

# DEVELOPMENT AND APPLICATION OF THE STARS-BASED BEAMLINE CONTROL SYSTEM AND SOFTWARE AT THE KEK PHOTON FACTORY

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## Abstract

The Simple Transmission and Retrieval System (STARS) [1] is a message transferring software for small-scale control systems, originally developed at the Photon Factory (PF). It has a server-client architecture using TCP/IP sockets and can work on various types of operating systems. Since the PF adopted the STARS as a common beamline control software, we have developed a beamline control system that controls optical devices such as mirrors and monochrometers. We also developed various systems and software, such as the information delivery system of the PF ring status based on the STARS and Three-fold Integrated Networking Environment (TINE) [2], and measurement software based on the STARS, for the PF beamlines. Currently, many useful STARS applications are available, such as device clients, simple data acquisition, and user interfaces. We will describe the development and installation status of the STARS-based beamline system and software.

## OVERVIEW OF STARS

The Simple Transmission and Retrieval System (STARS) consists of a server program, the *STARS server*, and client programs, the *STARS clients*. Each client is connected to the STARS server through a TCP/IP socket, and it communicates via text-based messages. Each client program has its own unique node name, and it sends text-based messages using the destination node name to the server, which then delivers the messages to the destination client. A STARS server, which is written in Perl, can run on various operating systems. STARS users can upgrade the system by writing client programs, and STARS clients can participate in the system at any time without system stoppage.

## STARS MESSAGE STANDARDIZATION

Originally, the STARS had the following simple rules for messages:

- A message that starts with “@” (e.g., @message) is a reply to a command.
- A message that starts with “\_” (e.g., \_message) is an event.
- Any other type of message is a command.

For adopting the STARS as a common beamline control software, moreover, we standardize the STARS messages that control the device components including such as mirrors and monochrometers. Table 1 shows commonly used standardized STARS messages.

Table 1: Commonly used Standardized STARS Messages

“GetValue”	STARS command to get the target value.
“SetValue”	STARS command to change the target value.
“IsBusy”	STARS command to get the moving status of the target.
“_ChangedIsBusy”	STARS event to notify the change in moving status of the target.
“_ChangedValue”	STARS event to notify the change in the target value.

The standardization of STARS messages enables reusable beamline control programs and software to be developed. In addition, this standardization allows anyone using the same message format to control these baseline programs and software.

Further, the standardization of STARS messages reduces developmental costs associated with the creation of control programs; moreover, it enables beamline users to develop their own control programs.

## BEAMLINE CONTROL USING STARS

### Installation Status

Since the Photon Factory (PF) adopted the STARS, a common beamline control software, the development and installation of STARS-based beamline control systems have been increasing every year. Recently, more than 30 beamlines have introduced STARS-based beamline control systems (see Table 2).

Table 2: Installation Status of STARS-based Beamline Control Systems (October 2014)

Category	Installed beamline
2.5 GeV Ring X-ray	BL-1A, BL-3A, BL-4B2, BL-4C, BL-5A, BL-6A, BL-6C, BL-7C, BL-8A, BL-8B, BL-9A, BL-9C, BL-10C, BL-12C, BL-14A, BL-15, BL-17A, BL-18B, BL-18C
PF-2.5 GeV Ring VUV and Soft X-ray	BL-2, BL-11A, BL-11B, BL-11D, BL-13A/B, BL-16A, BL-20A, BL- 28
PF-AR	NE1A, NE3A, NE7A, NW2A,

	NW10A, NW12A, NW14A
Other	Slow Positron Facility (SPF-A, SPF-B)

In addition installation of STARS-based beamline control system for BL-3B and BL-3C are in progress.

### System Configuration

Figure 1 is an example of an actual STARS-based beamline control system. The figure shows an operational STARS server, with several STARS clients connected to this server on the same computer. A STARS-based system can be distributed on multiple computers that are connected by a network; the system layout should be selected on a case-by-case basis, depending on a number of factors such as scale, requirements, and budget.

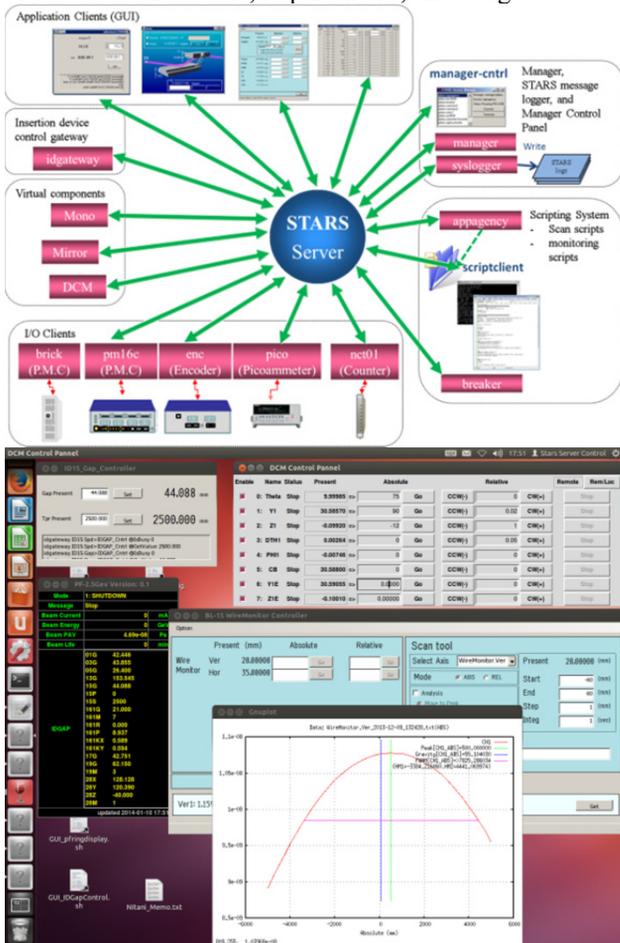


Figure 1: A beamline control system with a STARS and screenshots of the control GUIs.

### Insertion Device Control Software

For each undulator beamline, the undulator gateway server is prepared by the PF Ring and PF-Advanced Ring (AR) control groups. By connecting the gateway server via a TCP socket, we can remotely control the modification of undulator parameters such as the gap and mode. In order to facilitate modification of the undulator parameters at each beamline control system, we provide

STARS-based insertion device control programs. (See Fig. 2)

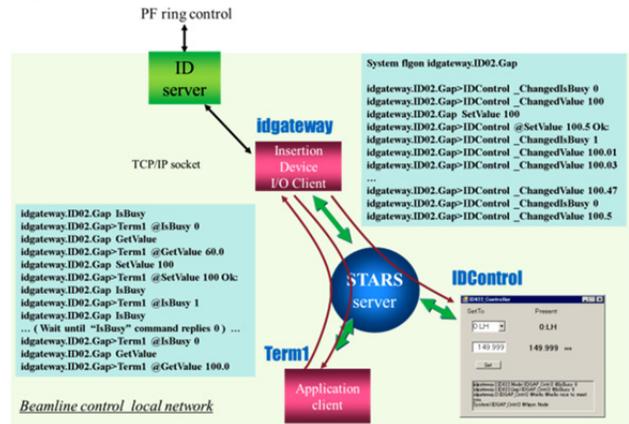


Figure 2: Insertion device control software. Any STARS clients connected to the STARS server, including the user programs, can obtain the values of the ID's properties.

### PF Ring Information Delivery System

The PF Ring information delivery system was first developed in 2006 using TINE and STARS. [3] PF ring properties such as beam current, lifetime, operation mode, and gap of undulator can be referred on a STARS-based beamline control system. The system consists of a TINE server, which obtains the PF ring properties; a TINE and STARS bridge client, which receives the PF ring properties from the TINE server and provides these properties to the STARS; and a display client of the STARS.

The TINE server is on the KEK internal network, and the PC that the TINE and STARS bridge client runs has two NICs: one is connected to the KEK internal network and another is connected to the beamline control local network. The display client can run on any PC on the beamline control local network. The PF ring information can be delivered from the TINE server to the TINE client by using the multi-cast function of TINE. The PF has installed the system on several beamlines. (See Fig. 3)

### Experiment and Measurement Software

As the use of the STARS-based beamline control system at KEK PF has increased, the software requirements for conducting experiments have also increased. For example, changes in the beamline component's properties, such as the energy and undulator gap values, then measure the experimental data.

As an example of experiment and measurement software, we developed the detector "PILATUS" (DECTRIS) control software and image monitoring software (See Fig. 4) for the KEK PF SAXS beamlines in 2012; it was successfully implemented. The programs are written in Perl and C# and the software requires a Perl and .NET 3.5 environment. The software can run on a single computer, and is portable. It has been installed on the other beamlines equipped with the "PILATUS" detector.

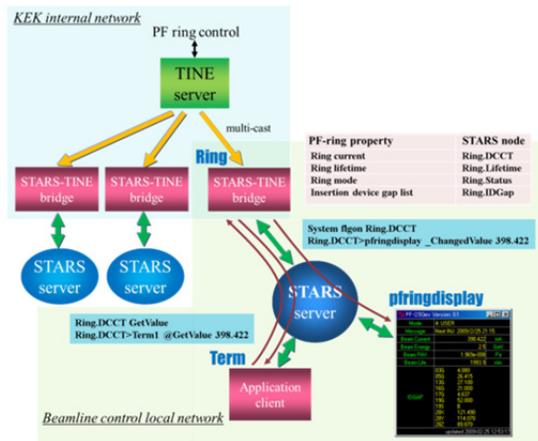


Figure 3: PF-Ring information delivery system. Any STARS clients connected to STARS servers, including the user programs, can obtain the values of PF ring properties.

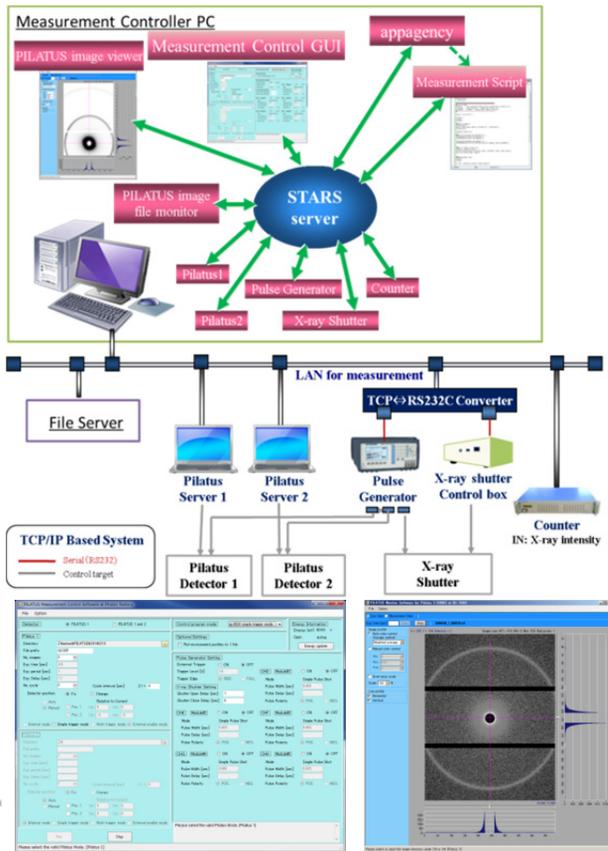


Figure 4: System configuration and screenshots of PILATUS control software and image viewer.

**RECENT DEVELOPMENT**

We introduce the two STARS I/O clients—a client for detector “PILATUS” and a client for a motion controller “Brick Controller”.

*STARS I/O Client for Detector “PILATUS”*

This client program was developed in 2012. It is written in Perl, and it has been steadily running since its

implementation. It supports all types of start modes and allows monitoring of the detector status—whether it is in the transaction stage. It has been already used to control the detectors “PILATUS-100K”, “PILATUS-300K”, “PILATUS3-300KW”, “PILATUS3-1M”, and “PILATUS3-2M”.

*STARS I/O Client for Motion Controller “Brick Controller”*

The motion controller brick controller (DELTA TAU), was newly installed in 2013 to control two-crystal monochrometers on BL-2 and BL-15.

We developed the STARS I/O client program for brick controller using Perl. It provides commands to control a single axis, and the STARS command “SendRawCommand” is prepared to send a device’s raw command directly. This program has been under test since the autumn of 2013, and will be ready for use by the autumn of 2014. (See Fig. 5)

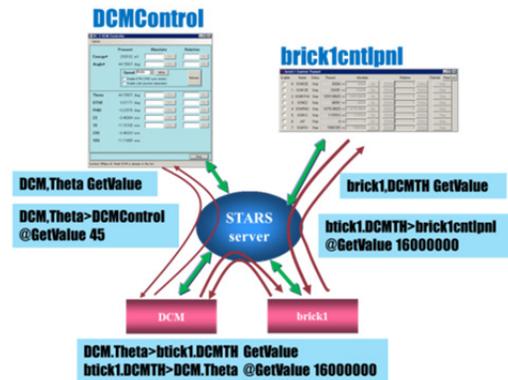


Figure 5: STARS-based Perl program code to control the brick controller.

“brick1” is a STARS I/O client of brick controller. We also made a virtual component client of monochrometer named “DCM”. It reads the brick controller’s values from “brick1” then it calculates the values of monochrometer properties.

**CONCLUSION**

The STARS is a highly flexible and powerful system for the development of small to middle-scale control systems. We have developed many types of STARS programs and beamline control software for beamlines; basic control functions for beamlines will soon be available. As the next step, we will focus on more integrated beamline control systems, such as databases and job control systems. We maintain development and support of STARS-based beamline control systems at the KEK PF.

**REFERENCES**

- [1] STARS website: <http://stars.kek.jp>
- [2] TINE website: <http://tine.desy.de>
- [3] T. Kosuge et al., “The Interconnection of TINE and STARS”, PCaPAC’06, Newport News, USA (2006).