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Establishment and service of user analysis environment related to computational science and engineering simulation platform

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요 약

계산과학공학 시뮬레이션 실행 환경을 웹 기반 플랫폼으로 제공하는 EDISON 플랫폼은 전문적인 계산과학공학 연구자 뿐만 아니라 일반 학생이나 사용자에게 다양한 분석 환경을 제공해 줄 수 있다. 이러한 시뮬레이션 환경의 사용자 확대 및 서비스 분석을 위해 매년 EDISON 플랫폼에서는 경진대회를 개최하고 사용자의 시뮬레이션 환경 요구사항을 분석하여 플랫폼의 경쟁성과 우수성을 증대하기 위해 노력해왔다. 계산과학공학 분야의 경진대회 시스템은 기존의 EDISON 플랫폼에서 사용중인 시뮬레이션 서비스와 연계되어 사용자에게 제공되고 있다. 이전까지의 EDION 경진대회 서비스는 시뮬레이션 서비스와 독립적으로 동작하여 최종 사용자 심사 및 중간 시뮬레이션 결과 확인 등의 서비스를 연계하지 못했다.

이러한 요구를 충족하기 위해 현재 서비스 중인 계산과학공학 경진대회의 서비스는 기존의 계산과학공학 시뮬레이션 서비스와 연계되어 사용자와 다양한 서비스 이용자에게 연계된 서비스를 제공할 수 있게 되었다. 또한 경진대회를 진행하고 참가하는 모든 사용자에 대한 다양한 분석을 통해 서비스를 제한적으로 제공함으로써 서비스 리소스에 대한 효율을 높일 수 있었다. 본 논문에서는 이러한 사용자의 시뮬레이션 환경 및 사용 환경 분석을 진행함으로써, 실제 사용자들에게 필요한 서비스와 사용자의 분석을 통해 경진대회 플랫폼을 제공하고 시뮬레이션 실행 환경에 대한 개선 방안에 대해 분석을 진행하였다.

☞ 주제어 : 경진대회, 계산과학공학, 플랫폼, 시뮬레이션

ABSTRACT

The EDucation – research Integration through Simulation On the Net (EDISON) platform, which is a web-based platform that provides computational science and engineering simulation execution environments, can offer various analysis environments to students, general users, as well as computational science and engineering researchers. To expand the user base of the simulation environment services, the EDISON platform holds a challenge every year and attempts to increase the competitiveness and excellence of the platform by analyzing the user requirements of the various simulation environment offered.

The challenge platform system in the field of computational science and engineering is provided to users in relation to the simulation service used in the existing EDISON platform. Previously, EDISON challenge servicesoperated independently from simulation services, and hence, services such as end-user review and intermediate simulation results could not be linked. To meet these user requirements, the currently in-service challenge platform for computational science and engineering is linked to the existing computational science and engineering service. In addition, it was possible to increase the efficiency of service resources by providing limited services through various analyses of all users participating in the challenge. In this study, by analyzing the simulation and usage environments of users, we provide an improved challenge platform; we also analyze ways to improve the simulation execution environment.

☞ keyword : Challenge, Computational Science and Engineering, Platform, Simulation

1. Introduction

The EDucation – research Integration through Simulation On the Net (EDISON)platform, which provides web-based computational science and engineering simulation services, has established services for users in various applied fields of computational science and engineering. Currently, more than

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10,000 users use the EDISON platform every year and 1,153,224 computational science and engineering simulations have been performed. In addition, we have continued to improve the existing platform services and develop new services, thus enhancing user satisfaction for the services provided by the platform in various fields of computational science and engineering.

The latest development in simulation service is a workbench simulation service that enables users to utilize a series of processes for executing and processing computational science and engineering analysis simulations as a single service. This simulation service is designed to increase user convenience and cross-support services in various fields. Consequently, it supports not only the existing computational science and engineering simulation service, but also adds or reconstructs new simulation services in real time. Simulation services are continuously evolving every year, and competitionchallenges are held to attract new users and increase the usability of the platform for existing users. The eighth competition was held in 2019, supporting computational science and engineering simulation services. The competition service had not been earlier serviced in connection with the EDSION platform because e-mails were received from each user or a separate system to cater to the competition was built. Nevertheless, since 2018, an EDISON challenge system that can be linked with regular platform services has been built; simulation usage and analysis of usage of each user in computational science and engineering simulation applications is now feasible [1-3].

As mentioned earlier, the existing system for competitons was not linked to the established computational science and engineering simulation service. Hence, it was difficult to check the CPU usage for analyzing the user's actual simulation and simulation. Because the competition system did not provide functions such as authoritymanagement of users participating in the challenge and access restrictions on service resources, it was difficult to share and access characteristics of each user and each simulation generated. Therefore, a competition platform linked to simulation services based on the applied field currently being serviced was built, and services for user analysis and analysis of simulation service usage were built and maintained. The competition service has been established and provided from the year 2018, and the platform service has been provided until the 2019 competition. Moreover, the EDISON challenge platform was required to be rebuilt according to the simulation service because of since the computational science and engineering simulation service is improving every year.

The competition platform currently in use mainly provides service usage and access control for each user participating in the competition; statistics of total CPU usage and usage of computational science engineering simulation applications are analyzed and provided to each user. Access control for users provided by the challenge platform aims to provide optimal services by analyzing and limiting service use and resource usage for each user type.

During the last two years of the competition challenge, we analyzed participant's usage and resources provided to users to expand and improve various services. In addition, by improving the service of the existing competition users and analyzing the simulation calculation algorithm and calculation node usage of various users in real time, a study was conducted to analyze the needs of various users and reflect them in new services.

In this study, a challenge platform for the EDISON platform, which provides simulation services in various fields of computationalscience and engineering, was built; this challenge platform was linked to the existing simulation service to serve users. In order to provide services to users in various fields of computational science and engineering, services were divided and provided for each field of use, and an access control system for each service resource and user resource was established.

In addition, while each challenge was conducted, the recent user usage and challenge result data were analyzed, and user analysis was conductedto reflect the analysis results of the end users in new services.

In Section 2, the existing computational science engineering simulation platform and EDISON platform are described.

Section 3 describes the competition system built in connection with the EDISON platform.

In Section 4, we analyze the service provision method and result data for users who access the challenge platform and use the service.

Section 5 provides the final conclusions and future research directions.

2. Computational Science and Engineering Platform

2.1 Web based computational science and engineering platform

The EDISON platform, a computational science and engineering platform system, provides to users with a computational science and engineering simulation service in a web-based environment. Various computational science and engineering simulation services allow users to register simulation analysis environments on the Science software app store, share their software with general users, It provides analysis results in the high- performance computing (HPC) environment. Each computational science and engineering simulation service operates based on high-performance, high-throughput HPC, and provides a service friendly UI to users.

In general, computational science and engineering simulation services require a large amount of computational science and engineering analysis environments, and general computational environments require a lot of calculation time and resources. Therefore, a system that provides web-based computational science and engineering simulation services, such as the EDISON platform, provides an Message Passing Interface (MPI) execution environment based on HPC. It provides a large-scale, high-performance computational resource to provide a better simulation computational environment than a general user computing environment [4] [5].

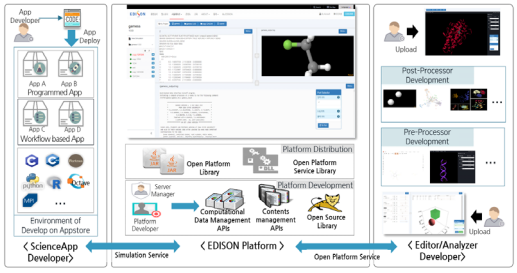
The needs of a web-based simulation service in the appiled field of computational science and engineering has recently increased with cloud computing environments such as Amazon's s3 [9] or Microsoft's Azure [10], which provide a resource sharing environment to share various resources. In addition, various services that provide computational science and engineering simulation services are also building a system that can provide shared resources to users by building cloud services [6] [7] [8].

2.2 EDISON platform

EDISON is a web portal system that provides computational science and engineering software using cloud services. Currently, the EDISON system provides eight applied fields of computational science and engineering software execution environments: computatianal fluid dynamics, computational nanophysics, computational chemistry, computational structural dynamics, computer aided optimal design, computational medicine, computational electromagnetics, and urban environment [1] [3].

The EDISON platform defines the process of registering analysis software in the field of computational science and engineering, executing simulations, and analyzing and post-processing result data. Therefore, the role of the developer who develops simulation software in the applied field of computational science and engineering, and developers of post-processing software that analyze and visualize result data are specifically separated. A service system that supports students and researchers who execute and run simulations is established combining the developers'role and resource control. In other words, the general user can be provided with all services that can perform analysis simulation and analyze the result data in a web-based environment using the computational science and engineering simulation software registered in the EDISON platform [2].

Figure 1 is a schematic diagram of the workbench simulation service being provided by the EDISON platform. By providing the entire process of simulation service such as data pre-processing, simulation execution, and post-processing that visualize a simulation result data as a single service, the platform lowers the barrier toward entry into computational science and engineering simulation services and provides services for general students and researchers. Even if the general user does not understand the



(Figure 1) Edison Workbench Service Architecture

internal algorithm of the simulation accurately, the service is provided to run the simulation and process the result data.

The platform also provides pre-processors, simulation software, post-processors, and analysis visualization services to perform computational science and engineering simulations for a variety of applied fields.

Table 1 shows the overall usage statistics of the EDISON platform and the number of registered contents and software.

(Table 1) EDISON Statistics

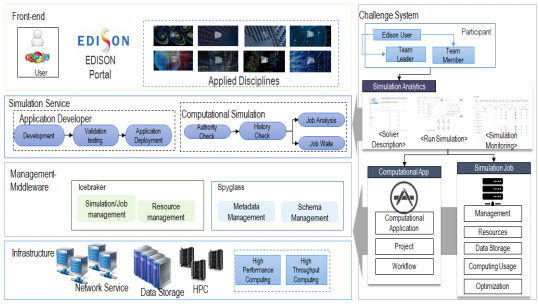
Class	Num.
User	54509
Simulation	1153554
Software	779
Contents	837

3. Challenge Platform with EDISON

The challenge simulation platform is a service that provides users with information about each challenge and participant in connection with an existing simulation system while conducting competitions on the EDISON platform. Currently, the EDISON platform is built using Liferay open source. Therefore, the construction of the challenge platform linked to the EDISON platform was built using the corresponding Liferay open source. The challenge system stores information about each user and configures each user's team to provide a service access control system. In addition, by analyzing the simulation execution information of each user, the average cpu usage information is extracted and managed.

3.1 Construct the Service Resource Access Control System

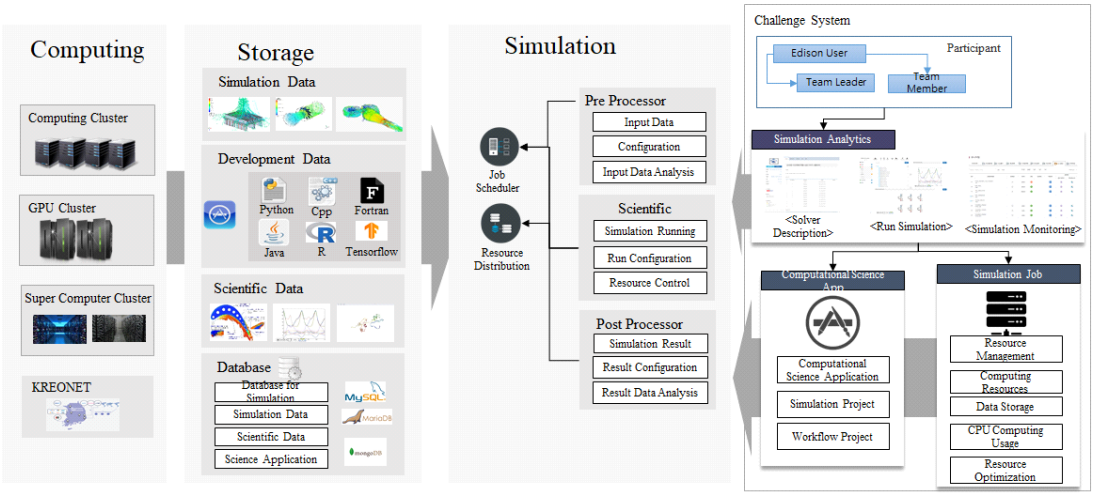
To build a challenge system in conjunction with the current EDISON platform, detailed user service control is required; access control function for each information must also be provided. Simulation information management including refined information and access control[11-13]is required for each applied field of computational science and engineering. Therefore, users who apply to participate in each challenge of applied field must also establish resource service management for access control and simulation execution information. The system structure for the EDISON competition is shown in Figure 2.



(Figure 2) EDISON Challenge System Architecture

The users who want to participatein the general challenge challenge must be users of the EDISON web portal. To participate as a team, team members can only add users of the EDISON web portal. Once a team is created to participate in a challenge, information, corrections, and deletions can be made by the administrator, evaluator, and system administrator for the team. Therefore, users who can access the entire challenge system can be largely divided into challenge participants, competition managers, evaluators, and overall system managers.Regular users can participate in the competition system to create teams and add new team members. In this case, the team members added as the same team are available only to all EDISON users; users added as team members can share the same information as ateam. In addition, when a new team is created, the manager and evaluator for each team can check the information according to the expertise of the team. Professional managers can modify or delete team information and manage assessments. The challenge evaluator who evaluates each team can check the simulation information, CPU usage, competition papers and presentation data used by the team, and input evaluation scores.

If the system administrator adds a challenge for a new applied field, the roles of the manager and evaluator for that specialty are automatically added.



(Figure 3) EDISON Simulation Plugin with Challenge System

3.2 Building Challenge Platform connected Simulation System

The currently established challenge system calculates and provides the linkage of each user, the number of simulation runs that the user is using in the EDISON platform, and the average CPU usage. Based on the members of each team participating in the challenge, the information of the simulation and usage science app used by the user is calculated and provided comprehensively.

Participating users in each team are provided in connection with users of the EDISON platform, and the average value of the total simulation CPU usage is calculated according to the number of users participating in the personal simulation.The architecture of the challenge system linked to the EDISON system is shown in Figure 3 below.

As shown in the figure, the simulations used by the challenge participants in connection with the services provided by the existing EDISON platform were analyzed to build the results. So that the evaluator and each challenge manager could check the results of paticipants. The challenge characteristics of the simulation were calculated by classifying the average value of CPU usages of simulation for each team participating in the competition.

4. Challenge Participant Analyze of Simulation Service Usage

The established challenge platform has been in use since 2018; it has been used twice. In addition, the platform analyzed the utilization of the simulation of the platform users. Futhermore, the service analyzed the simulation applications that were frequently used to support the utilization in the EDISON platform.

4.1. Challenge participant analysis of simulation service usage

The contest platform provides integrated services for various users and managers participating in the contest it also providesuser management. On the contest platform, the EDISON platform conducts large-scale computing calculations through computational science engineering simulations, analyzes the computational results, and conducts contests in various fields. The contest platform provides services to users in the computational science and engineering field in eight areas; it also provides services to themanagers who manage the contest, and evaluators who analyze and evaluate the results of each participant. The accessto service resources is controlled for each type of user,

and the service of the contest is provided separately according to the role and authority of each user.

Table 2 shows the resource service model definition for users defined in the current contest platform.

(Table 2) Service Definition

Service	Resources
Challenge Admin	5
Challenge Evaluation	5
Challenge Evaluation Management	19
Challenge Participation	19
Challenge Result	5
Challenge Team	35
Challenge Team Member	88

As shown in Table 2, service resources for each service model are defined. The resource usage for each service is as defined in Table 2. For example, in the Challenge Admin service model, a total of 5 service resources can be accessed and provided to users. Service resource refers to a transaction in which a user requests access to a resource and controls access to the resource. In the simplest example, in the Challenge Admin model, the five services include as a transactions that can create, delete, update, and modify new models.

Table 3 shows the relationship between the services provided in Table 2 and the services actually provided to each user.

(Table 3) Resource and permission correlation analysis

Service	User	
	Permission	Resources
Challenge Admin	0	0
Challenge Evaluation	0	0
Challenge Evaluation Management	0	0
Challenge Participation	1	3
Challenge Result	0	0
Challenge Team	0	0
Challenge Team Member	1	3

Service	Participant	
	Permission	Resources
Challenge Admin	0	0
Challenge Evaluation	0	0
Challenge Evaluation Management	0	0
Challenge Participation	1	11
Challenge Result	0	0
Challenge Team	0	0
Challenge Team Member	1	1
Service	Evaluator	
	Permission	Resources
Challenge Admin	0	0
Challenge Evaluation	1	4
Challenge Evaluation Management	0	0
Challenge Participation	0	0
Challenge Result	0	0
Challenge Team	0	0
Challenge Team Member	1	4
Service	Center Manager	
	Permission	Resources
Challenge Admin	0	0
Challenge Evaluation	0	0
Challenge Evaluation Management	1	16
Challenge Participation	0	14
Challenge Result	0	1
Challenge Team	1	23
Challenge Team Member	2	54
Service	Administrator	
	Permission	Resources
Challenge Admin	5	5
Challenge Evaluation	5	5
Challenge Evaluation Management	5	19
Challenge Participation	5	19
Challenge Result	5	5
Challenge Team	5	35
Challenge Team Member	30	88

Table 3 is the result of analyzing the number of service resources provided based on the privileges allowed and the privileges for each user type.

As can be seen in the table, general users have access to the contest team that participated in or participated in the contest. Also, you can check the number of service resources for the right. Likewise, in the case of an administrator, who is a total administrator, it means a super user with all rights, and has all access rights to each service resource. The Center Manager, which has management rights for each contest participant, has less management rights than the Administrator, but has management rights for the field of the Computational Science and Engineering contest, and additional service resource rights. Evalutator has the management authority to evaluate each contest participant, and has the authority to score points for evaluation items or to check computational science engineering simulation execution information for paticipants participating in the contest.

4.2 Analyze whole participants Challenge Simulation Challenge

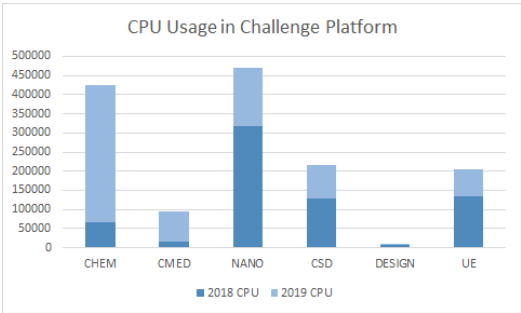
Figures 4 and 5 show the analysis of whole paticipants who registered on the platform and participated in the challenge challenge.

Figure 4 shows the results including all simulation CPU usage of all users participating in the challenge challenge.

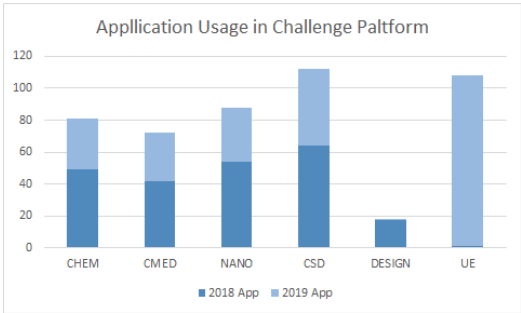
The total simulation CPU usage used during the challenges of users participating in 2018 and 2019 is plotted.

The computational nanophysis appiled field with the most CPU usage has many CPU usages as a result, because there are many applications that take a long time to interpret the results of each simulation. In the computer aided optimal design appiled field(DESIGN), the use of the platform is less than other fields because this appiled field challenge challenge is heldbased on the final demonstration with the actual design, rather than using simulation service on the EDISON platform. In addition, the urban environment appiled field(UE) was started by participating in the EDISON project since 2018, the simulation usage in 2018 is relatively small.

In Figure 5, the overall usage is similar, but the science application used in the appiled field of computer aided optimal design(DESIGN) is far less used than in other fields because it runs on the design platform and proves the result data through actual demonstration. In addition, the urban environment(UE)appiled field began to participate in platform services in 2018, and it was confirmed that the total number of applications registered in 2019 increased exponentially.



(Figure 4) CPU Usage in Challenge Platform

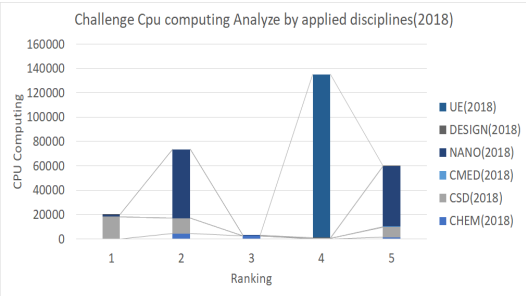


(Figure 5) Application Usage in Challenge Platform

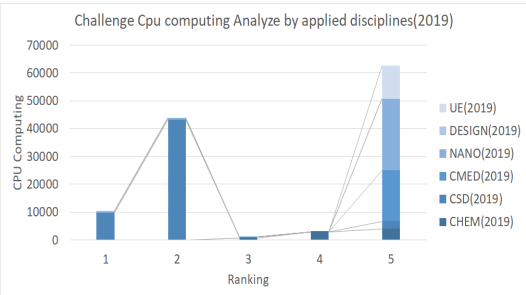
4.2 Analyze Prize WinnerChallenge Simulation Challenge

Among the users who participated in the recent challenge challenges, the results of the analysis centered on the users who have received the final award are shown in the following figures 6 and 7.

Figures 6 and 7 show the average value of simulation computing usage by ranking, centered on the award-winning teams of each year after building the competition system. Users in various appiled fields have run simulations during the challenge challenge, but overall, the usage of the



(Figure 6) CPU Computing Analysis(2018)



(Figure 7) CPU Computing Analysis(2019)

platform is decreasing. In some areas, computational science and engineering simulation by application area have decreased, and in some applications, CPU usage has increased. Overall, it can be seen that the amount of usage in the fields computational chemistry and computational medicine(CHEM, CMED) that used the platform as an evaluation criterion increased during the competition screening process. In the competitions in the remaining fields. There are also fields for designating specific simulation applications in field computer aided optimal design(DESIGN), and there are fields computatiaonl fluid dynamics, computational nanophysis(CSD, NANO) that have been reduced due to the completion of projects in the fields. Also, based on Figures 6 and 7, it can be seen that the final winner's usage was based on the completeness of the simulation itself rather than the computing simulation resource usage. It can be seen that the total number of CPU computing resources used by the first winner in the appiled field of computational science and engineering is not higher than that of other winners.

5. Conclusion

In this study, the challenge conste platform research and construction linked with the EDISON platform that provides computational science and engineering simulation services was described. In addition, during the competition, actual service usage analysis of the challenge platform was conducted through usage analysis and service analysis of registered users.

In the meantime, the EDISON platform has been building individual simulation services and simulation management modules for computational science and engineering. The challenge system was established by analyzing the system and connecting EDISON simulation services. Meanwhile, the competition used an independent system and could not analyze the actual users' analysis and screening results according to platform usage. In addition, as the services of the existing simulation system were diversified and advanced. It was not possible to conduct analysis on users' usage and simulation execution.

Using the challenge platform plugined with EDISON simulation service established in this study. It was possible to provide sperated challenge challenge including paticipant management in connection with simulation services in each field of computational science and engineering. There has two major feature of challenge challenge platform to service.

First, a system was developed to effectively analyze and control users by managing resources and restricting service access for each appiled field of computational science and engineering that holds each challenge challenge in the platform. As the number of users in the appiled field of computational science and engineering participating in the competition increased, the service and service resources required for each field of computaional science and engineering were different. So a challenge platform environment was established and provided as suitable for each appiled field.

Second, in conjunction with the EDISON platform module that provided the existing computational science and engineering simulation service, a system was developed to manage the information of CPU computing usage, simulation result data, and computational science and engineering

interpretation applications used by users participating in the competition. It was provided as a service along with the user's access control system.

As a future research, we will analyze the system configuration required for each specialized field by reflecting the user's analysis and service analysis in the competition system, and complement and develop the simulation system of the EDISON platform. In addition, by building a visualization module for existing result data, a monitoring system capable of real-time monitoring will be built to conduct user analysis.

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