Design and Implementation of Information Management Tools for the EDISON Open Platform

Jin Ma[1], Jongsuk Ruth Lee[1], Kumwon Cho[1] and Minjae Park[2]
[1] National Institute of Supercomputing and Networking, KISTI,
Daejeon, South Korea
[e-mail: majin, jsruthlee, ckw] @kisti.re.kr
[2] BISTel, Inc. Engineering Innovation Department
BISTel Tower, 128, Baumoe-ro, Seocho-gu, Seoul, Korea
[e-mail : mjpark@bistel.com]
*Corresponding author: Jongsuk Ruth Lee

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Abstract

We have developed an information management tool for the EDISON (EDucation-research Integration through Simulation On the Net) open platform. EDISON is, at present, a web-based simulation service for education and research in five computational areas, namely, nanophysics, fluid dynamics, chemistry, structural dynamics, and computer aided optimal design. The EDISON open platform consists of three tiers: EDISON application framework, EDISON middleware, and EDISON infra-resources. The platform provides web portals for education and research in areas such as computational fluid dynamics, computational chemistry, computational nanophysics, computational structural dynamics, and computer aided optimal design along with user service.

The main purpose of this research is to test the behavior of the release version of the EDISON Open-Platform under normal operating conditions. This management tool has been implemented using the RESTful API designed in EDISON middleware. The intention is to check co-operation between the middleware and the infrastructure. Suggested tools include User management, Simulation and Job management, and Simulation software (i.e., solver) testing. Finally, it is considered meaningful to develop a management tool that is not supported in other web-based online simulation services.

Keywords: Computational Science, Cyber Infrastructure, EDISON Platform, Web-based Simulation, Middleware, RESTful API

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※ EDucation-research Integration through Simulation On the Net.

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1. Introduction

In recent years, a new theoretical and methodological approach for computational science has become increasingly popular for analyzing and solving scientific problems in various scientific disciplines and applied research. Computational science is the field of study concerned with constructing mathematical models and quantitative analysis techniques and using sufficiently powerful computing resources to solve problems that are difficult to attempt in a physical experimental setting [1].

Additionally, simulation environments involving cyber infrastructure are being utilized in various fields for the purpose of education/research. Computer simulations can save time and eliminate the need to perform actual experiments, and also enable experiments to be conducted that would previously have been impossible for technical and ethical reasons [2].

Supercomputing systems have been increasingly adopted as general-purpose simulation environments for a broad spectrum of applications such as Internet services as well as large-scale computational science/engineering applications [3].

EDISON (EDucation-research Integration through Simulation On the Net) [4, 5, 6, 7] is a web-based platform that provides various simulation tools and related contents to support online education and research in areas related to computational science, namely, nanophysics, computational chemistry, computational fluid dynamics, computational structural dynamics, and computer aided optimal design. The EDISON open platform consists of three tiers: EDISON application framework, EDISON middleware, and EDISON infra-resources. With the help of high-performance computing resources, the EDISON open platform can support up to hundreds of simulation job requests, in parallel, under normal conditions. In this paper, we present the design and implementation of an information management tool that focuses on the release version of the EDISON open platform. The purpose of the work is to check the co-operation between the middleware and the infrastructure.

2. Related Work

Lately, simulation environments involving cyber infrastructure have been utilized in various fields for the purpose of education/research. PUNCH [8] began as a project to create an Internet computing platform that would provide a distributed computing portal on the early World Wide Web. Applications could be installed "as is" with simple web form interfaces for uploading and editing input files, running the application in a batch mode, and then retrieving, viewing, or post-processing output files. Alternatively, applications could have more elaborate web interfaces constructed within PUNCH to activate an infinite variety of different application flags or preprocessors and postprocessors automatically. Later versions of PUNCH added virtual file system support to execution nodes, support for VNC-based graphical, interactive application use, and even began linking to Condor and Globus submission. PUNCH was designed to allow users access to complex software packages without the need to use difficult installation processes or to familiarize themselves with arcane commands. Early implementations of PUNCH focused on scientific simulation applications for three different disciplines: Computational Electronics (CE Hub), Computer Architecture Research and Education (NETCARE), and Electronic Design Automation (EDA Hub). Of these, the Computational Electronics Hub, which was first brought online in 1996, was the most successful. A few years later it was transformed into a hub more specialized in nanotechnology, becoming the first incarnation of "nanoHUB"[9].

Some representative examples are nanoHUB, ICLCS (Institute for Chemistry Literary and Computational Science) [10], and ICEAGE [11]. Developed in 1995 under the Network for Computational Nanotechnology (NCN) [12] project, NanoHUB offers various simulation software and content for nanotechnology researchers. It is used by more than 200,000 researchers from 172 countries. Their range of services includes Rappture [13], a tool for the utilization of simulation software based on the HUBZero platform [14, 15], simulation sharing, and content conversion. The open-source HUBZero platform is being used in more than 30 application fields such as manufacturing, disaster management, and healthcare. ICEAGE, a multi-national education-oriented project led by the European Union (EU), provides large-scale and multi-purpose cyber infrastructure based on Enabling Grids for E-science (EGEE). Educational programs and materials are developed for researchers and educators to teach in a grid environment.

Table 1. Status of Simulation-based Education and Research Fusion Project [16]

Title	Field	Representatives and Participating	Budget
nanoHUB (http://nanohub.org) [9]	Nano	Purdue University, etc.	NSF
Composites Design and Manufacturing HUB (cdmHUB) (http://cdmhub.org/) [17]	Manufacturing	Ohio supercomputer center	NSF
C3Bio* (http://c3bio.org/) [18]	Biofuel	About 7 Universities, including Iowa State	DoE
NEES** (http://nees.org/)	Earthquake Research	About 20 Universities, including Cornell	NSF
CLEERhub (http://cleerhub.org/)	Engineering Education	Purdue University, etc.	NSF
thermalHUB (http://thermalhub.org/)	Thermal	About 9 Universities, including UC Berkeley	NSF
pharmaHUB.org (http://pharmahub.org/)	Drug Development	About 20 Universities, including Rutgers University	NSF
ncipHUB.org (http://nciphub.org/)	Cancer Research	About 10 Universities, including Purdue University	NIH
Materials Project (http://www.materialsproject.org/)	Materials research	About 6 Universities, including MIT	NSF
ICLIC*** (http://iclcs.illinois.edu/)	Computational Chemistry	NCSA, UIUC, etc.	NSF
VSCSE**** (hub.vscse.org)	Computing Science Engineering	Purdue University, etc.	Own budget

* Center for direct Catalytic Conversion of Biomass to Biofuels

** Network for Earthquake Engineering Simulation

*** Institute for Chemistry Literacy through Computational Science

**** Virtual School of Computational Science and Engineering

Presently, nanoHUB has 391 kinds of services on the basis of the Simulation SW and 4,500 kinds of content, and is used by the entire international research community in accordance with the educational community. More than 1.4 million users use the service. [16]

Neither HUBzero nor nanoHUB provides a testing tool for users to download the Virtual Machine (VM) and Simulation Tools. It is also necessary to improve user feedback or through HUBzero and nanoHUB self-testing. The following is a description of testability at the nanoHUB. Narwhal offered the ability to stress-test systems in advance of production use. A development environment could be prepared in which an administrator could start, for instance, 1000 random application sessions in rapid succession. Alternatively, 100 sessions could be started simultaneously (as would happen when students in a laboratory classroom started to use the system). Tests of this nature enabled bugs in the software to be found and

corrected. The expected behavior and capacity of the system could also be established in advance of production needs. [19]

3. EDISON Open Platform

3.1 Overview of EDISON

EDISON is an established web-based open platform on cyber-infrastructure where people can easily and conveniently access and utilize simulation software for educational and research purposes. The execution of simulation programs by using the EDISON open platform for development purposes can be expanded into multiple application domains and user portal service environments.

Fig. 1 is an overview of the EDISON open platform and shows its three tiers: application framework, EDISON middleware, and physical resources (infrastructure).

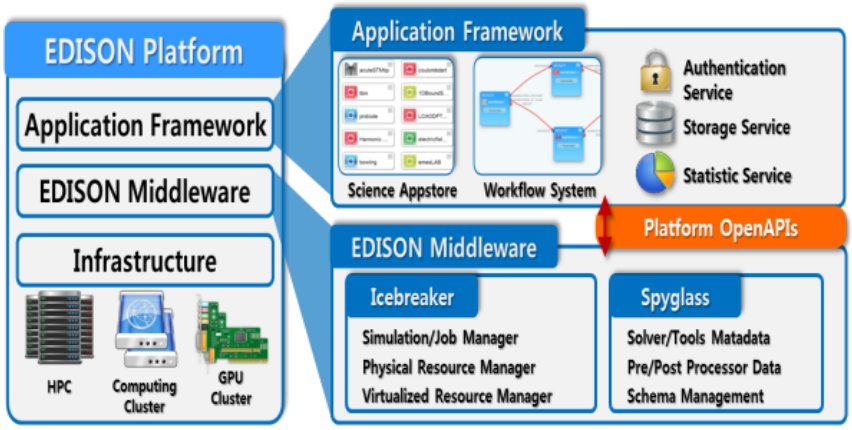

Fig. 1. Overview of EDISON open platform

In general, the simulation environment is comprised of various components such as preprocessors (e.g., control of simulation inputs), simulation software (solver), postprocessors (e.g., visualization scheme), computing resources, and job managers.

The Science Appstore manages tasks associated with simulation data and processing. It includes input and output data, various simulation software (solvers) and postprocessors. The simulation environment also supports the EDISON Workflow System using simulation software. EDISON Workflow can use the output work completed for other interpretations as an input. For different simulation software such as single simulation software, grouping can be used. The storage service provides support to ensure that each user can dynamically use the repository. [20] The statistics service provides usage statistics for the period, software, and support for institutions.

3.2 EDISON Middleware

EDISON middleware [21] is further divided into two components, IceBreaker [22] and Spyglass. IceBreaker is concerned with the design and implementation of a heterogeneous computing resource/job management framework to enable web-based supercomputing services. Spyglass, when present, is used to create a portlet application framework. The management tool of the current EDISON middleware focuses on IceBreaker.

The purpose of the proposed heterogeneous computing resources / jobs management framework (IceBreaker), as shown in **Fig. 2**, is to manage different types of computing resources and jobs, and to establish the foundational APIs for various supercomputing services.

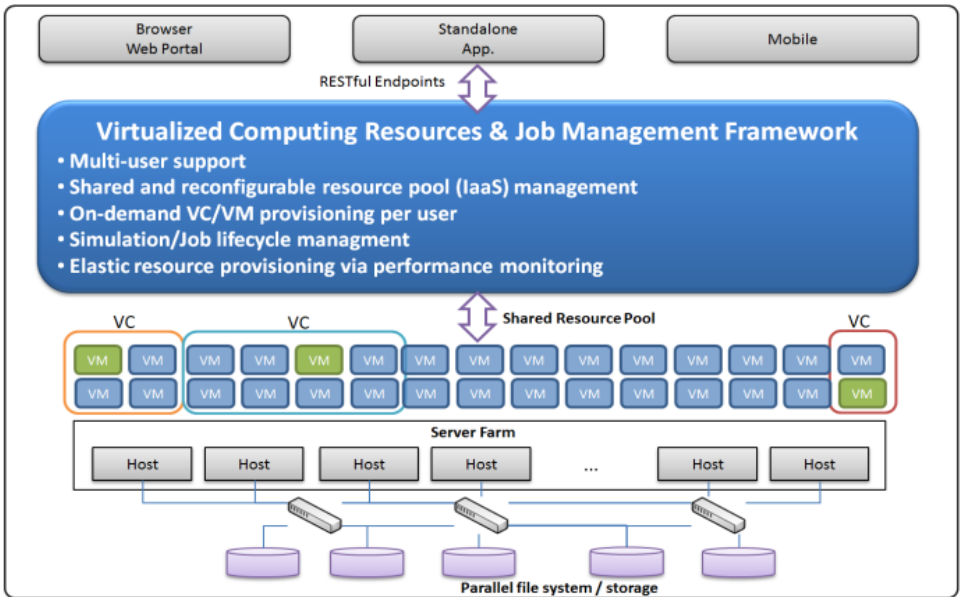

Fig. 2. Overview of IceBreaker [22]

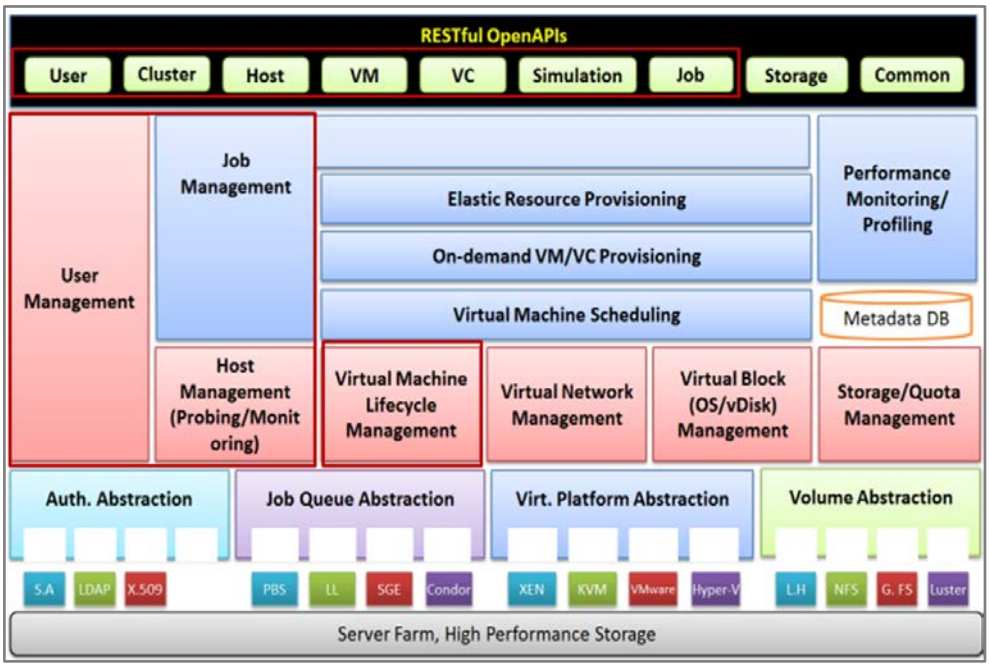

Fig. 3. Architecture of IceBreaker and Support Area of Management tools

Fig. 3 shows the hierarchy of the IceBreaker framework. From bottom to top, the framework consists of the abstraction layer, service core, and web service layer. The abstraction layer supports different types of existing environments (authentication, resources, job, storage subsystems, *etc.*), whereas the service core allows user management, provisioning of physical/virtual servers, and job management. The web service layer provides a web-standard HTTP(S) REST interface [23].

Fig. 3 shows the region that is of interest in the work presented in this paper. The information management tool for EDISON is responsible for the management of Users, Jobs, Hosts, and VMs of the service core. Next, the RESTful Open APIs that are supported are introduced in Section 4.

4. API Design of EDISON Information Management Tool

EDISON middleware provides the RESTful API [24-27], which is based on the service domain, for user management, simulation, and job management. And then,

4.1 User Management API

A system administrator is able to register and delete users. In this case, the system administrator is the user of the downloaded version of the EDISON open platform release.

General users can obtain system authentication through the login/logout interface and can access other service endpoints using the authentication token provided when successfully authenticated. Within the middleware, an HTTP(S) BASIC authentication mechanism is used for user authentication and authority delegation. **Table 2** presents the different levels of access granted to administrators and general users.

Table 2. User management API provided by EDISON Middleware

HTTP Method	Endpoints	Meaning	Access Control	
			Admin	Normal Users
POST	-/api/user/login	Login	O	O
GET	-/api/user/logout	Logout	O	O
GET	-/api/user/count	Get the number of all users	O	X
GET	-/api/user/list	Retrieves all the registered users' list	O	X
GET	-/api/user/list?startIndex={*startIdx*}&maxResults={*maxResults*}	Retrieve all the users for the specified range (starting from 0)	O	X
GET	-/api/user/{*UserId*}/info	Retrieve the specified user's information	O	O (only own user)
POST	-/api/user/register	Register a new user onto the system	O	X
PUT	-/api/user/{*UserId*}	Update an user's information (currently, allows the modification of password and email only)	O	O (only own user)
DELETE	-/api/user/{*UserId*}	Unregister the specified user	O	X

4.2 Simulation and Job Management API

Simulation, which serves as a virtual parent, is an object that encompasses job sets. The endpoint of the simulation management tool facilitates management of the parameter-sweep job sets and provides various functions such as simulation generation, information viewing, deletion, and modification. After creating a simulation object, users can engage in job submission and control.

The job title, job type (sequential or parallel), application to be executed, and other variables

are specified using XML or JSON. Once this job has been submitted, its status can be monitored or cancelled through the status/cancel API. **Table 3** provides the simulation and job management API list provided by EDISON Middleware.

Table 3. Simulation and Job management API provided by EDISON Middleware

	Simulation	
HTTP Method	Endpoints	Meaning
POST	-/api/simulation/create	Create a simulation
DELETE	-/api/simulation/{*simUUID*}	Delete the simulation
PUT	-/api/simulation/{*simUUID*}	Update the simulation information (i.e. title and/or description)
GET	-/api/simulation/list	Retrieve all the simulations • admin : all the simulations • normal users : his own simulations
GET	-/api/simulation/count	Get the number of simulations • admin : # of all the simulations • normal users : # of his own simulations
GET	-/api/simulation/list?userId={*userID*}&startIndex={*startIdx*}&maxResults={*maxResults*}	Query simulations by userID and/or range values
GET	-/api/simulation/{*simUUID*}/info	Retrieve the simulation information
	Job	
HTTP Method	Endpoints	Meaning
POST	-/api/simulation/{*simUUID*}/job/submit	Submit a job
GET	-/api/simulation/{*simUUID*}/job/{*jobUUID*}/status	Retrieve the status given the job
GET	-/api/simulation/{*simUUID*}/job/list	Retrieve the status of all the jobs which are included in the simulation
GET	-/api/simulation/{*simUUID*}/job/count	Get the number of jobs which are included in the simulation
PUT	-/api/simulation/{*simUUID*}/job/{*jobUUID*}/cancel	Cancel the job (only for the QUEUED or RUNNING jobs)
GET	-/api/job/{*jobUUID*}/input	Get the metadata of input files
GET	-/api/job/{*jobUUID*}/output?dir={dirName}	Get the metadata of output files
GET	-/api/job/{jobUUID}/file?name={fileName}	Get the metadata of a named file
GET	-/api/job/{*jobUUID*}/download/zip	Download ziped result

4.3 Host, Virtual Machine, and Cluster Management API

These endpoints are for (VM)/cluster provisioning on physical servers registered by administrators. As shown in **Table 4**, it is accessible by both administrators and general users. VM provisioning is requested by specifying the number of processors and memory size, and detailed information of the provisioned VMs is available for owners. The owner of a VM may submit requests to suspend/resume the machine [22].

Host service domain provides physical hosts management for hosting VMs. This domain supports the creation, retrieval, and deletion functions. However, currently, an update function is not provided. Another service domain provides VM creation, retrieval, and deletion functions. The lifecycle of a VM can be managed by using functions including pending,

starting, running, suspended, migration, shutdown, and error. Currently, an update function is also not provided for the VM domain. The Cluster API can be used to simply look up the list for the cluster.

Table 4. Host, Virtual Machine and Cluster management API provided by EDISON Middleware

Host		
HTTP Method	Endpoints	Meaning
GET	-/api/host/count	Get the number of all hosts
GET	-/api/host/list	Retrieves all the hosts
GET	-/api/host/list?startIndex={*startIdx*}&maxResults={*maxResults*}	Retrieve all the hosts for the specified range (starting from 0)
GET	-/api/host/{*hostId*}/info	Retrieve the specified host information
POST	-/api/host/register	Register a new host to the system
DELETE	-/api/host/{*hostId*}	Delete the specified host
Virtual Machine		
HTTP Method	Endpoints	Meaning
GET	-/api/vm/count	Get the number of VMs • admin : # of all the vms • normal users : # of his own VMs
GET	-/api/vm/list	Retrieve all the owned deployed VMs • admin : all the vms • normal users : his own vms
GET	-/api/vm/list?startIndex={*startIdx*}&&maxResults={*maxResults*}	Retrieve all the VMs for the specified range
GET	-/api/vm/{*vmId*}/info	Retrieve the specified VM's information
POST	-/api/vm/provision	Provision a new VM
PUT	-/api/vm/{*vmId*}/suspend	Suspend the specified VM
PUT	-/api/vm/{*vmId*}/resume	Resume the specified VM
PUT	-/api/vm/{*vmId*}/shutdown	Shutdown the specified VM
Cluster		
HTTP Method	Endpoints	Meaning
GET	-/api/cluster/list	Retrieve the metadata of clusters

Fig. 4 is a simple description of the simulation processing, to help elucidate the relationship between the infrastructure and middleware. The orange (or yellow) fields show the scope of proposed management tool (simulation and job management, simulation SW (Solver) management, Virtual Cluster management)

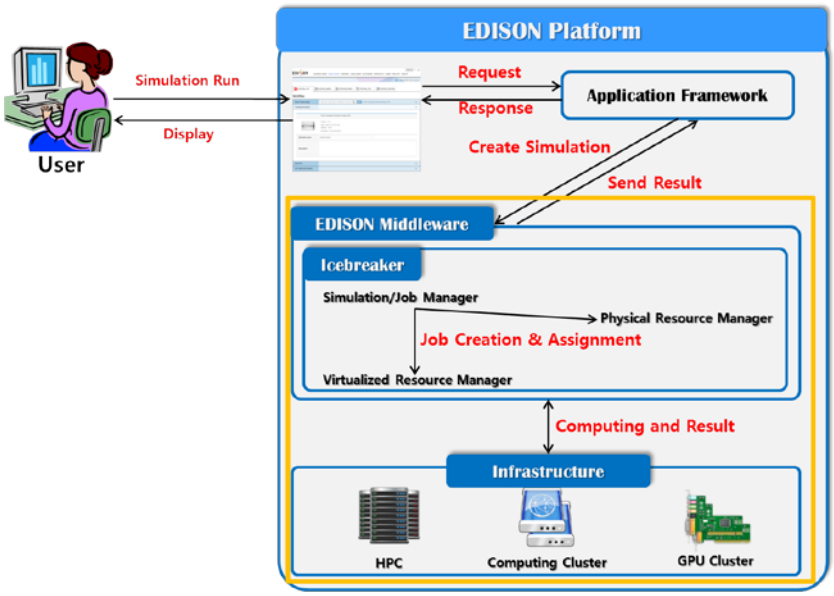

Fig. 4. EDISON platform simulation process and scope of proposed management tool

5. EDISON Open Platform Information Management Tool

5.1 EDISON Open Platform Deployment

Before explaining the information management tools, the tool will be described for EDISON open platform deployment [5]. The EDISON open platform is expected to be deployed this year and its purpose is to place the EDISON platform at the disposal of researchers of computational science engineering. The infrastructure is provided by KISTI (Korea Institute of Science and Technology Information), and science researchers who need to carry out computations can use the EDISON platform by downloading it.

Subsequently, the EDISON platform is expected to be deployed through the Liferay [28] Marketplace [29] and GitHub [30], and it is expected that the quality of the platform will be gradually improved through feedback provided by the community. **Fig. 5** shows the deployed EDISON open platform with a service region. Deployment of the EDISON open platform is divided into two parts. The first is composed of the Liferay-based portlets in the EDISON Application Framework. The second is composed of the simulation data management file, EDISON Middleware.

All infrastructure resources, other than those enclosed within the red square in **Fig. 5**, are provided by KISTI to users who have downloaded the EDISON open platform. However, if the repository and DBMS are installed on the local user's server, it is also possible for these services to access the user's system.

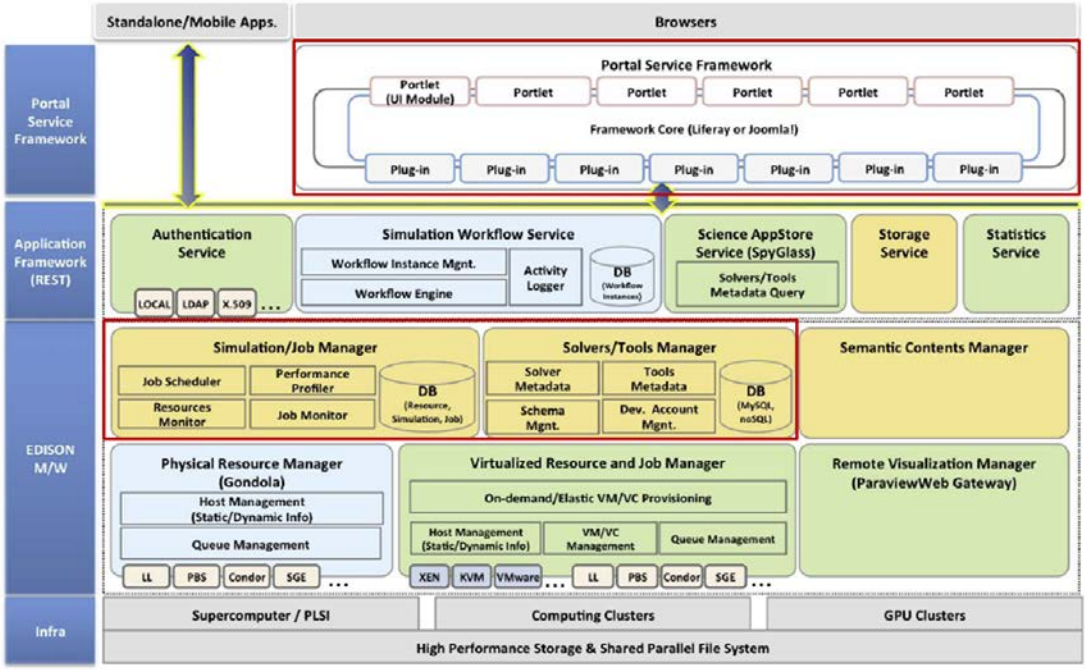

Fig. 5. Providing Areas of Deployment EDISON open platform [5]

Fig. 6 shows a screenshot of the official deployment web site of the EDISON Platform.

Starting in 2016, the EDISON deployment web site offers users the opportunity to download the EDISON open platform.

The official deployment site is as follows:

· EDISON official site

: Https://www.edison.re.kr/project-download [31]

· EDISON GitHub site
: Https://github.com/sp-edison/edison-2016 [32]

The available download list is as follows:

- Liferay Portal & SDK
- IceBreaker distribution files for simulation data management (on GitHub)
  - IceBreaker
    · edison-icebreaker
- EDISON Portal
  - Theme (CFD, Chem, Nano, Portal)
  - Hook
  - Portlet
    · edison-appstore-2016-portlet
    · edison-simulation-portlet
    · edison-virtuallab-2016-portlet
    · edison-workflow-2016-portlet
    · edison-custom-auth-manager-2016-portlet
  - Menu and Common Code
- Documentation
  - Project Setup Guide
  - User Guide
  - Class Manager Guide
  - Science App Developer Guide
  - API Document
  - Deployment Guide
    · Deployment File Installation Guide for platform installation
    · guide portal for end users
    · Science App Development Guide for Developers
    · Portal Deployment Guide for Administrators

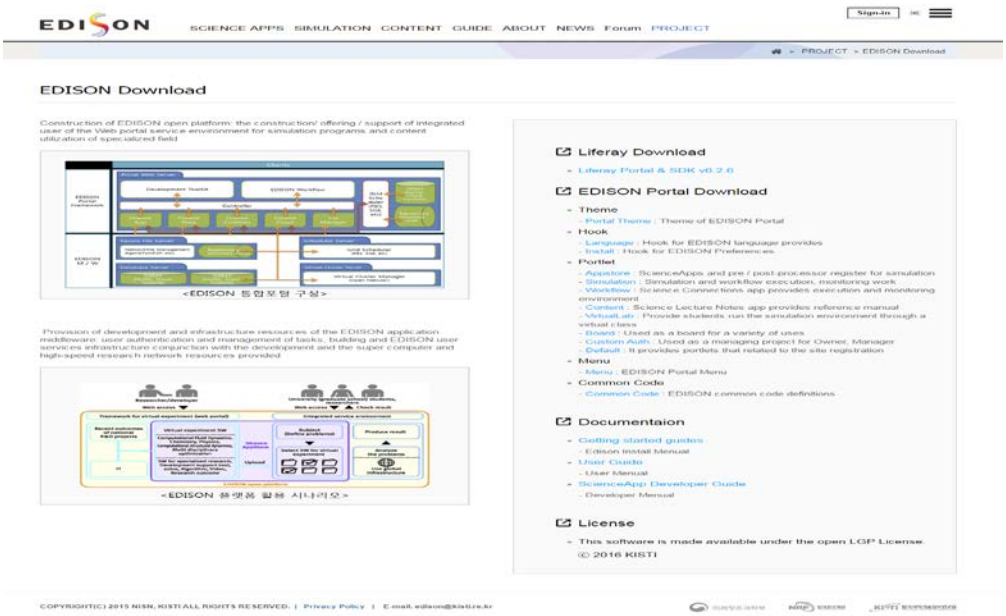

Fig. 6. EDISON open platform Download page

5.2 EDISON Open Platform Information Management Tools Implementation

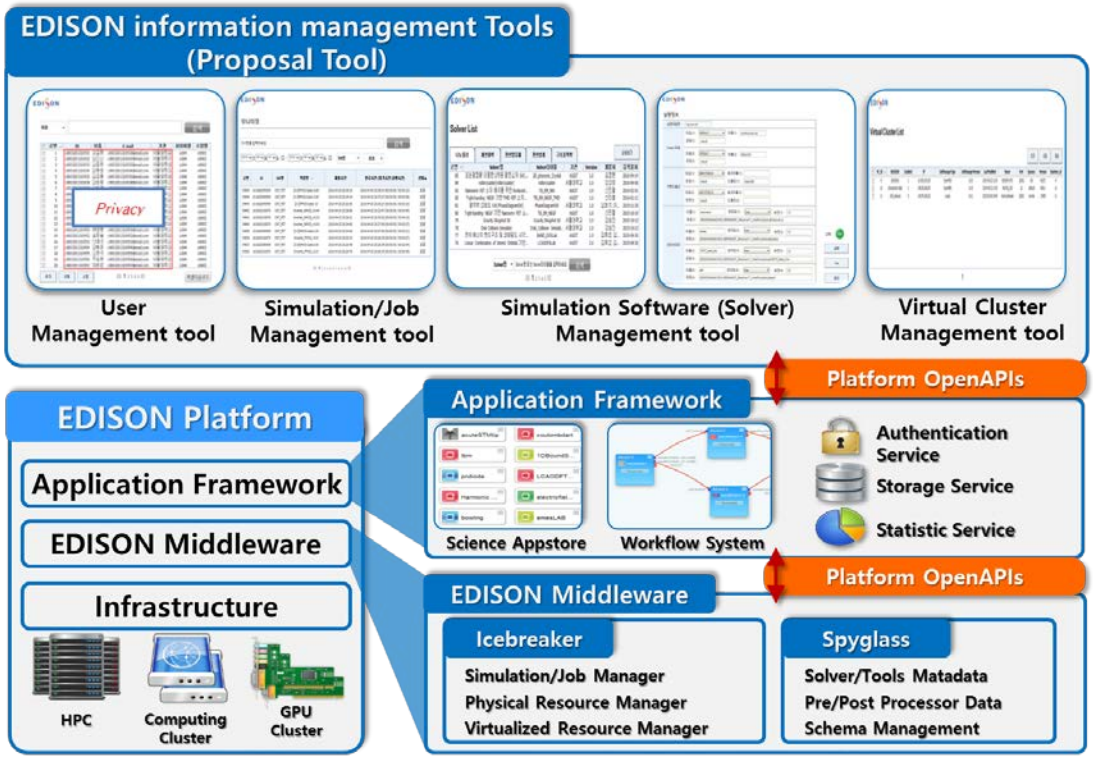

Fig. 7. Relationship between the proposed tools and the EDISON Platform

In **Fig. 7**, the configuration of the EDISON information management tools and the relationship between the EDISON platforms is shown. The proposed tools are able to support User management, Simulation / Job management, and Simulation software management. A simulation software test is a way to verify the connection to the infrastructure. We used the REST API design presented in Section 4 to implement the management tools on the EDISON platform. The management tools are divided into user management, simulation / job management, and the simulation software (i.e., the solver) test.

All pages of the management tools were developed using CSS and jQuery [33] based on HTML5, applied over Ajax communication. A snippet of the user management tool code is shown below. (See **Fig. 8**) The URL is generated by matching the Endpoint URL of **Table 2-4** for the above-mentioned purpose of configuring the tools; i.e., the API of Table 2-4 was called to create the HTML5 web page of the suggestion tool. Thus, it is seen that the REST API designed by EDISON middleware helps simplify the management tool code. Simulation / job management is also implemented in the same way. However, the simulation software (referred to as the solver) management tool that has been developed to test the integration between the middleware and the infrastructure is implemented in a different way. This tool was developed by the combination of UNIX commands and RESTful API.

Fig. 9 exhibits a screenshot that was taken while the user management tool was running. This tool supports user creation, deletion, modified retrieval, and Excel export functions.

```
<!DOCTYPE html>
<html>
<head>
<meta charset="UTF-8">
<title>EDISON UserManagement</title>
<link rel="stylesheet" href="./styles/layout.css" type="text/css" />
<link rel="stylesheet" type="text/css" href="http://w2ui.com/src/w2ui-1.4.2.min.css" />
<script src="./js/jquery.1.11.1.js"></script>
<script src="./js/json2.js"></script>
<script src="./js/common.js"></script>
<script type="text/javascript" src="http://w2ui.com/src/w2ui-1.4.2.min.js"></script>
<script type="text/javascript">
        $(document).ready(function(){
                login("admin","test");
                // check login
                if (isLogin()) {
                // success
                // get user list
                    $.ajax({
                          url: API_URL + "/user/list",
                          headers: {
                                "Accept" : "application/json",
                                "Content-Type" : "application/xml",
                                "Access-Control-Allow-Credentials" : "true",
                                "Authorization" : "Basic " + localStorage.getItem('Token')
                          },
                           type: "GET",
                           contentType:"application/xml; charset=UTF-8",
                           dataType:"json"
                           }).done(function(data, status, xhr) {
                // connection success
                           var records_data = new Array();
                           for (var i=0; i < data.count ; i++ ) {
                           var row_data = new Object();
                           row_data.recid = i + 1;
                           row_data.userId = data.users[i].userId;
                           row_data.userName = data.users[i].userName;
                           row_data.email = data.users[i].email;
                           row_data.affiliation = data.users[i].affiliation;
                           row_data.cyberLabId = data.users[i].cyberLabId;
                           row_data.className = data.users[i].className;

                           records_data.push(row_data);
                           }

                           $('#grid').w2grid({
                                name : 'grid',
                                show :{
                                        header : true, toolbar : true, footer : true, lineNumbers : true, columnHeaders : true,
                                        expandColumn : true, selectColumn : true, emptyRecord : true, toolbarReload : true,
                                        toolbarColumns : true, toolbarSearch : true, toolbarAdd : true, toolbarDelete : true,
                                        toolbarSave : true
                                },
                                columns : [{field : 'userId', caption : 'ID', size : '20%'}, {field : 'userName', caption :'이름', size : '20%'},
                                        {field : 'email', caption : 'E-mail', size : '20%'}, {field : 'affiliation', caption : '기관', size : '20%'},
                                        {filed : 'cyberLabId', caption : '사이버랩', size : '20%'}, {filed : 'className', caption : '수업명', size : '20%'}],
                                records : records_data
                           });
                           }).fail(function(xhr, status, error) {
                                  // connection fail
                                  ajaxError(xhr, status, error);
                           }).always(function(arg1, status, arg2) {
                           });
                }
        });
</script>
```

Fig. 8. User Management Tool Code

Fig. 9. User Management Tool running

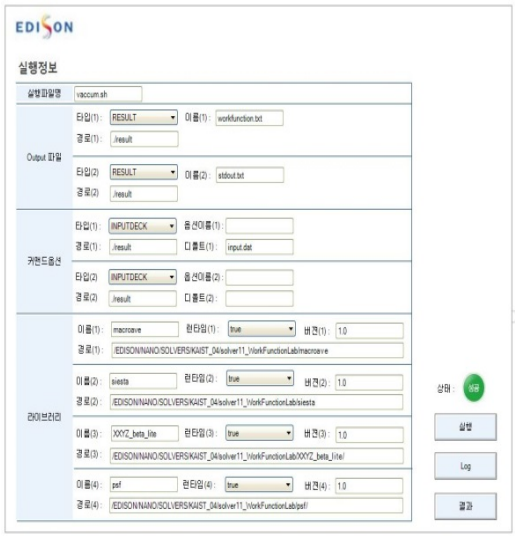

Fig. 10. Execution of simulation software test

The screenshot displayed in **Fig. 10** shows that, to test the simulation software, the command to be entered on UNIX was programmed to run by clicking a button on the HTML page. The simulation software information that is displayed was used to test information such as the executable name, output file, a command option, the library name, and the path. The status of the execution result is also shown. The proposed management tool has been designed and developed as a GUI-based management tool so that service managers of EDISON can manage simulation jobs and infrastructure resources. Conventionally, the service manager connected to the infrastructure using UNIX commands to register task and infrastructure resources and simulation SW and to verify proper execution. Using the proposed management tool, however, users can manage simulations, jobs, and virtual machine and cluster status on the HTML5-based GUI page. As shown in the image, the page consists of various parts that enable separate management of the following areas: User, Simulation, Job, Simulation Software (i.e., Solver), Virtual Cluster. As it is a newly developed system, there is no performance comparison with the conventional model in this research paper.

6. Conclusion

Table 5. Comparison of EDISON Information Management Tools with other online simulation services

	Execution of online simulation	Task and resource status monitoring	Provision of user management
nanoHUB	O	△ (Monitoring of the user's task only, executed on the user's local PC)	X
HUBZero	O	△ (Monitoring of the user's task on virtual machine (VM) allocated to the user)	X
Materials Project	O	△ (Monitoring of the user's task status only)	X
Proposed Tools	O	O (Check VM and Cluster status provided by the user's task status and services)	O (All users' information manageable)

Table 5 compares the services provided by EDISON with those provided by other similar online simulation platforms. nanoHUB, HUBZero, and Materials Project [34] enable the monitoring of the user's tasks only, and the status of other users' tasks cannot be viewed. As HUBZero provides a virtual machine (VM) to users, it allows users to look at the resource status of the provided VM. Material Project only allows monitoring of the status (submit, ready, complete) of simulations executed by the user since it provides services only via the web. As for nanoHUB, simulation is carried out through a VM provided by the local machine and the web in accordance with the simulation SW (Solver), which enables the user to check

the execution status. The management tool proposed in this research paper, however, enables users to look up their tasks as well as facilitating the monitoring of registered service infrastructure resources.

This paper presents the EDISON information management tool we developed by using the EDISON open platform. The proposed tool can be to test the behavior of the release version of the EDISON Open-Platform under normal operating conditions. The three areas of the proposed tool comprising management and simulation software (i.e., the solver) is intended to help developers and computational science researchers to understand the system operation process after installing the EDISON platform. Using the RESTful API, designed in the middleware, this paper implemented an HTML5-based GUI management tool utilizing AJAX communication, which provides more convenient points of management by transforming command-based manual tasks to GUI-based tasks.

Currently, approximately 300 simulation SWs are registered, with the figure expected to increase even further, and the process of registering and verification consumes a great deal of time because it is a Linux command-based system. However, the Simulation SW (Solver) management, one of the management tools proposed in this paper, streamlines the simulation registering and verification process and grants easy access to other users since it is a GUI-based system. The simulation software test tool is not able to test the management tools used in the MPI (Message Passing Interface) code. Future challenges include further development on simulation testing for MPI simulations since the simulation tests together with community feedback will help to improve the proposed tool and the platform.

In addition, further expansion of the simulation software test tool is expected to be possible at the management of simulation software (i.e., the solver) code level. If it is possible to test the code of the simulation software (i.e., the solver) once the future developments are registered, this is expected to have a significant impact on the EDISON service. This is because the changes in the simulation software registration process should simplify the process significantly. Furthermore, there are plans to extend the tool with simulation software quality automation.

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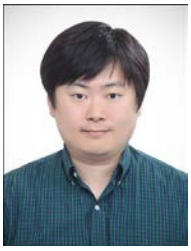
Jin Ma is a Researcher at the Supercomputing R&D Center of Korea Institute of Science and Technology Information (KISTI), South Korea. He received B.S., M.S. degrees in computer software and computer science from Kwangwoon University in 2010, 2012, respectively. He had worked as member of research staff at the solution R&D research center of BISTel, Inc., South Korea. His research interests big data, analysis system and visualization, distributed system.

Jongsuk Ruth Lee received her Ph.D. in Computer Science from Univ. of Canterbury, New Zealand. She is a principal researcher at at National Institute of Supercomputing and Networking, Korea Institute of Science and Technology Information (KISTI) and an adjunct faculty at Univ. of Science & Technology of Korea. Her research interests are smart learning, parallel/distributed computing & simulation, and big data handling.

Kum Won Cho received his Ph.D. in Mechanical (Aerospace) Engineering from KAIST, Korea. He is a head of Supercomputing R&D center and a director of EDISON (Education-research Integration through Simulation On the Net) Center, National Institute of Supercomputing and Networking, Korea Institute of Science and Technology Information (KISTI), Korea.



Minjae Park is a senior member of research staff at the solution R&D research center of BISTel, Inc., South Korea. He received B.S., M.S., and Ph.D. degrees in computer science from Kyonggi University in 2004, 2006, and 2009, respectively. His research interests include groupware, workflow systems, BPM, CSCW, collaboration theory, process warehousing and mining, workflow-supported social networks discovery and analysis, and process-aware factory automation systems.