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# THE DEVELOPMENT OF VACUUM GAUGE MONITORING AND CONTROL SYSTEM USING Web2cToolkit

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## Abstract

The Photon Factory is an accelerator-based light source facility that is a part of the High Energy Accelerator Research Organization (KEK) in Japan. At the Photon Factory, a message transferring software named Simple Transmission and Retrieval System (STARS) is used for beamline control. STARS is suitable for small scale remote-control systems using TCP/IP sockets and works with various types of operating systems.

STARS is applicable to various control systems; we developed the vacuum gauge monitoring and control system with STARS in this work.

Web2cToolkit is a framework developed by Deutsches Elektronen Synchrotron (DESY) that provides a user-friendly human machine interface, and developers can easily create web-based graphical user interfaces (GUIs) with Web2cToolkit.

Web2cToolkit supports various types of protocols (e.g., TINE, DOOCS, EPICS, TANGO), including the STARS protocol. We adopt Web2cToolkit as a framework for a front-end GUI application of our vacuum gauge monitoring and control system. Although the application development is still in progress, some features have already been implemented.

## OVERVIEW OF STARS

Simple transmission and retrieval system (STARS) [1] is composed of at least one server program “STARS server” and one client program “STARS client”. Each STARS client is connected to the STARS server through a unique node name and handles text-based messages through a TCP/IP socket (Fig. 1).

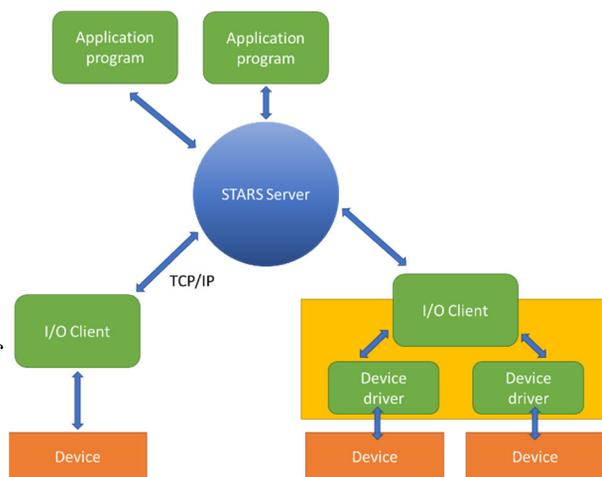


Figure 1: Communication between STARS clients and a STARS server.

The STARS server program is written in Perl. Therefore, it can be executed on different operating systems, such as Windows, MacOS, and Linux. STARS has been introduced as a beamline control system in more than 20 beamlines of the Photon Factory. In addition, an interface program of the beamline interlock systems has been developed using the STARS software.

## VACUUM GAUGE CONTROLLER

A large number of vacuum gauges, exceeding 300, are installed in the beamlines at the Photon Factory. These vacuum gauges are connected to various types of controllers that monitor the degree of vacuum of the beamlines. Each controller has a relay output port that either completes or disrupts an electric circuit according to the degree of vacuum, and this port is used for the beamline interlock system. The vacuum environment of the beamlines at the Photon Factory is managed by this beamline interlock system (Fig. 2). The thresholds for these relays can be configured using the switches on the front panels of the controllers or through their respective computer interfaces.

Most of the vacuum controllers have computer interfaces for monitoring the degree of vacuum and operating the controller. Data can be obtained or set through these interfaces and include the following:

- Getting the current value of vacuum;
- Turning the sensor device on or off;
- Setting and Getting the thresholds of the relay output function.

The interface of each vacuum controller has similar functions; however, the different types of communication protocols depend on hardware type or manufacturer.

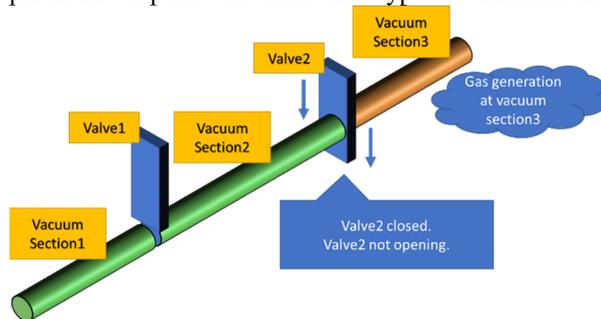


Figure 2: Beamline interlock system and vacuum monitoring.

## VACUUM MONITORING SYSTEM

The beamline interlock system uses only the relay output functions; therefore, it is impossible to protect the beamline before a vacuum hazard occurs. The vacuum hazard will interrupt all experiments via leaked synchrotron

radiation, so it is important to detect abnormal situations even if the changes may be insignificant. A vacuum data monitoring system has many benefits, such as prediction of vacuum-related issues of the beamline components.

Therefore, we developed the vacuum monitoring and data logging system shown in Fig. 3. We installed STARS on the vacuum gauge monitoring system, and all vacuum gauge controllers were connected to the STARS server through a TCP/IP socket with a serial interface device server.

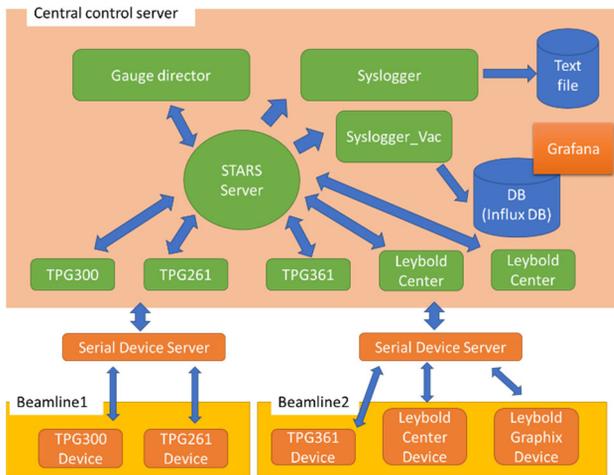


Figure 3: Vacuum monitoring system.

To transmit and receive messages between each vacuum gauge controller and the STARS server, a client software was developed, and the following client program was installed on each vacuum gauge controller (Table 1). Each client software instance has a unique identifier that consists of the beamline and gauge controller names (e.g., “bl1gal,” where “bl1” is the beamline name and “gal” is the gauge controller name).

Table 1: List of Vacuum Gauge Controllers Used in Photon Factory

Controller Type	Computer Interface	Manufacturer
TPG300	RS-232C	Pfeiffer Vacuum, GmbH
TPG261	RS-232C	Pfeiffer Vacuum, GmbH
TPG361/362	USB	Pfeiffer Vacuum, GmbH
Canter series	RS-232C	Leybold Vacuum, GmbH
Graphix series	RS-232C	Leybold Vacuum, GmbH

## DEVELOPMENT OF SOFTWARE

We developed individual STARS client software for the gauge monitoring system, and each client software has different functions, which are described below.

## Vacuum Gauge Control Client

Typically, the original commands of the vacuum gauge controller are not compatible for another type of controller. This is inconvenient for developers because the software requires modification in accordance with the type of controller. To resolve this problem, the client software has command converters between the original commands and the unified commands, which are defined for other STARS client softwares. For example, some common unified commands are as follows: “Get-Value,” “SetSFunction,” “GetSwFunction,” “SPS,” and so on. Using these commands, we can obtain information such as vacuum data, device setting data, and device condition.

## Gauge Director Client and Data Logger Client

A gauge director client automatically sends commands according to the configuration file, similar to the Cron utility in a Unix system. The configuration parameters are the sending interval, transmission command, and target node name. The gauge director client sends the “GetValue” command to all vacuum gauge control clients every 30 s in our vacuum monitoring system. The data logger client creates a log file for all STARS communication messages, including vacuum information, and sends the log data to an external database server. The log file is a text-based archive, and InfluxDB is used as the external database system.

## Graphical Interface

Grafana is an open source software for data visualization. We adapted Grafana to visualize vacuum logging data, which are recorded in the InfluxDB server. The log viewing interface is called “Dashboard” and can be easily edited on using a web-browser. Grafana has different kinds of graphical components such as graphs, tables, and so on. We used a graph component to display the time variation of the degree of vacuum in the beamlines (Fig. 4).



Figure 4: Example of “Dashboard” created with Grafana.

## STARS FOR WEB2C

The Web2c viewer is a configurable, browser based, dynamic, and bidirectional internet application for live displays (Fig. 5).

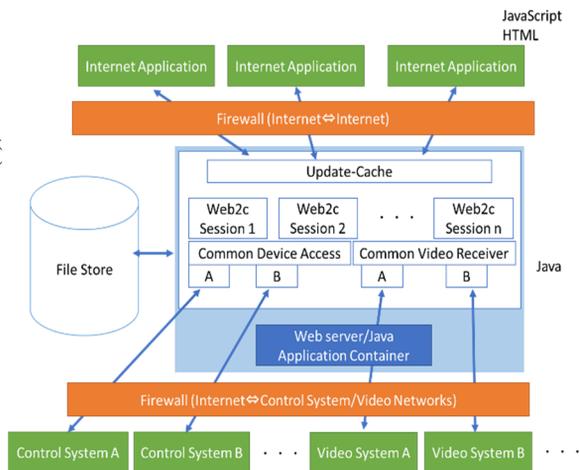


Figure 5: Web2c viewer.

Each application page is easily created using the Web2c viewer wizard or by directly editing the XML file. We created the application page to obtain the information from the beamline vacuum gauge controller using Web2c viewer wizard. The application page consists of various components listed in a corresponding configuration file [2]. The properties of the components are tooltip text, font size, arrangement, signal source URI, and so on. We used the “Web2cViewerText” viewer component in this case (Fig. 6). Currently, only a few Web2c viewer components are available on STARS. For example, “Web2cViewerButton,” “Web2cViewerLabel,” and “Web2cViewerText.”

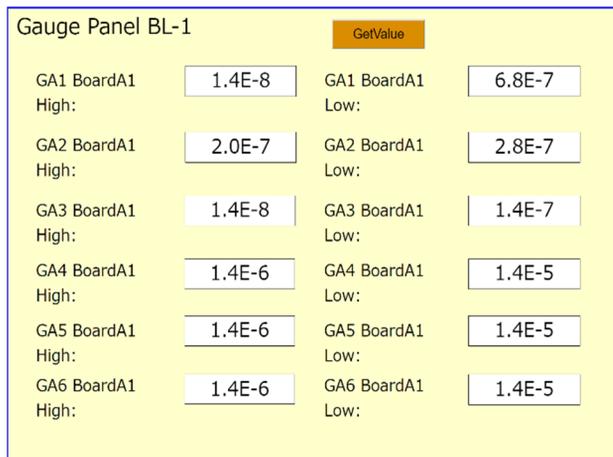


Figure 6: Web2c application page for the vacuum gauge controller.

In Fig. 6, the threshold values of the relay function of the vacuum gauge controller, which is obtained through STARS, are displayed in the text box. When the “Get-Value” button is pressed, the threshold values are updated to present values. The Web2c application communicates with STARS via the “STARS proxy.” The STARS proxy is the communication protocol between Web2c and the STARS client, and it converts the Web2c message to the STARS message of the gauge controller client. Both Web2c application and STARS proxy are connected to the STARS server as a STARS client (Fig. 7).

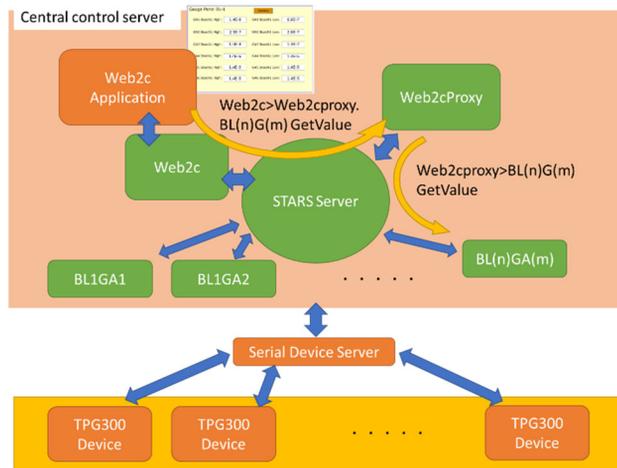


Figure 7: STARS server for Web2c.

## CONCLUSION

We constructed a vacuum monitoring system in conjunction with STARS and Web2c. This system supports various types of vacuum gauge controllers. These vacuum gauge controllers connect to the STARS server through a TCP/IP socket and have a unified command system. The vacuum data thus recorded can be displayed using graphs on a web browser. Web2c is a browser-based internet application that can obtain the threshold of a vacuum gauge controller through STARS. We are refining the STARS client program, which is associated with the Web2c framework, and intend to advance the development of other Web2c viewer components through STARS.

## REFERENCES

- [1] STARS, <http://stars.kek.jp>
- [2] Web2c Toolkit Framework for Web-based Controls Clients, [http://adweb.desy.de/mcs/web2cToolkit/web2c\\_home.htm](http://adweb.desy.de/mcs/web2cToolkit/web2c_home.htm)

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