Design of Integrated Management System for Electronic Library Based on SaaS and Web Standard

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ABSTRACT

Management systems for electronic library have been developed on the basis of Client/Server or ASP framework in domestic market for a long time. Therefore, both service provider and user suffer from their high cost and effort in management, maintenance, and repairing of software as well as hardware. Recently in addition, mobile devices like smartphone and tablet PC are frequently used as terminal devices to access computers through the Internet or other networks, sophisticatedly customized or personalized interface for n-screen service became more important issue these days. In this paper, we propose a new scheme of integrated management system for electronic library based on SaaS and Web Standard. We design and implement the proposed scheme applying Electronic Cabinet Guidelines for Web Standard and Universal Code System. Hosted application management style and software on demand style service models based on SaaS are basically applied to develop the management system. Moreover, a newly improved concept of duplication check algorithm in a hierarchical evaluation process is presented and a personalized interface based on web standard is applied to implement the system. Algorithms of duplication check for journal, volume/number, and paper are hierarchically presented with their logic flows. Total framework of our development obeys the standard feature of Electronic Cabinet Guidelines offered by Korea government so that we can accomplish standard of application software, quality improvement of total software, and reusability extension. Scope of our development includes core services of library automation system such as acquisition, list-up, loan-and-return, and their related services. We focus on interoperation compatibility between elementary sub-systems throughout complex network and structural features. Reanalyzing and standardizing each part of the system under the concept on the cloud of service, we construct an integrated development environment for generating, test, operation, and maintenance. Finally, performance analyses are performed about resource usability of server, memory amount used, and response time of server etc. As a result of measurements fulfilled over 5 times at different test points and using different data, the average response time is about 62.9 seconds for 100 clients, which takes about 0.629 seconds per client on the average. We can expect this result makes it possible to operate the system in real-time level proof. Resource usability and memory occupation are also good and moderate comparing to the conventional systems. As total verification tests, we present a simple proof to obey Electronic Cabinet Guidelines and a record of TTA authentication test for topics about SaaS maturity, performance, and application program features.

Key words *: Integrated Management System, Electronic Library, SaaS, Web Standard, Universal Code System, Electronic Cabinet.*

1. INTRODUCTION

In recent, there has been a dramatic variation in hardware, operating system, application and service as well as Internet environment because of cloud computing technology and its rapid spreading. At the same time, researches about electronic library are actively performing by effective managements of the library information using these computing and WWW (World Wide Web) technologies. Trends of software market are cloud computing, SaaS(software as a service), utility computing, SOA(service oriented architecture), web2.0, and RIA(rich Internet application) etc. Common intersection part of these trends is 'the Service' which has already been a main motivation of growth in software area [1]. SaaS is a kind of distribution model of software which makes it possible for users to utilize needed software as an online service through the Internet. This is an excellent supply technology of application software for multi-user as a whole [2], [3]. On the users' point of view, we can easily apply the software as a service connected through Internet and just pay the cost of usage without any burden of hardware as well as software managements.

Most of the utilizations of electronic library system software are 'Client/Server' or 'ASP(application service provider)' so that costs of HW, SW, installation, distribution, customization, upgrade, management, and/or license are relatively high and inconvenient as a whole of Software. In addition dissemination of mobile information terminals like smartphone or tablet PC is another considerable entry in the

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market of electronic library. Therefore research about user interface design is becoming more important issue as the cloud services are advancing toward 'mobilization' and 'personalization'. Without any doubt, we have to consider this total transition toward personalized user interface design for the sake of satisfying user's requirement of 'mobilization' and 'personalization' [4].

In this paper, we design and implement an integrated management system of electronic library based on SaaS observing Web standard. This transition toward SaaS scheme is relatively simple and low-cost for these IT services because almost all affairs of digital library have been standardized and modularized. Using this new SaaS scheme, we can operate and manage the library system more effectively and interactively so that the library personnel can be able to offer advanced effectiveness of official businesses and give their customers a lot more reliable information. This new electronic library system consists of a service model for 'hosted application management' and another service model for 'software on demand'. In addition, one of the most important things in the process of content-data improvement is consistency of data delivery, therefore checking for duplication of data should be an essential criterion in the evaluation of content-data quality measurement. We propose a novel algorithm for checking data-duplication which minimizes repetition of the same data records for the purpose of data quality improvement. There have been a lot of difficulties in maintenance of data quality by confirming duplication of collected data. Our algorithm improves the procedure of checking duplication in a step-by-step manner by extracting elements and processes of validation and concentrating on journal, volume/number, and paper to extract records duplicated. Moreover, we obey web standard recommended by W3C an international organization [5], [6] and construct the system based on universal code system(Unicode) so that our system can be operated on any kind of operating system or device including mobile phone and tablet-PC. Performance analyses are mainly performed on effectiveness of server including response time of server. Resource usability and memory occupation are also considered and compared to conventional systems. As total verification tests, we present a simple proof to obey Electronic Cabinet Guidelines and a record of TTA authentication test for topics about SaaS maturity, performance, and application program features.

In order to describe contributions of this paper, we first introduce related studies including characteristics and present states of electronic library, SaaS, web standards, metadata, and some problems of them in Section 2. We present the structure of proposed system and describe its design and implementation principles to give our range of development, flow of service, application of web standard, algorithm for duplication checking, and other environments and services developed in Section 3. In Section 4, we analyze performance of our system including its efficiency, obeying web standard, and expected effects. Finally in Section 5, we arrange the concluding remarks of this study and present some tips for future works.

2. RELATED WORKS

2.1 Characteristics of Electronic Library

For the purpose of developing contents of this paper, we can summarize a few special characteristics of modern electronic library system as follows;

First of all, electronic library is a virtual system. Even though conventional real library coexists with electronic virtual library system, we truly consider it as a virtual space connected through Internet which serves almost all kinds of possible library services. We can treat it as a site like a web page.

Second, electronic library is a market of information. Because all information and knowledge are collected in electronic library, we can get any kind of information needed. Therefore some people call it 'factory of information' or 'knowledge space'.

Third, there are secure connectivity and distribution of information sources and their users. Electronic library is not only an independent function of information center, but also a connected system to other organizations or libraries throughout networks so that we can search and refer to any other information possessed in remote systems.

Finally, extraction of information using electronic library is actually rapid these days and it can preserve enormous digitized information securely so that the cost of information usage can be continuously decreasing to be very cheap [7].

2.2 Domestic Present State of Electronic Library

Table 1 shows the present state of domestic market of electronic libraries comparing their platforms and markets according to their products. Figuring out their type of platform, we recognize the major part of system software of electronic library is 'Client/Server' or 'ASP(application service provider)' so that costs of their HW, SW, installation, distribution, customization, upgrade, maintenance, and/or license are relatively high and total management is inconvenient as a whole of Software. In addition dissemination of mobile information terminals like smartphone or tablet PC is another considerable entry in the market of electronic library. Therefore research about user interface design is becoming more important issue as the cloud services are advancing toward 'mobilization' and 'personalization'

Table 1. Domestic Market Share of Electronic Library

Products	Platform	Markets
KOLAS, KOLASYS, SMS	Smart Client	Public Library
iLips, R2DSpace(IR Solution) BOS, NOS, CMS	ASP/RIA	Professional Library National Library University Library
XMLAS, XMDL, TULIP	RIA	University Library National Library
Libeka, Maestro, BaroClick, SMS	C/S	School Library Professional Library University Library
SOLARS Dli, DLS, SSKS(KMS) DEXPEED(Search Engine)	C/S	University Library School Library
SLIMA-NET	C/S	University Library Public Library

2.3 SaaS (Software as a Service)

Recently SaaS can be divided into two different services. One is a service for general users, the other one is a service for business users. The former part contains a keyword like 'Web2.0', the latter part can be described by a keyword 'Enterprise2.0' on the other hand. 'Google service' is a representative SaaS for general users, 'Salesforce.com' is an example of SaaS for business users which utilizes essential business modules like CRM, ERP, and/or MES as services supplied from outside of the company [8].

Fig.1 shows the structure of web based SaaS platform and its applications. The platform consists of a huge storage for server clusters, user profiles with environment establishing data, metadata services, and application software instances for supporting multi-tenant users. Users and/or application SW services can easily be supported throughout SaaS application SW tools like 'user interface', 'work flow tool', and 'entity model' etc. Therefore SaaS scheme makes it possible to use the resource effectively by sharing the platform and solutions between a lot of users or tenants.

Technological characteristics of SaaS applications are 'multi tenancy', 'reliability', 'security', and 'easiness of environment establishment'. Although all the other features are general necessary conditions of software user environment, the most discriminant character of SaaS is that 'multi tenancy' that can be regarded as a main strong point in post level-3 SaaS.
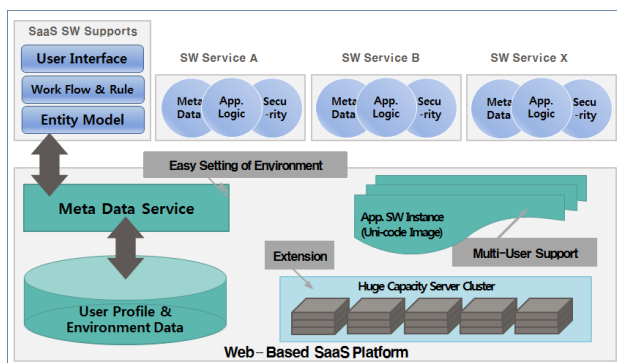

Fig. 1. Structure of Web Based SaaS Platform

2.4 Universal Code System

Universal Code System(Unicode) has been developed to overcome problems of conventional character sets in this multilingual environment. It is a good substitute for any other character set as an international standard UCS (Universal Code System) using two-byte system. Consortium of Apple Computer, IBM, and Microsoft announced the 1st version of Unicode in 1990. And ISO/IEC JTCI legislate the concept as an international standard in Sep. 1995. The official name of Unicode is ISO/IEC 10646-1 Universal Multiple-Octet Coded Character Set.

UCS consists of 4 Octets such as Group, Plane, Row, and Cell, and each octet has its value of 00~FF in Hexadecimal. The coding space of UCS consists of 128(0x00~0x7F in Hexa.) Groups, and each Group possesses 256(0x00~0xFF in Hexa.) Planes, and each Plane has 256x256 Cells. The Unicode using all 4 kinds of Octets is called UCS-4, and the Unicode using just 1 Plane including Row-Octet and Column-Octet is called

UCS-2. We use only 31-bit in 4-byte UCS-4 code system after setting the most significant bit '0' so that total number of Groups is (0x00~0x7F). UCS-2 and UCS-4 are code points as well as encoding itself [9].

2.5 Web Standard

Web standard indicates a fabrication method of web-page according to the international standard matter enacted by W3C (World Wide Web Consortium) an international standard organization [5]. Even though users operate any kind of operating system or web browser, they can see the same result of our web site under the same web standard.

When we implement web standard in our web site, we have to be sure that the structure get along 'html', 'xhtml', or 'xml', the presentation follows 'CSS', and the operation can follow 'Javascript' or 'DOM'. The structure 'html' is a kind of essential layer because any web page is impossible without it. However the presentation 'CSS' or the operation 'Javascript' is not essential. Although user deleted them on the other hand, our web page should still be shown in correct manner [6].

2.6 Consideration of Metadata

Metadata are another kind of data representing data structure which consists of structured set of elements expressing resources. Library book list is a typical example of metadata including book title, author name, publisher, and classification etc. This information is exactly the data of the book itself.

In addition, metadata can be divided into various elements representing information resources such as contents, correlation with other resources, attributes, physical formalities, and date of creation etc. that make us recognize entries of information resources [10].

Table 2 shows merits and necessities of metadata for retrieval of digital content in modern network environment [11].

Table 2. Necessities of Metadata

Standpoints	Merits & Necessities
Users	- More correct retrieval of data or fields - Boolean conditional retrieval of information - Reducing overload of information in the retrieving process
Generators	- Providing correct explanation of data - Easier management and operation of data - Providing additional information of data
Providers	- Service possibility without any estimation of the contents of data - Management of structured index of data - Reducing bandwidth of transmission and storage

We can arrange some important kinds of metadata used in the area of electronic library and their analyses as follows;

1. MARC(MAchine Readable Cataloging) is a representative metadata for bibliographical records using machine readable list [12].
2. Dublin Core has been proposed for representation of electronic resources [13].
3. RDF(Resource Description Framework) has been presented for representation of web literatures.
4. ONIX(ONline Information eXchange) is a kind of metadata for online book store.

5. MODS(Metadata Object Description Scheme) is another kind of metadata system for electronic library which can be used as a substitute of MARC or Dublin Core [14], [15].
6. CSDGM(Content Standard for Digital Geospatial Metadata) is a kind of metadata scheme designed particularly for GIS(geographical information system).
7. CDWA(Categories for the Description of Works of Art) has been proposed as a metadata scheme for art works.
8. GILS(Government Information Locator Service) has been devised specifically for description of open information of the Federal Government of US [16].

2.7 Deduced Problems of Present Library System

Recently most of electronic library systems in our country are based on C/S or Web program and their mixed environment so that we can derive the following problems from their somewhat old concept of platforms. C/S or Web program concept makes it difficult to manage software as a whole system of library. It drives high cost and takes a lot of time and effort in the processes of maintenance and repair because;

1. It has limited running environments of specific operating system and web browser in view of user interface. Therefore it cannot be adapted on smartphone or tablet PC spreading rapidly these days.
2. In the data management aspect, it is difficult to deal with metadata as a whole because of their violation of standard. Of course this is true for just a small portion of domestic systems, but the harmful effect of it is serious in view of distributed total library systems.
3. In multi lingual environment including Latin, French, German, and Japanese, there are compatibility problems and encoding-decoding hazards between systems. ASCII scheme representing English, Korean, and 4,888 Chinese letters has such a substantial problem in the process of dealing domestic and foreign data at the same time under this multi lingual environment.
4. Web standard like 'HTML5' is strongly recommended in the process of building any kind of web site. Mobile web devices like smartphone or tablet PC are rapidly increasing these days, and obeying web standard is one of the most important issues in our n-screen and cloud computing services. Without any adaptation program like RIA, it should be possible for any user to be served for any kind of multimedia content on any kind of device.

3. DESIGN AND IMPLEMENTATION OF INTEGRATED MANAGEMENT SYSTEM

3.1 Development Scope

In this section, we design and implement electronic library services based on SaaS. The scope of our development consists

of two different kinds of services like 'hosted application management model' and 'software on demand model'. We present them based on the Electronic Cabinet Guideline so that they can be possible to process multi lingual environment based on Unicode system. In addition we obey the web standard recommended by W3C so that our system can be operated on any operating system or any web browser to build a user-adaptive interface.

Implemented scheme consists of typical library services like acquisition, list-up, and loan-and-returning services considering their interconnections and standardizations. The structure of our integrated management system for the next generation electronic library based on web standard is show in Fig. 2.

As mentioned above, the system consists of SaaS platform, SaaS application generating environment, and database with its input/output mechanism. All the structures are based upon Electronic Cabinet Standard Framework, programming obeys web standard, and operating concepts are following service-oriented architecture. In addition communication with other network or website can be realized through interface layer including I/O formatter, web server, and several kinds of gateways.
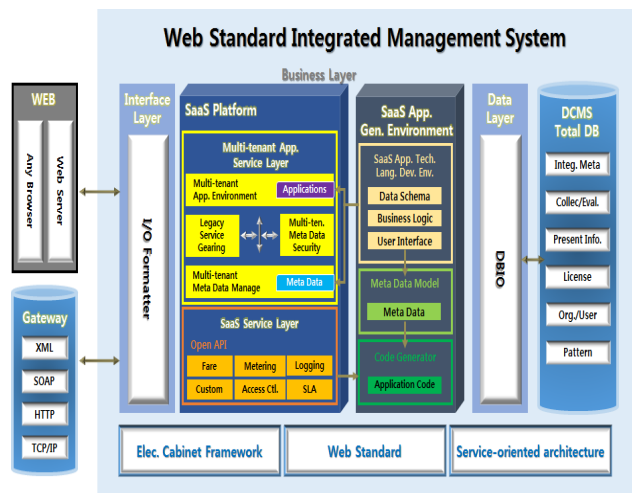

Fig. 2. Block Diagram of Integrated Management System

3.2 Flow Diagrams for Core Services

Acquisition Service Fig. 3 shows a flow diagram of operation of acquisition sub-system that we should implement as a core service of our integrated management system. Analyzing user book-requiring data and budget of purchase, we choose necessary materials and order them to publisher or agency. Sometimes we can require claims of incoming materials and/or perform reordering processes. If there is no drawback or warranty problem, we can get admission of incoming books and go over into a registration process.

There are 3 different parts in the flow of acquisition service as shown in Fig.3. User can require what he/she wants to the personnel of acquisition part of library. And then most of the affairs for acquisition service are performed by the personnel with a little help of department of financial affairs.
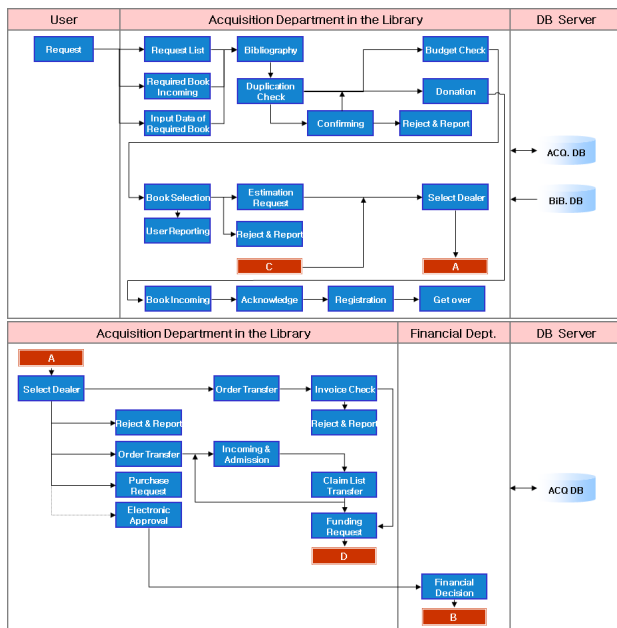
Fig. 3. Flow Diagram of Acquisition Service

Fig. 4. Flow Diagram of List-Up Service

Point-A indicates the interface between selection of material and ordering procedure. After selection, ordering, and other admission processes, operating control touches Point-B to check financial availability. There are always two kinds of buttons at every step of operation. 'Processing' button indicates continuing the present step of operation, on the other hand 'Not Processing' button makes present data return to previous step or jump into another necessary step of the job. This method makes it possible to process job affairs more flexible. When a flow-control reaches Point-D, financial condition just decides whether we may purchase selected material or not. When all the steps of acquisition flow are performed, registration works using DBs and getting over into other affairs.

Therefore we can arrange main functions of acquisition service as follows; 1) Environment Setting includes regulation and code, financial, exchange rate, dealer, and message management etc. 2) Purchase Request Management includes input, modification, and deletion controls of the list, inquiry of required materials, selection of purchase etc. 3) Ordering and Purchase management includes exchange rate, order and/or reject, and transportation of ordering sheets etc. 4) Distribution and Claim Management includes possession, belonging, admission or claim, and registration etc. 5) Funding and Reject/Delay Management includes paying for the purchase, reject or delay of the purchase, and invoice delivery etc. 6) Incoming Material Management includes addition, modifying, or deletion of possession, confirming and acknowledgement e-mail delivery etc. 7) Report and Statistics includes request, selection, and ordering lists and statistics, reject and delay lists and statistics, ordering sheets, incoming material lists and statistics, registration originals, and financial budget and statistics etc.

List-Up Service We can depict a flow diagram of list-up service of our management system for electronic library as shown in Fig.4. First of all, receiving the data from acquisition

service explained above, we search for the possession list to decide whether the incoming material exists or not. Giving request mark and possession information on the incoming material, we arrange the detailed information of the content throughout this list-up service. After arrangement of content, we endow label and bar-code on the incoming materials and get them over to the loan-and-return service.
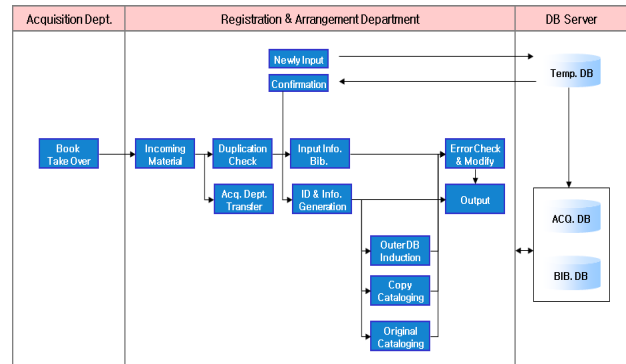
List-up service which is the lowest basement of electronic library is one of the most important elements for the quality of database. The structure of list-up system follows international standard such as KORMARC, USMARC etc. In addition it is so closely related to Acquisition as well as Perusal Service that we should transfer the business affairs between these cooperative jobs.

Therefore we can summarize the functions of list-up service as follows; 1) Taking Over Acquisition Data including MARC data from acquisition department, searching for possession list, and detecting of document duplication etc. 2) Entry of Bibliographical Data includes KORMARC, USMARC, original cataloging, copy cataloging, record editing, and input of URL etc. 3) Management of Bibliographical Data includes related or series books, error control, multi-lingual process using KSC5601 standard code system, blind list control, and data input/output/transform/deletion etc. 4) Management of Data Quality includes supporting similar bibliography with their title, author name(s), publisher, and ISBN, post processing when duplication, similarity, or error occurred, etc. Duplicated error records can be deleted by overwriting or eye checking procedure. And deleted data or bibliographical records are saved in trash box for the future reuse. 5) Taking Over Arranged Data to Perusal Department and Reporting. Arranged bibliographical data are automatically taken over to the perusal department and become readable documents. Tables of present situation such as new book lists, taking over approval, check list of registration, label, book pocket, and their bar-codes can be printed out. In addition, various statistical data such as job related, book related, and possession related statistics are possible.

Loan-and-Return Service Fig. 5 shows a flow diagram of loan-and-return service used in our management system of electronic library designed in this paper. After receiving data of incoming materials from list-up service, they are arranged on the book shelves with other existing materials ready for user

loan. If there is a user request for loan, personnel inputs the registration number of the required book and proceeds loan service. When there is a request of return of the loaned material, personnel can check its abnormality and perform necessary stuffs according to the situation.
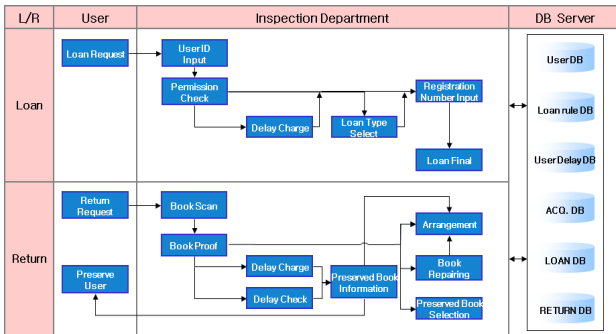

Fig. 5. Flow Diagram of Loan-and-Return Service

Loan-and-return service should be developed to offer high quality service for users and make it possible to deal with management or perusal affairs for personnel at the same time. From taking over arranged data to possession and user management, all the processes are automated in the integrated management system.

Therefore Loan-and-Return service implemented in our system can be arranged as follows; 1) User Management includes registration, ID processing, searching key assignment, user status analysis, and their modifying, deleting, and/or update. 2) Loan Processing includes regulation of loan-and-return, various codes for the module, and delivery message. 3) Reservation Management can be operated in both perusal and retrieval system directly by users. 4) Loan Management includes its processing such as general, special, and long-term loans etc. Postpone processing, delay checking for persons, dates, and groups. In addition various history management features can be included.

3.3 Application of Web Standard

We apply W3C web standard, its guide line, and all the related indicators in our design and programming of the integrated management system for electronic library so that any content offered by the system can accurately operate on any kind of PC, mobile device, and any kind of network environment. We investigate effectiveness and adaptive characteristics of W3C standard in order to build our system available for any kind of modern variety of terminal environment.

The details of web standard made by W3C include HTML, CSS, XML, XHTML, and standard DOM(Document Object Model) schemes. If we correctly organize content using HTML and unify visual expression by CSS, it can be possible to build cost effective web pages and fabricate various web browsing environment which make it available for any user including handicapped, elderly, and other social weak parties. One of the most important roles for web standard is the rapid expansion of HTML5. Using HTML5 and CSS at the same time, we obtain compatibility and interoperability of our system and we can suitably display our content even on older browsers that had

been operated on typical system in the past. Followings are some advantages of our system we got through applying web standard mentioned above;

We can provide with various features, interactions, and rich UXs using standard technology. We overcome the limitation of HTML which can be considered as a platform for simply information delivery. Interactive components like moving pictures, chatting, and/or other features can be supported directly by HTML5, which could be possible using Flash or other plug-in SW in the past.

3.4 Improvement of Duplication Check Algorithm

Data Consistency is one of the most important features in dealing with content contained in an electronic library system because consistent data can only be utilized or managed more effectively than other cases. Therefore data duplication feature is a rather important factor to evaluate the quality of content measurement. We propose, throughout this study, a precise algorithm for duplication check to minimize double processing in dealing with data quality improvement. There has been a lot of difficulties confirming duplications and maintaining the consistency of collected data using conventional algorithms. Overcoming these defects, we detect verification entries and processes of duplicated records of journal, volume number, and paper articles in various contents coming into electronic library system.

Duplication Check Algorithm for Journal Total logic flow for duplication check can be depicted as Fig.6. Extracting ISSN(International Standard Serial Number), title of Journal, and Year for launching or closing from Marc data, we estimate duplication of the journal following the logic of the flow chart.
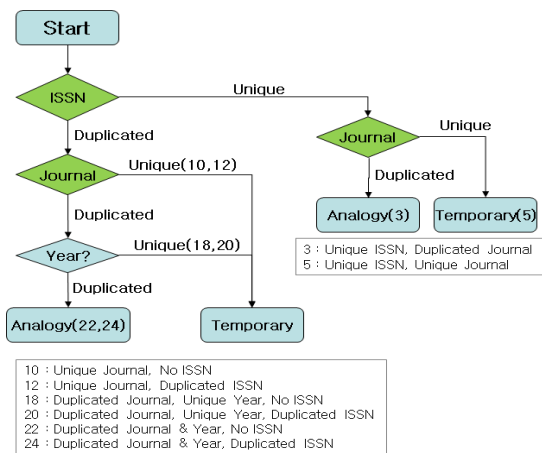

Fig. 6. Flow Chart of Duplication Check Algorithm for Journal

After extracting ISSN of corresponding journal from Marc data, we decide whether the detected ISSN is duplicated or not. If the ISSN is unique (or different), we detect title of Journal and check its duplication for the next step. If the title of Journal is duplicated, we decide the object to be an 'Analogy' and make it waiting for manager confirmation. Else if ISSN is duplicated, we have following two branches of logic; if title of Journal is unique, we assign 'Temporary' data, else if title of

Journal is duplicated, we compare Year of launching or closing. Comparing the Year of launching or closing, if they are different we assign 'Temporary', else if they are duplicated we assign 'Analogy'.

Name of Journal can be extracted from Marc data. There exists 245 fields in Marc data and the information of Name of Journal exists in these fields. Name of Journal contains 'Title proper', 'Parallel title', and 'Other title'. Identification Symbols for data of Name of Journal are described as follows; $a-Title proper, $b-Other title, $d-First author, $e-Second and/or other authors, $h-Common document, $n-Volume number, $p-Volume name, and $x-Parallel title. For our duplication check for Journal, we just extract $a, $b, $n, and $p and apply them to processing of SGML special characters, processing of article, and processing for sorting algorithm.

Volume/Number Duplication Check Algorithm Logic flow of duplication check for Volume/Number information can be started to extract name of volume/number and year of publication from Marc data. Fig.7 shows the procedure from the starting point mentioned above to assigning behavior explicitly as 'duplicated', 'analogy', and 'unique(new)'.
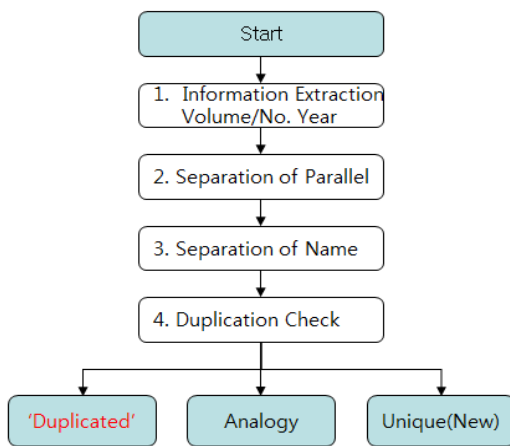

Fig. 7. Logic Flow for Duplication Check of Volume/Number

Name of volume/number is important to be transformed into a unified form. For example 'No.23', '23n', and '#23' are all transformed into our standard form 'n.23'. In addition parallel volume/number like 'v.52 no.4=no.871' should be separated into name of Volume 'v.52' and name of Number 'no.4' so that we can check their duplications of separated volume/number 'v.52' and 'no.4' as well as parallel name of Number 'no.871'. 'Ho(Korean)', 'No', or 'Number' etc. should be transformed into our unified representative 'n'. 'Part', 'pyeon(Korean)', or 'pt.' into 'pt'. 'Kwon(Korean)', 'vol', 'band', 'jahrg', or 'volume' into 'v'.

In quarterly publication, we need another strategy to represent 4 different seasons using our unified 4 different numbers. We transform 'Sp/spring/1stquarter', 'Su/summer'/2ndquarter', 'A/ F/autumn/fall/3rdquarter' and 'W/winter/4thquarter' into our number representations '3', '6', '9', and '12'.

Duplication Check Algorithm for Papers Logic flow of duplication check for papers is shown in Fig. 8. The procedure starts with extraction of 'First page', 'Authors', and 'Title of paper' from the content data.
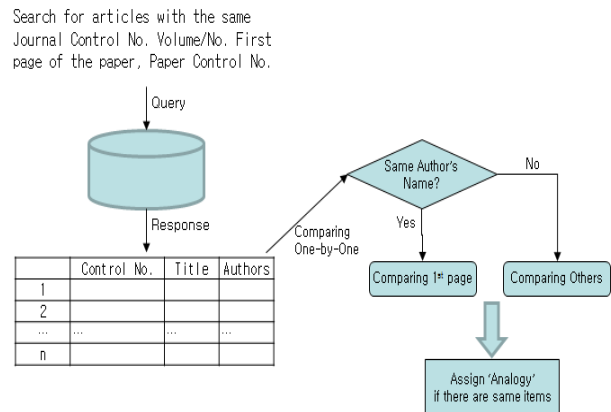

Fig. 8. Duplication Check Algorithm for Papers

In duplication check algorithm of paper, there exists various cases to describe their page information. For examples 'p.955-958', 'pp.955-958', or '955~958' etc. mean the same thing. In some cases they describe page numbers using Roman character like 'IXVV'. But we unify these cases into only '1st page' information like '955'. Name of author can be checked by the 1st author's family name. All the page information like 'p 7-10', 'p7-p10', 'vii- x ', or 'pp.7~10' should be transformed into '7'. If names of authors are given by 'C.E.Baker, Barton,G., and Zheng,D.W.', we only check 'Baker'.

3.5 Operating Environment and Service implementations
Fig. 9 shows the operating environment of our integrated management system based on web standard considering stable operation, interaction between systems and extension in the future. We represent our implementation as 'Integrated Management Applications for Electronic Library' as shown in Fig.9, which includes security and safety features. All other upper and lower layers consist of inner or outer environments connected to our library system throughout networks nested private and/or public.
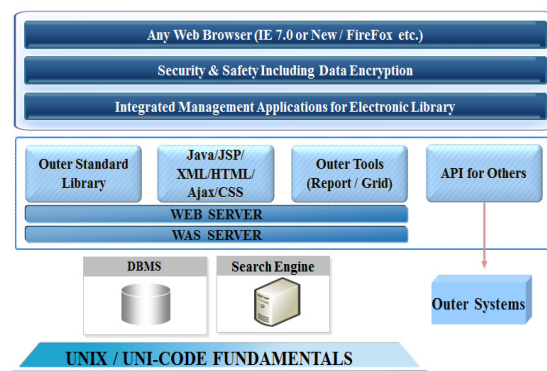

Fig. 9. Operating Environment

Under the operating environment described above, we constitute an integrated development environment based on

Eclipse, which makes it possible to develop components of the system and to reduce the cost, time, and effort in the process of development, production, and repairing. Table 3 shows the list of development environment, and compact guideline of it can be mentioned as shown in Table 4.

Table 3. Development Environment

Class	Used Software
Developing Servers	- Web Server - WAS Server - DB Server - Search Engine Server
DBMS	- Oracle 11G
WAS	- JEUS
Search Engine	- Apache Lucent
Web Server	- Apache etc.
Web Developing Tool	- JSP, JAVA, Proc*C, C/C++
Design & Others	-Photoshop, Flash MX, Dev. PC& Ptr.

Table 4. Implementing Guideline

Class	Guideline
J2EE	- Web Server - WAS Server - DB Server - Search Engine Server
Commun. Protocol	- Oracle 11G
HTML	- JEUS
Character Set	- Apache Lucent
Struts	- Apache etc.

Using these SW tools like somewhat generally applied, we fabricate the framework of our integrated services as show in Fig. 10. Next generation web standard electronic library can be described as an integrated management system including automation of acquisition, listing-up, and loan-and-return services. Modules of basic affairs in business layer indicate typical library affairs from conventional concepts of library. Common work-module and system-module are needed for integrated library works and networking through webs.
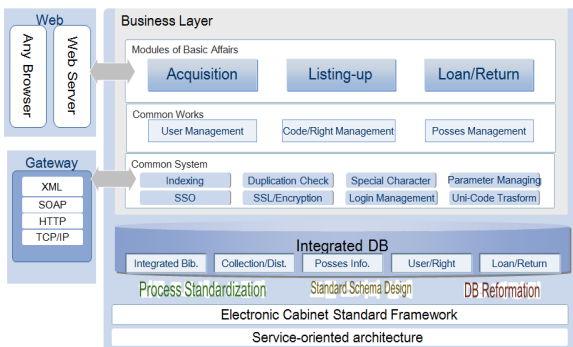

Fig. 10. Service Frameworks of the System

In addition, these services and management modules are fabricated on the Electronic Cabinet Guidelines standard framework of Korea Government, and they are all constituted on a service-oriented architecture under considerations. Total operating system is Linux5.0, CPU is Intel Xeon Dual with

2.0GHz, and memories are 2GB ECC DDR SDRAM and 146GB/10k-rpm SAS disk*4 etc.

Based on the scope of development and service concepts described above, the integrated management system of electronic library obeying web standard consists of acquisition, listing-up, and loan-and-return sub-systems and their sub-modules. Roles and capabilities of these sub-systems and their implementations are as follows;

The core design concept of our integrated management system is personalized customizing as shown in Fig. 10. User can edit any item he/she wants according to given category or menu and the content obtained will be displayed at the top of the screen. Although this design entry is such an important consideration, a lot more important concepts are usability and accessibility which make it possible to find easily the information or content that user actually try to find. We focus on obeying web standard in our developing process so that any kind of computer including cell phone and tablet PC can smoothly approach to access our integrated management system.

Characteristics of our system comparing to other conventional systems can be listed as follows;
- Easy maintenance and management because of its integrated environment.
- Obeying web standard, independence of operating system.
- Modularization of common feature such as searching, simple and/or detailed screen displays, distribution targets, loan/return, duplication check, incoming material, and multi-lingual inscription.
- Consistency and convenience of the web-site etc.

4. PERFORMANCE ANALYSIS

4.1 Effectiveness Analysis

In order to analyze the performance of our integrated management system for electronic library, we construct a simulated environment which consists of 5 servers and 2 clients. Web, DBMS, media, exchange, IPPBX servers are connected and 2 separated clients are participated. We set up 'TeamQuest 10.1 Manager' on the Web server, 'TeamQuest 10.1 View' on one of the Clients, and 'LoadRunner 8.1' on the same Client. The scenario of effectiveness analysis for the system is given as follows;

『100 users access our electronic library system at the same time. While they are performing registrations, modifications, deletions, and search capabilities of data with each other, we measure 'resource usability' of server, 'memory amount used' in server, and 'response time' of server etc.』

In this analysis, 'resource usability' is defined as %-processor time which means percentage of time used for preforming non-idle threads. 'Memory amount used' is measured by 'private Mbytes' which means the amount of memory assigned on processes being performed in the computer. In addition, 'response time' can be measured by exhausted time on the unit of 'seconds' from the input of

command for searching or request to the time of resulting output for the command.

As a result of measurements fulfilled over 5 times at different test points using different data, the average 'response time' for commands of registration, modifying, delete, and inquiry is about 62.9 seconds for 100 clients. Therefore it takes about 0.629 seconds per client on the average as shown in Fig. 11. This can be evaluated as a result of real-time play level proof.
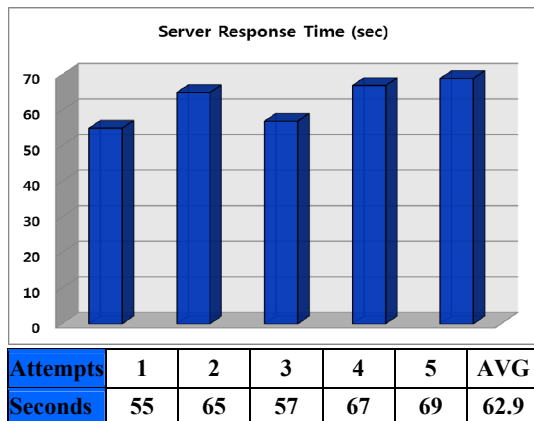

Attempts	1	2	3	4	5	AVG
Seconds	55	65	57	67	69	62.9

Fig. 11. Measured 'Response Time'

Although the 'resource usability' of server can temporarily be increased up to 7.81%, it just returns to the original stable state after finishing the corresponding operations. On the other hand, 'memory amount used' by the server is measured as 803(MB) on the average. In view of 'playing congestion criterion' given in our analysis scenario, processing unit and storage usability of the proposed system is very stable. Data management is also adequate with this stable resource condition.

4.2 Verification of Web Standard Based on Electronic Cabinet Guide Lines

When we are developing our integrated management system of electronic library, we continuously refer to the 'Web Standard Guide Lines of Electronic Cabinet' of Korean Government and verify effectiveness and accessibility of W3C standard so that any computer, any operating system, and any web browser can directly access our web pages without any kind of restriction.

Table 5 shows 8 items of web standard guide lines offered by electronic cabinet of Korean Government.

Table 5. Web Standard Guidelines of Electronic Cabinet

1. Observing the grammar over the content   All the web documents should obey the corresponding grammar adequate for the types of them. They also have to inscribe their types and encoding methods.
2. Separation between content and expression   We have to fabricate structured pages considering logical mark-up. In addition, we should obey the standard grammar in our style language.
3. Proof of technical neutrality in operating scripts   We should not use any non-standard extension of scripts. We

also have to give substitutes of text or information about it for whom don't use scripts.

4. Compatibility of plug-in   Plug-in should be compatible with any web browser considering its various aspects.
5. General permission of content usage   Menu can generally be approached by users with any web browser. In other words, user can access our web-site by various types of interface or input terminal
6. OS-independent content provision   We should be able to provide with widely used content format for any media can be supported without considering the type of operating system.
7. Compatibility of authentication   Authentication should be supported in various types of web browsers.
8. Variety of applications   Inspection of information can be performed on any kind of web browser. Programs need to be downloaded in a separate way should support more than 2 operating systems among Windows, Linux, and Mackintosh.

In addition, the effects expected by obeying the guide lines can be expressed as follows;
- Stability, extendibility, and effectiveness of system can be advanced because of this integrated concept of configuration.
- Service process can be improved throughout UI standard and re-analysis of structure of service and its procedure.
- Web based programming makes the system more compatible and securable.
- Standardization and modularization of common features in the system improve the extensible property.
- Improvement of reusability, operability, and convenience of maintenance by standardizations of code and development.

We obey all the metadata standards and develop the system based on Universal Code System so that we can provide with variety of services and their platform.

4.3 TTA Authentication Test

In order to obtain an official credit of our integrated management system for electronic library, we execute TTA (Telecommunication Technology Association) authentication test. Experimental check points of this test consist of 4 items related to SaaS Maturity, 3 items of Performance, and 3 items of Application Program Features. Table 6 shows these experimental check points and their detailed items.

Table 6. Experimental Items of TTA Authentication Test

Topics	Experimental Items
SaaS Maturity	- Multi-tenant Supporting - Universal Code System Supporting - Customization Supporting - Data Sharing Supporting

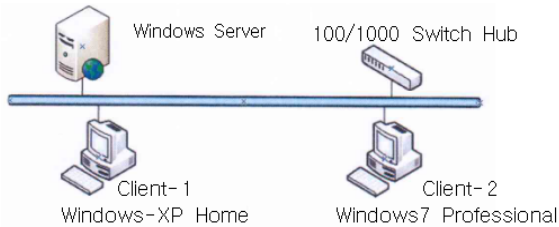| Performance	- Processing Unit Usability - Memory Usability - Response Time(sec)
Application Program Features	- Acquisition Sub-system - List-up Sub-system - Loan-and-Return Sub-system

Fig. 12. Environment of TTA Authentication Test

In addition the structure of simulated test environment is shown in Fig.12. 'SaaS Maturity' can be measured by checking whether the developed items properly operate well-balanced with Level-3 or not. Detailed items include multi-tenant capability, universal code system, customizing, and data sharing etc. 'Performance' can be analyzed by CPU-usability, memory amount used, and response time when 100, 200, and 300 users access the server at the same time under clearly defined environment. Finally 'Application Program Features' can be confirmed by checking whether all the developed items are properly operating or not. This topic contains the core sub-systems of our integrated management system such as 'Acquisition', 'List-up', and 'Loan-and-Return' sub-systems. After all, results of these authentication tests are given by 'Pass', 'Partial Pass', 'Fail', or 'NA'. We do not have any detailed items evaluated as 'F' or 'NA' in our test record shown in Table 7. There are some commercial items added in 'SaaS Maturity' topics and 'Performance' topics, and we exclude 'Application Program' topics in the table because of its qualitative property and complexity.

Table 7. Records of TTA Authentication Test

Evaluation Items	Units	Measured Values
SaaS Maturity	Level	Level-3
Connection	Ratio	N tenants : 1 Instance
Program Codes	Ea	Universal Code System, Unique
Customizing	y/n	Y (User Setting per Tenant)
Scale Economics	y/n	Y (Sharing Instances)
Exchange	y/n	Y (for Better Performance)
Sharing	Style	Data Sharing
Performance	Class	Class-A
CPU Usability	%	Below 8 %
Memory Used	Bytes	Below 500MB
Response Time	Sec.	Below 1 Sec.
Transplantation	y/n	Y (Better Transplantation)

5. CONCLUDING REMARKS

We have designed and implemented an integrated management system of electronic library based on SaaS and Web standard throughout this paper. We have developed core elements of SaaS feature which make it possible to realize multi-tenant environment characterized as Level-3. In addition, using Universal Code System and Web Standard offered by the Guidelines of electronic cabinet of Korea Government, this system got over various drawbacks from conventional compatibility problems that had been existed in Client/Server or ASP frameworks. Moreover, we have presented a novel sophisticated duplication check algorithm for data consistency in dealing with content contained in an electronic library system. We expect this method can minimize double processing in the process of data quality improvement.

These days, there are a lot of difficulties to extract correct information from huge world-wide web environment because the scale of web has been continuously increased and user can hardly formalize his purpose in an adequate manner of current web environment. Therefore we need to spend more cost and effort in the process of searching and modifying our objects in this huge flow of information. On the other hand, general methods of software operation for present electronic library are Client/Server or ASP so that the cost of software and hardware including purchase, install, distribution, customization, upgrade, problem solving, and license can truly be increased. Features of hosted application and SW on demand based on SaaS have been developed as service models to overcome these conventional defects of Client/Server or ASP features.

Obeying metadata standard, web standard, and universal code system make it possible to be used for any OS and web browser as well as multi lingual service. We expect that user interface, encoding standardization, and compatibilities in operation, management, and maintenance will be good topics of research in the near future.

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