Postprint: Cloud Architecture Program Production Management System Design

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Abstract

The Program Production Management System is an integrated business management system centered on program production, managing the full lifecycle of programs. The system employs a cloud computing architecture, addressing management needs through three service models: IaaS, PaaS, and SaaS, thereby enhancing efficiency in information sharing, resource allocation, collaborative work, process monitoring, and other aspects.

Full Text

Preamble

Title: Design of a Cloud-Architecture-Based Program Production Management System
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Abstract: The program production management system is a comprehensive business management platform centered on program production, managing the entire lifecycle of programs. By adopting a cloud computing architecture and leveraging three service models—IaaS, PaaS, and SaaS—the system addresses management requirements and enhances efficiency in information sharing, resource allocation, collaborative work, and process monitoring.

Keywords: program production; full-process management; cloud computing architecture; IaaS; PaaS; SaaS

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The program production management system is a comprehensive business management platform centered on program production, covering the entire lifecycle from planning and pre-production preparation to production, broadcast preparation, and post-broadcast management. It enables full-process management and monitoring of program production, establishing a complete lifecycle management chain from initial planning through production, storage, and broadcasting. The system' s primary requirement is program management, focusing on tracking the status, time consumption, and relevant information at each node in a program' s lifecycle from creation to broadcast archiving, thereby providing a foundation for future program improvement.

1.1 Cloud Architecture Design

Cloud computing encompasses more than just software; it requires comprehensive consideration of data center space layout, power supply adequacy, cooling systems, and other factors. The program production management system plans to adopt a hyper-converged private cloud architecture to maximize resource utilization by deploying computing and storage within a single node. The core of cloud computing lies in managing compute, storage, and network resources to provide on-demand services to users. As users, they can directly utilize IaaS services or build their own PaaS services on top of IaaS to deploy applications and achieve elastic scaling.

The IaaS layer provides foundational services such as compute, storage, and networking for the program production management system through the open-source software OpenStack. IaaS abstracts hardware equipment, data, and computing resources into services, with key technologies including server virtualization, distributed storage, distributed routing, and energy consumption management. The low-cost, high-elasticity characteristics of IaaS align with and satisfy the broadcasting industry' s future development requirements toward converged media.

The PaaS layer is a platform service layer capable of elastic scheduling based on the IaaS layer, providing orchestration services for different business applications. Various production tasks within the program production management system can directly utilize PaaS platform services to efficiently complete related work, such as transcoding and video editing, thereby offering a computing and solution service platform. The PaaS layer also provides various back-end middleware components and capability support, including unified user management, workflow management, and foundational technology components.

SaaS is the most common cloud computing model, allowing applications to be obtained as "Software-as-a-Service" according to specific business requirements. SaaS key technologies can be summarized as multi-tenancy technology, scala-

bility technology, and customization technology, providing application services for the entire system.

[Figure 1: see original paper] Cloud Architecture Design Diagram

1.2 System Infrastructure Resource Design

System infrastructure resources primarily include server compute resources, distributed storage resources, distributed network resources, and various terminal resources for users. Compute resources are provided through deployed virtualization servers that supply necessary computing capabilities for various functional services, with enhanced processing power allocated to high-traffic applications to improve their computational performance. As database servers form the core of the system with relatively large instantaneous read/write volumes, they also require higher performance configurations.

Storage resources are designed to accommodate both high-concurrency applications on the virtualization platform and a small number of media storage applications. IP-based online media storage is configured to provide online storage for all virtualized server operating systems and application systems through FC channels.

Distributed network resources solve single-point-of-failure problems through distributed architecture, achieving reliable, secure, and cost-optimized transmission networks. With the popularization of 25GE network switching technology, the network can now meet the high-throughput, low-latency requirements of video services. Full IP-based switching networks are now well-adapted to the production needs of broadcasting and television news operations.

The SaaS layer faces specific business operations, with its hardware resources, services, and foundational application tools uniformly provided by the PaaS layer. Terminal resources mainly include program production management workstations, data import workstations, technical resource management workstations, content retrieval workstations, and system management workstations. For program production management tasks only, thin clients can be deployed subsequently; for business needs involving content query and retrieval, program review, and technical resource management, independent workstations can be configured.

1.3 Back-end Service Design

System back-end services primarily include unified user management and workflow approval and management. The unified login management service provides unified user management for various application systems, including unified user information management and authentication. The workflow management service mainly implements system workflow management, workflow status monitoring, and workflow service orchestration.

1.4 System Application Design

The system provides a unified portal login system that supports customizable personal portals after login according to different user permissions, offering quick access to software functions. When users log in and access other applications from the application portal, they need not re-enter usernames and passwords; they can simply click the application icon, and the new application will completely inherit user information and obtain corresponding internal application authorization. The login page can display announcements, ratings rankings, and other content. After logging into the system, users see different personalized homepages based on their role permissions and can customize homepage portal modules and content according to personal habits and preferences.

The program production process encompasses different stages including program planning, production preparation, production, broadcast preparation, and post-broadcast management. System applications include production management, unified information publishing, task management, personnel management, technical resource management, and administrative office services. During the program planning stage, program codes are generated, columns submit topic proposals, broadcast plans and shooting plans are formulated after topic discussion. During the shooting process, various resources are requested through the program production management system, including shooting equipment, studio reservations, and non-linear editing room bookings.

After the finished program is produced and approved, it is sent for broadcast, while simultaneously being archived into the media asset system. Production management services include topic management, new program management, broadcast plan management, shooting plan and budget management, program broadcast management, program change management, ratings statistics, content review management, error statistics, and awards management. Unified information publishing services include public notification management, public opinion statistics, and ratings statistics. Program sharing services include unified task scheduling management and program sharing queries. Personnel management services mainly complete account permission management for columns and personnel, enabling comprehensive management of personnel at different permission levels according to user groups. Technical resource management services mainly implement functions such as non-linear editing room usage, studio usage, equipment application, fixed asset management, and column financial statistics.

Furthermore, the program production management system must interface with internal business systems such as studio systems, production systems, broadcast systems, and media asset systems to enable data transmission and interaction, implementing functions such as business process display, unified content retrieval, and task submission.

1.5.1 Production Management Platform

[Figure 2: see original paper] Program Production Management System

Each program is assigned a unique "Program ID," or program code, which serves as the program' s sole identifier. Approved program topics automatically generate program codes in the system. Only after obtaining a program code can a new program production task be created. The program management interface allows filtering and retrieval based on program code, column name, topic name, topic code, creation date, creator, and other information. Approved program topics are used to formulate broadcast plans based on program broadcast time, duration, broadcast column, and other details. The broadcast plan management interface displays all approved programs and generates broadcast schedules, allowing retrieval of required program broadcast plans by column name, title, broadcast date, status, and other criteria. Relevant departments can formulate weekly program broadcast plans based on program resource availability, then generate more detailed daily program lists from the weekly schedule to form broadcast program rundowns, which are transmitted to the broadcast system through data exchange for execution. Column directors formulate shooting plans, including required shooting personnel, shooting priorities, shooting instructions, etc., while evaluating budgets based on planned shooting content, time, and location, including equipment costs, catering, transportation, and other necessary shooting expenses. After the shooting plan and budget application are submitted and approved, program shooting can commence. Upon completion and approval, the finished program file enters the broadcast preparation stage driven by workflow, while a copy is simultaneously migrated to the media asset system for archiving. All these processes can be queried within the program production management system. When program broadcast plans change, program change applications must be submitted detailing change content and reasons for review.

The program production management system enables unified scheduling management of program production tasks, which are created in two primary ways: regular program topics reported by column directors, and major program topics discussed in meetings by authorized departments that directly allocate tasks and resources. For major topics, top-level design is conducted based on publicity priorities and overall program planning, determining key publicity content and refining task assignments for key topics, major typical reports, emergencies, special programs, and regular programs, completing processes including topic approval, personnel dispatch, equipment resource allocation, program scheduling, and full-process production monitoring.

Additionally, the production management platform includes functions such as copyright management, error statistics, program awards management, and program acquisition management.

Program production begins with column directors planning topic content, including filling in basic information such as content summary, planned broadcast time, topic source, and personnel before submitting the topic. To enable flexible, real-time management and monitoring of programs within the network architecture, each program is assigned a unique "Program ID."

Copyright management is widely applicable to broadcasting, television, cultural education, digital publishing, and other industries, supporting copyright information management for digital objects throughout the entire business process from production to management and distribution. The copyright system records and manages copyright description information for digital resources, providing a basis for authorized participants to rationally utilize and manage copyrighted works, and offering foundational information support for copyright-related systems such as digital watermarking and licensing. Functions include: copyright information management for all-media digital objects, including video, audio, images, and text; comprehensive copyright metadata recording, including five major metadata sets covering contracts, transfer rights, authorized participants, original records, and digital resource content; support for contract trading and billing management for digital resource usage; and support for networked publishing of associations among contracts, transfer rights, authorized participants, digital resources, and original records.

Errors occurring during program production, such as those in scripts, dubbing, and subtitles, are compiled in the error statistics module, serving both as performance evaluation criteria and as reminders to prevent similar mistakes.

Outstanding programs can be submitted for awards, and information about awarded content is managed. Award submissions include textual introductions and descriptions, while awarded programs have their winning details recorded, facilitating queries by award category, time, and content.

Occasionally, excellent programs are imported, and the system manages import applications and copyright records. The program acquisition module allows submission of import applications with details such as program content, source, price, intended broadcast time slot or column, and reasons for import. Approved applications are reviewed, and copyright information for imported programs is recorded, including copyright start date, expiration date, and regional rights.

1.5.2 Personnel Management Platform

User permissions adopt a hierarchical management model. System administrators possess the highest level of system access and can set corresponding operational permissions for different users. Administrators can adjust column personnel permissions, roles, and available tool types at any time, while column personnel can request permission modifications from administrators based on changing business needs. Through this approach, administrators can centrally manage all column-related personnel.

1.5.3 Technical Resource Management Platform

Non-linear editing workstations employ a reservation-based usage model, where users book idle workstations based on director scheduling, column production timelines, and broadcast schedules to ensure high utilization efficiency. The

system provides emergency reservation methods for unexpected situations to guarantee workstation availability. Before reserving a workstation, users must fill in usage time (start and end times), number of workstations and specific workstation IDs, and content to be edited. Based on a secure software control mechanism that locks non-linear editing workstations, the system achieves software-controlled editing line usage without affecting normal NLE system operation. The reservation system supports data query, statistics, printing, and real-time status monitoring.

Studio usage also adopts a reservation model, with system notifications to relevant departments after successful booking to improve work efficiency. Studio reservations are initiated by column personnel, requiring completion of studio usage time (start and end times), number of camera positions needed, lighting requirements, brief studio purpose description, and number of related personnel.

When column directors require special effects packaging for programs, they fill in broadcast time, relevant column information, and special effects requirements, then assign tasks to the effects packaging department through the platform. When effects personnel are scarce, the department can real-time inform column directors about availability, accepting and completing tasks when personnel become available.

Equipment and materials are managed by a unified department through the equipment management module, which handles application, return, extension, and scrapping. The equipment department primarily manages discrete equipment such as cameras and computer hardware. When equipment is needed, users must submit applications with relevant details, which are reviewed by equipment managers before approval. Scientific equipment management covers the entire equipment lifecycle. Users can authenticate their identity through network clients or on-site verification, complete equipment application and reservation forms, and submit them for approval. After approval, users collect reserved equipment and accessories from managers, who verify identity based on approval results and authentication information. Upon equipment return, managers inspect for damage and register any issues for repair. During check-out and return, managers scan equipment barcodes, and the system records applicant name, borrowing time, return time, calculates usage fees based on duration and rates, and tracks equipment status for backend server queries, statistics, billing, timing, reservations, and lending/returning operations.

The fixed asset management module accommodates diverse management modes for different asset types, providing tailored management for television station fixed assets, low-value consumables (such as office supplies, tools, cosmetics), costumes, lighting, and props with different characteristics. This module enables comprehensive fixed asset management including equipment warehousing, outbound, return, transfer, allocation, borrowing, inventory, maintenance, and scrapping, providing warehouse receipts, acceptance transfer forms, application forms, asset management cards, and various query and statistical reports to meet physical asset management requirements. To manage and inventory fixed

assets, the system records a unique asset code for each asset and tracks its location to facilitate search and counting.

1.5.4 Unified Information Publishing Platform

The unified information publishing platform includes announcements, ratings statistics, and public opinion statistics. Notifications and announcements can be published through this module. The system receives feedback ratings information and automatically matches it with each program column, generating intuitive charts displaying program names, broadcast times, ratings, and whether ratings have improved. Public opinion statistics primarily show audience attention levels for specific topics and content reporting directions to guide public opinion orientation.

A cloud computing architecture-based information management system designed according to program production standards can achieve full lifecycle program management, moving offline processes such as program planning, production, content review, scheduling, broadcast preparation, and post-broadcast management online, thereby improving efficiency in information sharing, resource allocation, collaborative work, and process monitoring.

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