A REAL-TIME OBSERVATION SYSTEM OF ACCELERATOR OPERATION USING JAVA

M. Mutoh, M. Nanao and O. Konno
Laboratory of Nuclear Science, Graduate School of Science, Tohoku University
1-2-1 Mikamine, Taihaku-ku, Sendai 982-0826, Japan

Abstract

A stretcher-booster ring (STB) was constructed at Tohoku University. Real-time information on the STB operation is provided through the Internet. Our goal for this system is for accelerator researchers and engineers to be able to diagnose any accelerator problems from their offices or homes via the Internet. A recently developed Java language is used for various graphic displays of the operation records which are saved in the database. The database which provides real-time information to the Internet is separated from the control database and has been installed on the www server. This has been done to protect the control database from illegal access from the Internet and also to help reduce the CPU load in the database server used for the accelerator control. The transmission of the data from the control database to the www database is achieved using a replication function having the MS-SQL. The control database is defined as a publication-server, and the www database is defined as a subscription-server. Vacuum pressure in the STB and a beam current of an experimental target point are currently displayed on our laboratory's home page using Java-applets, we will provide other information about the status of the operation to the Internet soon.

1 INTRODUCTION

The World Wide Web (www) has become rapidly more popular, because it allows easy access to a wide variety of information from across the world and because it is an open system independent of computer platforms. At the inception of the www, the information flow using only HTML was a one-way communication from the www server to the browser. Further development of the computer and network technologies made possible two-way communication between the source and destination of information on the Internet. In particular, the appearance of Java language made it possible for the www to expand into the transmission of dynamic information using animation, video or voice. We propose here that if these new Internet or Intranet technologies were applied to an accelerator control system, it would be possible to construct a real-time observation system to provide constantly updated information on the accelerator's operation.

The STB [1], constructed at our laboratory in the autumn of 1997, has been operating under test conditions and will soon begin practical operations for nuclear experiments. Accelerator engineers and physicists wanted information on the STB operation to be available on the Internet so that they could monitor the conditions of the accelerator's operation and diagnose any accelerator problems from their offices or homes. We therefore have been constructing a real-time observation system, and so far the conditions of the STB vacuum system and the accelerated beam current at the experimental target point have been transmitted graphically and dynamically in Java applets on the Internet. We aim to present via Internet all of the information on the accelerator operation that is ultimately saved into the control database.

2 DATABASE SYSTEM

The structure of the database system in the STB control is shown in Fig. 1. The STB control system [2][3] consists of eleven personal computers and a database server computer , which acts as a control manager in the core of the control system [4]. All operation data from the accelerator devices are collected into a database server known as a control database. The collected data in the control database is processed and distributed to the operator consoles or accelerator devices as feedback data. If the control database can be accessed through the Internet, all information concerning the accelerator operation can be accessed easily. In order to prevent illegal access to the control database via the Internet, the database for providing real-time information to the Internet is kept separate from the control database and installed on the www server. Separating these databases helps also reduce the CPU load in the server computer that is used for STB control. Both the STB control database and the www database are MS-SQL Server. The www server is connected with a 100Base-TX/FX network for the STB control and through a campus network extended to the Internet. The transmission of the data from the control database to the www database is achieved using a replication function having MS-SQL. The control database is defined as a publication-server, and the www database is defined as a subscription-server. Consequently, accessing the www database is equivalent to accessing the control database, and furthermore, if the www database were issued the wrong SQL command and

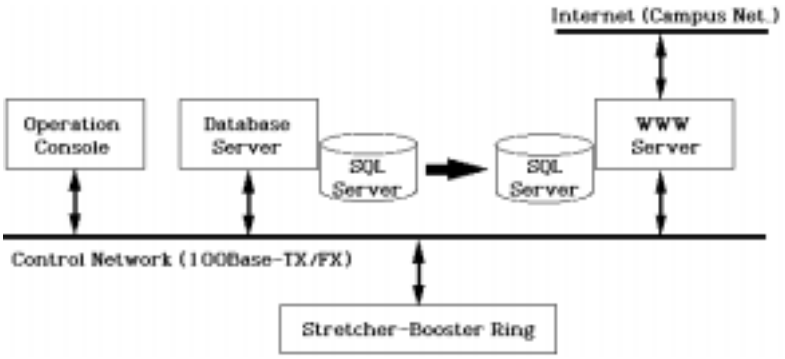

Figure 1: Structure of the database system in the STB control.

temporarily destroyed, the accelerator's operation would not be affected.

At present, the status of the vacuum components and the vacuum pressure values are collected at 2 minute intervals and the past week's worth are saved in the www database. Also, the beam current values collected at 2 minute intervals over the 24 hours are saved in the www database. Past records of these values can be observed graphically on web-browser via the Internet [5]. We are presently preparing other data for presentation on the web, for example, fluctuations of RF frequency, power level and phase, water flows and temperatures in cooling system, statuses of the magnet power supplies, wave-form signals and pictures from beam monitors, operation logs, alarm records and so on. In addition, we will soon extend the data range within our main facility, an electron linear accelerator to provide for the internet.

3 JAVA APPLET

In order to display the STB operation information graphically and dynamically on the web-browser, we elected to use Java applet. Java has the following excellent features:

(1) it is executable on computers supporting multiple platforms such as Windows, Macintosh, and Unix,
(2) it provides easy access to data or application programs on remote computers via the computer network,
(3) it offers simple program structure and effective programming development by means of object-oriented programming,
(4) it contains useful Graphical User Interface (GUI) components like buttons, check-boxes, lists, labels, text and so on, making it easy to communicate via mouse.

The display programs written in the Java language are converted to a middle-code called Java applet by the Java compiler. Java applets are put into the www server, transferred to the client computer and executed by the web-browser.

At present, the following four applets are offered for the observation of the STB operation information:

(1) statuses of valves and actual pressure measured in vacuum gauges and ionization pumps in the STB vacuum system,
(2) distribution map of vacuum pressure in the STB using a bar-graph,
(3) past record of vacuum pressure in the STB over one week,
(4) past record of the beam current from the accelerator over 24 hours.

A display window for the record of past vacuum pressure is shown in Fig. 2. A device list of ten pressure gauges and twenty-seven ionization pumps and a color list appear in the window, and the observer can select the gauges or the pumps to be observed using the mouse on the client computer. The selected device's data is sent from the www server to the client computer every two minutes, and past records are displayed with selected color and updated whenever data comes in. Moreover, the displayed graphs can be shifted in the window using the scroll buttons to view data from anytime within the last week. Fig. 3 shows the distribution map of vacuum pressure in the STB. The horizontal axis numbers in the window indicate the ionization pump's names.

4 CONCLUSION

The STB operation information, which has been provided through the Internet, has been helpful for engineers and physicists, and the provision of more information on the accelerator operation and nuclear experiment conditions has been enthusiastically requested. We plan to not only extend the information that is offered, but also to develop various Java components to facilitate the design of an effective Java programming environment.

REFERENCES

[1] T. Tamae et al., "1.2GeV STRETCHER-BOOSTER RING PROJECT AT TOHOKU UNIVERSITY", The XVI RCNP OSAKA International Symposium on Multi-GeV High-Performance Accelerators and Related Technology, Osaka, Japan 1997
[2] M. Mutoh et al., "A New Approach to Control System for Medium-Scale Accelerators", International Conference on Accelerator and Large Experimental Physics Control Systems, Chicago 1995
[3] M. Mutoh et. al., "The Present Status of the Control System for a Stretcher-booster Ring at Tohoku University", PCaPAC99
[4] M. Mutoh et al., "Improvements in Database System for Accelerator Control", International Conference on Accelerator and Large Experimental Physics Control Systems, Beijing 1997
[5] URL:http//www.lns.tohoku.ac.jp/operation/operation.html

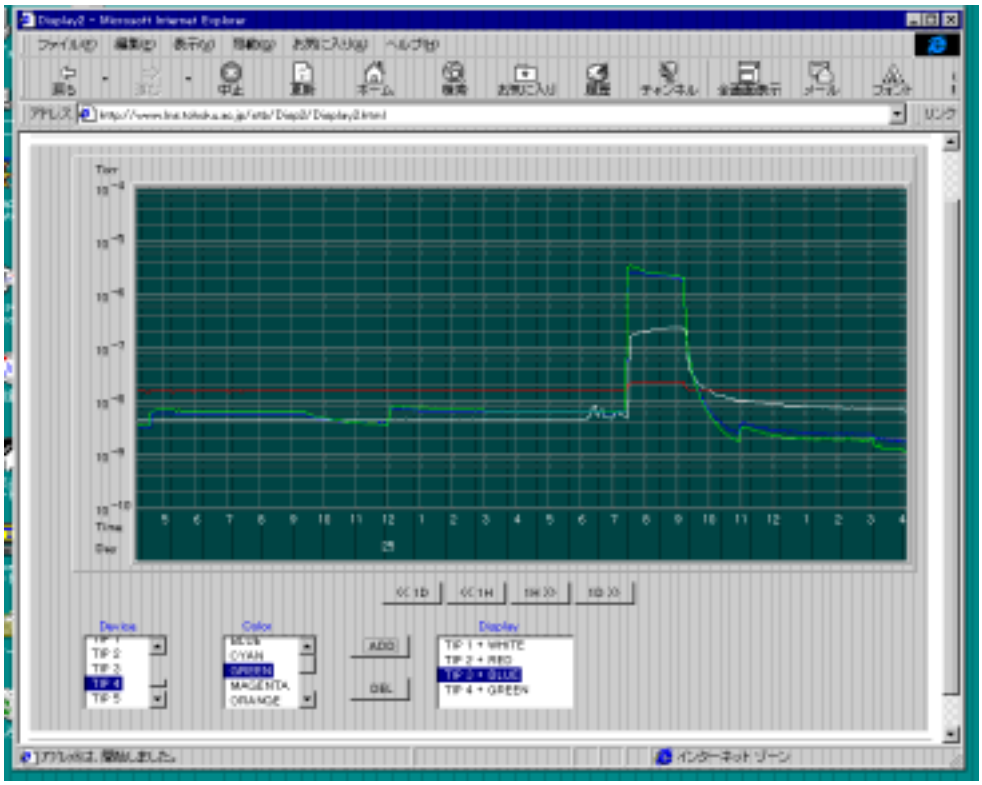

Figure 2: Past record of vacuum pressure in the STB.

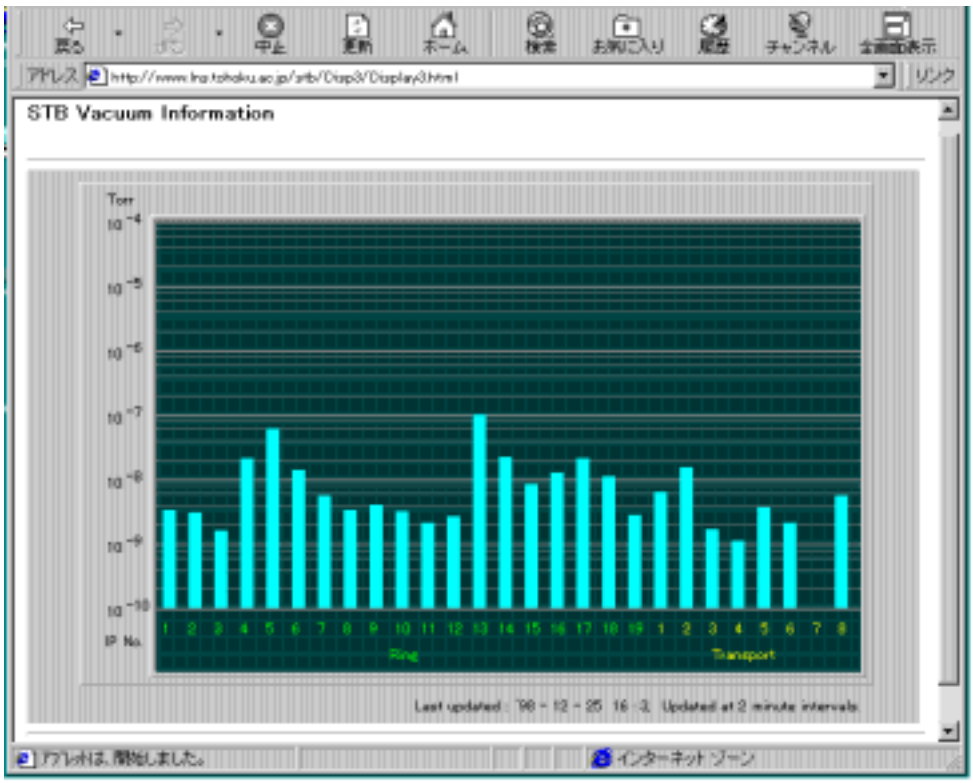

Figure 3: Distribution map of vacuum pressure in the STB.