The Research of Building the Private Cloud Based Collaborative Management System

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Abstract. In order to solve the problems such as difficulty in implementing design standards, lack of efficient collaborative system, and lack of effective control over printing and digital signatures.We built a private cloud-based design collaboration management platform. It combines the actual needs of designers and integrates design standards, process management and project management. It achieves multi-disciplinary cooperative design, promotes standardization of drawings, digitalizes process information, and enables real-time synchronization and data sharing, thus further improves design quality and management level.

Keywords: Collaborative management; Material delivery management; Proofreading management.

1 Introduction

Cooperative design is not only an important part of technical updates in the current design industry, but also an inevitable trend in design technology. Through cooperative design, a unified design standard is developed that includes layers, colors, line types, printing styles, etc[1]. On this basis, designers from different disciplines can use a unified design platform to minimize errors caused by inadequate communication between disciplines and improve design efficiency and quality. Therefore, it is necessary for us to build a collaborative design platform to improve work efficiency and further realize the informatization of design management.

2 The current situation of collaborative management system

The concept of collaboration began in the 1980s and developed rapidly in foreign countries. So far, there have been several mature commercial software[2]. ZBLIN and STRAGAB, a well-known European contractor, have joined forces to promote iTWO platform, which is a platform for the whole construction process. With the technical support of 3DEXPERIENCE platform from Dassault Systemes, CATIA is able to realize the online cooperative design. WebScope, a software development company, has launched web-based tools to support CAD cooperative design[3]. On the whole, text-based collaboration has been well developed and implemented, and has obtained good economic benefit. However, the implementation of graphic-based collaboration requires further development.

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In China, the information construction of investigation and design industry started early. Nowadays, various software systems have been widely used, and the theory of cooperative design has been deeply explored[4]. So far, numerous developers, such as Shenzhen Sifang Zhiyuan, Beijing Lizheng Software, Beijing Yuanxinke, Weiheng Haojian, have already created cooperative design platforms[5]. However, due to their neglect of the actual situation of design institutes, many cooperative design software is limited by modes and resisted by designers, and thus fail to be promoted[6]. As a result, the implementation of cooperative design software has lagged behind.

3 The current situation of collaborative management system

3.1 Functional requirements analysis

3.1.1 Project management

Project management includes project establishment, project planning, document management, etc. Participants are assigned different permissions according to their roles to perform different operations. For example, the design director needs the function of project establishment, project planning, staffing, node planning, data sharing, progress monitoring, etc[7]. Meanwhile, the designer needs the function of project switching, project viewing, data searching, etc.

3.1.2 Material delivery management

Material delivery management includes process management, document management and records management. This function facilitates access to all versions of provided materials and related records, allowing for verification, locking, and comparisons of accepted file versions.

3.1.3 Proofreading management

Proofreading management should involve proofreading standard management, proofreading process management and comment management. Through the collaborative management system, online review can be achieved, the entire process can be automated, and the comments can be automatically collected and summarized in the checklist[8].

3.1.4 Result management

Result management needs to include catalog management, filing management, change management. These functions facilitate online file checking, reviewing, and sharing. The system should have the capability of extracting information from drawings, generating the catalog automatically and archiving documents based on different versions.

3.2 Non-functional requirements analysis

3.2.1 Friendly interface

In order to make the system easy to operate, the interface needs to maintain a uniform appearance, with the elements positioned reasonably and clearly defined primary and secondary.

3.2.2 Scalability requirements

The relevant software should be able to adapt to the various structural changes of the institute and meet the requirements in terms of data availability and other aspects[9].

3.2.3 Technical requirement

The system adopts a microservice architecture and SaaS-based deployment. It supports offsite collaboration and teleworking. The transfer of underlying files should adopt P2P file distribution network to reduce the pressure of bandwidth and traffic on the server side.

4 Design and implementation of collaborative management system

4.1 Architecture Design

4.1.1 The enterprise's private cloud platform is built through cloud computing technology

IT resources, such as servers, storage, networks, graphics cards, are gathered into the private cloud resource pool, depending on the usage demand. The GPU passthrough solution with hyper-converged architecture allocates and schedules resources as needed, thereby increasing the utilization and flexibility of hardware resources. Deploying the collaboration management system, along with AutoCAD and other professional software to the server can achieve real-time offsite collaboration while ensuring data security. The architecture of the private cloud platform is shown in Fig 1.

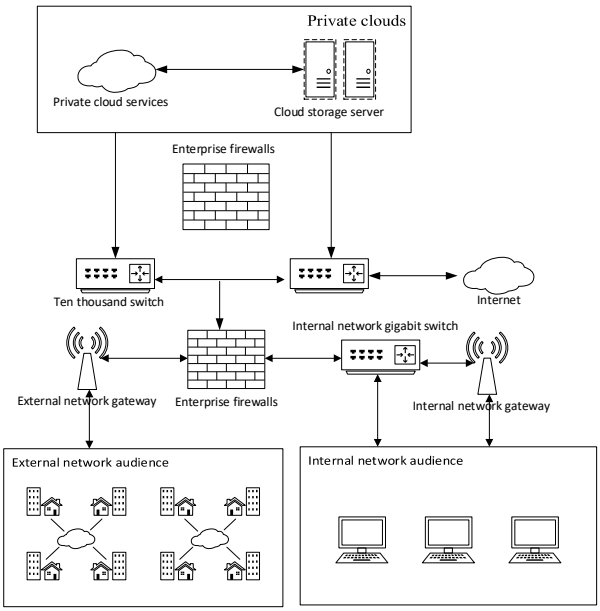

Fig. 1. The architecture of the private cloud platform.

4.1.2. Technical architecture design

Collaborative management system adopts an architecture which separates front-end and back-end. The front end is the operation layer. The service layer in the middle deploys the application services as the system needs. The storage layer consists of the back-end data server and the storage server. The support layer is used for data storage. The technical architecture is shown specifically in Fig 2.

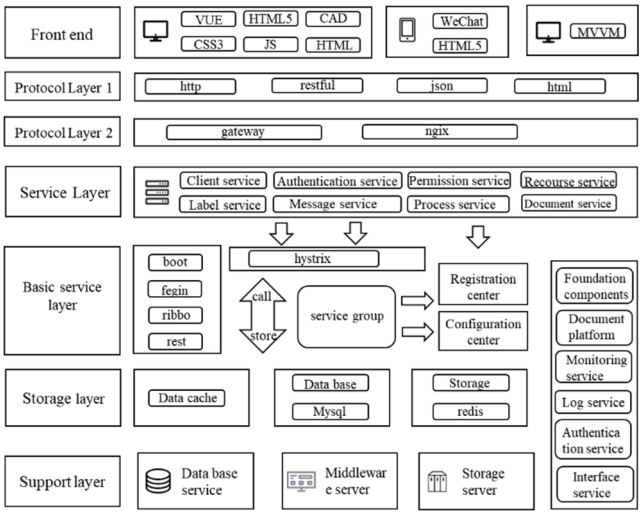

Fig 2. The technical architecture.

4.1.3. Functional architecture design

The functions of collaborative management system are created based on the requirements of cooperative design. The system mainly includes project management, material delivery management, proofreading management and result management. The system architecture is shown in Fig 3.

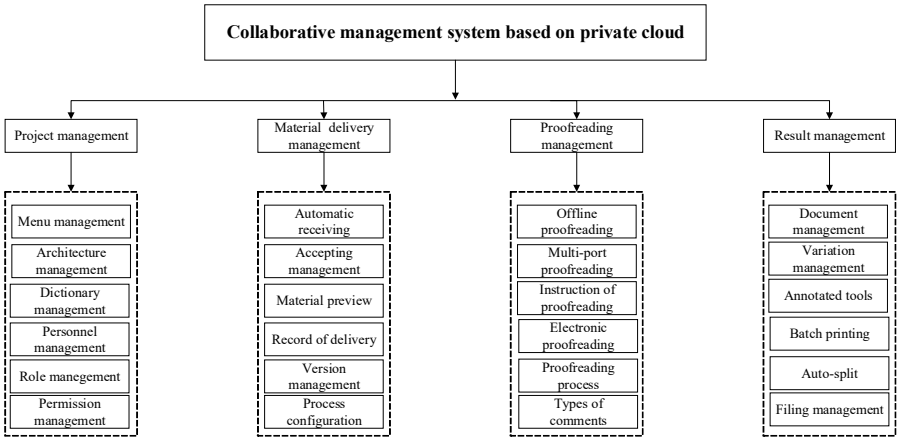

Fig 3. The system architecture.

4.2 Functional design

4.2.1 Project management

Project management includes project establishment, sub-project planning, personnel planning, node planning, schedule planning, and result management planning. The system can customize the built-in design standards. It achieves real-time view and invocation of the standards through matching the function names with design standards at the back end. Participants with different roles can view and operate different tree nodes. The design director can view all nodes, but cannot add any new files. The discipline leaders can view all the drawings of their discipline while the designers are allowed to view, add, delete or modify documents.

4.2.2 Material delivery management

In order to complete the material delivery process, designers must initiate it in the material delivery interface first. Then the file is proofread by the proofreader, audited by the auditor and ultimately, approved by the chief engineer before being accepted by assigned discipline. For non-critical content, the process can be simplified. Only the proofreader needs to review the files before they are accepted. After the documents are formally submitted, the submission record will be generated automatically. The accepted file will be automatically matched with the related design file based on the customized name and compared across versions. The flow chart of material delivery management is shown in Fig 4.

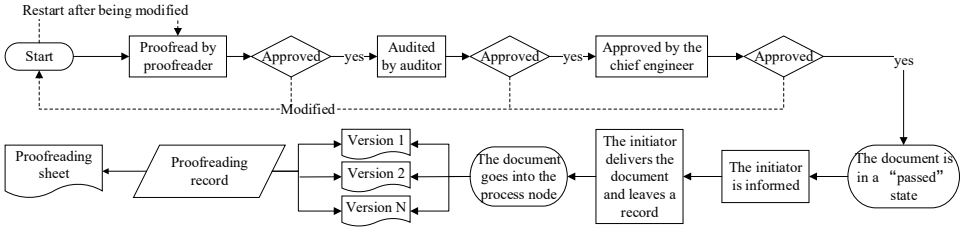

Fig 4. Flow chart of material delivery management.

4.2.3. Proofreading management

Proofreading of drawings is required at key points of the project. The designer begins the proofreading process with copies of selected drawing. These copies will not subject to changes while the original drawings may still undergo changes in the working area. Once the proofreader or other assigned person opens the task in the proofreading interface, the system downloads the drawings and locks the original layers to make them uneditable. The proofreader annotates the drawing errors with cloud lines and text. After the proofreading is completed, the process task is sent to the designer. The comments on the drawings can be viewed by the designer in the workspace, allowing them to modify their design based on the feedback. The specific proofreading process is shown in Fig 5.

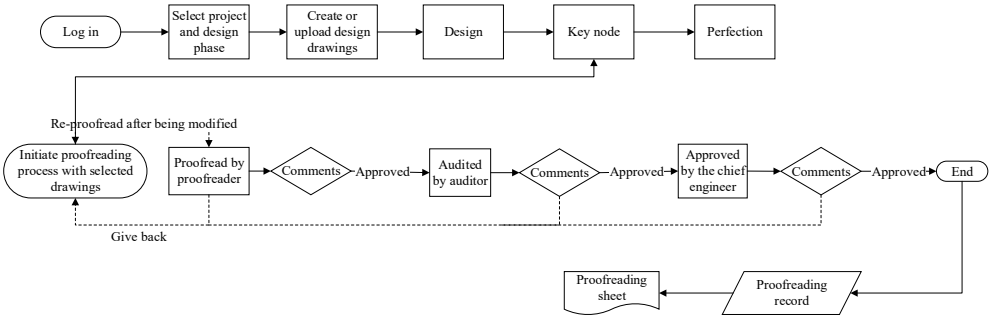

Fig 5. Flow chart of proofreading management.

4.2.4 Result management

The project's results can be collected, summarized, organized and reused automatically by the result management system. Drawings can only be printed officially after proofreading. They will be automatically matched with the appropriate frame size and scale, split, and printed according to the built-in standards and automatically filed thereafter. All archived versions can be queried and traced. The flow chart of result management is shown in Fig 6.

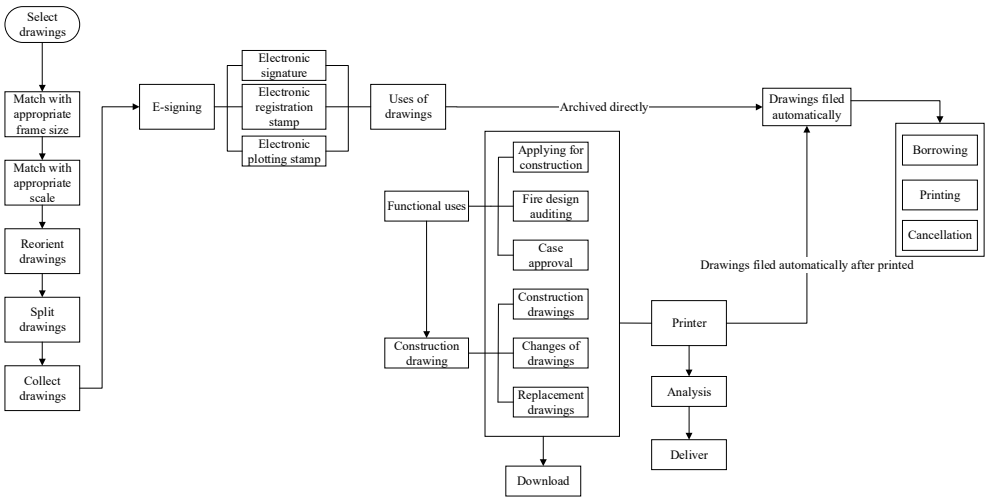

Fig 6. Flow chart of result management.

4.3 Database design

The collaborative management system uses the Mysql database to provide relevant data services. The database design follows the requirement description and functional design of the collaborative management system, and adheres to relevant specifications of database design. The database of the collaborative management system carries out data synchronization and data exchange through the interface project to ensure the real-time synchronization of data. The database structure table is shown in Tables 1 and 2.

Table 1. The database structure table of material delivery.

Steps	Name	Content	Type
1	Mem_ID	The ID of the provider	NOT Null Unique
2	Pack_ID	The ID of the file	int
3	Pack_name	The name of the file	varchar
4	Pro_NO	The ID of the project	NOT Null Unique
5	Subpro_ID	The ID of the sub-project	int
6	Class_ID	The ID of the discipline	int
7	Toclass_ID	The ID of the discipline that will accept the file	int
8	Remember	Memo	varchar
9	Tocreate_date	The creation time of the file after being delivered	datetime
10	Toversion	The version of the file	varchar
11	Tover_date	The update time of the file	datetime

Table 2. The database structure table of proofreading.

Steps	Name	Content	Type
1	Mem_ID	The ID of the provider	NOT Null Unique
2	Pack_ID	The ID of the file	int
3	Pack_name	The name of the file	varchar
4	Pro_NO	The ID of the project	NOT Null Unique
5	Subpro_ID	The ID of the sub-project	int
6	Class_ID	The ID of the discipline	int
7	CorrectorID	The ID of the proofreader	int
8	AssessorID	The ID of the auditor	int
9	ValidatorID	The ID of the chief engineer	int
10	Create_date	The creation time of the file which needs to be proofread	datetime
11	Correct_state	The condition of the file which needs to be proofread	int
12	Assess_state	The condition of the file which needs to be audited	int
13	Validat_state	The condition of the file which needs to be approved	int
14	AuditCount	Number of reviews of current file	int
15	Verdate	The update time of the file which needs to be proofread	datetime
16	Toversion	The version of the file which needs to be proofread	varchar

5 Conclusion

Aiming at the actual needs of collaborative design and design management, this paper presents a collaborative management platform of design based on private cloud. According to the key points of integrated design and the requirements of digital design management, the platform develops functional modules such as project management, material delivery management, proofreading management, and results management.This enables real-time synchronization

and sharing of design data and information, as well as refinement management throughout the project lifecycle. The platform provides replicable experience for the research of industry collaborative design. Since it was officially put in operation, the platform has run well. By implementing cooperative design through the platform, designers not only improve the efficiency of the multi-disciplinary design, but also significantly improve the quality of design at the same time.

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