Postprint: A Brief Discussion on the Application of Key Technologies in Television Broadcasting

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Abstract

Television technology has developed rapidly, evolving from traditional standard-definition tape broadcasting to present-day high-definition, 4K, and 8K, with broadcasting methods becoming increasingly diversified. This paper explores the application of network security, monitoring, and full-process workflow in television broadcasting. By introducing advanced equipment and technologies, integrating security-related devices, browser-server (BS) architecture software systems, and mobile applications into the system, the system becomes more intelligent, with greater advancement, convenience, and security. Television broadcasting workflows become clearer, with significant improvements in both convenience and efficiency, and richer auxiliary functions for secure broadcasting. Networking, informatization, and workflow are characteristics of current broadcasting, with network security becoming increasingly important in modern broadcasting. Browser-server architecture, workflow monitoring, equipment information monitoring, etc., are also indispensable components of the system.

Full Text

Preamble

A Brief Discussion on the Application of Key Technologies in TV Broadcasting

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Abstract

[**Objective**] With the rapid development of television technology—from traditional standard-definition tape broadcasting to today' s high-definition, 4K, and 8K formats—broadcasting methods have become increasingly diversified. This paper explores the application of network security, monitoring, and full-process integration in television broadcasting. [**Methods**] By introducing advanced

equipment and technologies, security-related devices, browser-server architecture software systems, and mobile apps are integrated into the system, making it more intelligent, advanced, convenient, and secure. [**Results**] Television broadcasting workflows have become clearer, with significant improvements in convenience and efficiency, and a richer set of auxiliary functions for safe broadcasting. [**Conclusion**] Networking, informatization, and process integration characterize modern broadcasting, and network security has become increasingly important. Browser-server architecture, process monitoring, and equipment information monitoring are also indispensable components of the system.

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1. Television Broadcasting Development Status and Solutions

Traditional television broadcasting transmission primarily relied on SDI and ASI interfaces, but IP-based transmission is now increasingly in demand. While IP stream transmission offers greater simplicity and convenience, it requires a sufficiently stable network as its foundation. With the demand for media convergence and system interconnectivity, file exchange has become more widespread, transforming the broadcasting system into an open state closely connected with production systems, chief editor offices, and media asset systems. Television broadcasting has evolved into a platform for cross-departmental interconnectivity and multi-service integration. However, this interconnectivity has also complicated broadcasting system workflows and made network security more difficult to guarantee. Therefore, how to conduct safe and efficient broadcasting interconnection under these new circumstances? The author believes we should start with rational network planning and strengthened network security construction; simplify complexity by presenting all business operations as processes to broadcasting personnel; enhance system information analysis and display; and introduce various technologies to improve system structure.

2. Network Application in TV Broadcasting and the Criticality of Network Security

In the information age, the rapid development of hardware facilities and broadcasting technologies in television broadcasting has integrated network technology into all aspects of broadcasting operations. Network technology develop-

ment ensures high-quality, high-efficiency television broadcasting systems. During broadcasting system design, network system planning must be prioritized to maximize the advantages of network technology and lay a foundation for the stable development of television broadcasting.

2.1 TV Broadcasting Network Requirements Analysis

With the popularization of high-definition broadcasting, material bitrates have increased and file sizes have grown, posing significant challenges to storage and network transmission rates within broadcasting systems. Additionally, file-based delivery has become the mainstream method in modern broadcasting systems, placing higher demands on network bandwidth and switch throughput. Under a fully interconnected network model, materials must be transmitted across departments, undergoing technical review, manual review, AI review, MD5 verification, and other processes. To enhance workflow convenience while ensuring security, thorough network deployment planning is essential. Many stations are now experimenting with mobile app applications for remote program review and playlist editing, as well as monitoring material delivery workflows. This requires secure interconnection between broadcasting networks and external networks, posing a tremendous challenge to network security.

2.2 Considerations for Network Construction in TV Broadcasting

According to the three-level security protection requirements for radio and television safe broadcasting: "Different network areas should be divided based on system functions, business processes, network structure hierarchies, business service objects, and other factors." During network architecture design, the connection methods between core switches and access switches, VLAN division, and inter-VLAN access restrictions must be clearly planned. Based on different business requirements, isolation through VLANs is necessary. If interconnection with other systems is required, isolation must be implemented through firewalls or network gateways using Layer 3 routing methods to avoid network storms that could cause large-scale network paralysis.

Equipment with large material migration volumes should be planned together to maximize bandwidth utilization through switch backplane bandwidth. The total system storage bandwidth and daily migration volume should be calculated in advance as reference data for switch selection. If switches need to be stacked or cascaded, multiple ports should be bound for cascading based on actual business requirements to prevent network bottlenecks. Migration networks and business networks with smaller daily data volumes should preferably be separated, as large-scale material file migrations may cause network congestion. Even if the business network data volume is small, access speed requirements could still cause application software access timeouts.

Modern broadcasting systems require IP streaming to downstream units, necessitating primary and backup IP switch configurations. Ports interconnecting with

downstream systems require ACL policy restrictions, such as limiting source addresses or multicast addresses. When network data volumes are too large, IP stream transmission can be significantly affected, causing packet loss or stream interruption that directly leads to broadcasting accidents.

If mobile app functionality needs to be deployed, more rigorous network security design is required. If the mobile app is only for viewing without data feedback, the network can be designed as a one-way mode that sends data outward without receiving return data. Alternatively, blue light or infrared methods can be considered for data isolation transmission. If the mobile app needs to write data back into the system, more secure methods are required, such as establishing an independent app database with other secure filtering methods for data synchronization.

2.3 The Importance of Network Security in TV Broadcasting

Modern television broadcasting networks are no longer independent local area networks. Interconnection with other business systems and even external networks introduces network threats. According to the *Basic Requirements for Classified Protection of Radio and Television Networks Security* (GY/T 352-2021), television broadcasting must, under unified security strategies, protect against malicious attacks from organized external groups with abundant resources, severe natural disasters, and other threats of equivalent severity that could cause major resource damage. The system must be able to promptly detect and monitor attack behaviors, handle security events, and recover most functions quickly after being compromised.

The importance of network security for television broadcasting is self-evident, making the introduction of security equipment particularly crucial. Beyond ensuring daily network security, security equipment also greatly assists in broadcasting system maintenance. Anti-virus software must be installed in broadcasting systems with real-time virus database updates under secure conditions. Anti-virus software can prevent, detect, and remove malicious software and viruses to ensure computer operational stability.

When interconnecting with other systems, besides Layer 3 routing through switches and IP address restrictions, firewalls are needed for port and access restrictions, or network gateways for physical isolation. Intrusion Detection Systems (IDS) monitor network transmission in real-time, issuing alerts or taking proactive countermeasures when suspicious transmissions are detected. Deploying IDS within the system can provide early warning and protection against illegal transmissions in broadcasting networks.

Log auditing systems help administrators audit logs from all IT equipment and switches, assisting technical personnel in troubleshooting and optimizing system performance. Database auditing is even more critical for broadcasting systems, as it provides real-time alerts for risky behaviors against databases. It can monitor database risk status, operational status, and performance status, recording

and analyzing statements executed by various software to help technical personnel identify software faults.

Other security equipment, such as vulnerability scanners and bastion hosts, also safeguards broadcasting network systems. Vulnerability scanners can analyze vulnerabilities in all IT equipment. Bastion hosts enable secure remote access within the system, fully protecting networks and data from intrusion and damage by external and internal users when remote maintenance is required.

3. Program Preparation System Design in TV Broadcasting

Broadcasting systems have continuously evolved, with traditional signal upload/download methods gradually being phased out. In new broadcasting systems, automatic file-based material delivery is the primary method, and program preparation systems play a crucial role throughout the broadcasting system, responsible for program code planning, migration, and review—forming the prerequisite for material security in broadcasting systems.

3.1 Program Preparation Process Design

3.1.1 Program Code Process In a converged media environment, program codes serve as the unique and unchanging identifier for material delivery. To ensure program code standardization and uniqueness, a program code management system is required. Program code application follows an automated process, automatically combining codes according to established rules based on business systems, channels, dates, etc., with the preparation system managing program code generation and management through backend interfaces.

3.1.2 Material Migration Interface Deployment Material delivery interfaces are critical for interconnection with other systems, generally including duplicate checking, delivery request sending, metadata storage, and synchronous/asynchronous return functions. Interfaces typically adopt IIS architecture, and to ensure interface security, load balancing clusters are generally used to provide load balancing and high-availability services for frontend and backend applications.

3.1.3 Migration System Management In a fully network-based file broadcasting environment, media processing systems implement material file migration, support simultaneous MD5 file verification, technical review, transcoding, and other file processing functions through a series of technical means, uniformly providing programs ready for broadcast to the broadcasting system. The preparation process adapts to the characteristics of networked, file-based, and fragmented production. It subdivides, summarizes, and integrates positions from traditional program production such as program scheduling and media

asset management, reclassifying various types of data according to different attributes of management layer, business layer, execution layer, circulation layer, and archive layer to ensure reasonable data flow and node control.

3.1.4 Process Management The preparation process requires coordination among many servers and software components, with numerous stages needing unified interface monitoring. Different program types require classified process design, such as news processes and emergency processes, categorized according to broadcasting urgency.

3.2 Application of B/S Architecture in TV Broadcasting

B/S (Browser/Server) architecture is a model that emerged with the rise of Internet technology as a variation or improvement of C/S (Client/Server) architecture. Traditional broadcasting system software primarily used C/S architecture, but B/S architecture is now increasingly widely applied in television broadcasting. The advantage of B/S architecture is that all software resource consumption runs on backend servers, allowing clients to complete operations simply by opening a browser. Client expansion is also relatively simple, requiring only browser installation.

In broadcasting systems, program review and playlist editing are the most widespread applications under B/S architecture, with numerous and dispersed clients. Adopting B/S architecture simplifies equipment replacement and expansion without software installation and with lower machine configuration requirements, making system maintenance more convenient (review software shown in [Figure 1: see original paper]).

3.3 Mobile App Applications in Preparation Systems

The popularity of mobile apps has made many people increasingly dependent on smartphones. Mobile app usage enables work to be completed easily without geographical or equipment limitations, prompting many television stations to deploy mobile app software that connects broadcasting systems to external networks through security devices. Current mobile app usage in preparation systems mainly includes two functions:

1. **Program Schedule and File Delivery Process Status Query**: Published through external networks, relevant personnel can install mobile app software to query program generation status anytime, further utilizing networks and mobile devices to facilitate leadership and technical staff monitoring of the generation system (program viewing app shown in [Figure 2: see original paper]).
2. **Remote Program Review**: Through secure connections, mobile apps enable remote program review, allowing review and confirmation of materials anytime and anywhere. Remote review software deployment can

improve the timeliness and convenience of material review (mobile app review shown in [Figure 3: see original paper]).

4. Data Analysis Technology in TV Broadcasting

Data analysis technology has become ubiquitous, and its application in media work is increasing. In the era of big data, traditional broadcasting must consider how to acquire and utilize big data from business systems to achieve greater progress, and what benefits data analysis can bring to technical personnel.

4.1 Hardware Monitoring Information Acquisition

Compared with traditional broadcasting systems, modern broadcasting systems increasingly utilize storage, network, virtualization, and storage resource pools. From the perspective of duty maintenance personnel, there is insufficient capacity to individually check the status of so many devices and backend software operations, making the importance of integrated monitoring systems increasingly prominent. Many television stations have implemented equipment monitoring systems that allow viewing of all equipment operation status through a monitoring system interface, including peripheral environmental monitoring such as air conditioning, UPS, temperature, and humidity. Monitoring systems also require statistical functions, such as equipment resource consumption, failure frequency, and redundancy status. When equipment fails, timely alarms should be triggered, and duty personnel can review monitoring system logs to understand recent system equipment operation status (monitoring software shown in [Figure 4: see original paper]).

The purposes of monitoring software are twofold: first, timely alarms, and second, failure statistics. For equipment with high failure rates, timely measures must be taken.

4.2 Broadcast Software Auxiliary Information Statistics and Summary

In television broadcasting systems, the core backend software is the broadcast control software, which controls material broadcasting according to playlists and represents the most critical component of the entire broadcasting system. Broadcast software status requires constant attention from duty personnel. Many television stations require broadcasting duty personnel to simultaneously monitor the broadcast status of two or more channels, which presents a significant challenge. To help duty personnel better complete their work, several solutions are available:

1. **Broadcast Software Information Aggregation Platform**: Aggregates broadcast software information from multiple channels into a single software interface, allowing monitoring of currently broadcasting and upcoming programs across multiple channels, and aggregating and displaying

broadcast software alarm information together, enabling duty personnel to clearly view status (broadcast information aggregation software shown in [Figure 5: see original paper]).

2. **Missing Material and Material Migration Status Viewing**: Duty personnel' s primary concern is which materials in the playlist have not arrived and where they are stuck in the process. A complete statistical software system is needed to categorize and display missing materials based on time until broadcast, with red display for less than one hour, yellow for less than two hours, while simultaneously showing backend material migration status, allowing broadcasting duty personnel to easily grasp material preparation status (missing material monitoring large screen shown in [Figure 6: see original paper]).

4.3 Broadcast System Data Statistics

Broadcasting systems are complete software application platforms. In daily work, through analysis of broadcasting databases and logs, diverse statistical data can be generated for personnel assessment and workload statistics. Several key statistics include:

- **Broadcast Program Query**: Through statistical analysis of post-broadcast data, timely querying of program broadcasting status during specific periods, broadcast content, actual broadcast duration of each program, and emergency operations by duty personnel.
- **Workload Statistics**: Based on usernames, querying all work content within a specific period, such as uploading, reviewing, and playlist editing, to generate workload statistics tables.
- **Material Broadcast Volume Statistics**: For individual materials, querying annual or monthly broadcast frequency and total broadcast duration based on material name. This is most suitable for statistics on small materials like advertisements and promotional videos.

5. Signal Monitoring Technology in TV Broadcasting

Modern television broadcasting systems have increasingly more peripheral devices. Under dual-link configurations, broadcasting monitoring personnel must monitor more nodes, and traditional multi-viewers can no longer intuitively display link status. After IP-based transmission, IP stream monitoring also becomes a consideration.

5.1 SDI Signal Comparison Technology

SDI signal comparison technology includes key technologies in video/audio signal detection and video/audio signal detection process control. It performs dual or multi-channel cyclic comparison of important nodes in distribution control.

Video signal detection includes image content matching and pixel drift detection technologies. Video signal detection process control includes video signal delay measurement and detection process control technologies. Audio detection adopts waveform-based audio signal matching methods, including audio waveform matching algorithms and audio filtering algorithms. Audio detection process control methods include audio signal delay measurement and detection process control technologies.

Signal comparison systems are now widely applied in broadcasting systems, performing technical review and alarming of signals, and providing automatic and manual emergency response methods after faults occur, playing an important role in channel broadcasting security.

5.2 NDI Technology Application

NDI (Network Device Interface) technology is a network device interface protocol launched by NewTek in 2015. Based on local area network signal transmission protocols, NDI can transmit and receive multiple broadcast-quality signals in real-time through IP networks. Using NDI transmission technology, a single device within a local area network can output or receive multiple NDI signals through a single network cable.

NDI technology application enables video monitoring nodes in the system to be received by a backend server, with clients obtaining NDI signals through the network to flexibly compose link monitoring structure diagrams. Simultaneously, backend technical review results can be obtained to view overall link status through the link diagram, accompanied by audio-visual alarms to enable duty personnel to quickly locate fault points (link detection diagram shown in [Figure 7: see original paper]).

6. Conclusion

6.1 The Transformation to Networking and Informatization

With the technological development of broadcasting systems and comprehensive system functions, broadcasting systems are gradually transforming toward networking and informatization. Network security and wireless communication are the foundation and direction of broadcasting network development. The in-depth application of network-related technologies represents the general trend, requiring continued research into advanced technologies to ensure security while strengthening system intelligence.

6.2 Process Integration and Mobile Applications

The application of B/S architecture technology can improve work efficiency across business departments. Process-integrated preparation technology provides a centralized process platform for multi-department collaboration, facilitating fault node identification and timely notification of relevant personnel.

Mobile app usage has opened a new era of remote work, making television broadcasting systems more open.

6.3 Data Analysis and Continuous Improvement

Data statistics have always been a broadcasting system requirement, including workload statistics, total material broadcast duration, material broadcast frequency, hardware damage frequency, software failure frequency, etc. This statistical data is not only needed for business operations but also plays a positive role in system maintenance.

6.4 Flexible Monitoring and Intelligent Comparison

Broadcasting signal monitoring has always been central to broadcasting operations. With NDI technology-based link monitoring and intelligent signal comparison systems, signal security is fully guaranteed. To ensure broadcasting signal stability, there remain many topics to explore in signal monitoring and viewing.

In the network information age, television broadcasting must conform to the tide of development, seize opportunities, and meet challenges. Television broadcasting technical personnel must cultivate scientific thinking, combine radio and television with intelligent modern technologies, improve service quality, attract audiences, and promote the transformation, upgrading, and development of radio and television.

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