMP (Real Time Messaging Protocol), RTSP (Real Time Streaming Protocol), and HLS (HTTP Live Streaming). Some broadcasts also incorporated traditional television transmission technologies, completed only after thorough safety broadcast risk assessments and contingency planning.

1. Television Program Small-Screen Live Streaming

Television program small-screen live streaming has evolved beyond simply playing television programs on proprietary platforms such as websites and apps. Instead, it strategically shifts television content from TV screens to third-party platforms like Kuaishou, WeChat Channels, and Douyin to expand influence based on promotional and client needs [2].

1.1 Front-End Equipment and User Terminals

Front-end equipment includes encoders and streaming scheduling matrices, which convert video signals into streaming signals and provide either push or

pull streaming as required. User terminal selection is primarily determined by the chosen live streaming platform and may include mobile phones, computers, tablets, and other devices.

1.2 Live Streaming Process Implementation

To accommodate different platform requirements, this type of live streaming employs two methods: push streaming and pull streaming. Push streaming refers to the process of transmitting packaged content from the acquisition stage to the server, while pull streaming involves retrieving existing live content from a server using a specified address.

For push streaming, encoders convert television signals into streaming signals compliant with third-party platform protocols and push them to a designated address—a string generated by the third-party platform that includes domain name, publishing point, stream key, and authentication information, created when establishing the live streaming room.

For pull streaming, encoders convert television signals into streaming signals pushed to proprietary streaming servers, which generate pull stream addresses for third-party platforms to access. When establishing the live streaming room on a third-party platform, selecting pull streaming (if supported by the platform) enables acquisition of the live signal source.

1.3 Live Streaming Security

Live streaming involves both broadcast safety risks and content piracy risks, requiring comprehensive consideration and effective preventive measures. Broadcast safety risks primarily manifest as encoder equipment failures or network link failures. To mitigate these risks, primary and backup encoder equipment should be deployed with different network links, parameters configured and tested in advance. For push streaming, dedicated personnel should monitor the entire process; if the primary stream fails, backup equipment should immediately take over. For pull streaming, two heterogeneous encoder devices and links should push streams to streaming servers operated by two different CDN providers for platform access. If the primary stream fails, the pull stream address can be changed on the third-party platform to restore the broadcast. Piracy risks are specific to pull streaming—if the pull stream address is stolen, it may generate massive abnormal traffic, significantly increasing streaming costs. We typically implement whitelist-based access control, allowing only whitelisted platforms to access the stream [3].

1.4 Considerations

Dedicated encoder equipment should be allocated for such broadcasts. Since these devices require internet-based data interaction, they should not be shared with other systems—particularly internal network encoders—for security reasons. Before push streaming, resources such as encoder equipment and bandwidth

should be allocated based on the number of target platforms to avoid 卡顿 or interruptions caused by insufficient resources. Additionally, when push streaming, avoid pushing to too many platforms from the same device; we have encountered situations where abnormal push requests to one platform caused a sudden spike in device resource utilization, directly affecting other platforms' streaming quality. For bitrate and resolution selection, considering video source parameters and outbound bandwidth, we typically use a bitrate of 2 Mbps and resolution of 1920$×$1080.

2. Broadcast Visualization Live Streaming

Broadcast visualization live streaming here extends beyond traditional radio studio visualization to include outdoor reporter video connections and on-site event video feeds.

2.1 Front-End Equipment and User Terminals

Front-end equipment includes cameras with 4G field encoders, mobile phones, drones, surveillance cameras, and integrated production switchers. Cameras with 4G encoders, mobile phones, drones, and surveillance cameras serve as signal acquisition devices, while integrated production switchers function as signal aggregation and push devices. User terminals include mobile phones, tablets, and computers.

2.2 Live Streaming Process Implementation

The integrated production switcher, deployed in the control room, serves as the signal aggregation and push device. Outdoor video signals from cameras with 4G encoders, mobile phones, drones, and surveillance cameras are IP-encoded and transmitted to a relay streaming server, which the integrated switcher accesses via pull streaming. Studio video signals are captured by cameras and output via SDI to the integrated switcher. Directors select corresponding video feeds for switched output, using the switcher' s encoding and push capabilities to transmit the main program output to publishing servers for distribution.

Field cameras work in conjunction with 4G encoders: camera footage is output via SDI or HDMI to the encoder, which encodes and transmits the signal via 4G network to the relay server. The relay server generates an RTMP stream address that the integrated switcher accesses to acquire the field camera signal. Both mobile phones and drones operate with dedicated apps, following the same transmission principle as field cameras—signal acquisition via RTMP stream address access.

This type of broadcast can also employ both push and pull streaming, with the same principles as above, though the integrated production switcher replaces the encoder device.

2.3 Live Streaming Security

Since all field signals are transmitted over networks, their stability is subject to on-site bandwidth and signal conditions. Preparations should be made before broadcasting, including preparing filler clips or posters in the switcher' s DDR channels as backup sources. Additionally, due to the unpredictable nature of field-captured content, necessary broadcast delays should be implemented to ensure content safety.

2.4 Considerations

As the core device for signal aggregation and live streaming, the integrated production switcher uses downstream bandwidth for pulling field signals. This must be calculated based on the number of field signals with adequate redundancy. Simultaneously, upstream bandwidth must be prepared according to push streaming requirements. Communication between directors and each signal source can be maintained via 4G walkie-talkies to ensure uninterrupted coordination.

3. Multi-Camera Event Live Streaming

Multi-camera event live streaming involves deploying multiple camera positions at event sites, transmitting on-site footage to field production equipment, and converting it into streaming signals. The process and methodology are similar to traditional television event broadcasting but represent a lightweight version, with the primary difference being the target broadcast platforms [3].

3.1 Front-End Equipment and User Terminals

Front-end equipment includes cameras, drones, integrated production switchers, intercom systems, and tally systems. Cameras and drones serve as signal acquisition devices, intercom and tally systems facilitate communication between directors and camera operators, and integrated switchers handle signal aggregation and push streaming. User terminals include mobile phones, tablets, and computers.

3.2 Live Streaming Process Implementation

These broadcasts typically use three to four on-site cameras to capture different angles and depths of field, outputting via SDI to the integrated switcher. Depending on site conditions, drones can capture wide-scale footage, transmitting via the controller' s HDMI output to the switcher. If large-screen content needs to be displayed, signals can be fed from the screen control console or presentation materials can be loaded into the switcher' s DDR channels for playback. Directors select corresponding video feeds for switched output, using the switcher' s encoding and push capabilities to transmit the main program output to publishing servers. On-site audio is fed through the venue' s audio

mixing console. These broadcasts typically use push streaming; if multiple platforms are targeted, pull streaming can be employed to reduce on-site bandwidth load and switcher burden.

3.3 Live Streaming Security

For broadcast safety, integrated production switchers with hot-backup functionality should be used as primary and backup systems. For push streaming, the primary unit handles pushing while the backup is pre-configured; if the primary fails, the backup takes over. For pull streaming, both primary and backup units simultaneously push to different streaming servers, which provide separate pull addresses for broadcast platforms. Network links should use dedicated lines for the primary path and 4G networks for backup. For content safety, broadcast delays should be employed to enable timely response to emergencies.

3.4 Considerations

For push streaming, bandwidth should be calculated based on the number of target platforms. 4G networks are not recommended for simultaneously pushing to multiple platforms; instead, relay encoders in the machine room can forward streams to ensure smooth broadcasting. After on-site audio integration, audio-video synchronization testing should be performed, and the software audio mixer in the integrated switcher should be checked to avoid audio leakage from multiple video signals.

4. Cross-Regional Multi-Person Interactive Live Streaming

Cross-regional multi-person interactive live streaming emerged in response to pandemic prevention requirements in 2020, developed to facilitate interactive participation of multiple cast members in new drama release conferences. This represents a novel internet-oriented live streaming approach.

4.1 Front-End Equipment and User Terminals

Front-end equipment includes mobile phones, live streaming apps, integrated production switchers, and WeChat. Mobile phones and live streaming apps serve as signal acquisition devices, WeChat video conferencing functions as the communication method between locations, and integrated switchers handle signal aggregation and push streaming. User terminals include mobile phones, tablets, and computers.

4.2 Live Streaming Process Implementation

Mobile phones with live streaming apps serve as video acquisition devices for each interactive guest, capturing their footage as streaming signals transmitted via internet to relay streaming servers. The integrated switcher aggregates these signals from the relay server using a unique stream key as an identifier

to ensure correct source acquisition. For multi-person interactive broadcasting, we implement multi-screen compositing, displaying all signals within a single output frame.

To enable guests to monitor program status in real-time, we abandoned the integrated switcher' s return feed function due to network latency issues, instead adopting WeChat video conferencing for both program return feed and communication.

4.3 Live Streaming Security

For broadcast safety, station personnel appearing on-camera should participate locally to ensure a stable and reliable primary signal source, with necessary backup sources prepared. For signal transmission safety, since all signals are network-transmitted—essentially involving the switcher pulling mobile signals from streaming servers for forwarding—the nature of streaming transmission introduces packet loss risks, potentially causing video frame drops and 画面卡顿. To mitigate these risks, buffers should be configured for each signal acquisition. Testing and practical application have shown that under normal conditions, a 1-3 second buffer provides stable and effective results. Buffers should not be set too large, as they consume substantial system resources and introduce other broadcast risks.

4.4 Considerations

In this type of broadcast, each mobile video signal originates from different locations, converging via the internet. Different mobile phone models and carrier networks introduce varying network latencies that can affect synchronization. We recommend using identical phone models and the same carrier network to minimize latency-induced interaction asynchrony; manual calibration of each signal via the integrated switcher is also possible. Additionally, public cloud platforms now offer corresponding services, utilizing cloud production and acceleration packages to address latency issues.

5. Converged Media Large-Screen and Small-Screen Interactive Live Streaming

Converged media large-screen and small-screen interactive live streaming was developed for outdoor live commerce broadcasts by television channels requiring simultaneous broadcasting on both television and new media platforms. This approach controls costs while fully considering television broadcast safety risks, utilizing new media technologies to achieve converged media broadcasting. Compared to traditional television broadcasting systems, it offers simpler, faster, more flexible deployment and lower costs.

5.1 Front-End Equipment and User Terminals

Front-end equipment includes cameras, mobile phones, drones, integrated production switchers, intercom systems, tally systems, and television 4G field encoders. Cameras, mobile phones, and drones serve as signal acquisition devices; intercom and tally systems facilitate director-camera communication; integrated switchers handle signal aggregation and push streaming while physically outputting television-compliant video signals to television 4G field encoders, which return field signals to the studio for television broadcasting. User terminals include mobile phones, tablets, and computers.

5.2 Live Streaming Process Implementation

This broadcast type requires simultaneous streaming on both television and new media platforms, with new media broadcast duration exceeding television broadcast duration. Television broadcasting includes both studio and field components, while new media broadcasting covers only the field portion. The studio component follows traditional television broadcasting procedures and is not discussed here; we focus on field broadcast implementation.

Camera signals are output via SDI to the integrated switcher, drone signals are output via the controller' s HDMI to the switcher, and mobile phones serve as field roving cameras transmitting signals to the switcher via live streaming apps. Field directors communicate with camera operators via intercom systems and use tally systems to indicate current and upcoming camera positions. The integrated switcher' s physical output function converts field signals into television-compliant formats for television 4G field encoders, which transmit field signals back to the studio for television broadcasting. Simultaneously, the switcher' s network streaming function enables push or pull streaming to third-party new media platforms as required.

5.3 Live Streaming Security

For broadcast safety, field operations use primary and backup integrated production switchers with hot-backup functionality and different network links to ensure new media platform security. Television broadcast safety is ensured through dual television 4G field encoders returning primary and backup signals to the studio. The studio serves as a final safeguard—if field signals fail, studio signals replace field signals for television broadcasting. Drone and mobile phone signal safety can be addressed by pre-recording aerial and roving footage as backup sources in the switcher' s DDR channels.

5.4 Considerations

Mobile phones, television 4G field encoders, and integrated switchers all require bandwidth for push/pull streaming. Bandwidth calculations and preparations should be completed in advance to avoid broadcast anomalies. Given the multi-

terminal targeting and complex workflows, full-process rehearsals should be conducted before official broadcasts, with corresponding emergency response plans prepared.

The aforementioned live streaming types have been widely applied at our station and represent mature application forms that have achieved excellent results in numerous converged media broadcasting activities. While utilizing these methods, we continue exploring new technologies and formats, focusing on optimizing network latency issues, balancing transmission quality and user experience, and integrating features such as beautification and interactive effects from new media live streaming into our workflows.

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