

Web Portals of the K computer

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Modern computer and communication technologies have transformed computers into information appliances, where people can have at their fingertips any information spread throughout the World Wide Web. The current Web technologies provide means for accessing a computer's sophisticated functionalities through easy-to-use and intuitive user interfaces. Such features are also important in the technical computing field, where researchers require not only high-speed computing power, but also capabilities to easily access the complex functionalities of supercomputers. As part of the effort to provide easy access to the K computer, We developed Web-based User's Portal, which provides means for the end users to access the K computer through the Web. We also developed the Systems Administrator's Portal to make it easier for systems administrators to manage the large-scale computer system. In this article, we introduce key design issues in developing the User's Portal and the Systems Administrator's Portal.

1. Introduction

The K computer^{note)} with a computational capacity of 10 PFLOPS is intended not only for executing unprecedented large-scale numeric simulations and data analysis but also for providing a system friendly to users including various researchers and engineers.¹⁾

We have built Web portals to support users of the K computer and administrators responsible for system operation (**Figure 1**).

1) User's Portal

The User's Portal is equipped with a graphical user interface (GUI) that enables anybody to easily access the world's fastest²⁾ supercomputer from a Web browser. It helps users to easily use the K computer and analytic

applications on the K computer.

2) Systems Administrator's Portal

The Systems Administrator's Portal has a GUI that allows monitoring and operation of a massive-scale, advanced system with more than 80 000 nodes from a Web browser. It helps to reduce the administrator's burden of system monitoring and operation and operational errors.

3) Portal base

The portal base is a content management system equipped with functions required for the portal site including user authentication and menu. Its simplified page description language allows easy creation of Web pages such as the system usage and operation guides, and manuals.

This paper presents the User's Portal and Systems Administrator's Portal.

2. User's Portal

The User's Portal is a Web application that allows easy execution of analytic applications on

note) "K computer" is the English name that RIKEN has been using for the supercomputer of this project since July 2010. "K" comes from the Japanese word "Kei," which means ten peta or 10 to the 16th power.

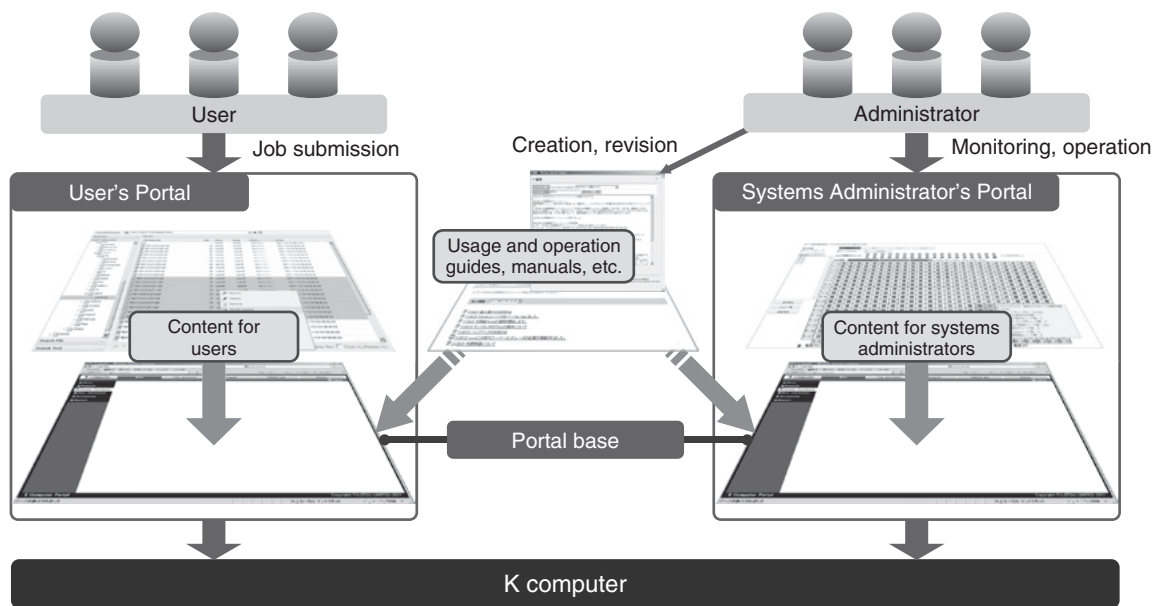


Figure 1
Web portal structure.

the K computer from a Web browser or the user's own program. The major functions include:

- Job submission
- Job status indication and basic job operations
- Basic file operations on the K computer
- File transfer with client PC
- Program compilation and link operations

Figure 2 shows sample screens of the User's Portal. This section describes the points where we adopted special measures for the K computer, a large-scale environment.

2.1 Support of various job models

The K computer is designed to be capable of executing various jobs including independent jobs (normal jobs), jobs executed in multiplicity with combinations of different parameters (bulk jobs) and jobs with fixed dependencies of the order of execution between jobs (step jobs).

Accordingly, we have provided a GUI that allows these jobs to be submitted from the job submission screen of the User's Portal. The job status indication screen shows the status of the individual jobs (sub-jobs) that constitute bulk

and step jobs.

On the job submission screen of the User's Portal [Figure 2 (a)], a pulldown menu offers a selection out of normal, bulk and step jobs, and job parameters according to the job type can be set easily. When a step job is submitted, for example, the predecessor step jobs are listed as dependency candidates, and this allows dependencies between jobs to be easily specified.

2.2 Indication of tens of thousands of files and jobs

The user checks the existence of files required and status of jobs submitted before considering the next operation. Accordingly, the file operation and job status indication screens must enable the user to quickly identify the desired files and jobs. To prevent degradation of the screen display speed, the K computer, which handles more than 10 000 files and numerous jobs in one numeric simulation or data analysis, is provided with the following measures taken for the file operation screen [Figure 2 (b)] and job status indication screen of the User's Portal.

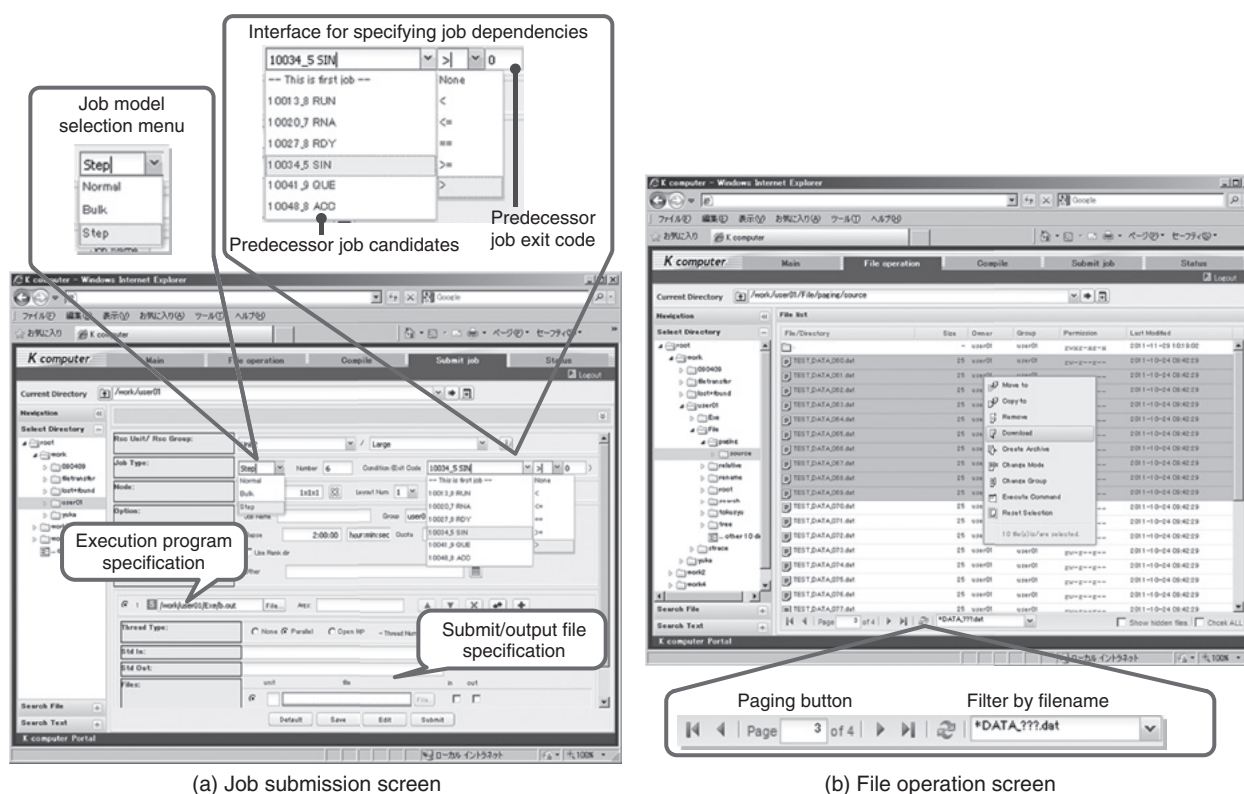


Figure 2
User's Portal sample screens.

2.2.1 Partial screen update by asynchronous communication

The User's Portal of the K computer makes use of the Asynchronous JavaScript + XML (Ajax)³⁾ technology to adopt a screen update technique that redraws only the necessary screen areas according to user operation.

Ajax is a technology that uses the hypertext transfer protocol (HTTP) communication function of JavaScript for asynchronous communication with the server to partially redraw the screen. Unlike the existing Web applications that involve screen transitions, this technology does not erase an entire screen for every operation, which makes it popular for use in Web applications that make a point of interactivity.

With this new technique of screen update, the User's Portal features reduced screen generation processing by the server, less data transfer between the server and client and

reduced drawing processing of Web browsers as compared with the existing user's portals, which update an entire screen. The advanced GUI based on Ajax allows the user to operate files and jobs in the same way as Windows Explorer.

2.2.2 Narrowing of listings

Displaying tens of thousands of files or jobs on the screen at one time increases the amount of data transfer from the server. In addition, a Web browser applies a certain style when files or jobs are displayed, which uses more memory than just for the amount of data received from the server, leading to degradation of the display speed. As a result, user operability is also deteriorated as well.

To address this problem, the User's Portal of the K computer adopts the following measures for smooth display and operation of enormous numbers of files and jobs.

1) Paged screen view

Paged view is used for both file operation and job status indication screens. The maximum number of files or jobs displayed on one page is defined on the server in advance and the screen displays one page's worth of files or jobs. The server caches the list information of files or jobs of all pages. The user's paging button operation immediately transfers one page's worth of file or job list information from the cache to be displayed on the screen.

2) Filtering by filename pattern

Of the files in a directory, in many cases only some are files that the user wants to view. Accordingly, the file operation screen is provided with a function to narrow down the files to be displayed by specifying a filename pattern. This not only reduces the amount of data transfer from the server but also allows the user to easily select the files to view out of the enormous number of files and operate them.

2.3 Long-time processing for groups of large files

The K computer assumes that the user handles a few hundred Gbytes to a few tens of Tbytes of data. Operation (file copying, searching, archiving, etc.) of such large files is time-consuming and the Web browser may time out during the operation.

Accordingly, the User's Portal uses an innovative processing sequence to prevent Web browser timeout in spite of operating a large amount of data, which is described below.

- 1) Execution of long-time processing is requested from the Web browser to the User's Portal.
- 2) The User's Portal starts long-time processing and returns a response to the Web browser without waiting for the completion of processing.
- 3) The Web browser shows an animation indicating "in process" and queries the User's Portal to check whether or not the

long-time processing has been completed.

- 4) The User's Portal checks the progress of the long-time processing and returns a *processing complete* or *processing not complete* response to the browser.
- 5) Upon reception of a *processing complete* response, the Web browser stops the animation indicating *in process* and shows the result of processing on the screen. If it receives a *processing not complete* response, it queries the User's Portal again to check the processing situation.
- 6) Steps 4) and 5) are repeated until the long-time processing is completed.

2.4 Ensuring of customizability

The K computer has been designed by assuming it will be used by researchers and engineers with varying computer skills. It is possible to add dedicated screens to allow easier execution of individual analytic applications for expanded services along with the expansion of the user base.

The User's Portal is provided with a function of creating a job submission screen for an analytic application (**Figure 3**). Simply by preparing a definition file and job execution script template file, the administrator can create a job submission GUI for an analytic application and the services can be flexibly expanded in accordance with the expansion of use of the system.

2.5 Use from programs other than Web browsers

Operations that use analytic applications consist of preparation of data to submit to the solver program (pre-processing phase), execution of the solver program by means of a supercomputer (analysis phase) and evaluation of the output data of the solver program (post-processing phase). The pre-processing and post-processing phases take place on the user's PC or workstation (WS) so that data can be visualized

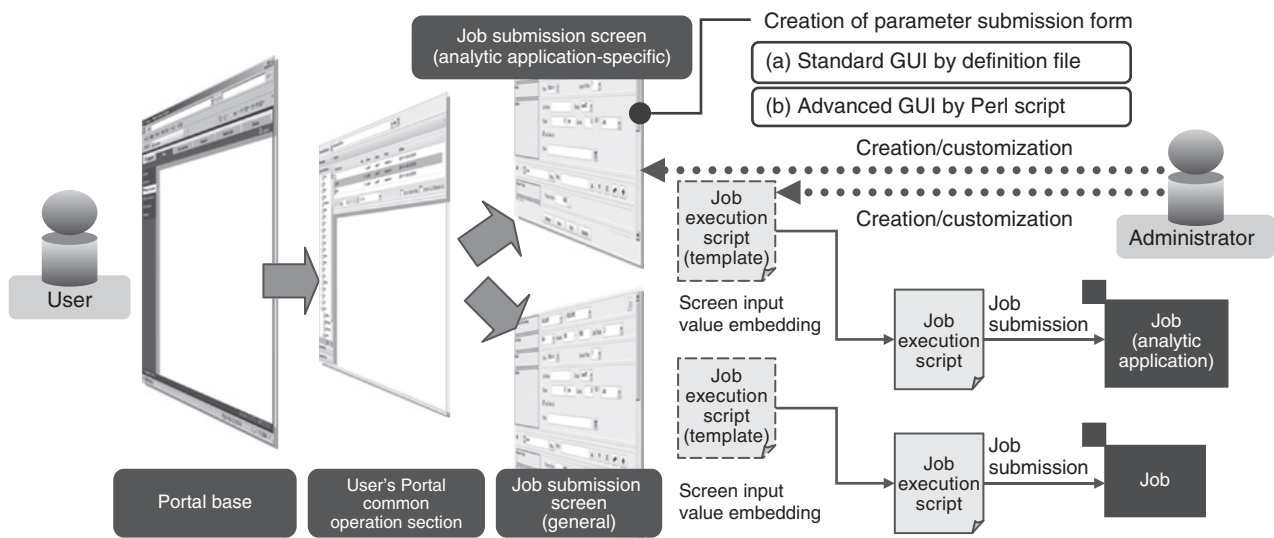


Figure 3
High customizability through application GUI customization function (User's Portal).

and the analysis results can be checked in an interactive manner. For this reason, we consider that allowing consecutive execution of the processing of the three phases across different execution environments will lead to improved efficiency of the user's operations.

The User's Portal has the screen control function for Web browsers separated from the function of executing user operations on the K computer to allow the K computer to be operated from client programs other than Web browsers. The latter function can be called from a program other than a Web browser via a Web service. In addition, to enable the user to easily create a client program for the K computer, a client library (in command and Perl-API formats) that runs on Windows, Linux and Mac OS X is provided. The user can seek to automate and improve the efficiency of operations that use both PC/WS and the K computer by using the client library to create a script that runs on the PC or WS at hand.

3. Systems Administrator's Portal

The Systems Administrator's Portal is a Web application intended for systems administrators

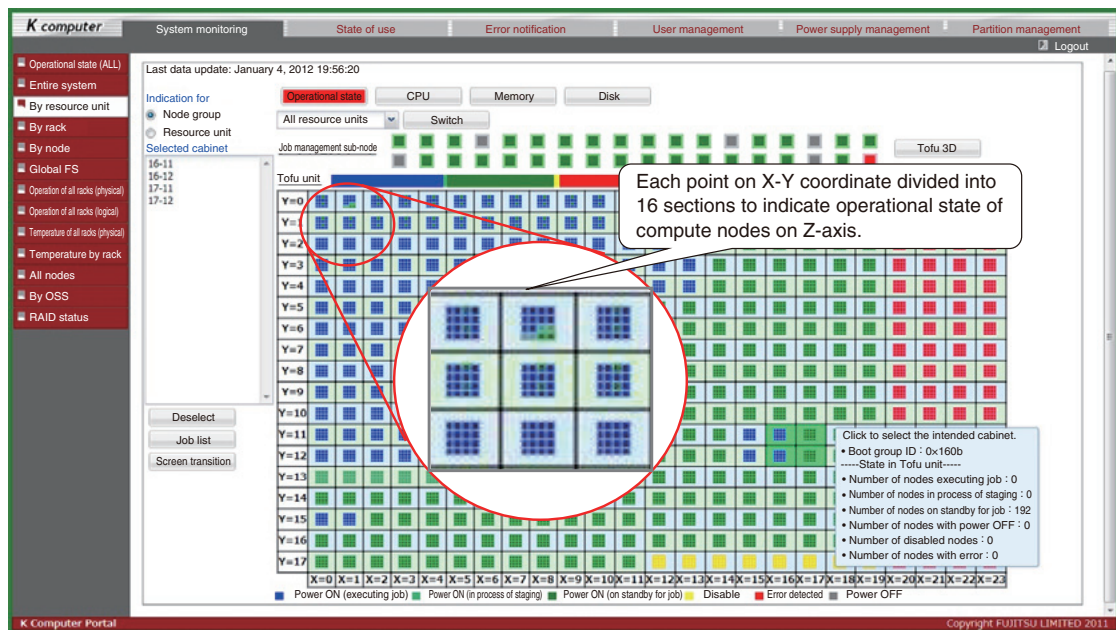
that allows them to easily monitor and manage compute nodes and storage systems of the K computer from a Web browser. Major features include:

- Indication of operational status of compute nodes
- Indication of CPU, memory and disk usage
- Power supply control of systems and compute nodes
- Indication and operation of a job list
- Indication of error information list
- Management of user information and indication of billing information

Sample screens of the Systems Administrator's Portal are shown in **Figures 4, 5** and **6**. This section describes the measures taken in the development of the Systems Administrator's Portal with the K computer, a large-scale environment, taken into consideration.

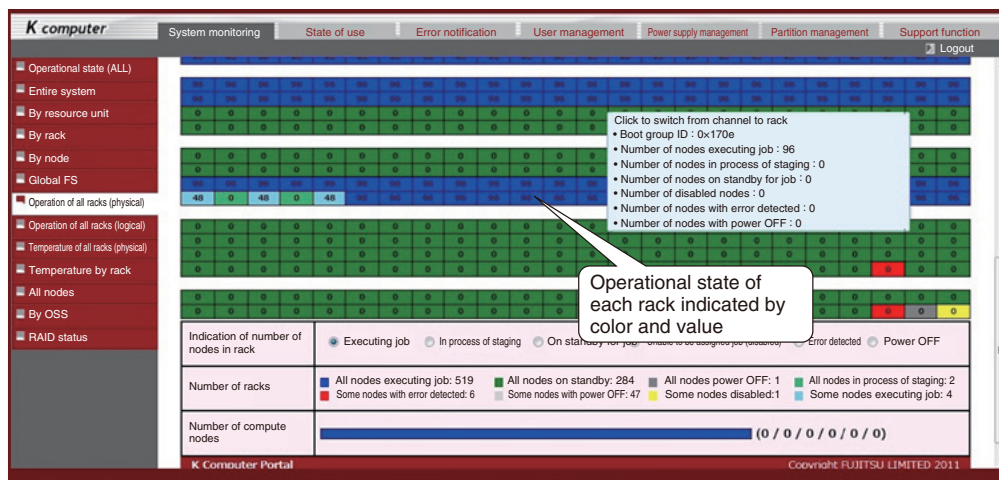
3.1 Large-scale node status indication with different logical and physical placements

To optimize 6D mesh/torus network, the K computer has different physical and logical placements of compute nodes. There are limits



(Original is in Japanese)

Figure 4
Operational state indication for individual resource units (Systems Administrator's Portal).



(Original is in Japanese)

Figure 5
Indication of operational state of all racks (physical placement) (Systems Administrator's Portal).

to what the systems administrator can do in monitoring over 80 000 compute nodes and 864 racks that house them while converting between logical and physical placements. For that reason, a system capable of monitoring from the perspective of both physical and logical placements is required, rather than the conventional system that indicates the

operational state based on the physical placement.

The Systems Administrator's Portal is provided with separate screen views for monitoring the operational state of an entire rack from the perspective of logical and physical placements. Operational state indication for individual resource units (Figure 4), which is

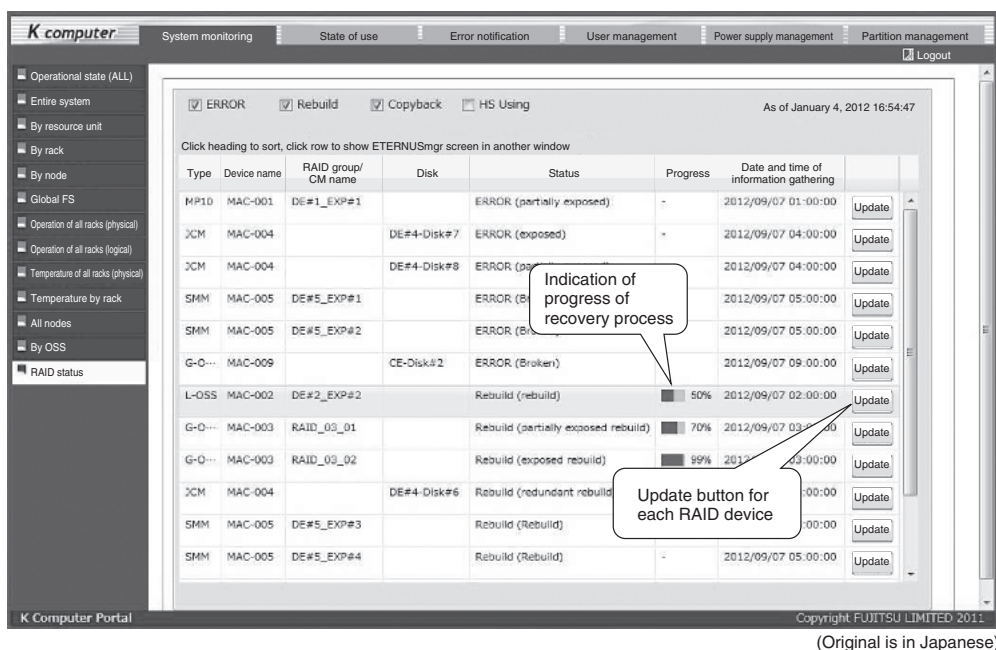


Figure 6
Screen for monitoring RAID status (Systems Administrator's Portal).

one screen for logical placement, has each point on the X-Y coordinate divided into 16 sections to show the operational state of all compute nodes including the Z-axis direction. This is in view of assignment of jobs to a logically continuous 3D torus view space. Indication of the operational state of all racks (physical placement) (Figure 5), a screen for physical placement, shows the operational state of each rack represented by a color and value of an icon.

The systems administrator can visually acquire the necessary information from screen views that suit the respective operations. To monitor a job, for example, a screen for logical placement can be used to monitor the state of the job assigned to a continuous region. In addition, the compute node that is executing the job to be monitored can be selected and associated with the CPU, memory or disk usage for monitoring the state. For maintenance, a screen for physical placement can be used to identify the locations that require replacement of parts. Furthermore, the screen providing temperature information makes it easier for the systems administrator to decide the surrounding temperature of failure

part for any abnormality.

3.2 Disk status monitoring of large-scale storage

The global file system of the K computer has a data capacity of over 30 Pbytes and almost 100 000 disks are used in the entire system. When any disk fails, a backup disk is used for rebuilding and, after the failed disk has been replaced by a maintenance engineer, recovery (copy back) from the backup disk is carried out. Because of the vast number of disks, grasping the progress of rebuilding and copying back for each disk is cumbersome, which poses a problem.

The RAID status monitoring screen (Figure 6) of the Systems Administrator's Portal gathers and aggregates information about the operational state of the individual RAID devices to provide a centralized view on a Web screen. This screen uses two ways of information gathering to allow the systems administrator to view the latest information when required while minimizing the burden of processing of information gathering from the RAID devices. One is an automatic gathering process that

regularly gathers information from all RAID devices. The other is a process of information gathering from the individual RAID devices, which is activated by the administrator's pressing the Update button provided on the screen for each RAID device and gathers the latest information from the intended RAID device for its indication.

This screen provides an at-a-glance view for exhaustive monitoring of the state of disks with any error in the entire system. The systems administrator can press the Update button when he or she wants to intensively monitor a RAID device and view the latest status of processing on that device. This enables the systems administrator to estimate when the disks will return to their normal state, which helps in planning operations of the system.

4. Conclusion

This paper has described the User's Portal

and Systems Administrator's Portal introduced in the K computer. These two Web portals can be used not only for the K computer but also for PC cluster systems and supercomputers that will follow the K computer in the future. Demand for technical computing is expected to grow in the future both in Japan and overseas. We are committed to continuing our efforts to improve operational efficiency and reduce the burden on users and administrators of supercomputers by providing the User's Portal and Systems Administrator's Portal presented in this paper.

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