

# Analysis of the Intelligent Content Review and Restoration Module in the Tianhong Television Broadcast System (Postprint)

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## Abstract

Television broadcast systems have evolved from early videotape players and cassette machines to simple single-server hard-disk broadcast system integration in the early 1990s, and subsequently, with the advent of the Master-21 switcher-based automatic broadcast system in the mid-1990s, began to be deployed across provincial-level television stations nationwide. With the introduction of the Tianhong TH-2000, the first domestic automatic broadcast system equipped with a switcher, hard-disk broadcast systems commenced application in all television stations nationwide, and have today evolved to support high-definition, standard-definition, and whole-station network broadcasting at various stations, with the automatic content review system assuming an increasingly prominent and indispensable role within the entire broadcast system. It addresses deficiencies in broadcast materials, addresses the issue of labor-intensive manual content review, enhances review efficiency and accuracy, and strengthens broadcast stability and security. Through on-site integration, operational practice, and comparative evaluation, this paper presents a specific and objective analysis of the intelligent content review and repair module of the Tianhong television broadcast system.

## Full Text

### Preamble

#### Analysis of the Intelligent Review and Repair Module in Tianhong Television Broadcast Systems

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**Abstract:** Television broadcast systems have evolved from early tape players and cassette decks to simple single-machine hard disk broadcast systems integrated in the early 1990s. The mid-1990s saw the emergence of automatic broad-

cast systems based on the Master-21 switcher, which began to be deployed across provincial-level television stations nationwide. With the advent of China's first domestically-produced automatic broadcast system with an integrated switcher—the Tianhong TH-2000—hard disk broadcast systems were adopted by television stations across the country. Today, these systems have developed into high-definition and standard-definition network-wide broadcasting platforms, where automatic review systems have become increasingly critical and indispensable. Such systems address material defects, reduce labor intensity in manual reviewing, improve review efficiency and accuracy, and enhance broadcast stability and security. This paper provides a specific and objective analysis of the intelligent review and repair module in Tianhong television broadcast systems based on field integration, operational practice, and comparative evaluation.

**Keywords:** Tianhong Television; Broadcast System; Intelligent Review; Lossless Technical Review; Repair Module

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## 1. The Necessity of Intelligent Review Systems in Broadcast Infrastructure

Television broadcast review is an essential yet complex process conducted prior to transmission, encompassing content review, technical review, manual review, and automated review. Content review focuses on newsworthiness, timeliness, compliance with propaganda requirements, and—most critically—ideological appropriateness. Technical review, commonly referred to as “tech review,” verifies whether programs meet broadcast technical specifications. The evolution of broadcast review skills has been a tortuous history marked by errors and incidents. Beyond personnel quality and professional competence, machine performance has been a limiting factor, making television review a progression from simple to complex, from low-level to high-level, and from advanced to intelligent systems.

The review workflow typically involves material providers, editors, and ultimately, leadership personnel conducting overall program control and approval. In the earliest days of television broadcasting, review was performed by duty editors who single-handedly managed the entire packaging and compression process. Due to historical limitations in editing machine performance, even when errors were discovered before broadcast, there was virtually no capability for

rapid modification. Early editing systems were linear, with tape players as the recording medium. Although reviewers could play back and edit material on these devices, the inability to perform non-linear editing meant that re-editing and re-recording to tape required at least two hours—lacking both the software and hardware conditions for immediate detection and repair. Broadcasts could only be manually interrupted, followed by passive filler content. This lack of effective technical review methods persisted for a considerable period, particularly in provincial and lower-level television stations.

Today, with increasingly complex broadcast environments and source materials, program content within the entire production chain—encompassing acquisition, editing, broadcasting, and transmission—originates from diverse sources. In addition to in-house produced content and relatively safe materials from superior stations, the station's chief editorial office must handle a large volume of externally sourced materials, including network downloads, purchased content, and advertiser-provided optical discs. These external sources feature inconsistent production standards, varied formats, and non-uniform compression parameters, making it impossible to effectively guarantee broadcast material security. Material sources are widespread and channels are numerous, with review personnel located in dispersed office areas, different production zones, and varying requirements, resulting in poor coordination, slow review processes, and relatively low efficiency.

Furthermore, as materials flow through the station's acquisition, recording, editing, broadcast, and transmission systems, analog-to-digital/digital-to-analog conversions, compression encoding, and high-definition to standard-definition transformations can produce various defects: frame freezing, video loss, audio-video desynchronization, insufficient or distorted loudness, timeline errors, mosaic artifacts, and other material damage that directly impacts broadcast system security and may even cause broadcast accidents.

Traditional review systems suffer from low efficiency, inconsistent standards among editors, varying professional competence among reviewers, poor interactivity, and no intelligence. They could only identify errors without real-time repair capabilities, involved high labor intensity, and could not completely detect or eliminate hidden dangers—far from meeting the growing demands of networked broadcasting and actually increasing the probability of broadcast accidents. As television stations advance toward file-based, high-definition, and network-integrated production and broadcasting, there is an urgent need to liberate productivity, improve efficiency and accuracy, enhance broadcast safety coefficients, and increase social impact. With advances in computer software and hardware technology, high-speed codec processing, microelectronics development, and practical applications of intelligence across various social domains, intelligent broadcast systems have emerged, bringing intelligent review modules to the forefront of broadcast system design. The mid-1990s introduction of automatic broadcast systems based on the Master-21 switcher began nationwide deployment across provincial stations, and with the advent of China's

s first domestically-produced TH-2000 automatic broadcast system with integrated switcher, hard disk broadcast systems were adopted nationwide, gradually paving the way for widespread promotion of intelligent review and repair modules.

## **2. Functional Positioning Analysis of Tianhong Intelligent Review System Modules**

### **2.1 Unified Review Standards**

The system implements intelligent review strategies and automatic technical examination, ensuring comprehensive coverage within established standard parameters. It offers diversified technical review methods and module types, including file format examination, baseband chip detection, and detection of freeze frames, black fields, high/low audio, loudness inconsistencies, and silence. Additionally, it provides intelligent detection of timeline discontinuities, storage material time gaps, encoding format errors, missing or extra frames, audio-video desynchronization, field order, frame rate, image dimensions, pixel parameters, audio channels, sampling rates, sampling formats, and non-uniform packaging parameters across different subsystem personnel.

### **2.2 Intelligent, Shared, Efficient, Secure, and High-Speed Operation**

The intelligent review system is integrated at critical nodes throughout the broadcast infrastructure, capable of operating independently or embedded within the main network. All station materials pass through centralized nodes, enabling centralized deployment, network-wide interconnection, and station-wide sharing. The system supports heterogeneous architectures and can perform technical review on materials produced by any third-party equipment. The chief editorial office implements sequential playlist compilation with batch technical review, multi-threading, multi-processing, and concurrent processing. The review system intelligently schedules technical review engines with dynamic load allocation, offering both real-time manual review and background automatic review functions, with all results recorded in databases. Problematic files trigger real-time alarms, automatically displaying fault time points and corresponding video frames.

### **2.3 Integrated Real-Time Detection and Repair with Unattended Operation**

The review system achieves automatic technical review, automatic detection, and rapid real-time error correction and repair. It performs synchronous video and audio material repair with automatic adaptation and processing to ensure normal broadcast signal parameters. Through hardware configuration identical to broadcast servers and baseband detection for review, combined with software-configured server decoding strategies, the system implements file-based review and repair, resolving issues with heterogeneous system crashes. Supporting

7×24-hour unattended automatic technical review, it enables a review-and-broadcast mode.

### 3. Functional Characteristics of Tianhong Review System

Based on a hybrid CS/BS architecture, the system offers flexible application scenarios and multi-channel review capabilities, supporting efficient interactive review with mainstream and non-mainstream non-linear editing systems, media asset systems, studio systems, and various servers (such as Dayang systems). It supports common television station formats including mpg, mxf, rmvb, and mp4, with built-in multiple UI styles and diversified technical review modules and methods. The system supports file-level, stream-level, and content-level detection with frame-accurate positioning, and can be embedded in parallel or series with media asset management modules, supporting full-text search, scanning and archiving, distribution, and cataloging.

### 4. Application Scenario Analysis of Tianhong Intelligent Review and Repair Module System

All types of station-wide networks—including advertising networks, news media asset networks, non-linear editing networks, and studio networks—connect to the review module through isolation gateways. This allows each relatively independent small local area network to undergo 7×24-hour real-time technical review using unified standards and diverse methods at the review center.

### 5. Analysis of Core Technical Advantages

The integration of an intelligent audio repair engine enables Tianhong' s audio and video repair engines to flexibly apply error correction methods for rapid intelligent repair of common audio and video errors or various preset defects. It can repair storage time interval inconsistencies, timeline discontinuities, encoding errors, loudness variations, volume distortion (excessive or insufficient), channel distribution errors, and audio format errors, restoring program quality to a lossless state and ensuring broadcast quality and security [1].

### 6. Core Equipment of Tianhong Intelligent Review System

**(1) Mainstream Servers.** The hardware platform provides robust technical support, including WEB and database servers, scheduling server software modules, and a Web resource management platform supporting station-wide all-media content resource management. It provides full-text search, upload, download, and recycle bin modules; supports global system parameter settings, directory navigation, and batch file operations; includes over 10 UI skins; supports review task distribution and task priority sequencing; supports dual-machine hot backup, real-time logging, and task load balancing.

**(2) Background Technical Review Servers.** Built on mainstream server hardware platforms, these support 7×24-hour unattended background automatic technical review, single-task multi-threading operation modes, and custom technical review templates.

**(3) Review Workstations.** The review function module supports detection of loudness inconsistencies, black fields, freeze frames, brightness and chroma saturation issues, and color deficiencies. It simultaneously manages local disk materials and server storage materials, supports review report export, and offers two review modes: software detection and baseband detection, with customizable interface layouts and technical review template repair functions.

**(4) Baseband Signal Detection Module.** Supporting multiple HD/SD formats including 1080p, 1080i, 720p, 625i, and 525i, each device handles one signal channel. It features high-performance FPGA with embedded HD/SD-SDI interfaces, equipped with 100Mbps network ports, supports local and remote network log export, and provides 1RU standard chassis with intuitive panel status display and audio-visual alarm capabilities.

**(5) Baseband Detection Software Module.** This supports basic SDI signal status and audio-video content detection, including signal lock status, synchronization status, freeze frames, black fields, and silence. It performs SDI signal format detection such as audio control packet and data packet status, video field and line sampling structure, and AFD codes. The module supports threshold configuration for signal detection, including video thresholds, high audio, and low audio parameters.

## 7. Room for Improvement in Intelligent Review Systems

Intelligent review systems still have significant room for enhancement, particularly through the addition of text review modules. Current intelligent review only performs preset examination of video, audio, format, and encoding, but the text editing review module offers substantial improvement potential. For instance, the system could intelligently pair and lock pictographic text, polyphonic characters, frequently appearing names or fixed terms, and fixed-time visual and audio elements for intelligent review. Once locked, any deviation from preset pairings would trigger alarm prompts with modification suggestions for manual verification or automatic repair.

## 8. Expansion of Television Broadcast System Intelligent Review and Repair Modules

During major events or holidays such as the National Two Sessions or Spring Festival, delayed broadcasts are common. In such scenarios, broadcast duty personnel typically perform manual switching based on provincial station information prompts. However, these prompts only provide approximate delay times with significant margins of error, never precise to the second level, let alone mil-

lisecond level. Consequently, automatic broadcast schedules cannot be preset for automatic switching, leaving broadcast control personnel in a state of high tension. Manual switching that occurs too early results in incomplete visuals, while delayed switching produces extraneous content—both failing to achieve desired broadcast effects. Manual switching struggles to achieve second-level, much less millisecond-level, precision, troubling broadcast control personnel at municipal and county-level stations. Integrating these delay scenarios into the intelligent review system by creating a new review time module would enable automatic delay detection and automatic switching through intelligent technical means, representing significant importance for broadcast security.

Feasibility analysis of automatic detection and intelligent review-based automatic switching: For example, a program’s “closing remarks” are fixed—the closing audio is constant, and the announcer remains relatively consistent over a given period. The closing visual is also fixed, representing a combination of facial recognition and planar graphic elements. During automatic visual detection, the system must recognize both the announcer’s face and the uniformity of planar graphic elements. When both audio and visual elements are fixed, the intelligent review system can perform intelligent detection and take corresponding actions. The “closing remarks” audio serves as the primary condition for program conclusion, supplemented by the closing visual for unified audio-visual comparison as a secondary condition. Through intelligent judgment of these two conditions, the system issues switching commands to the switcher, enabling millisecond-level action for lossless, intelligent switching [2].

The modular design of Tianhong’s intelligent review system allows deployment on the main network backbone or branch lines, either before broadcast servers or after upload workstations, at any node within the station network. It can integrate into larger systems or operate as an independent review subsystem, providing robust broadcast security support for the entire station network. This approach extends security measures across the entire station comprehensively, rapidly, accurately, and user-friendly, eliminating broadcast hazards before transmission. With advances in computer software and hardware technology, high-speed codec development, and practical intelligent applications, a new revolution in broadcast technology will inevitably emerge. Tianhong’s intelligent review system, with its pioneering vision and distinctive technical characteristics, will stand out in the new generation of broadcast systems.

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

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