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Postprint of Cloud-Based Advertising Playlist Assembly and Broadcast Delivery System Design

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Abstract

Based on the cloud platform architecture of Zhejiang Radio and Television Group, this paper explores the design scheme of the advertisement insertion and broadcasting system from aspects including overall architecture, business processes, network architecture, and system functions, constructs a modernized advertisement insertion and broadcasting system, and achieves networked and file-based advertisement insertion and broadcasting for the advertising departments of seven television channels of Zhejiang Radio and Television Group.

Full Text

Preamble

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Design of an Advertising Compilation and Broadcasting System Based on Cloud Platform Architecture

Abstract: This paper examines the design of an advertising compilation and broadcasting system from the perspectives of overall architecture, business processes, network architecture, and system functionality, built upon the cloud platform infrastructure of Zhejiang Media Group. The system modernizes advertising operations across seven television channels, enabling network-based, file-based compilation and broadcasting of advertisements.

Keywords: advertising compilation and broadcasting; cloud platform; multi-tenant; VPC

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1. Background

As cloud computing technology matures, major media conglomerates have embraced it as a strategic tool for transforming the competitive landscape of the information industry. In this context, Zhejiang Radio and Television Group has embarked on a comprehensive cloud platform initiative, establishing a foundation of compute, storage, database, and networking resources to enable true cloud-based acquisition, storage, production, and distribution. This effort supports the gradual formation of a collaborative, integrated, and open all-media virtual news center and converged media content production system.

Through multi-tenant architecture and VPC (Virtual Private Cloud) technology, system resources can be allocated with greater flexibility—adding or removing foundational IT resources according to tenant requirements while ensuring efficient operation of applications and services. The advertising compilation and broadcasting system exemplifies the multi-tenant characteristics of the cloud platform, allowing each channel's advertising department to apply for cloud resources and services based on actual needs to build channel-specific advertising compilation and broadcasting systems. This approach maximizes resource utilization while satisfying business independence requirements through tenant isolation.

In 2014, Zhejiang Radio and Television Group completed a station-wide interconnectivity transformation, implementing standardized file-based production and broadcasting across the entire network. However, advertising operations remained relatively independent across channels, often built separately by each channel using standalone production or shared storage methods integrated with advertising management systems. For both in-program and channel broadcasting, content delivery relied on physical media downloads (P2, Blu-ray, tape, etc.). Each channel's advertising compilation system operated independently with varying degrees of equipment aging, yet the production process remained simple, primarily consuming non-linear editing and storage resources. The cloud platform construction presented an opportunity to integrate the group's advertising management and compilation systems. Moreover, given the dispersed office locations of advertising and compilation staff—some operating outside the main station—deploying physical professional workstations would create management challenges and require dedicated switching infrastructure. Therefore, unified integration under the cloud platform's multi-tenant and VPC framework was essential to meet file-based broadcasting requirements.

2.2 System Overall Construction Objectives

Leveraging the International Film and Television Center's cloud platform, this system aims to build a unified group-wide advertising compilation and broadcasting system to serve the advertising production and broadcasting operations of all channels. The specific objectives include:

- Relying on the unified hardware resource platform of the International Film and Television Center cloud platform to achieve centralized management and allocation of foundational resources and upper-layer applications for the advertising compilation and broadcasting system.
- Utilizing the cloud platform's "multi-tenant" feature to maintain relative independence for each channel's advertising operations while enabling unified resource management and allocation.
- Resolving interoperability between channel advertising compilation/broadcasting operations and the group's existing main platform to achieve network-based, file-based broadcasting.
- Providing practical application functions tailored to each channel's advertising business characteristics, including advertising compilation, version verification, and other essential features.

3.1 System Overall Topology

The advertising compilation system requires several functional modules: advertising upload, editing, review, channel promotion packaging, and broadcasting. Existing workstations in each channel can be repurposed as physical upload workstations, with packaging modules integrated as needed. For both in-program and channel broadcasting, the current practice involves downloading to physical media.

The overall system topology is illustrated below:

[Figure 1: see original paper] System Topology Diagram

The advertising compilation and broadcasting system is built on the cloud platform, with each channel's advertising department constructing advertising compilation VPCs through multi-tenant services based on actual requirements. This approach maximizes resource utilization while enabling a scalable, elastic architecture through VPC isolation.

3.2 Business Process Design

The advertising compilation workflow begins by extracting advertising business schedules from the advertising management system, which can be associated with program codes for individual time slots. The advertising compilation system automatically converts the schedule transmitted from the advertising management system. If uncollected materials exist, advertising material collection and organization must be completed first. The system then generates a compi-

lation timeline and inserts channel promotional videos as required by the time slot. The timeline can either be downloaded to media for broadcasting or processed by backend rendering services that split and synthesize content into single advertising programs for batch review. Upon approval, file-based broadcasting is automatically initiated.

Material import follows two pathways: channel upload and advertiser upload. Uploaded materials undergo transcoding and technical review, with non-compliant formats and quality issues flagged for early remediation.

This solution accommodates both expedited editing for advertising time slots and automated schedule generation from the advertising management system. The design automatically generates time slot schedules and matches them with materials in the advertising asset library. Uncollected materials require upload, after which they are sent to backend rendering services for time slot packaging. The resulting review segments undergo approval, after which file-based broadcasting to the main trunk and delivery to the production network are automatically completed.

3.3 Storage Design

Based on requirements for 11 channels, with each channel producing 5,000 finished advertising clips at a maximum duration of 60 seconds and 50 Mbps bitrate, total storage capacity is calculated as follows:

$$11 \text{ (channels)} \times 5,000 \text{ clips} \times 60 \text{ seconds} \times 50 \text{ Mbps/second} \div 8 \text{ bits} \div 1,000 \div 1,000 = 21 \text{ TB}$$

Considering redundancy for temporary uploads, finished time slots, and system safety, the effective capacity required is approximately 27 TB. Based on the table estimates, a total of 8.2 Gbps effective bandwidth is needed.

3.4 Network Architecture Design

As shown in the network architecture diagram, the advertising compilation and broadcasting system is deployed in the production domain of the International Film and Television Center cloud platform. It achieves network interoperability with business-related systems through the film and television center's core switches, including:

- Connectivity to the high-security internet boundary zone of the International Film and Television Center, establishing data pathways between WEB servers and streaming media servers deployed in this zone and other services within the system.
- Connectivity to the station-wide network core switches, thereby establishing data pathways with the main platform to enable advertising delivery for broadcasting and production through the trunk network.

[Figure 3: see original paper] Network Architecture

3.5 System Security Design

The advertising compilation and broadcasting system is deployed within the International Film and Television Center cloud platform. It interacts externally with advertisers and advertising business terminals via the internet and internally with the office network and station-wide main platform, spanning multiple security zones. Network security for the system is addressed uniformly by the cloud platform.

4.1 Upload/Download Workstation

The system supports common high-definition formats: MPEG2-I (422/420) 100M, MPEG2-IBP GOP, AVC-Intra (50/100M), XDCAM HD, IBP (15/25/35/50), DNxHD, and DVCPRO HD.

An upload portal is provided on the internet, allowing advertisers to log in and directly upload advertising materials to the advertising compilation and broadcasting system. After upload, files are automatically synchronized to cloud storage and processed through the ingest interface.

4.2.1 Advertising Editing Function

This module completes advertising material editing by accessing the packaging template library through packaging system plugins. It offers robust capabilities for program editing, effect adjustment, audio processing, and subtitle overlay, along with comprehensive advertising material management.

4.2.2 Advertising Compilation Process Function

The advertising compilation process primarily handles advertising entry editing and production, program code acquisition and binding, and issuance of packaging and migration commands. The system interfaces with the group's existing advertising management system to obtain advertising schedules containing program code information, extracts the program code details, and binds corresponding codes to finished time slot programs during the review process. The program editing module leverages professional cloud desktop services provided by the cloud platform, integrating the advertising compilation and broadcasting system with various non-linear editing tools available through these services to complete advertising compilation tasks.

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

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