OPERATION LOGGING SYSTEM USING THE DATABASE FOR THE SYNCHROTRON RADIATION BEAM LINES AT THE PHOTON FACTORY

Noriichi KANAYA, Seiji ASAOKA and Hideki MAEZAWA

Photon Factory
High Energy Accelerator Research Organization (KEK)
1-1, Oho, Tsukuba, 305, Japan

Abstract

The operation Logging System has been designed and built using the Oracle database for the twenty-two synchrotron radiation beam lines at the 2.5 GeV positron storage ring at the Photon Factory, where X-ray/VUV synchrotron radiation experiments are simultaneously carried out. The operation Logging System has a real-time capability to automatically store the database with all possible operational events of all vacuum valves/shutters and interlock signals, and all static operational data, including the pressures of the beam lines and the storage ring, and related operational data which represent the physical behaviors of the beam lines. By retrieving any combination of operational data, the system allows to reproduce the physical behaviors that have occurred in the beam lines.

1 INTRODUCTION

There are twenty-two synchrotron radiation beam lines at the 2.5-GeV positron storage ring, Photon Factory at the National Laboratory for High Energy Physics. These beam lines feed synchrotron radiation to the experimental hall where experiments such as surface physics, x-ray lithography, microscopy and crystal structure analysis are simultaneously carried out. These beam lines are simultaneously in operation, providing intense synchrotron radiation beams.

These beam lines are automatically controlled by the twenty-two computers connected to a VAX Station 4000/90, running under VAX/VMS, through an optical-fiber network with a star configuration [1]. The host collects all operational data and control data of the beam lines. The operational and control data have been automatically stored in the logging file system to retrieve later specific combinations of behaviors of beam line components.

There have been further necessities to allow clients, such as the staff of the Beam Line Group or operators of the storage ring at the Photon Factory, to retrieve any combinations of control data for the beam lines. A new logging system has thus been designed and implemented using the Oracle database. The Logging System for the synchrotron radiation beam lines has a real time capability to fetch any event real our experience with the Logging System based on the database for the synchrotron radiation beam lines at the Photon Factory.

2 SYSTEM DESCRIPTION

It is crucial for the Beam Line Group to be capable of improving the performance of the beam lines by using the Logging System. In addition, they must be capable of identifying later when, how, what, where and which device was controlled in order to predict any sign that suggests any presence of malfunctioning behavior of a beam line component beforehand. When a beam line component is unexpectedly malfunctioning, the Logging System must provide play-back control-information that leads to a swift recovery of the problem with the component. This is also true for predictive maintenance; for example, the Beam Line Group monitors the closing/ opening times of more than ninety vacuum valves at an accuracy of 0.1 seconds or less are ranging within ordinal closing/opening times every day in order to ensure the safety of synchrotron radiation experiments. For these reasons, all control data, including the operational status of the beam lines to be controlled and the set-up values for the beam lines, have to be automatically logged into the on-line Logging System being incorporated with the Beam Line Control System [1]. For a large accelerator, a logging system using a database has been also in operation[2].

Each beam line has a number of components and sensors to be controlled, including vacuum valves, interlock devices (Cooling water flow sensor, fast/slow vacuum sensors, pneumatic-pressure sensor, atmosphere sensor, Open-Request signal from the storage ring, and from the experimental hall), vacuum pressure gauges of the storage ring and the beam lines, valve driving units). These components are controlled and monitored by a computer of the beam line control system.

There are two categories of data available from the beam line control system: event data and static data. Each dada has a time stamp with an accuracy of 20 ms. The first category includes "asynchronous event data". The event data are obtained from digital ON/OFF signals generated by the vacuum valves, shutters together with time-stamps. Event data also include driving signals for controlling these vacuum valves and shutters, and the status signals of safety

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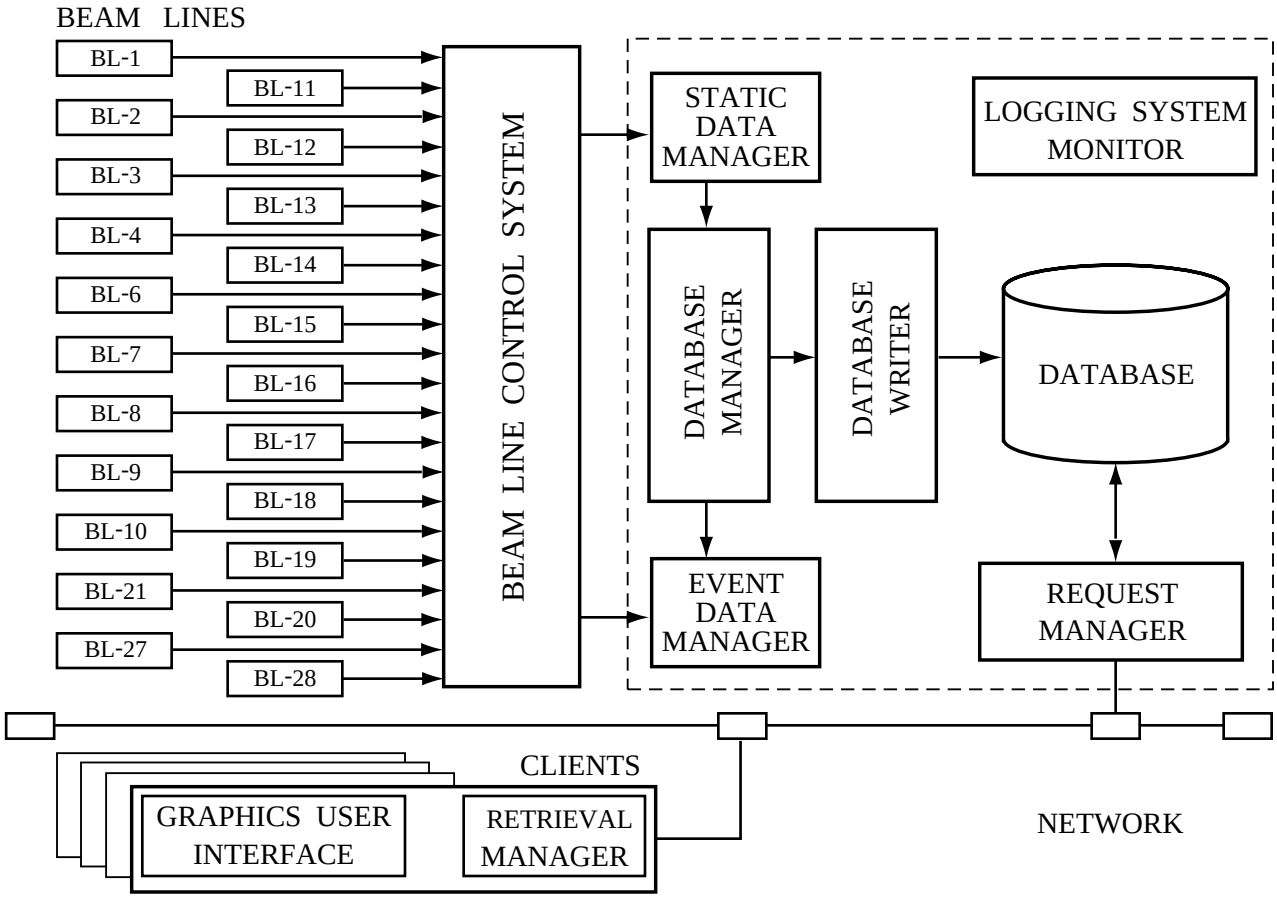

Figure: 1 Block diagram of the Operation Logging System for Synchrotron Radiation Beam Lines at the Photon Fctory, KEK.

interlock signals. Event type of data are obtained at any instance of time when a component changes its status; for example, when a valve opens it simultaneously generates 'status-open-on' signal and 'status-close-off' signals. There are approximately 2000 pick-ups in total. The maximum event rate typically occurs at 9 AM every morning when all beam lines have to simultaneously close/open due to radiation safety reason before and after a beam injection, generating a number of event signals. The maximum rate of event signals reaches ~300 events/sec. This also happens when one of the interlocks is triggered in the case that an unexpected failure occurs [3]. It is very important for the Logging System not to miss any event signal.

The second category includes static analogue data: static data comprises analogue data that are periodically measured at a specified interval ranging from 3 seconds to one minute. The static data includes a beam current of the storage ring, pressures signals which are measured at the middle point of the beam line and the storage ring at an interval of three seconds. These should be stored in the Logging System. The total amount data to be logged into the database reaches approximately 35 million items, consuming 1.5 GB of disk space per year.

Figure 1 shows a block diagram of the operation Logging System. When an operational condition changes or when the status of a device changes, the beam line control

system automatically notifies event data representing the device status of the Event manager running on the VAXStation 4000/90 (~30MIPS, 80 MB of memory). The VAX has two 2GB disks for the system, database management, user applications, and a 4.5GB-disk for storing only operational data of the beam lines, allowing at least three years of data to be on-line.

Upon receiving event data, the Event Manager attaches a time stamp to the event data, and makes compliance checks in terms of validity of the event data that contains a device code and condition status code. If the event data have valid codes, the Event manager forwards the event data to the Database Manager.

The Static Data Manager fetches static data at specified time intervals associated with the devices to be measured. The Static Data Manager attaches a time stamp and device code to the measured value, and then sends it to the Database Manager. The Database Manager specifies a data-table name to which event data/static data is stored, depending on the event data code and condition status code. Then, the Database Manager sends a set of data to the Database Writer that stores the data to the specified table in the database. Data tables and index tables in the on-line database are separately assigned for each set of valves and interlocks, pressures and a beam current. All operational data stored in the database are archived for at least three years.

A Graphics Interface for operators is a client on the network which is implemented using Motif widgets on a VAX/Station 4000/90. An operator can choose any items associated with devices to be searched. The Retrieval Manager encapsulates these items into a packet, and queries the Logging System across the network. Then the Retrieval Manager receives reply from the database through the Requet Manager, transfering the reply to the Graphics User Interface to display the results.

3 CONCLUSION

The Logging System using database for the synchrotron radiation beam lines at KEK was designed and implemented in the late 1994, and come into actual operation in the beginning of 1995 to replace the existing logging file system. The Logging System based on the database has been reliably operating for several years, providing better performance than the ancestor logging file system, even to the degree of acquiring real-time event operational data from the beam lines. The Logging System provides a means to improve the performance of the beam lines[4], and is useful for determining the cause of a problem in a beam line.

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